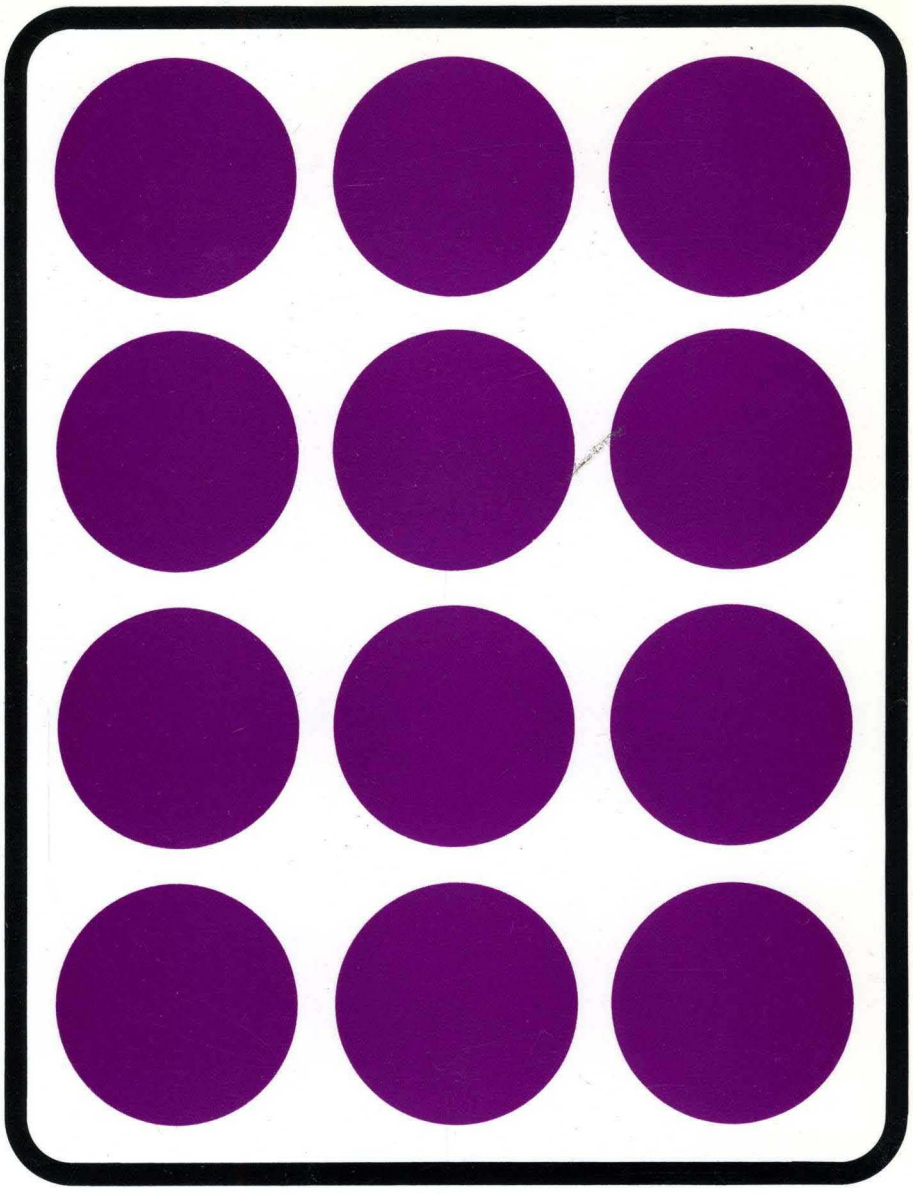
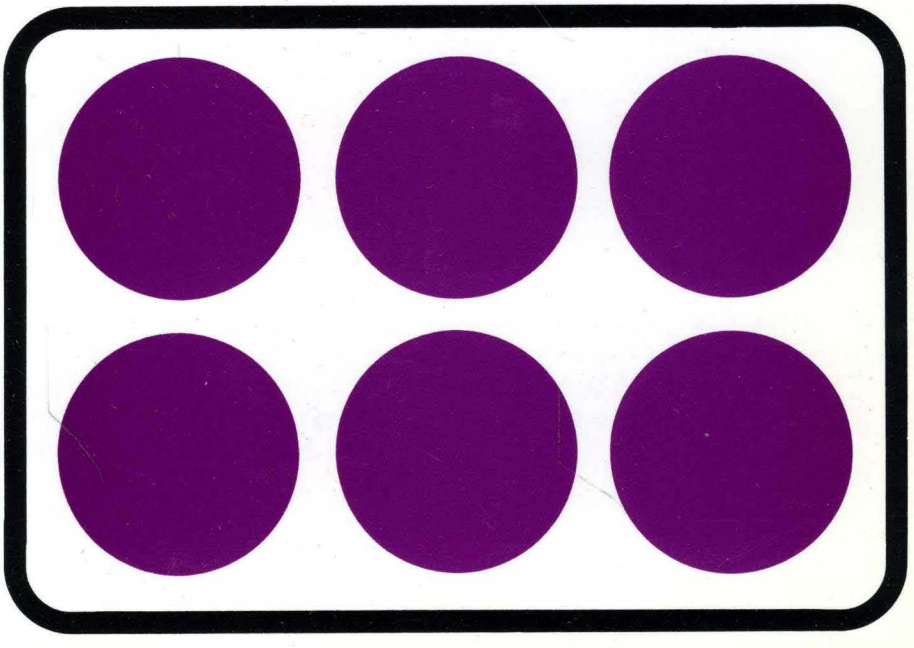


1995 DISK/TREND® REPORT



DISK DRIVE ARRAYS

1995 DISK/TREND® REPORT

DISK DRIVE ARRAYS

April, 1995

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FOREWORD

DISK/TREND's report on disk drive arrays is now in its third year, and this segment of the computer industry is still in its early high-growth phase. Despite the disappearance of several participating companies during the last year, the number of manufacturers active in the disk drive array business continues to expand. In 1993, the first year of the DISK/TREND Report on arrays, we identified 100 companies active in manufacturing array products and/or complete assemblies. Last year, the total grew to 154, and this year the count is 179.

The reason we go to the considerable effort required to cover 179 companies is our desire to make the report as complete as possible, both in identifying all companies which are originating array products and in describing the size and nature of the industry. We believe that it is necessary to be thoroughly familiar with all aspects of an industry changing as rapidly as disk drive arrays, in order to adequately describe the key trends accurately. We are now in the 19th year of the DISK/TREND Report, a period long enough to live through numerous generations of disk drives -- and a background very helpful in understanding many of the changes now under way in the disk drive array business.

We are always willing to help you at any time by providing additional information on the industry which we may have available. Your suggestions for improvements in the DISK/TREND Report are always welcome and are sincerely appreciated.

James N. Porter

Robert H. Katzive

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Note: All trademarks mentioned within this report are the property of their owners.

INTRODUCTION

Defining the language. The product groups, types of products, market classes, and geographical classifications used in this report have been defined very carefully in the *DISK/TREND array definitions* at the end of the opening summary section. Individual terms used in describing disk drives and arrays have been defined in the *Glossary* section. We suggest you refer to both, as needed.

Pricing levels can be confusing. As in all DISK/TREND Reports, we report revenues for the sale of array products at the level of the first public sale, at the estimated net transaction price, whether the sale occurs at the captive, PCM/Reseller or OEM/Integrator level -- to accurately record the value of the business to the original seller. You may find it helpful to refer to the tables in each product section which display the average unit price, broken down by each of the market channels and by each of the types of arrays. In addition to assisting many users in specific analyses, it is hoped that this information will be useful to many readers in understanding the relative price levels of captive, PCM/Reseller and OEM/Integrator array sales revenues, which is important in interpreting DISK/TREND revenue statistics.

Array system considerations. If you lack experience with arrays, you will find this nontechnical review useful in understanding what arrays are, the product variations in which they are offered, and when it makes sense to use them. If you are going through the process of deciding whether or not to use a disk drive array, the checklist on system selection and integration is a must, to make sure you cover all the bases. Even if you have experience in the array field, you may find this section of the report helpful.

Next year we're in the chips. The DISK/TREND Report on arrays has included, during its three year history, all types of disk drive arrays sold as finished products -- complete subsystems, board-level controllers and software products. We have not included array capabilities incorporated into computer operating systems, nor have we included chip sets intended to be used in manufacturing array controllers. However, the single chip array controllers expected to enter the market next year may significantly change the array market and make it appropriate to include them in future editions. We will be watching developments, and if warranted, will include coverage of single chip array controllers next year.

DISK/TREND ON DISK. The statistical and specification tables are available on floppy disks, as a separately purchased option to buyers of this report. For easy reference, instructions are included in the last section of this report.

SUMMARY: DISK DRIVE ARRAYS

Industry size

1994 was another year of rapid growth for disk drive arrays. Worldwide sales revenues were $5.7 billion, up 67.2%. The DISK/TREND forecast for 1998 revenues is more than $13.1 billion, an average annual increase during the 1995-98 period of 23.3%. Unit shipments are projected to increase at a higher rate during the same period, from 403,788 arrays in 1994 to 1,166,028 in 1998, an average annual increase of 30.6%.

Captive array sales by a broad range of manufacturers of personal computers, midrange computers and supercomputers produced 59.1% of the 1994 worldwide revenue for all arrays, a total of almost $3.4 billion. The 1998 captive sales revenue total is forecasted to rise to more than $8.3 billion, 63.6% of the overall array total. Revenues for arrays sold through captive channels will increase at a somewhat faster rate than for noncaptive arrays due to a greater emphasis on fully redundant complete subsystems, sold for relatively high prices.

The PCM/Reseller channel dominates noncaptive array sales. The 1994 PCM/Reseller revenues of $1.9 billion were 33.9% of the overall array total, but despite growth to $3.6 billion in 1998 revenues, the overall share of array total revenues for this channel is expected to decline to 27.8%, as the slow-down of high value subsystems shipments for the mainframe plug compatible market inhibits growth. OEM/Integrator sales, although smaller in revenue, are expected to maintain a faster growth rate, averaging 30.3% annual increases in the 1995-98 period, with total OEM/Integrator revenues reaching $1.1 billion in 1998.

The largest DISK/TREND array product group continues to be network/minicomputer/multiuser arrays, and the group's share of overall array sales revenues is forecasted to increase from 66.6% in 1994 to 78.1% in 1998. With the 1994 entry by IBM and others into the mainframe array market, the mainframe array sales revenue share is expected to increase through 1996, but will drop to 20.9% in 1998, depressed by lower disk drive prices.

Continued revenue growth is expected for complete subsystem and software array products through 1998, but board revenues are expected to start declining in 1998, as single chip array controllers divert sales from board-level controllers.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

DISK DRIVE ARRAYS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994		Forecast							
	Revenues		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1,771.8	3,345.1	2,486.3	4,544.7	3,076.8	5,521.7	3,688.4	6,874.4	4,217.3	8,159.9
PCM/Reseller	1,003.1	1,685.2	1,398.5	2,213.9	1,693.2	2,688.5	1,840.9	2,919.1	1,993.1	3,176.7
OEM/Integrator	226.2	390.2	296.1	454.1	400.8	604.8	462.9	702.1	510.3	784.8
TOTAL U.S. REVENUES	3,001.1	5,420.5	4,180.9	7,212.7	5,170.8	8,815.0	5,992.2	10,495.6	6,720.7	12,121.4
Non-U.S. Manufacturers										
Captive	--	47.2	--	89.9	.3	140.3	1.3	191.6	2.0	207.2
PCM/Reseller	156.6	263.6	198.6	339.7	237.9	405.7	282.5	481.5	280.9	480.8
OEM/Integrator	4.9	13.3	101.5	133.7	165.6	220.2	217.4	291.7	260.7	353.1
TOTAL NON-U.S. REVENUES	161.5	324.1	300.1	563.3	403.8	766.2	501.2	964.8	543.6	1,041.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	3,162.6	5,744.6	4,481.0	7,776.0	5,574.6	9,581.2	6,493.4	11,460.4	7,264.3	13,162.5

Marketing channels

Sales revenue leadership in the disk drive array industry is held by computer system manufacturers which market internally produced arrays on a captive basis, and those manufacturers are expected to retain leadership through 1998. Internally developed arrays are being sold with their own systems as captive products by many types of system manufacturers, including supercomputer manufacturers such as Cray Research and Thinking Machines, midrange system manufacturers such as Digital Equipment, Tandem Computers, Hewlett-Packard and Data General, and by personal computer manufacturers such as Compaq Computer and Dell Computer. Captive arrays of all kinds held 59.1.% of the 1994 worldwide sales revenue total, and despite the substantial growth projected for noncaptive array manufacturers, sales revenues for the captive sales channel are expected to increase slightly to 63.6% in 1998, reaching more than $8.3 billion.

Nevertheless, the young disk drive array industry has seen enthusiastic missionary selling campaigns sponsored by the numerous noncaptive, independent manufacturers of controllers and other data storage peripherals which have entered the disk drive array business, with a full range of complete subsystems, boards and software products.

Noncaptive array sales are dominated by the PCM/Reseller channel which starts the five year span of this report with 33.9% of all array sales revenues, but is projected to decline to 27.8% in 1998, with $3.6 billion. 73.2% of 1994's PCM/Reseller sales revenues were derived from mainframe arrays, but arrays for the mainframe market are forecasted to decline to only 47.9% of the 1998 PCM/Reseller revenue total, depressed by falling disk drive prices. Arrays for networks/minicomputer/multiuser applications will provide the major growth in PCM/Reseller sales, rising to 49.9% of the 1998 revenue total.

179 array manufacturers are identified in this report, 147 of which are headquartered in the United States, and these manufacturers produced over 94% of 1994's worldwide array revenues. Despite the fact that the U.S. is less than 60% of the worldwide array market, the product development and sales momentum already attained is expected to make it possible for U.S. companies to hold more than a 90% share of the worldwide disk drive array market through 1998.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1994 Revenues $M	1994 Revenues %	1995 Forecast $M	1995 Forecast %	1996 Forecast $M	1996 Forecast %	1997 Forecast $M	1997 Forecast %	1998 Forecast $M	1998 Forecast %
U.S. Manufacturers										
Captive	3,345.1	58.2%	4,544.7	58.3%	5,521.7	57.5%	6,874.4	59.9%	8,159.9	61.9%
	+63.1%		+35.9%		+21.5%		+24.5%		+18.7%	
PCM/Reseller	1,685.2	29.3%	2,213.9	28.4%	2,688.5	28.0%	2,919.1	25.4%	3,176.7	24.1%
	+79.8%		+31.4%		+21.4%		+8.6%		+8.8%	
OEM/Integrator	390.2	6.7%	454.1	5.8%	604.8	6.3%	702.1	6.1%	784.8	5.9%
	+136.2%		+16.4%		+33.2%		+16.1%		+11.8%	
Total U.S. Manufacturers	5,420.5	94.2%	7,212.7	92.5%	8,815.0	91.8%	10,495.6	91.4%	12,121.4	91.9%
	+71.9%		+33.1%		+22.2%		+19.1%		+15.5%	
Non-U.S. Manufacturers										
Captive	47.2	.8%	89.9	1.1%	140.3	1.4%	191.6	1.6%	207.2	1.5%
	+32.6%		+90.5%		+56.1%		+36.6%		+8.1%	
PCM/Reseller	263.6	4.5%	339.7	4.3%	405.7	4.2%	481.5	4.2%	480.8	3.6%
	+15.5%		+28.9%		+19.4%		+18.7%		--	
OEM/Integrator	13.3	.5%	133.7	2.1%	220.2	2.6%	291.7	2.8%	353.1	3.0%
	-29.3%		+905.3%		+64.7%		+32.5%		+21.0%	
Total Non-U.S. Manufacturers	324.1	5.8%	563.3	7.5%	766.2	8.2%	964.8	8.6%	1,041.1	8.1%
	+14.7%		+73.8%		+36.0%		+25.9%		+7.9%	
Worldwide Recap										
Captive	3,392.3	59.1%	4,634.6	59.6%	5,662.0	59.1%	7,066.0	61.7%	8,367.1	63.6%
	+62.6%		+36.6%		+22.2%		+24.8%		+18.4%	
PCM/Reseller	1,948.8	33.9%	2,553.6	32.8%	3,094.2	32.3%	3,400.6	29.7%	3,657.5	27.8%
	+67.2%		+31.0%		+21.2%		+9.9%		+7.6%	
OEM/Integrator	403.5	7.0%	587.8	7.6%	825.0	8.6%	993.8	8.6%	1,137.9	8.6%
	+119.3%		+45.7%		+40.4%		+20.5%		+14.5%	
Total All Manufacturers	5,744.6	100.0%	7,776.0	100.0%	9,581.2	100.0%	11,460.4	100.0%	13,162.5	100.0%
	+67.2%		+35.4%		+23.2%		+19.6%		+14.9%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Product groups

Sales revenues for arrays used with mainframe computer systems have increased rapidly during the 1994-95 period, with the advent of long anticipated shipments by IBM, Storage Technology and Hitachi. During the early 1990's, EMC produced most of the revenues for mainframe arrays as the result of the company's sales success with its Symmetrix mirrored disk systems, with an assist from Hitachi Data Systems, which introduced its own mainframe disk subsystem with RAID-1 capability in mid-1993.

Sales of mainframe arrays generated only $867.4 million in 1993 revenue, but as most of the leading suppliers of disk storage for the mainframe market added arrays to their product lines, 1994 sales revenues jumped 113.6% to more than $1.8 billion and are expected to top $3.0 billion in 1995. It is expected that the total amount of disk storage purchased for mainframe applications will continue to increase through 1998, but with annual gains declining to less than 10% by that year.

Mainframe array sales revenue is projected to peak in 1996, at $3.4 billion. By that time, most mainframe disk storage will be provided by array subsystems, and growth in shipments for arrays will be limited to the annual increases in the mainframe market's requirement for additional disk storage capacity. The disk drive price per megabyte will decrease much faster in the 1996-98 period than the mainframe market's appetite for more storage, so the DISK/TREND sales revenue forecast for 1998 is down to $2.7 billion.

The networks/minicomputer/multiuser product group generated 66.6% of all disk drive array sales revenues for 1994, as well as 93.1% of all unit shipments. Extensive participation in this product area by more than ten U.S. systems manufacturers, selling internally developed arrays with their own computer systems on a captive basis, has provided a large initial sales thrust for the product group, with captive revenues contributing 81% of the 1994 overall total for the product group. But while captive sales in the networks/minicomputer/-multiuser systems product group are expected to more than double in revenues by 1998, sales revenues for noncaptive arrays are forecasted to grow even more rapidly. PCM/Reseller revenues are projected to climb from 1994's $493.4 million to a 1998 total of $1.8 billion, and OEM/Integrator revenues from $234.1 million to

$1.0 billion. Complete subsystems will lead other types of array products in providing revenue growth for both noncaptive sales channels.

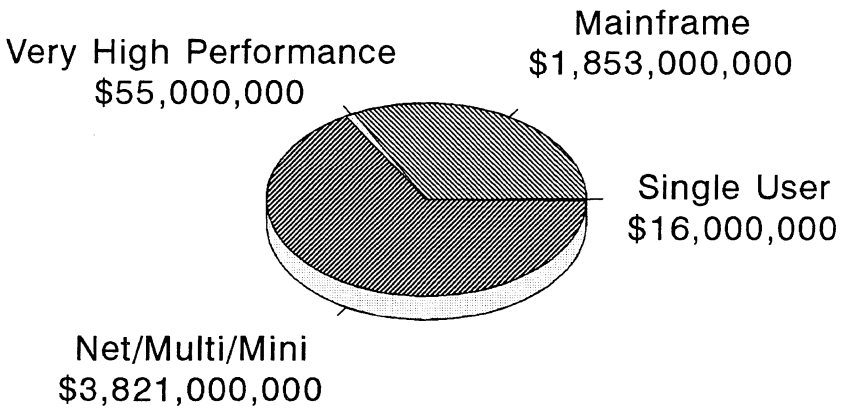
Neither single user arrays nor very high performance arrays are expected to produce as much as 1% of the overall 1994-98 revenue total. Although significant to the participating companies in each product group, the revenue totals in both groups will be modest -- but for different reasons in each product group.

Single user arrays are forecasted to provide only 0.3% of the overall total array sales revenue during the entire 1994-98 period, with a $42.6 million total for 1998, depressed by very low average unit prices. Usage will be broader than the revenue total suggests, however, with 1998 shipments of 51,370 single user arrays projected. Growth in this product group relies heavily on noncaptive add-on sales of low cost subsystems, mostly RAID-0/1 mirrored disk arrays, with significant increases for unit shipments of software array products. PCM/Reseller sales will continue to predominate, with sales concentrated in a narrow segment of the Macintosh, IBM compatible PC and UNIX workstation market -- serving those single users who think their work is mission critical, or who want to maximize performance, and have the funds available for highly reliable data storage.

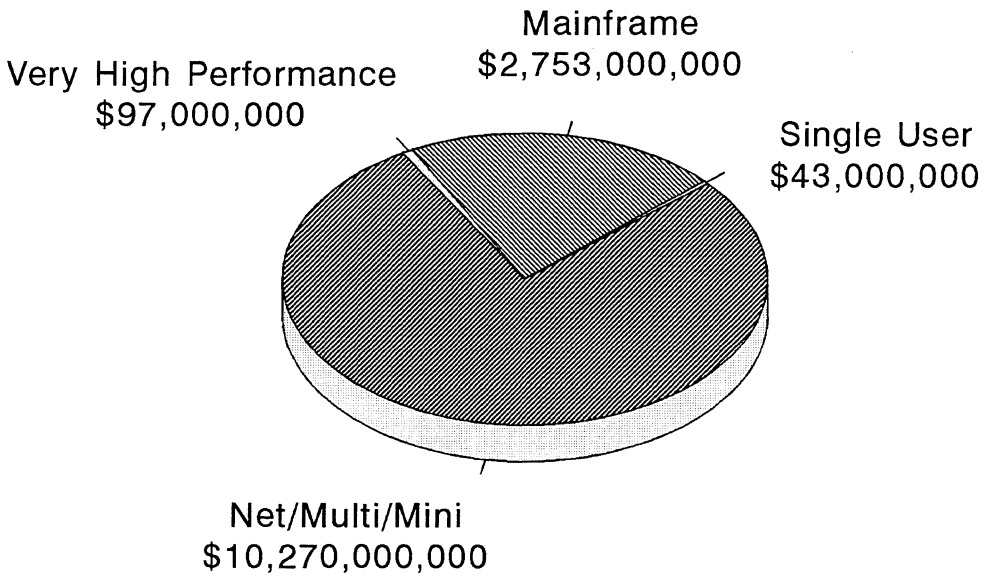
Very high performance arrays, used by supercomputers, imaging systems and high-end workstations, are forecasted to generate revenues of $97.2 million in 1998. Most of the significant supercomputer manufacturers have already added captive array subsystems to their product lines, so that the growth envisioned in DISK/TREND forecasts is probably all that can be expected from the system manufacturers' product line enhancements. Growth in the traditional supercomputer system market is expected to be modest compared to other computer application areas. The largest shipment increases for this product group through 1998 are expected to be generated by OEM/Integrator shipments to massively parallel computer manufacturers, high-end workstation producers and specialized video/imaging system manufacturers, plus PCM/Reseller shipments to the end-users of equipment sold by those manufacturers. PCM/Reseller sales revenues and unit shipments are expected to exceed those for other sales channels in the product group by 1998.

Figure 1

CHANGING PRODUCT MIX
Worldwide Disk Drive Array Revenue



1994



1998

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	------1994-----		----------Forecast----------							
ALL MANUFACTURERS	----Revenues---		------1995-----		------1996-----		------1997-----		------1998-----	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	16.0	.3%	20.6	.3%	29.8	.3%	35.1	.3%	42.6	.3%
	-4.2%		+28.8%		+44.7%		+17.8%		+21.4%	
NETWORKS/MINI/MULTIUSER	3,821.0	66.6%	4,667.9	60.0%	6,054.4	63.2%	8,139.6	71.1%	10,269.9	78.1%
	+52.4%		+22.2%		+29.7%		+34.4%		+26.2%	
MAINFRAMES	1,853.0	32.3%	3,014.3	38.8%	3,412.8	35.6%	3,191.3	27.8%	2,752.8	20.9%
	+113.6%		+62.7%		+13.2%		-6.5%		-13.7%	
VERY HIGH PERFORMANCE	54.6	.8%	73.2	.9%	84.2	.9%	94.4	.8%	97.2	.7%
	+21.9%		+34.1%		+15.0%		+12.1%		+3.0%	
Total Worldwide Revenue	5,744.6	100.0%	7,776.0	100.0%	9,581.2	100.0%	11,460.4	100.0%	13,162.5	100.0%
	+67.2%		+35.4%		+23.2%		+19.6%		+14.9%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 2

UNIT SHIPMENT SUMMARY

Worldwide Shipments in Thousands of Units

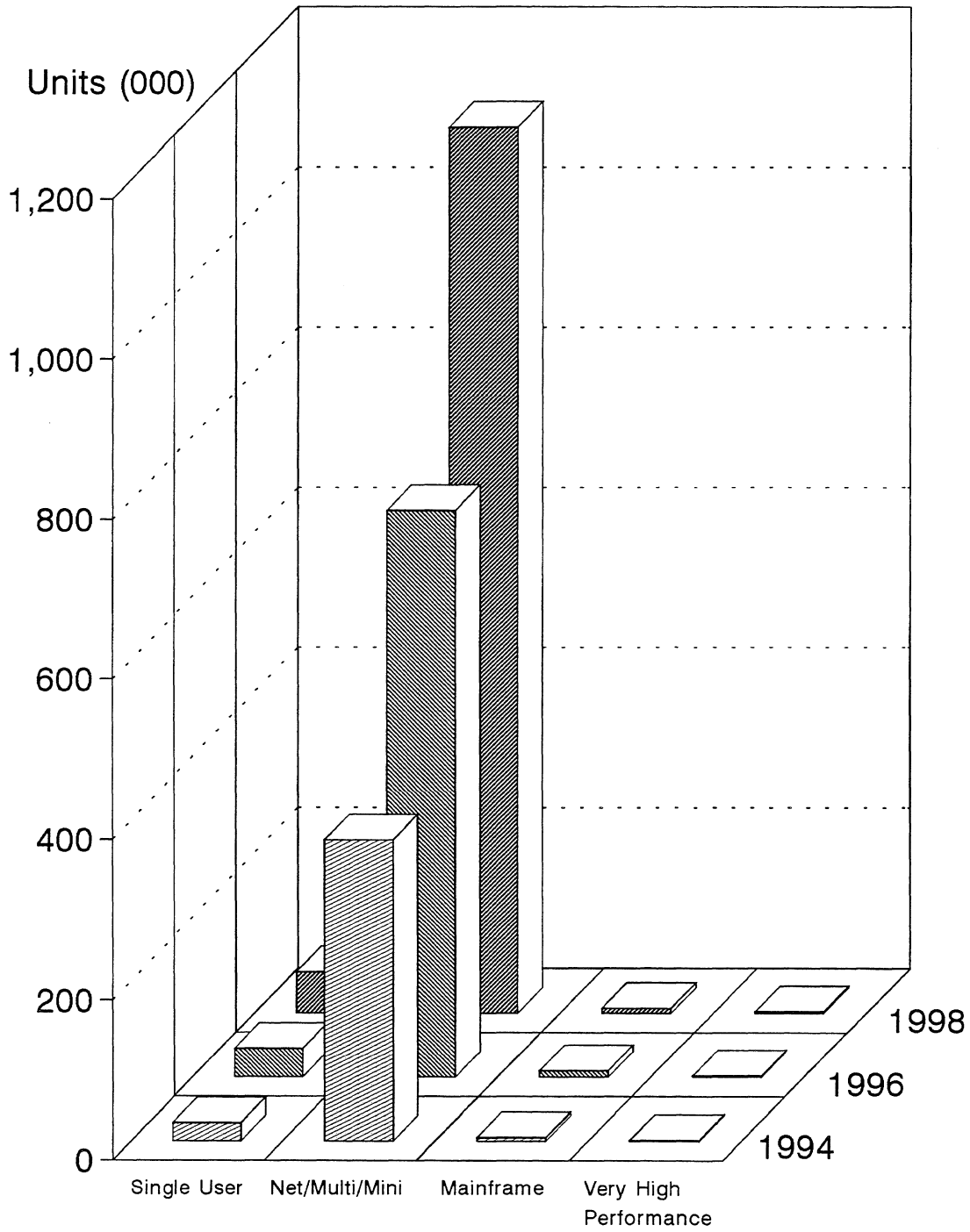


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	1994		Forecast							
SINGLE UNITS	Shipments		1995		1996		1997		1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	22,495	5.6%	28,705	5.1%	35,680	4.7%	43,380	4.5%	51,370	4.4%
	+24.3%		+27.6%		+24.3%		+21.6%		+18.4%	
NETWORKS/MINI/MULTIUSER	375,392	93.1%	524,805	92.9%	707,450	94.1%	910,470	94.8%	1,106,220	95.0%
	+93.5%		+39.8%		+34.8%		+28.7%		+21.5%	
MAINFRAMES	4,571	1.1%	10,512	1.9%	7,970	1.1%	5,955	.6%	6,190	.5%
	+125.7%		+130.0%		-24.2%		-25.3%		+3.9%	
VERY HIGH PERFORMANCE	1,330	.2%	1,537	.1%	1,783	.1%	2,035	.1%	2,248	--
	+162.8%		+15.6%		+16.0%		+14.1%		+10.5%	
Total Worldwide Shipments	403,788	100.0%	565,559	100.0%	752,883	100.0%	961,840	100.0%	1,166,028	100.0%
	+88.1%		+40.1%		+33.1%		+27.8%		+21.2%	
% U.S. Manufacturers	95.2%		91.5%		91.1%		91.1%		91.4%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Array product mix

The DISK/TREND Report breaks down all shipment statistics for arrays by three product types. Subsystems -- complete arrays, including disk drives, ready to use. Boards -- array controllers, sometimes including enclosures, power supplies and other array elements, but without disk drives. Software -- an individual software product providing array functionality, not part of an operating system. Array chip sets, and the expected future single chip array controllers, are not currently included in DISK/TREND statistics, although it is expected that they will be covered in future editions, when shipments become significant.

Complete subsystems have provided about half of total disk drive array unit shipments during recent years, and the share held by subsystems is expected to grow to 62.6% of the worldwide total for 1998. Complete subsystems constitute all of the mainframe array shipments and are expected to continue to provide most of array unit shipments for very high performance systems. Shipments of complete subsystems for networks/minicomputer/multiuser applications are expected to dip slightly below half of the 1995 total for the product group, due to a surge of board shipments to personal computer manufacturers, but the share for subsystems is projected to rise to 63.1% of the product group's 1998 total, as users' requirements for fault tolerance move the market to more sophisticated arrays. Growth is expected in subsystem penetration of single user computer markets, with their share increasing from 38.5% of 1994 array shipments for that product group to 47.9% in 1998.

Board shipments have been increasing most rapidly in the networks/minicomputer/multiuser product group, where the 30.0% share of shipments held by boards in 1994 is forecasted to increase to 36.7% in 1996. Shipments are then expected to decline in the face of competition from single chip array controllers, which can be mounted on system motherboards, eliminating the need for a separate array controller board. Board shipments for single user computer systems, once dominant in the product group due to early adoption by sophisticated computer users, are declining due to competition from software arrays.

The software share of overall array unit shipments is forecasted to drop from 17.9% in 1994 to 11.9% in 1998. Shipments of software arrays are forecasted to decline in all DISK/TREND product groups except single user arrays -- where the

usage of processor capacity required for disk array functions frequently will not be noticed by most users, and where the simpler mirrored disk arrays will continue to predominate.

DISK/TREND statistics do not count shipments by the individual RAID level of each array, because so many of today's arrays are capable of operating at multiple levels at the choice of the user, or concurrently. However, it is clear that a very high percentage of the arrays shipped to date are RAID-1 mirrored disk versions. Most single users and many users of networks/minicomputer/multiuser and mainframe systems have found RAID-1 to be an appropriate product selection during the last few years. RAID-1 subsystems and boards have been readily available, have offered high reliability and have been cost-effective compared to the perceived alternatives. Rapidly declining disk drive prices will help to maintain the attractiveness of RAID-1 for many data storage applications, especially when limited total capacity is needed.

RAID-3 has been favored for very high performance arrays. It has been the almost unanimous choice for supercomputers and other systems requiring the highest possible data transfer rates, but has now been supplemented with RAID-5 arrays with very high data rates. The earlier reliance on multiple individual disk drives, disk drives with multiple head parallel transfer, and RAID-0 striping is being replaced by high data rate versions of RAID-3 and RAID-5 arrays.

RAID-5 is expected to assume an ever larger role in the networks/minicomputer/multiuser and mainframe array markets, as the availability of appropriate subsystems becomes widespread and unit prices are reduced through product simplification and competition. Since mirrored disk arrays require 100% drive redundance, while redundancy for RAID-5 is in the 20% range, RAID-5 has natural price advantages over RAID-1 when larger numbers of drives are required.

For the record, here are the total number of all types of array models included in the product specifications section of this report, arranged by the highest numerical RAID level claimed for each subsystem, board or software product:

RAID-1 and RAID-0/1 combinations	161
RAID-3 and RAID-0/1/3 combinations	37
RAID-4	3
RAID-5 and RAID-0/1/3/4/5 combinations	503

Figure 3

ARRAY TYPE SUMMARY

Worldwide Shipments in Thousands of Units

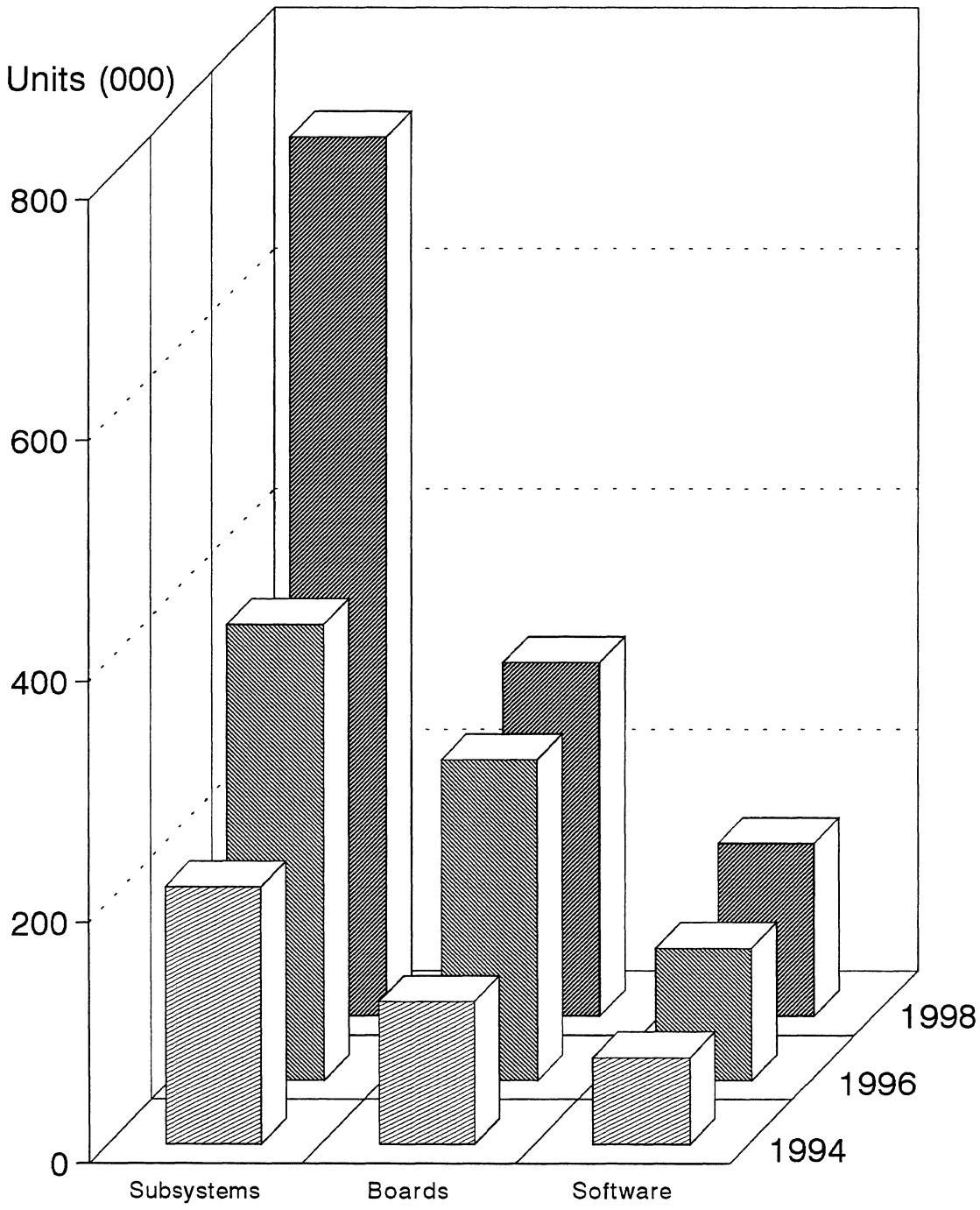


TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
SUMMARY BY ARRAY TYPE

UNIT SHIPMENTS	1994		Forecast							
SINGLE UNITS	Shipments		1995		1996		1997		1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
SUBSYSTEMS	213,240	52.8%	278,986	49.3%	377,783	50.2%	539,141	56.1%	729,897	62.6%
	+88.5%		+30.8%		+35.4%		+42.7%		+35.4%	
BOARDS	118,289	29.3%	195,368	34.5%	265,565	35.3%	294,964	30.7%	293,206	25.1%
	+103.2%		+65.2%		+35.9%		+11.1%		-.6%	
SOFTWARE	72,259	17.9%	91,205	16.1%	109,535	14.5%	127,735	13.3%	142,925	12.3%
	+66.8%		+26.2%		+20.1%		+16.6%		+11.9%	
Total Worldwide Shipments	403,788	100.0%	565,559	100.0%	752,883	100.0%	961,840	100.0%	1,166,028	100.0%
	+88.1%		+40.1%		+33.1%		+27.8%		+21.2%	

Notes: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Noncaptive market

Noncaptive array sales revenues and unit shipments are forecasted to maintain continuous growth through 1998. As a result of a major boost in PCM/Reseller sales of mainframe arrays, total noncaptive array revenues reached over $2.3 billion in 1994, and the 1998 projection is twice as large, at almost $4.8 billion. While captive disk drive array shipments by many types of system manufacturers are already well established, noncaptive sales are relatively undeveloped, with numerous new array programs by independent manufacturers getting under way during the last few years. Noncaptive unit shipments are forecasted to increase from 228,903 in 1994 to 605,481 arrays in 1998.

Mainframe sales have dominated DISK/TREND statistics for noncaptive array sales revenues since 1994, with the largest impact provided by EMC's spectacular growth in selling heavily cached mirrored disk subsystems in the IBM plug compatible market. However, after 1996 it is expected that noncaptive array sales revenues for networks/minicomputer/multiuser markets will take the lead, with 60.1% of the total array revenue, based on a diverse group of subsystem, board and software products from scores of manufacturers.

1994 unit shipments for noncaptive networks/minicomputer/multiuser markets were 202,002 arrays, with the 1998 total forecasted to grow to 552,270 units, producing sales revenues of almost $2.9 billion. During the entire 1994-98 period, the largest noncaptive shipments in this product group will be boards -- which make it possible for a large number of system manufacturers, integrators and distributors to assemble their own arrays for various resale markets.

While unit shipments for noncaptive networks/minicomputer/multiuser markets will be dominated by boards, a majority of the sales revenues is already provided by complete subsystems, and that sales lead will be overwhelming by 1998. The PCM/Reseller sales revenue for subsystems in 1994 was $464.2 million, with growth to over $1.7 billion forecasted for 1998. During the same period, OEM/Integrator revenue is projected to grow from $112.7 million to $857.7 million. Although noncaptive subsystem sales are not expected to catch up with captive sales by major system manufacturers, the independent array suppliers will continue to rapidly develop attractive new product features and innovative sales programs.

TABLE 6

NONCAPTIVE WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1994		Forecast							
ALL MANUFACTURERS	Revenues		1995		1996		1997		1998	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	16.0	.7%	20.6	.7%	25.0	.6%	29.2	.7%	32.9	.7%
	-4.2%		+28.8%		+21.4%		+16.8%		+12.7%	
NETWORKS/MINI/MULTIUSER	727.5	31.0%	1,373.3	43.8%	1,838.1	47.0%	2,372.6	54.1%	2,877.6	60.1%
	+61.9%		+88.8%		+33.8%		+29.1%		+21.3%	
MAINFRAMES	1,583.0	67.3%	1,700.3	54.1%	2,000.3	51.1%	1,927.8	43.8%	1,818.6	37.9%
	+82.5%		+7.4%		+17.6%		-3.6%		-5.7%	
VERY HIGH PERFORMANCE	25.8	1.0%	47.2	1.4%	55.8	1.3%	64.8	1.4%	66.3	1.3%
	+63.3%		+82.9%		+18.2%		+16.1%		+2.3%	
Total Worldwide Revenues	2,352.3	100.0%	3,141.4	100.0%	3,919.2	100.0%	4,394.4	100.0%	4,795.4	100.0%
	+74.3%		+33.5%		+24.8%		+12.1%		+9.1%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 4

UNIT SHIPMENT SUMMARY

Worldwide Noncaptive Shipments in Thousands of Units

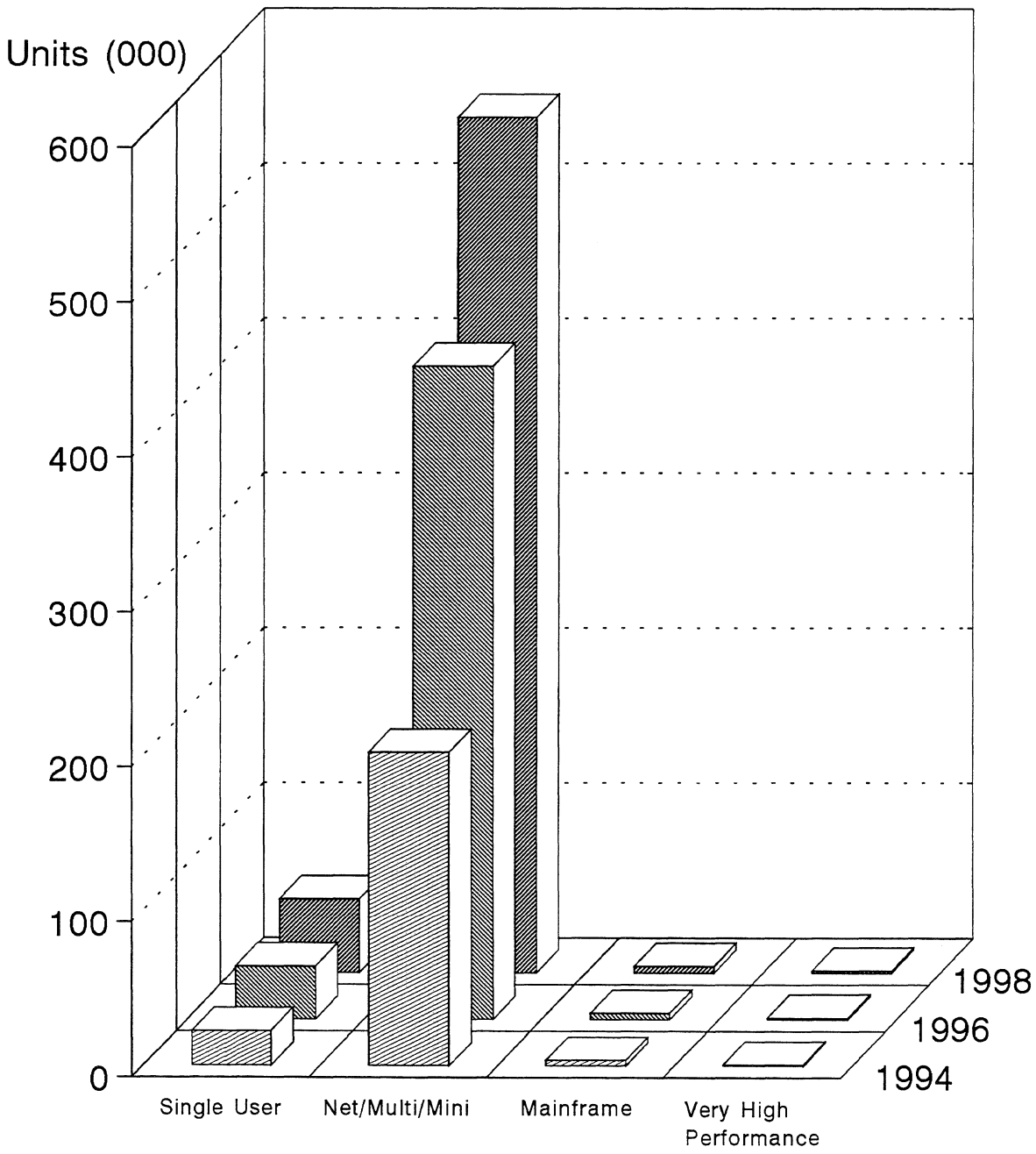


TABLE 7

NONCAPTIVE WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

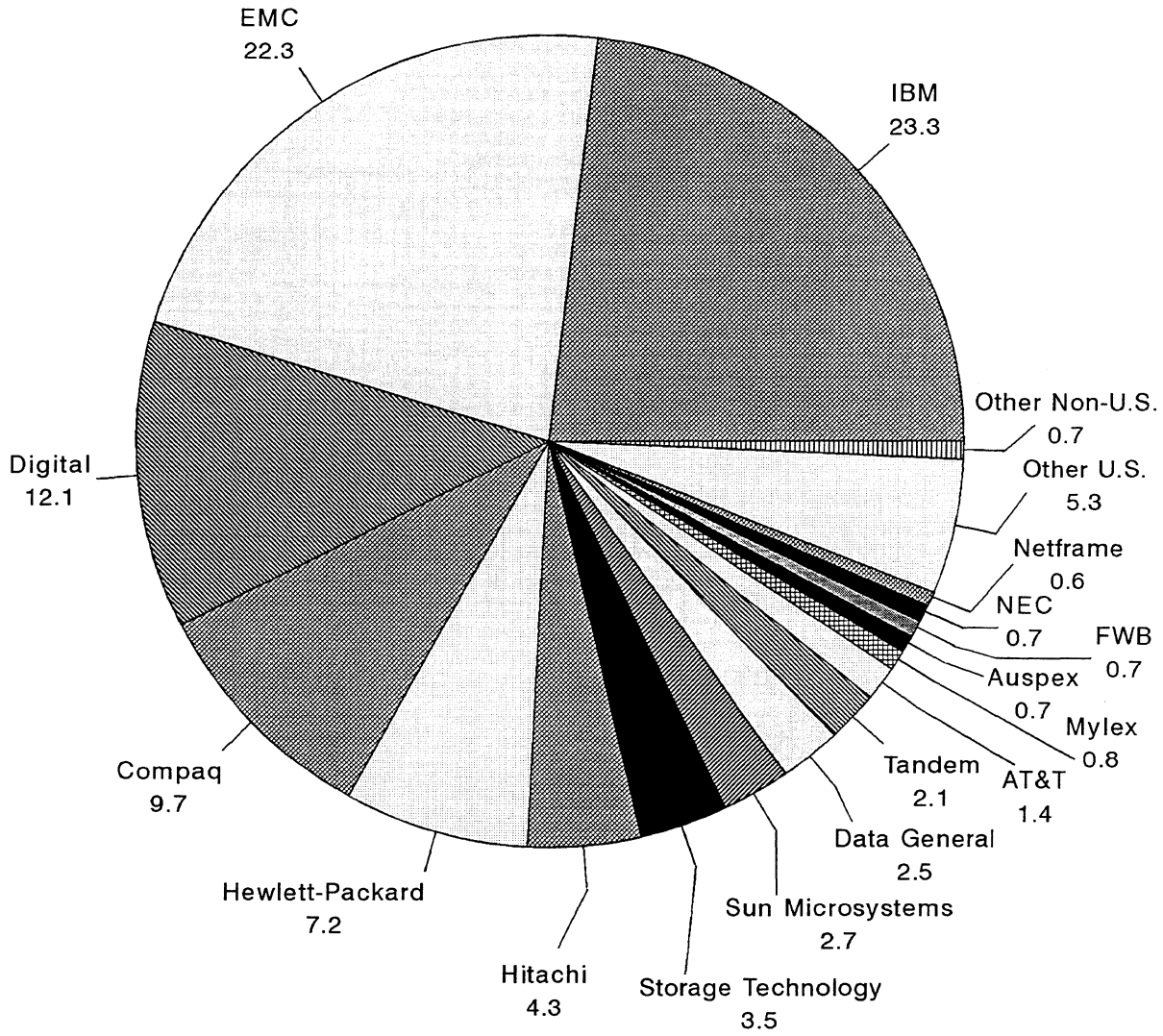
UNIT SHIPMENTS	1994		Forecast							
SINGLE UNITS	Shipments		1995		1996		1997		1998	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	22,495	9.8%	28,705	8.2%	34,080	7.4%	41,280	7.5%	47,470	7.8%
	+24.3%		+27.6%		+18.7%		+21.1%		+15.0%	
NETWORKS/MINI/MULTIUSER	202,002	88.4%	315,105	90.5%	421,500	91.6%	501,315	91.6%	552,270	91.4%
	+139.8%		+56.0%		+33.8%		+18.9%		+10.2%	
MAINFRAMES	3,571	1.5%	3,852	1.1%	4,135	.8%	4,150	.8%	4,265	.7%
	+76.3%		+7.9%		+7.3%		+.4%		+2.8%	
VERY HIGH PERFORMANCE	835	.3%	988	.2%	1,155	.2%	1,334	.1%	1,476	.1%
	+168.5%		+18.3%		+16.9%		+15.5%		+10.6%	
Total Worldwide Shipments	228,903	100.0%	348,650	100.0%	460,870	100.0%	548,079	100.0%	605,481	100.0%
	+118.7%		+52.3%		+32.2%		+18.9%		+10.5%	
% U.S. Manufacturers	92.8%		87.1%		86.4%		85.7%		85.0%	

Note: Percentage figures with plus/minus signs refer to year-to-year growth rates.

Figure 5

1994 ESTIMATED MARKET SHARES

Worldwide Percentage Revenues for All Disk Arrays



1994 Revenues: $5,744,600,000

TABLE 8

1994 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL DISK DRIVE ARRAYS
(Value of non-U.S. currencies estimated at average 1994 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
AT&T Global Information Systems	51.1	1.5	--	--	31.3	7.8	82.4	1.4
Auspex Systems	--	--	39.8	2.0	--	--	39.8	.7
Compaq Computer	557.7	16.4	--	--	--	--	557.7	9.7
Data General	81.7	2.4	35.7	1.8	27.6	6.8	145.0	2.5
Digital Equipment Corporation	662.5	19.5	10.4	.5	21.0	5.2	693.9	12.1
EMC	--	--	1,125.1	57.7	156.6	38.8	1,281.7	22.3
FWB	--	--	42.3	2.2	--	--	42.3	.7
Hewlett-Packard	338.2	10.0	37.8	1.9	39.5	9.8	415.5	7.2
IBM	1,339.5	31.5	--	--	--	--	1,339.5	23.3
Mylex	--	--	6.7	.3	41.1	10.2	47.8	.8
Netframe Systems	--	--	23.2	1.2	12.0	3.0	35.2	.6
Storage Technology	--	--	199.2	10.2	--	--	199.2	3.5
Sun Microsystems	154.6	4.6	--	--	--	--	154.6	2.7
Tandem Computers	83.3	2.5	--	--	--	--	83.3	1.5
Other U.S.	76.5	10.2	165.0	8.5	61.1	15.1	302.6	5.3
U.S. Total	3,345.1	98.6	1,685.2	86.5	390.2	96.7	5,420.5	94.4
NON-U.S. MANUFACTURERS								
Hitachi	--	--	245.0	12.6	--	--	245.0	4.3
NEC	37.5	1.1	--	--	--	--	37.5	.7
Other Non-U.S.	9.7	.3	18.6	1.0	13.3	3.3	41.6	.7
Non-U.S. Total	47.2	1.4	263.6	13.5	13.3	3.3	324.1	5.6
WORLDWIDE TOTAL	3,392.3	100.0	1,948.8	100.0	403.5	100.0	5,744.6	100.0

TABLE 9

CURRENT PRODUCT LINES
MANUFACTURERS OF DISK DRIVE ARRAYS

Codes: C = Captive
O = OEM/Integrator
P = PCM/Reseller
SB = Subsystems
BD = Boards
SW = Software

		DISK/TREND PRODUCT GROUP			
N. American Manufacturers (148)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
1776, Inc.	O,P		SW		
AC Technology	P		SB		
Adaptec	O,P		BD		
Adjile Systems	P		SB		
ADS International	P		BD,SB		
Advanced Logic Research	P		SB		
Allodyne	O,P		SB		
American Digital Systems	O,P		SB		
American Megatrends	O,P		BD		
ANDATACO	O,P		SB		
Apple Computer	C,P		SB		
Applied Digital Systems	P		SB		
APS Technologies	P	SB			
Artecon	P		SB		
AST Research	C,P		SB		
AT&T Global Information Sol.	C,O,P		SW		
ATTO Technology	O,P	BD,SW			
Auspex Systems	C,P		SB		
Avcom Systems	P		SB		
Aviv	P		SB		
BoxHill Systems	C,P		SB		
BusLogic	O,P		BD,SW		
Cambex	P		SB	SB	
Canary Communications	O,P		BD		
CharisMac Engineering	O,P	SW			
Ciprico	O,P		SB		SB
CLone Star Software	P		SW		
Clovis Manufacturing	P		SB		
CMD Technology	O,P	BD	BD,SB		
Compaq Computer	C		SB		
CompuAdd Computer	P		SB		
Computer Marketplace	P		SB		
CompuTrend Systems	P		SB		
Concorde Technologies	P		SB		
Concurrent Computer	C		SW		
Conley	O,P		BD,SB,SW		
Conner Storage Systems	P		SB		
Consensys	O,P		BD,SW		
Control Data Systems	C		BD		
Convex Computer	C				SB
Core International	O,P		SB		
Corel	O,P		SW		
Cray Research	C				SB
Cyranex	O,P	SW	SW		
Dallas Digital	O,P		SB		
Data General	C,O		SB		
Datalink	P		SB		
Dataram	P		SB		
Data Storage Marketing	P		SB		
Dell Computer	C		SB		
Digi-Data	O		BD		
Digital Equipment Corporation	C,O,P		BD,SB,SW		
Direct Connections	P		SB		

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
Direct Connect Systems	P		SB		
Diverse Logistics	P		BD		
DPT	O,P		BD,SB		
DynaTek Automation Systems	P		BD,SB		
ECCS	O,P		BD,SB		
Eclipse Technologies	O,P		BD		
EMC	P		SB	SB	
Encore Computer	C,P			SB	SB
Falcon Systems	P		SB		
Formation	O,P		SB		
FWB	P	SB	SB,SW		
Gain Systems	O,P		SB		
Hewlett-Packard	C,O,P		BD,SB		
High Performance Storage	O,P		SB		
IBM	C,O,P		SB	SB	SB
Information Management Tech.	P		SB		
Invincible Technologies	P		SB		
IPL	P		SB		
La Cie	P		SB		
Legacy Storage Systems	O,P		SB		
Lighthouse Technology	P		SB		
Lomas Data Products	O		BD		
Macro Computer Products	P			SB	
Marner International	O,P		SB		
MasPar Computer	C				SB
MaxConcept	P	SB			
Maximum Strategy	O,P				SB
Media Integration	P		SB		
Megabyte Memory Products	P		SB		
Mega Drive Systems	O,P		SB		
Micronet Technology	O,P	SB	SB		
Micropolis	O,P		BD,SB		
Microtech International	P	SB			
Mirror Technologies	P	SB			
Morton Management	P		SB		
MountainGate Data Systems	P	SB			
MTI Technology	P		SB		
Mylex	O,P		SB		
NCL America Computer Products	P	SW			
NetFRAME	O,P		SB		
Network Appliance	C,P		SB		
Network Connection	P		SB		
Nonstop Networks	P		SW		
OMNI Technology	O,P		BD,SB		
Optima Technology	P	SB	SB		
PACE Technologies	O,P		SB		
Pacific Micro Data	O,P		SB		
Parity Systems	P		SB		
PC Expanders	P		SB		
Perceptive Solutions	O,P		BD,SW		
Perisol Technology	P		SB		
Phoenix International	P		SB		
Polywell Computers	P		SB		
Precision Computers	O,P		SB		
Procom Technology	O,P	BD	SB		
RAAC Technologies	P		SB		
RAID Power	P		SB		
Raidtec	O,P	BD,SB	BD,SB		
Ranger Plug 'N' Go	P	SB			
Rose Datasystems	P		BD		
R Squared	P		SB		
See First Technology	P		SB		
Seek Systems	P		BD,SB		
Sequent Computer Systems	P		SB		

N. American Manuf. (CONTINUED)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
Sequoia Systems	C,O		SB		
Seraph	P	SB	SB		
Silicon Valley Computer	O,P	BD	BD		
Spin Peripherals	P	SB	SB		
Storage Computer	O,P		SB		
Storage Concepts	O,P		SB		SB
Storage Dimensions	O,P		SB		
StoragePath	O,P		SB		
Storage Solutions	O		SB		
Storage Technology	P		SB	SB	
StorNet	P		SB		
Stratus Computer	C		SB		
Sun Microsystems	C,P		SB,SW		
Tandem Computers	C		SB		
Tangent Computer	P		SB		
TD Systems	O,P		BD		
Texas Microsystems	P		SB		
Thinking Machines	C				SB
Total Tec Systems	P		SB		
Transoft	O,P		SB		
Tricord Systems	C		BD		
Trillium Research	P	SW	SW		
UltraStor	O,P		BD		
Unisys	C		SB	SB	
Uni Solution	P		SB		
Unitrol Data Protection Sys.	O,P		SW		
Veritas Software	O,P		SW		
Western Scientific	P		SB		
Winchester Systems	P		SB		
ZZYXZ Workstations & Periph.	P		SB		
Asia/Pacific Rim Manufacturers (15)					
Acer	P		SB		
Advanced Technology & Systems	O,P	SB	SB		
Aresys	O,P	BD	BD,SB		
ATEN International	O,P		BD		
Fujitsu	C,P		BD,SB	SB	SB
Hitachi	C,O,P		SB	SB	
Hitachi Data Systems	P			SB	
INFOCOM Digital Systems	O,P		BD		
Infortrend	P		BD		
Midori	P		SB		
NEC	C,P		SB		
Nippon Texa	C,O,P	SB	SB		
Nissin Electric	P		SB		
Symbios Logic	C,O,P		BD,SB		
Tekram Technology	O,P	BD			
European Manufacturers (16)					
Advanced Telecomm. Modules	C,O,P		SB		
Arco Electronics	P	BD			
ATON Systemes	C,O,P	BD	BD,SB		
Baydel Ltd.	O,P		SB		
Comparex	P			SB	
Disk Pack	P		SB		
Eurologic Systems	P		SB		
Future Computers	P		SB		
Hi-Data	O		BD		
ICL	P		SB		
Solid Computer	P		SB		
Teledisk	P	BD			
TwinCom	O,P		SW		
Vortex Computersysteme	O,P		BD		
Xyratex	O,P		SB		
Zenith Data Systems	P		SB		

DISK/TREND ARRAY DEFINITIONS

Many basic terms have varying meanings within the computer industry. In the DISK/TREND Report on disk drive arrays, these specific meanings are used:

Product group classification

Arrays are classified into four product groups according to the type of system attachment for which they are designed. They include:

Single user systems: Intended for use with single personal computers or workstations. Attached processors typically run under DOS, Windows, Macintosh System 7, OS/2, UNIX, etc.

Networks/Minicomputer/Multiuser: Consists of all midrange systems, to which individual personal computers, workstations or terminals are typically attached. Host platforms include the IBM AS/400, Digital Equipment and other minicomputers, engineering workstation networks and personal computer networks. Software environments include UNIX and its variants as well as other minicomputer operating systems and include network operating systems such as Novell NetWare, Banyan VINES, and Artisoft Lantastic.

Mainframe systems: Classic mainframe and supermini system environments.

Very high performance systems: Supercomputers, specialized imaging systems and other systems with requirements for very high data transfer rates.

Product type classification

Within each product group, arrays are classified into three product types for purposes of the DISK/TREND Report. Only products specifically and primarily intended to permit disk drives to operate as an array, in accordance with the Berkeley RAID-1/2/3/4/5 definitions, are included in this classification.

Complete subsystem: Arrays consisting of controller or array software, drives and supporting elements such as fans, power supplies, enclosure, etc., ready for installation.

Board: A board or subsystem providing array capability to a system, but not including disk drives. This category includes products that are boards only, as well as boards mounted in an enclosure, with power supplies, fans and other array elements, but without drives.

Software: A specific software product that provides array functionality without requiring a separate controller. Operating systems that include array functions,

such as Novell NetWare SFT III or Microsoft Windows NT Advanced Server, are not included in this category or counted in the statistics. Sales of software arrays obtained via a technology license with production rights from the licensor are credited to the licensee and not the licensor to avoid distortion of sales revenue figures.

Market classification

Market class is used here, arbitrarily, to differentiate captive, PCM/Reseller and OEM/Integrator marketing activities.

Captive: Arrays manufactured internally by a computer systems manufacturer, its subsidiary, or exclusive contractor, and sold or leased primarily for use with systems offered by the manufacturer. Note that the term is used to describe the products, not the manufacturer; arrays sold to PCM/Reseller or OEM/Integrator market classes are classified accordingly.

Example:

* Arrays sold by Digital Equipment, IBM or Compaq for use with their own systems are considered captive, if the array controller or array software is internally manufactured.

Noncaptive: Any public sale or lease by any array manufacturer, except sales or leases of internally manufactured arrays by computer system manufacturers primarily for use with their own systems. Both OEM/Integrator and PCM/Reseller shipments are included in the noncaptive sales channel.

Examples:

* Shipments by Data General's CLARiiON unit are noncaptive, except for arrays sold with computer systems made by the parent company or other subsidiaries.

* Shipments made by Micropolis or CMD Technology are noncaptive.

PCM/Reseller: Arrays sold or leased by "plug compatible manufacturers" or their distributing organizations directly to end users for use with systems sold by another manufacturer. Also includes arrays sold in the "aftermarket" -- shipments by array manufacturers to subsystem producers, distributors, retail chains, mail order firms and individual dealers. It includes disk drive arrays to be connected to computer systems of all types, including personal computers, minicomputers and mainframes, or arrays sold as add-on devices by distributors and dealers.

Examples:

* Arrays sold by Core International or Micropolis through distributors.

* Arrays sold by EMC to end users of IBM equipment.

OEM/Integrator: Arrays sold by the original producer to system manufacturers which resell them as part of complete computer systems. Also includes sales to system integrators or value-added resellers which combine finished system components and software to provide complete systems for specific applications. Sales by an array manufacturer to a second manufacturer for resale are included only in shipment totals for the originating manufacturer, except when arrays are produced on a contract manufacturing basis with a design supplied by the manufacturer which finally sells the drive to a third party.

Examples:

* Arrays produced by Maximum Strategy for sale to system manufacturers.

* Software produced by Trillium Research for sale to system manufacturers.

* Array controllers produced by Mylex for sale to system or subsystem manufacturers.

Geographic classification

Geographic analysis is based upon U.S. and non-U.S. regions. Together, these two regions comprise the worldwide market.

U.S. vs. Worldwide SHIPMENTS: Shipments are classified U.S. or worldwide depending on the country in which the headquarters of the purchasing company is located.

Examples:

* An OEM shipment by a U.S. array manufacturer to a European system manufacturer is included in worldwide totals, even if the array is integrated into a system within the U.S.

* An OEM shipment by a European array manufacturer to a U.S. based system manufacturer is included in U.S. totals, even if the array is integrated into a system in a third country, regardless of the final destination of systems in which the arrays are used.

U.S. vs. Non-U.S. MANUFACTURERS: Manufacturers are classified U.S. or non-U.S., depending on the location of the firm's headquarters, regardless of the location of individual manufacturing plants.

Units of measurement

Array units: The basic array unit consists of the electronics (or software package) required to operate multiple disk drives as an array, regardless of whether it is sold originally as a board level array, software package or complete subsystem. All DISK/TREND array unit shipments are credited to the company that makes the first public sale of the basic array unit.

Examples:

* When CMD sells a controller to a system integrator which combines the CMD controller with Seagate disk drives and an enclosure with fans and power supplies to produce a complete array subsystem, CMD is credited with the sale of an array board.

* When Compaq Computer sells a system which includes an internally built array controller, with disk drives, Compaq is credited with the sale of a complete subsystem.

* When BusLogic sells a copy of its Chantal array software, it is credited with the sale of a software array unit.

Revenue: Based on sales of array units, including bundled drives (if any), as normally sold by individual manufacturers. Add-on drives sold as separate units are not included in array revenue, nor are replacement parts or service. Sale prices are estimated public sale transaction prices, whether at captive end user, PCM/Reseller or OEM/Integrator levels, and are credited to the company that makes the first public sale of the basic array unit. All prices are in 1995 constant dollars.

Forecasts: Expected shipments and revenues for current or announced products in new production. Evolutionary improvements within existing disk array architectures are included, but completely new configurations or technologies are not included.

Examples:

* Enhancements such as write latency improvements and revised compression schemes are anticipated in DISK/TREND forecasts.

* Innovations such as arrays for portable systems or video servers may require establishment of new DISK/TREND product groups.

ARRAY SYSTEM CONSIDERATIONS

ARRAY SYSTEM CONSIDERATIONS

Disk drive arrays come in a variety of configurations and implementations ranging from inexpensive and simple to costly and complex. This section of the report reviews array characteristics and issues pertaining to their use.

ARRAY CHARACTERISTICS AND CLASSIFICATION

What is an array? A disk drive array is an assembly of disk drives and hardware controllers operated by array management software. The array presents itself to its host system environment as if it were a single physical disk drive. The storage devices that are members of the array can be any type of random access, non-volatile storage device with unlimited read/write capabilities, including rigid magnetic disk drives, rewritable optical disk drives and nonvolatile solid state disk drive equivalents.

Array management software can be program code, to be executed within the host system environment, or it can be implemented as firmware within the array controller, or as a hybrid combination of the two.

Implementations: For purposes of this report, arrays are considered to be implemented in one of three ways, which represent the forms in which arrays are sold:

* Complete subsystems: Array subsystems include disk drives, controllers with software to operate the array, enclosures, power supplies, fans, cables and possibly other physical elements. The array controller contains the programs necessary to operate the array and appears to the host system as a single drive. The host system is relieved of the need to manage the details of operating the array. Some controllers allow partitioning of the array drives into several types of array (each appearing to the host system as a single drive), all of which can operate concurrently with data routed by the host computer to the array type best able to handle it. Subsystem manufacturers usually include software tools to configure, manage and monitor the array subsystem, frequently for a specific host system and software environment.

* Boards: This category includes array controllers sold individually or with other subsystem elements such as enclosures, fans, power supplies and cabling, but not including disk drives.

* Software: If the array is implemented purely by use of software and without hardware specifically designed to operate an array, then it is a software implementation. Hybrid arrays combining software and hardware functions exist, but are considered as hardware implementations in

this report. Software implementations are relatively inexpensive and usually easy to integrate, but may be slower than hardware implementations and may not provide all the functions a hardware array implementation can provide. Exact performance will depend on processor load, the controllers, disk drives and drivers used with the disk drives, as well as processor performance. Array specific drivers are often provided with software arrays to improve performance. Software array implementations are often specific to the host system and may not be effective at all sites in multihost network environments.

When to use an array -- and when not: Disk drive arrays may provide several kinds of advantages over individual disk drives. Certain array configurations can improve system throughput, and the use of an array can spread data over multiple drives, avoiding unbalanced I/O loads and consequent bottlenecks. Other array configurations can improve data availability by providing a degree of fault tolerance, although the degree of improvement in either case depends upon the specific design of the array subsystem.

Disk drive arrays can provide performance enhancements or fault tolerance enhancements, but these advantages tend to be mutually exclusive, in that optimizing for one usually penalizes the other. There is always an economic penalty compared to nonarray implementations of data storage. If the needs of the system user can be met without improved throughput or improved fault tolerance, there is no need for the additional expenses associated with an array. In short, choosing an array is a balancing act between cost, performance, and data availability.

Arrays should not be viewed as a way of avoiding the need for disk drive backup. While data can be protected against a failure of a drive or other subsystem element, no protection is provided against operator error, disasters, viruses or other external disruptive influences. Furthermore, while arrays may provide for redundancy at the disk drive level, failures elsewhere in a nonredundant system can make the data stored on the array unavailable. Only by duplicating each element of a system, including processors, controllers, cables, ports, fans, power supplies, etc. can the highest probability of data availability be achieved. The need for fault tolerance must be analyzed for each processing node in a network to select the most cost-effective approach.

Choosing the right array for the application: Although some types of arrays have been used for a number of years, they received prominence after publication of a classification scheme in a technical report by researchers at the University of California in Berkeley in December, 1987 (Technical Report UCB/CSD 87/391). The authors discussed a set of array configurations which they characterized as Redundant Arrays of Inexpensive Disks, RAID by acronym, as compared to a Single Large Expensive Disk (SLED). Five configurations, or RAID levels, ranging from RAID-1 to RAID-5 were defined (an additional level, RAID-6, was proposed later). While not defined by UC, RAID-0 has been generally adopted as referring to a striped set of disks with no redundancy.

Because the prices of disk drives have declined radically since the RAID acronym was coined, the use of arrays as a means to reduce storage costs is no longer relevant, so the RAID acronym is currently interpreted by many as Redundant Arrays of Independent Disks.

The RAID configurations describe ways of organizing data on the disk drives and organizing the flow of data to and from the drives, but do not cover the details of interfaces or of controller or software operation. The RAID levels merely describe configurations: A higher RAID level does not imply anything regarding relative performance, complexity, cost or reliability, which are functions of specific configurations. Because of broad industry usage, RAID nomenclature is used throughout this report.

The various configurations and their uses are reviewed briefly below:

* RAID-0: RAID-0 disk configurations have data striped across the drives that are included in the set. Because each drive is accessed independently, portions of data from an I/O operation can be read or written to each drive simultaneously, minimizing data transfer time. While fast, RAID-0 provides no redundancy in data storage, so if one drive in the set fails, all data becomes unavailable. If the failed drive cannot be repaired, all of the data is irretrievably lost. RAID-0 is best where high performance is desired and fault tolerance is not a consideration. It also offers the lowest cost per megabyte. Some manufacturers have referred to collections of disks without striping as RAID-0, but this runs counter to industry usage, which would refer to nonstriped, nonredundant groups of drives as JBOD (just a bunch of disks).

* RAID-1 (Mirrored disk drives): In this mode, data is written or read in identical form to two or more drives. This provides fast read performance, because the first drive to respond to an I/O request can provide the data requested, reducing latency. Furthermore, there is no need to compute and store parity blocks, a time-consuming operation in other RAID modes. Write performance may be somewhat slower than in JBOD configurations, since both drives have to complete the write operation. The strongest objection to RAID-1 is economic: The cost of the drives at least doubles for any given storage capacity. However, management is relatively simple and controllers or software need not be overly complex, which facilitates integration into a system. RAID-1 is useful where high performance is needed, high data availability is required, and data block sizes are not overly long, but doubles the cost per megabyte since twice as many drives are needed.

* RAID-2: This configuration is rarely used and was included in the Berkeley work primarily to cover a few systems that had been shipped earlier. In RAID-2, bytes are broken into smaller units which are then transmitted in parallel to a set of disk drives. In addition, parity data, computed using

Hamming codes, is sent to additional drives used specifically to store parity data. The redundancy of data provides good data availability. Read performance is good because data is transferred in parallel. Write performance is degraded because of the need to compute parity and then write it to the parity disks. Relative to other array types, RAID-2 is uneconomical because it requires a larger number of drives, and RAID-2 controllers tend to be complex and expensive. RAID-2 performance can be achieved by RAID-3 at lower cost.

* RAID-3: Data is sent to and from the disk drives in parallel, one I/O request at a time. Parity data is stored on a single additional drive. The disk spindles may be synchronized to transfer data to all drives simultaneously. Because of the high degree of parallelism, data transfers are very fast, although concurrent I/O is not possible. If a single drive fails, data is still available by using the data on the working drives plus the parity drive to reconstruct the data, although the effective data rate will be degraded as a result. RAID-3 is typically used on supercomputers, image manipulation processors and other applications where very high data transfer rates are needed. It is most efficient for long block transfers and is inefficient for short transactions with high I/O request rates. For a given capacity, fewer drives are needed than for RAID-1, as only a single drive for redundancy must be added to the data drives. However, the controller may be more complex and expensive. RAID-3 is best for situations requiring very fast data transfer rates and/or long data blocks.

* RAID-4: In RAID-4, data is striped across the array drives while parity data is accumulated on a separate drive. Data is recoverable if a drive fails. Read performance is similar to RAID-1, but writes are considerably slower than on a single disk because of the need to funnel the parity information through a single drive. RAID-4 has been supplanted by RAID-5, which offers the same read performance but much better write performance.

* RAID-5: Data in a RAID-5 array is striped across the drives in the array, but parity data is also distributed among all of the drives, eliminating some of the write bottleneck. Writes are still slow because of the need to read data from all drives to recompute parity when writing (sometimes called the read-modify-write process). Concurrent I/O transactions can be processed. Data can be recovered in the event of a single drive failure. RAID-5 is efficient for long data records, but is also reasonably efficient for short ones if the array design includes features to improve write performance, or if the application requires a high proportion of reads. It is a good choice for achieving high data availability, with acceptable performance provided that the data block size is small. RAID-5 carries only a modest cost per megabyte penalty compared to a nonarray approach.

* RAID-6: Similar to RAID-5, but with additional parity information written that permits data recovery if two drives fail. This configuration requires

extra parity drives, and write performance is theoretically slower than for an equivalent implementation of RAID-5. It was proposed by UC Berkeley in late 1989. RAID-6 is also used by some manufacturers to designate a layered array with RAID-1 and RAID-0 capabilities, but this does not conform to the Berkeley definition.

* Non-Berkeley RAID levels: In addition to the RAID levels defined above, there are a variety of nomenclatures used by specific manufacturers. There is no agreement on the meanings of these; most are meant to imply the ability to operate in more than one mode simultaneously or to imply that a specific design incorporates features of more than one RAID configuration. Others, such as RAID-7, imply attempts to improve RAID-5 performance through vendor specific design features. Terms such as RAID-10, RAID-1/0 or RAID-1+0 have become commonly used to mean a layered array operating simultaneously in both modes, offering the advantages of striping and mirroring.

In meetings of the RAID Advisory Board, an industry group attempting to create agreement on array nomenclature, test procedures, interface specifications and similar matters, a proposal has been made to classify arrays by their access method rather than by RAID level. While it is unclear that this will be adopted as standard nomenclature, it does provide an alternative way of classifying arrays.

* Parallel access arrays: All of the member disk drives in a parallel access array operate on every I/O transaction handled by the array. RAID-2 and RAID-3 arrays are examples of parallel access arrays. A few RAID-1 arrays fall into this class.

* Independent access arrays: In this category, the disk drives act independently, and may have the ability to be operating upon multiple I/O requests concurrently. RAID-4, RAID-5 and RAID-6 and most RAID-1 implementations fall into this category.

The RAID Advisory Board has not defined RAID-0 as parallel access or independent access, since it does not consider RAID-0 an array, as it does not provide any data redundancy.

Another method of classifying arrays now occasionally used in the industry divides arrays into "parity arrays", in which parity blocks are created (RAID-3/4/5), and "nonparity arrays", which use only mirroring (RAID-1) for redundancy.

Non-RAID approaches: Performance and fault tolerance issues can be addressed without using an array. System designers may choose to employ very fast disk drives, employ controllers with extensive caching and buffering, or use drives with parallel transfer heads to meet speed requirements, or may distribute data files (nonstriped) over many drives. Fault tolerance can be addressed by mirroring (duplexing) whole disk drive subsystems (which in themselves may not be arrays) or by mirroring entire file servers, as does Novell in its SFT III fault tolerant networks.

SYSTEM SELECTION AND INTEGRATION CHECKLIST

The following discussion touches upon significant issues that system integrators and end users should take into account when choosing an array.

Host platform and operating system compatibility: Arrays must operate in the context of attachment to specific hardware platforms and software environments. The possession of a SCSI interface does not automatically guarantee proper operation with every system that has a SCSI port. Usually specific drivers and other software "glue" are necessary. The various release levels and variants of UNIX and other operating systems may have varying ability to correctly operate a given array product. Other concerns:

* Does the system have sufficient memory available to operate the array? Will operating the array slow down other host activities? These are major considerations for software implementations, but less so for hardware implementations.

* Are the software and documentation distribution media used to ship array software and documentation supported on the target system? What other devices need to be connected, and can the array controller support those devices?

* For software arrays, can the array device driver provided be co-resident with the device drivers provided with the system? Are special disk partitions needed?

* Do the cables match? If SCSI is used, does the system SCSI port match the performance characteristics of the array SCSI port? Are the SCSI paths the same width? Single ended or differential? If a board must be plugged into the host system, is there sufficient room, power, cooling available? Are special SCSI terminations needed, or are the drives self-terminated? Do the terminations match the width of the path? Do you need shielded cables to solve EMI problems?

* Can the array use existing drives, if any? Can it support drives of different capacities? Can it support drives from different drive manufacturers or a preferred manufacturer? Does the array packaging limit the total capacity needed? Does drive interface performance match the array controller performance?

* Can the array controller support drives as logical units? Are resources adequately shared between logical units (no starvation if one drive or partition is hyperactive)? Can you boot from the array? Can the array create logical devices on the fly? Which SCSI level is supported? Can the array handle redundant drive controllers and dual ported drives?

* Does the array controller block low level access to the drives? Does the host system need such access and does it know how to use it?

RAID-1 or RAID-0 arrays are the simplest to integrate. Other RAID levels are more complex. Ideally, the array should look exactly like a single disk to the host environment and operate transparently with respect to file systems, applications, data base managers and system utilities once the array is configured.

Types of data used: The form of the data stored may influence the choice of array. Long blocks of data such as images or satellite dumps may best be handled by RAID-3. Short blocks typical of on-line transaction processing may best be handled by RAID-5, especially if the data availability requirements are stringent. If a mixture of performance, availability and ability to handle a variety of data is needed, RAID-1 may be most suitable. If the system handles multiple data types, arrays capable of partitioning the disks into multiple array types should be considered. The array should be capable of handling data block sizes efficiently handled by the host and by the drives.

Data availability: If data availability is an issue, then RAID-0 is inappropriate, since it provides performance but no fault tolerance. RAID-6, though not generally available, theoretically provides superior availability, but at extra cost. Ultimately, data availability may be influenced more by the overall redundancy in the storage subsystem architecture than by the RAID level chosen. If an extremely high level of data availability is mandatory, then dual ported disk drives, redundant controllers, even redundant processors and power feeds, will be required. Any element whose failure can make the system non-fault tolerant should be hot plugable. If write cache is used anywhere in the system, then backup power sufficient to keep the system operating until the contents of the write cache are written to disk is needed.

Data availability may be impacted due to performance degradation while data on a failed drive is being recreated. Performance drops of 50% during reconstruction are not unusual, and reconstruction can require time periods ranging from a few minutes to hours depending upon the drive capacity, array loading and other factors. While the data is accessible, it may not be available within the time window needed for satisfactory performance.

Performance: The question of performance revolves around the conditions under which it is measured. It is affected by the mix of reads vs. writes, the mix of sequential vs. random reads and writes, the length of the data blocks and many other factors. Controller and system design features strongly influence performance, especially the presence and configuration of cache. At present, there is no generally accepted way of measuring or specifying performance, requiring array users to exercise caution in interpreting performance specifications. Performance may be optimized by partitioning the array drives into multiple arrays. For instance, an array could be partitioned into a RAID-1 segment and a RAID-5 segment, using the RAID-1 portion for write-intensive I/O mixes and the RAID-5 segment for read-intensive I/O mixes. Some considerations:

* Would a layered array provide better cost/performance benefits than a nonlayered approach?

* Would you benefit from a look-ahead read cache in the array controller? Where is your write cache, if any? Is its size and configuration (write-through, write-back) appropriate to the application? How is it protected from a power failure?

* Is the RAID level appropriate to the data block sizes, I/O transaction rates and other system factors?

* Does your array support queued commands? Does it need to?

* If your array uses a log structured file system, is there enough reserve storage capacity to prevent performance degredation? Would compression of data before storage avoid a capacity limitation?

Storage management: An array may be provided with the ability to support other devices, such as tape, robotic libraries, and optical drives that may be used for backup or save/restore operations. While disk drive arrays may provide a high level of insurance against hardware failures, they do not insure against the effects of operator error, fires or natural disasters. Only a rigorously managed backup program can protect data from such events. Some arrays provide for the addition of backup devices operated directly from the array controller and may be convenient where hierarchical storage management is implemented.

The ability to operate the array in several RAID modes simultaneously may be helpful in managing the flow of data. If different array types can be created using different logical partitions, not only can the data be assigned to the RAID mode most efficient in handling it, but backups can be done selectively on partitions as appropriate.

Economics: The economic considerations relevant to arrays are not limited to acquisition costs. For the system integrator there are costs of integration and testing. All array users should recognize that there will be costs of training, spare parts inventories, preventive maintenance and other indirect costs. Also to be considered are the availability and cost of upgrades and expansions for the array. An initially inexpensive array may not be a bargain if it can't be expanded to meet future needs or if it won't work with new software releases. Other considerations:

* Does the storage capacity required justify RAID-3, RAID-4, or RAID-5? Would RAID-1 be less expensive? Do performance requirements require a hardware based array, or would a software array be acceptable?

* If a high degree of fault tolerance is not initially needed, can it be economically added in the future? Can you upgrade the array by loading new firmware, or must components be replaced?

* Will an array capable of operating at multiple RAID levels concurrently be a better cost-performance choice than an array which does not have such a capability? How easy is it to migrate data from one RAID level to another?

* How much system administrator time is needed to set up and configure the array? How much system administrator time is required to deal with reconfiguration or to deal with the results of a component failure? Some manufacturers will supply tools, such as Hewlett-Packard's AutoRAID, that have the potential to significantly reduce array created stresses on system administrators.

The most important cost of all may be the cost to the organization using the array if the stored data is not available for the time required to bring the failed system back into service. For some customers, badly degraded availability is almost as costly as complete unavailability, so the array's performance when a component fails may be a critical issue, even though the array continues to operate. Furthermore, once an array element fails, there is no remaining fault tolerance in most array configurations and the system will crash and may actually lose data if further failures occur while the original failure remains unrepaired. Many disk drive array users keep critical spare parts on-site to minimize the window of vulnerability.

Manufacturer support, warranty and maintenance policies and costs vary widely. Array users need to realistically evaluate their internal abilities to support the array with the assistance realistically expected to be available from the manufacturer.

Maintenance: Maintainability issues include the costs and availability of service, the ability of the array to be serviced by an end user in case of a component failure, the ability of the array to identify a failed disk drive and start up an on-line spare (if available), and the ability to replace disk drives and other elements of the array subassembly without disrupting operations (hot plugging or hot swapping). Some arrays will automatically recognize a failed drive and rebuild missing data on a spare drive. Others require the operator to physically replace a defective drive and manually initiate the data rebuild. Most disk drive arrays will continue to operate while a drive is replaced, and some allow replacement of a power supply, fan or other element without taking the array out of service. If battery backup or a UPS is used, the batteries may need to be changed periodically.

Arrays that minimize the complexity of the connections to the disk drives by employing serial interfaces or plug-in backplanes are likely to demonstrate significantly lower failure rates and repair costs than arrays constructed with parallel interfaces or connecting cables to the drives.

Some arrays make it easy to locate a failed drive, fan or power supply with indicator lights marking the defective element and software capable of reporting the failure of an array component over a network to a system administrator. Since removing the wrong drive when making an array repair will make data unavailable to users, the array design should provide protections against this kind of inadvertent error. Good fault detection systems help to insure the correct replacement parts are used.

It is often necessary to suppress I/O operations to an array member (and sometimes the array) while hot swapping is being done. The array manufacturer usually supplies utilities to do this if a host bus pause operation is required.

Another useful maintenance feature is the ability to run diagnostics in a non-intrusive manner while the system is in normal operation. This can develop useful information for service personnel and may help prevent repeated service calls.

Monitoring and control: Depending upon their design, arrays can be configured by commands from a dedicated control panel, by data from the host sent through the primary data bus, or by data from a remote processor via a separate RS-232 port. Some arrays are factory preset and offer the user little ability to change configuration.

Most arrays are provided with utility software that can be used to configure the array from the host or a remote processor. Some software is easy to use and includes safeguards against the user making disastrous choices. Some require considerable skill and knowledge to use.

Another desirable feature is the ability to monitor and control the array remotely over a network. Some arrays provide performance monitoring information on request, allowing network supervisors to detect impending drive failures, overheating conditions and other matters requiring remedial action before a failure actually occurs. The actual failure of a component can be detected, and in some cases, parts ordered and maintenance personnel notified automatically.

Some other considerations:

* What kind of messages or alert signals are generated when an array component fails? Messages to the server? Messages to a master console? Audible alarms? Can alarms be cut off once acknowledged?

* Can the system automatically dial a remote system and notify it of a failure? Can it notify a technician via a beeper?

Facilities requirements: Some highly fault tolerant arrays require dual AC power feeds from separate circuits. They may also require external uninterruptable power supplies (UPS) to sustain operation in case of power failure. Other requirements may exist for low noise creation by the array system, necessitating the use of quiet fans and disk drives. Variable speed fans are increasingly being used to minimize blower noise generation as well as to provide for continuation of adequate cooling in case of a fan failure.

1995 DISK/TREND REPORT

TECHNICAL REVIEW

Disk drive arrays come in a variety of configurations and implementations ranging from inexpensive and simple to costly and complex. This section of the report reviews some aspects of significant array technologies and issues pertaining to their use.

ARRAY TECHNOLOGY: STATUS AND POTENTIAL ENHANCEMENTS

Array architecture: The details of array architectures lie in the structure and location of the array management software, which can be host resident, array controller resident, drive controller resident, or scattered throughout the storage subsystem. Implementation can be in pure software, pure firmware, or a combination thereof. While the implementation can influence performance, economics, maintainability and other important factors, architecture is largely independent of implementation details. There are several ways to view array architectures:

* Layered versus nonlayered arrays: A nonlayered array controls array configuration at one point in the array structure, and typically operates as a pure RAID-3, RAID-5, etc. A layered array distributes different array configurations to different points in the array architecture. For instance, striping may be done in the array driver, while mirroring may be done at the disk controller level. This provides the advantages of both RAID-0 and RAID-1. Similarly, the array controller may stripe for RAID-3 while the disk controller provides a RAID-5 layer. Several array providers have implemented hybrid RAID-3/RAID-5 approaches to sidestep the write performance limitations of pure RAID-5 designs.

* Host based versus controller based arrays: If all of the array capability is associated with the host system (usually as a software implementation), rather than with a storage subsystem, there is great flexibility in configuring and using the array. The host can select its array members from among multiple subsystems, stripe to individual subsystems to improve performance, and provide a level of tolerance for catastrophic disasters that affect a particular subsystem. A host based array can also create arrays with older drives and storage subsystems otherwise incapable of being so operated. The downside is that the use of host resources may be disruptive in computing intensive environments. It may also be difficult for a host based array to take full advantage of the capabilities of intelligent disk drives and controllers because the host may not support the commands needed to do so. Controller based arrays are usually able to optimize storage subsystem performance, but are less able to optimize use of all of the storage resources attached to the host. A host based array may also be difficult to integrate with some operating systems if the

operating system is not modular, with well designed software interfaces. In such cases, the controller based array may offer more functionality.

* Modular architecture: This approach, still not fully implemented, incorporates a core array management software module that can be implemented in various forms and places within the storage subsystem, including the host as a virtual device driver, the host bus adapter, the array controller, or an intelligent device controller servicing multiple drives. The core module communicates through software interfaces appropriate to the location of the core module in the array. Modular architectures allow reuse of program code (which makes development and configuration of midrange and large systems easier), but tend to be too expensive to justify in low end systems. AT&T (now Symbios Logic) has been among the active investigators of modular array architectures.

* Augmented arrays: Much of the advanced work being done in array design centers around methods to reduce or eliminate write delays associated with the read-modify-write cycles associated with RAID-5 configurations. For some developers, the inclusion of large buffers and algorithms that allow the creation of a few large transactions from the combination of many small ones is a preferred approach. Others use combinations of RAID-3 and RAID-5 technology in which data is placed upon the drives in a RAID-5 format but written to the drives from a large buffer in parallel. Still another approach involves use of log structured files in which data is written into any available space with conversion to a RAID-5 format done while the system is otherwise idle. An augmented array frequently has a non-Berkeley RAID level defined by its manufacturer.

In some cases the array is bundled into an operating system or OS-like environment, such as Microsoft's Windows NTAS. Such implementations usually provide mirroring, duplexing or both. Some, such as Novell's SFT-III, duplex entire servers rather than requiring an array of disk drives. While providing fault tolerance, these approaches don't really qualify as an array product per se and have not been counted in the array statistics in this report.

Hierarchical storage: The more advanced and flexible array controllers provide for the support of tape drive, optical drives and automated libraries, allowing the host system to move inactive data to off-line or automated library storage and to stage recalled data to the disk drives for use. Some arrays allow the use of optical disk drives or tape drives as array elements, although not intermixed with magnetic drives. While feasible, the use of removable media makes careful physical volume management mandatory to avoid data corruption.

Packaging: Small array subsystems are usually packaged in tower or rack mount enclosures. Larger array subsystems are frequently integrated into floor standing cabinets along with other system elements. Some innovative ap-

proaches have emerged, including the modular array packaging of Micropolis and the practice of fitting the entire array, including drives, into the volume of a single 5.25" full height drive by using 2.5" disk drives for the array, such as the array announced by Core Technology. When 1.8" diameter drives achieve larger capacities, it is expected that arrays of PC card 1.8" drives will be sold in miniaturized packages.

The Micropolis approach packages a disk drive, power supply, fan and controller in modules, which may be stacked to make an array of the desired size. Advantages of this approach include flexibility, plus easy installation and expansion capability.

In the typical array, the disk drive is mounted on a removable frame, or SLED, which may also contain a power supply, fan and other elements associated with the drive. The array is designed to permit removal of the SLED without shutting down the array in most cases. Mathematically, service events are less likely in arrays that have common power supplies and fans, since there are fewer components to fail. In practice, service needs depend upon design techniques and avoidance of stress on array components. In particular, high RPM drives that generate unusual amounts of heat must receive adequate cooling to avoid unduly high failure rates.

Arrays implemented in software require no special packaging, but may influence system packaging as array drives are added or if additional memory is required in the processor to support array operations.

Driven by the need to reduce cost and improve reliability, array designers are abandoning conventional cabling for drive packages that plug into a backplane directly. Further simplification is expected in 1996 as serial interfaces begin to displace parallel SCSI interfaces. Perhaps the ultimate simplification is the anticipated migration of the board level array controller to a few chips located on a processor motherboard, a development that is anticipated in 1996, and which has the potential to seriously impact some producers of board level controllers.

Semiconductors: Specialized semiconductors for use in disk drive arrays have been available from AT&T (now Symbios Logic) since 1991, and other firms are also beginning to produce specialized chips for this purpose, including drive controllers, array management chips and specialized processors. As noted previously, basic array controller chips may migrate to the motherboards of computing systems, much as graphics controllers, modems and other I/O functions have already done. While this has negative implications for companies providing array controller boards, it is likely that high performance needs of servers and workstations will continue to create a demand for specialized controllers not required in sufficient quantities to justify chip development expense.

Flash memory is expected to have a significant role in future array controllers as a residence for the microcode associated with array management. The ability of flash memory to be updated will make it easy to perform field upgrades of arrays as new software versions are released.

The decreasing cost per megabit of semiconductor memory will tend to increase the likelihood of cache memory being present on array controllers and will tend to expand cache size. Array controllers for even small systems may contain several megabytes of cache, and cache sizes exceeding 50 megabytes are increasingly common.

Disk drives: The trend to higher areal density will continue. The drives that offer 800 megabits per square inch density today are expected to offer well over a gigabit per square inch in 1996. As a result, over a gigabyte will be available in a single platter 3.5" drive or a double platter 2.5" drive. By the end of the decade, leading edge drives are expected to be able to provide areal densities in the 10 gigabit per square inch range. With the reduced parts count implied, the cost per megabyte of storage is expected to steadily decline for the foreseeable future. If there are any serious concerns, they relate to the capability of read channel chips to advance at the same rate as areal density.

The 3.5" disk drive in the one inch high form factor is becoming the mainstay product for array producers because of its packaging efficiencies. Such drives with one gigabyte capacity have been available since 1993 from IBM and others: Availability of inch high 3.5" drives with 4 gigabytes capacity from several manufacturers is expected in 1996. At the present time, most array producers are using a mix of one inch and half height drives in their product lines because they cannot obtain all the drive types they need in the one inch form factor, so most array drive enclosures are still fabricated with drive canisters that will accept half height drives.

Disk drive performance is expected to improve. Though only marginal improvements in seek time are expected, 5,400 RPM spindle speeds have become common. Seagate, IBM and others are shipping 7,200 RPM drives, which are now widely used in arrays. Because of the potential heat generated by drives rotating at the higher speeds, packaging of these drives for easy removability in an array is challenging. Increases in areal density and increases in RPM will combine to produce higher data transfer rates in future disk drives, although the ability of the drive read channel to support these new capabilities will be stretched.

Disk drive arrays require drives with very high MTBF. With multiple drives in a system, the overall probability of a failure within a given time increases with the number of drives. To minimize service events or the possibility of two drives failing within the same time frame, very high drive MTBF is required, and the disk drive industry has responded by extending MTBF dramatically over the last several years. Hewlett-Packard initiated the MTBF race when it announced drives with 150,000 hours MTBF. Specified MTBF has climbed steadily through 200,000 hours and 500,000 hours to the 1,000,000 hour MTBF drives announced by IBM in 1993.

Arrays can make use of increased drive intelligence. The ability of a drive to test itself is significant in improving the operator's ability to monitor the health of the

array. If the drive can collect and report the occurrence and location of soft errors (Predictive Failure Analysis, or PFA), advance warning of impending failures is possible, as well as recognizing that a detected error may require repeating a transaction. The ability to reorder commands to improve performance by minimizing seek and rotational delays is also a useful capability. Some subsystem functions may migrate onto high end drives, including the exclusive OR computation.

For applications requiring isochronous data retrieval (equal data flow per time interval, with no interruptions), such as video servers, the drives must be able to retrieve data without interruption for such housekeeping events as thermal recalibration. Micropolis, IBM and Seagate offer drives for video server applications.

Spindle synchronization has been available for several years on some drives and is useful for RAID-3 implementations. Other drive related capabilities include the ability to be safely hot plugged and to operate with multiple controllers.

Interfaces: The interfaces involving arrays are the interface to the host computer, the interface to the drives, the interface to an array control device (which may be the host system) and the interface to the human operator.

Most array host interfaces use SCSI or SCSI-2, some in the fast and/or wide configuration. Arrays for PC based systems, such as Compaq's, frequently use the EISA bus, although there are also a few array controllers designed to attach to the older ISA bus, to the VESA bus, and to the NuBus. Future array designs are expected to accommodate the PCI bus. At the high performance end of the product range, arrays are connected through the HIPPI bus (some using the IPI-3 protocol). Support for SCSI tagged command queuing has become important to reduce latency delays and improve concurrent operations in RAID-4 and RAID-5 configurations. As the SCSI-3 command set is defined and implemented it is expected to see wide use in array controllers because it will support advanced commands and high data transfer rates useful in improving array performance. The ability to queue commands at the controller and at the drive provides a significant improvement in array performance.

Drives for arrays mostly use SCSI-2 interfaces, although a few arrays have been developed to use IDE interfaces. SCSI-3 and serial interfaces (SSA and fibre channel) are expected to be widely used with arrays because they support higher data transfer rates and, in the case of SCSI-3, up to 64 devices per SCSI address rather than the 8 devices of SCSI-2. Differential SCSI is starting to become more common, but is still infrequently encountered. Serial interfaces such as the fibre channel interface and IBM's SSA are expected to become widely available in 1996. Concerns about the power required by serial interface solutions may limit the rate of acceptance, especially in desktop and small server class equipment.

Drives configured to plug into parallel SCSI bus backplanes are adopting the Single Connector Attachment (SCA), eliminating unwieldy, expensive and failure prone cables and making drive removal and replacement faster and simpler.

Some arrays use separate RS-232 ports to communicate with a remote computer which functions as the control device for the array. Some systems provide control through the host computer, using utility routines that can be employed through the host console or across a network. These interfaces are expected to remain stable in form.

The human interface provided by arrays varies from very sophisticated and user-friendly to rudimentary and requiring expert experience (plus luck). The long-term trend is towards control and monitoring interfaces that can be used at varying levels of skill by authorized users of varying capabilities and which can be used on a server or over a network. An increased use of graphical user interfaces is expected.

Cache: The way cache is used in an array subsystem is one of the more significant determinants of performance and fault tolerance. The best way to employ cache may be nonobvious; cache may also exist within the host system or within the disk drives used in the array. Operating with all of these levels of cache active can lead to performance degradation and loss of data under fault conditions if they are not carefully coordinated, as in the multilevel caching employed in IBM's RAMAC. The optimum location and type of cache also varies with the architecture of the host computer and its associated storage subsystem.

Some array controllers contain cache, while others do not, anticipating that system cache or drive level cache will be adequate for performance needs. Most array controllers incorporate cache, usually both read and write cache. Many of the controllers with write cache incorporate battery backup to avoid data loss in the event of power failure. Other designs use nonvolatile semiconductors for write cache and at least one array design, the IBM 9337, employed a separate disk drive as a write cache device in its initial implementation.

Write cache in an array controller can be configured as a write-through cache, write-back cache or either. Write-through cache passes write operations directly to the disk drive, notifying the host system that the write is complete after all the drives have reported transaction completion. Write-back cache buffers the writes until the cache is full and then writes to all drives. A "write complete" status is given to the host when the data is placed in the cache. Write-through cache is typically employed in data base applications where multiple users need access to the latest possible version of a file. Write-back cache is employed where processor efficiency is of paramount concern.

Software: Array software can range from the expanded disk drivers used for simple disk mirroring on personal computers to the 300,000 plus lines of microcode needed to operate a mainframe array such as the Storage Technology Iceberg subsystem. The design complexities and testing requirements demanded by reliable interfaces to mainframe environments are major factors in determining when a high end product is ready to ship. However, array software add-on packages limited to providing mirroring and striping have been well accepted in systems running under the various types of UNIX and in Sun NFS environ-

ments. This success has been achieved primarily because well-defined interfaces between software modules have made array software relatively easy to integrate and support.

Array software is expected to migrate to microcode implementations at both the high end and the low end of array product lines, although array software for mirroring is expected to remain popular because of its relative ease of integration and lack of associated hardware expenses.

Compression: Data compression can help improve the performance of storage subsystems by reducing the number of bytes that must be sent to and from the disk. While the best location within the system to do data compression and decompression remains a subject of controversy, in the long run the argument is expected to be settled in favor of performing compression/decompression in the originating/using system, with data stored or transmitted in compressed form until reaching the processing point at which decompression is needed for processing. In many cases, a dedicated compression/decompression coprocessor will be used to avoid loading the host computer's primary processor with such a compute intensive task. There are many compression algorithms in use, with the choice depending upon the characteristics of the data to be compressed. Typical compression ratios range from 1.5:1 up to 200:1 depending upon the data type and content. There is no single method best for all types of data.

Some compression products for small systems require repartitioning of the disk drives, a feature not compatible with the capabilities of some arrays.

The STC Iceberg, which is intended to operate with mainframes, includes compression as a capability. It is unclear whether this will prove an advantage now that compression is beginning to appear as a feature included in some IBM mainframe systems.

Configuration and control: The ability to easily and reliably configure, control and monitor server arrays is a significant issue for system administrators. If the capabilities revealed by Hewlett-Packard in their early 1995 AutoRAID announcement are indicative of future trends, then future array users can expect to benefit from such adaptive features as array self configuration when drives are added or removed and automatic migration of data between RAID-1 and RAID-5 modes, depending upon the service request rate.

Standards: There are a number of standards issues that impact the development of the disk drive array market, most of which are being addressed by RAID Advisory Board committees. Among these are:

* Definition of a RAID-ready disk drive interface. The intent of the standard is to specify the minimum SCSI command requirements for the drive and how it responds, as well as setting forth requirements on connectors, mechanical configuration details, optional features and compliance test requirements. An industry vote on the definition is scheduled for May, 1995. The current target for the specification is the parallel SCSI-2 inter-

face. A related issue is how to define the interface to other types of devices in an array whose status must be controlled or monitored. These include fans, power supplies, indicators, controls, etc. Standardization efforts for these issues are scheduled for the latter portion of 1995.

* Definition of standard test procedures for determining if an array is properly functioning and if a drive complies with the RAID-ready standard being prepared under the auspices of the RAID Advisory Board.

* Definition of standard test procedures for benchmarking array performance. This is likely to be the most difficult area in which to reach agreement, as each manufacturer will have a set of conditions under which their array products will show optimum performance relative to competing products.

Many of the standards issues are being addressed by study groups established by the RAID Advisory Board. There is also an ANSI Technical Subcommittee (X3T10) with the charter to address RAID standards issues on a formal basis.

Hot plug capabilities: Ideally, it should be possible to exchange defective array components such as drives, power supplies and fans without removing power from the array or its host system. This requires that connectors be designed so when the component is removed, power is removed before the ground connection and that the ground is restored before power upon reinsertion. Furthermore, there should be no transients produced that can disrupt other array elements, nor should the drives be sensitive to shock events that might occur during hot swap operations.

COMPETING TECHNOLOGIES

Besides the mainline technologies discussed above, other data storage technologies may provide competition to arrays in years to come.

Nonarray storage architectures: If minimizing storage costs per megabyte is a primary objective and backup is sufficient for achieving data availability needs, a nonarray architecture will probably be chosen, ranging from a single disk drive at the low end to the strings of disks common in high end systems. However, the emphasis on data availability in networks suggests that nonarray architectures will be less appealing over time. A possible exception is the practice of mirroring complete nodes as opposed to mirroring the drives or mirroring the storage subsystem. This approach, admittedly expensive, has been promoted by Novell and others as an effective way of providing fault tolerance. However, duplexing can result in significant, extended network performance degradation if reconstruction of data from one duplexed server to another is needed.

Holographic storage: It is theoretically possible to store data at very high densities and at very high speeds using crystalline materials as the storage medium and laser scanning devices for input and output to the crystal array. Holographic storage for data is just leaving the pure research stage and entering the development stage. It is expected that there will be no competition to magnetic storage from holographic storage until well past the end of the century.

Holographic storage devices are expected to eventually offer capacities in the range of 200 megabytes to 10 gigabytes, have average access times in the 1 to 10 microsecond range and data transfer rates in the gigabyte per second range. Such devices could challenge RAID-0 and RAID-3 configurations implemented with rigid disk drives where very high data transfer rates are required.

Solid state arrays: It is possible to fabricate an array using solid state technology rather than disk drives. Although the cost per megabyte is substantially higher than for magnetic storage, if there is a requirement for very high speed or resistance to mechanical stress, solid state arrays may be appropriate. For example, Raymond Engineering has announced an array incorporating several of SunDisk's disk-emulating flash memory modules.

Because a solid state array is already very fast, performance improvement is not a primary motivation for using an array configuration, especially in large systems. However, fault tolerance is a desirable and legitimate reason for using solid state storage in an array configuration. Mirroring is the simplest, and probably most appropriate method, given the emphasis on speed in high end systems, but if utmost speed is not a requirement, RAID-5 organization could provide fault tolerance while minimizing the cost of expensive semiconductor memory.

At the smaller scale end of the systems world, arrays using flash memory cards may find a niche. Provided that each card maintains its own drive address, the cards could be placed in any PCMCIA slot providing disk drive support -- the exact order of insertion would not matter. However, implementation of arrays using removable media creates a storage management problem -- when the media is reinserted, there is a risk of synchronizing a recently created volume against an obsolete volume with the resultant loss of recent data.

Optical disk drive arrays: Optical disk drives can also be used in arrays. For instance, Pinnacle Micro's Orray stripes data across several optical drives to achieve improved data transfer rate while retaining removability. However, the removability of the media imposes the need for keeping the disks together as a set: Loss of a disk or scrambling of disk sets could make the data unrecoverable. If RAID-3 or RAID-5 were to be employed in the future, data could be reconstructed if only a single disk in the set was lost or damaged.

The most probable uses of optical disk drive arrays will be for image and video editing and content preparation, where removability is often desired.

GLOSSARY

GLOSSARY

In addition to the definitions of individual terms included in this section, the product groups, types of products, market classes, and geographical classifications used in this report are defined in the DISK/TREND Array Definitions, at the end of the opening summary section.

Actuator: The device used to position the movable heads in a drive. Linear actuators use a straight line motion, while rotary actuators turn around a pivot point.

Actuator level cache: A cache segmented to provide separate support to each individual actuator in a drive string, preventing monopolization of the cache by an actuator with an unusually heavy level of activity.

Areal density: A measure of the information stored per unit of area on the surface of a recording medium. Normally computed by multiplying tracks per inch times bits per inch, and expressed as megabits per square inch. (Depending upon the recording code used, bits per inch may not be the same as flux changes per inch.)

Array: A group of storage devices controlled in such a way as to provide higher data transfer rates through parallel operation, higher data availability through redundancy, or both. See RAID. Array functionality is provided by a specialized controller, specialized software or both.

Array processor: The processor in the array controller, separate from the host processor, that performs the local computing and control functions within the array.

Array software, array driver: Programs that operate multiple disk drives as an array directly from the host system without the need for a specialized hardware controller. The software performs typical array functions such as striping, error correction, parity functions, data recovery, etc. An array driver is a smaller piece of code controlling basic data flow functions to the array.

Automatic rebuild: The process by which data from a failed drive in an array is automatically reconstructed using another drive in the array. Manual rebuild is the same process, but is initiated upon operator command rather than automatically upon detection of a failure. See data reconstruction, rebuilding.

Automatic swap: Describes a situation where spare array components are automatically brought into active use when a similar component fails. The array continues to operate while the exchange is taking place, possibly at a degraded rate if data on a new drive must be rebuilt. See hot spare.

Availability: The probability that data will be available when requested within an acceptable time. If averaged over all data requests, it is the percentage of data requests satisfactorily fulfilled. "Satisfactory" may have different meanings in different applications.

Average access time: The average time elapsed between the time a command to access data is received by a disk drive and the time data begins to be transmitted or received. It usually consists of average head positioning (seek) time, average rotational delay (latency) time and settling time. If the drive uses an embedded controller, there may be an addition to controller latency caused by command processing within the drive.

Average positioning (seek) time: The average time required to move the head of a disk drive between tracks in response to random positioning requests. Frequently approximated as the time to move the head one third of the distance from inner track to outer track, beginning and ending with the head at rest. The time for the head to settle into its final position after it reaches the desired track is generally included. Often, and erroneously, referred to as "average access time". See average access time.

Average rotational delay (latency): The amount of time required for the disks in a disk drive to rotate through one half of a revolution, thus the average time for the drive to bring the beginning of the requested data block under the heads.

Bandwidth: The amount of data transmitted through a data channel per unit time. Usually expressed in terms of megabytes per second. To understand channel performance, it is useful to know how many signal conductors are included in the data channel.

Bit: The fundamental unit of digital information. In digital recording, it is a single recorded information cell.

Bit density (linear density): The number of recorded bits per unit distance as placed upon the tracks of a storage device. Typically given as BPI (bits per inch).

Cache: A portion of memory dedicated to collecting and holding related data until a processing, storage, communications or other module within the system is ready to process it. Cache is usually implemented as fast semiconductor memory, but other forms of memory are sometimes used. The form and architecture of the cache used is a major influence on system performance. See read cache, write cache, segmented cache, multiple threaded cache, actuator level cache.

Check disk, parity disk: Disk in an array that is dedicated to storing redundancy information.

Cold swap: Describes a situation where system operation must be stopped and power removed from the system before a defective component can be exchanged. See hot swap, warm swap.

Controller: A physical module that interprets signals sent between the host processor and a peripheral device. The controller is sometimes embedded within the peripheral device, but can also be implemented as a separate PC board or as chips on a host system motherboard.

DASD: Direct Access Storage Device. Traditionally, IBM's term for a disk drive.

Data reconstruction, Data rebuild: The process of recreating data that was stored upon a failed drive or is unavailable from a drive because of component failures. The source of the recreated data is data plus parity information from the operating drives.

Data stripe: A sequence of logically consecutive "stripe units" written to the disk drives in an array. A logical I/O request to a disk array corresponds to a data stripe, which may extend across one, several, or all the drives in the array depending upon the array configuration. See stripe unit.

Data transfer rate, drive: Maximum data rate from the disk drive to the array controller. The rate is a function of the interface transfer rate, bus width, and buffer output rate from the drive. It is usually measured in megabytes per second. The burst rate from the drive is the fastest instantaneous rate between the drive interface and the controller interface. The sustained rate is the rate at which data is extracted from the disks in the drive.

Data transfer rate, host: The rate of data exchange between the host processor and the array. It can be expressed as a burst rate (maximum instantaneous rate) or as a sustained rate (combined effective rate the drives in the array can produce when operating as a group over a period of time). Sustained rate varies as a function of the number of drives in the array and the array configuration.

Degraded operation, degraded mode: The state of operation of an array after a drive has failed. Performance is reduced because of the overhead associated with reconstructing data as requested, rebuilding data on a spare drive, or both.

Disk spanning: A technique that operates several disk drives from a single controller, with the entire set of drives appearing to the host system as a single drive. Data is not striped, nor is there any redundancy, so disk spanning is not recognized as an array technique.

Duplexing: A configuration in which each element of a system or subsystem is duplicated. For instance, in a duplexed RAID-1 array, for each drive pair, each drive has its own controller and host adapter.

Dynamic sparing: A technique that automatically transfers data to a spare drive when the detected error rate for an active drive exceeds a specified threshold.

Exclusive OR (XOR): The logical algorithm used to recover data from an array when a drive has failed.

External RAID: Array subsystem with the array controller and drives located externally to the enclosure of the host processor. Typically has a SCSI interface from host to controller. See Internal RAID.

Fault tolerance: The ability to operate normally, albeit at a degraded rate, even though one or more elements of a system have failed.

Fibre Channel: A high speed serial interface. The FC specification allows implementation with fiber optic cable or metal wire. A subset, fibre channel-arbitrated loop (FC-AL), supports strings of up to 126 devices. Data transfer rates may be up to 100 megabytes per second in each direction in a dual ported configuration.

Fire Wire: See P1394.

HIPPI: High performance parallel interface.

Hot spare, hot patch, on-line spare, automatic swap: In an array, a disk drive that is present but normally unused until there is a drive failure, at which time the drive is used to substitute for the failed drive. The data from the failed drive can automatically be rebuilt upon the spare drive, but may require operator intervention in some arrays. See automatic rebuild. By contrast, a cold spare is not installed in the system; it's a shelf item. While widely used among array producers and users, the term "hot spare" is actually a trademark of Core International.

Hot swap, hot fix, automatic swap: The ability to automatically exchange a defective component without shutting down the equipment of which the component is an element. In arrays, this typically refers to exchanging a drive, but may also apply to exchanges of fans, controllers, wiring or other elements.

Input/Output operations per second (I/O per second): See transaction rate.

Interleaving, data interleaving: The process of distributing a byte of data across several storage devices. Typically used in RAID-2 and RAID-3 arrays.

Internal RAID: Array subsystem with controller located inside the enclosure of the host processor. The array controller typically plugs into an I/O bus slot.

IPI: Intelligent Peripheral Interface. An older high performance interface which may still be found in some larger systems. Two variants: IPI-2 and IPI-3.

JBOD: Just a Bunch of Disks. Term used to refer to a multiple disk drive configuration in which there is no redundancy. Used by some manufacturers to mean a RAID-0 configuration.

Log Structured File System: A method of writing data into the first available space on a disk file. The data on the disk file is compacted so that there is always a large contiguous free space on the device. This technique avoids the delay in generating parity that slows down RAID-4 and RAID-5 arrays, but requires that the system do frequent housekeeping to insure that adequate free space is available on all drives.

Mirroring: A recording technique where data is recorded identically upon two or more disk drives. If a drive fails, operation continues using the other drive. If the drives are accessed for read concurrently, the first drive responding supplies the data. Drives operated in a mirrored mode are defined as a RAID-1 configuration.

MTBDL: Mean Time Between Data Losses. A statistic indicating the elapsed time before half of a group of arrays will experience events that cause data to be lost. Frequently interpreted as the average time between data loss for a single array. For an array with redundancy, this average can exceed 1,000,000 operating hours, but an individual array may fail at any time.

MTBF: Mean Time Between Failures. A statistic indicating the elapsed time a group of devices will operate before half of them experience failure. Frequently interpreted as the average time a single device will operate between failures.

MTDA: Mean Time of Data Availability. This is the average period of time data is available to be used for its intended purpose. See availability.

Multimode operation (Universal RAID): The ability of a disk array to operate in more than one RAID configuration simultaneously.

Multithreaded cache: A cache which has been segmented and in which each segment is assigned to support one of several simultaneously executing tasks.

P1394: Informally known as "Fire Wire". A specification for a serial interface, originally sponsored by the IEEE. While capable of supporting many types of devices, it is considered to be oriented more to video, multimedia and consumer applications. Has been supported strongly by Apple Computer.

Parity: A mathematical technique that adds bits to a data stream containing redundant information allowing reconstruction of the data stream if part of the stream is corrupted or absent. In arrays, single level parity permits data recovery from a single drive failure. Two level parity permits recovery from a two drive failure. Parity information may be held on one drive, as in RAID-3, or spread across all drives in the array, as in RAID-5.

Parity RAID: Refers to RAID level which uses a parity block to generate redundancy. Typically refers to RAID-3, RAID-4, RAID-5, RAID-6. Nonparity RAID refers to mirrored (RAID-1) or striped/mirrored (RAID-10) implementations.

PCI: Peripheral Component Interconnect. A high speed bus structure originally developed for PC compatible systems but now being offered on other platforms as well. The burst transfer rate is 132 megabytes per second, making it appropriate for use with high performance storage subsystems, especially those employing high speed serial interfaces to disk drives.

RAID: Redundant Array of Inexpensive Disks. This term was originally coined in 1987 at U.C. Berkeley, as was the initial categorization of RAID configurations. May also stand for Redundant Array of Independent Disks. See also, SLED.

RAID Advisory Board (RAB): The RAB is an association of organizations concerned with sales or purchases of drive arrays and closely related products. RAB activities include the proposal of standards for commonly used nomenclature, array interfaces, test procedures and definitions, and the promotion of array technology throughout the computer industry.

RAID level: A number designating the general configuration of an array. RAID configurations are defined and generally accepted for levels 0 through 5. Higher levels have been used by specific manufacturers to indicate additional features but are not universally accepted. See the Array Considerations section.

Read cache: A cache or cache segment dedicated to accumulating information read from the disk drives. Typically, the read cache will load a track or a few tracks of data on the assumption that the next data requested will be closely related to the initial data requested. The system will search the cache for requested information, initiating further disk accesses only if the desired information is not located in the cache.

Read-modify-write cycle: For RAID-4 and RAID-5 arrays, a write operation requires readback of data from the drives across which the data stripe is to be written, recomputation of the parity data, and rewriting the data and parity.

Read/Write ratio: The ratio of read operations to write operations in a typical host system work load. Important in selecting array configuration, because some configurations are inefficient in write intensive environments. Usually given as "x% reads" in data sheets.

Rebuild: See Reconstruction, Automatic Rebuild.

Reconstruction: The process of recreating the data from a failed disk, rebuilding the information on a new drive from data and parity information on the remaining functional drives. This can occur concurrently with normal operation in most arrays, although the processing overhead will slow the transaction rate.

Recovery period: The time required to reconstruct data from a failed disk drive.

Redundant drive: In a RAID-3 configuration, a drive dedicated to parity data.

SCSI: Small Computer System Interface. SCSI-2 is a more recently defined advanced version. The standard SCSI burst transfer rates for SCSI and SCSI-2 are 5 megabytes/second. Fast SCSI operates at up to 10 megabytes per second. Wide SCSI, with a double width bus, operates at up to 20 megabytes per second. Serial SCSI is a new 20 megabyte per second format using fewer cable wires. SCSI-3 is a proposed new standard adding some new commands, many of which are needed for efficient array performance. SCSI interfaces may operate asynchronously or synchronously. They may be single ended (6 meter cable length limit) or differential (25 meter cable length limit).

Segmented cache: A large block of cache memory divided in such a way that the segments are assigned to individual disk drives, hosts, or processing tasks.

Serial interface: An interface architecture in which data is transmitted in bit serial form rather than in parallel. IBM's SSA (Serial Storage Architecture) and FC (fibre channel) are leading contenders for industry adoption. SSA transmits at 20 megabytes per second, while FC operates at 100 megabytes per second. Typical use will be with two controllers serving large numbers of attached disk drives.

SLED: Single Large Expensive Disk. The alternative to RAID.

Spindle synchronization: A technique for causing the rotational position of all the disks in an array to be identical, facilitating the flow of information in parallel to the drives in the array. Usually used for RAID-3 configurations. Disk drives must be designed specifically to provide spindle synchronization capability.

SSA: Serial Storage Architecture. This is a full duplex, 4 wire channel operating at 40 megabytes per second in each direction, providing high transfer rates and a less costly, more reliable way to connect up to 126 devices to the array controller. Originally devised by IBM, it is also supported by a number of disk drive and system manufacturers.

Storage overhead, array overhead: The percentage of the total capacity of the disks in the array that is used to store redundant information needed to recover data or correct errors. The percentage varies with array configuration and number of disks in the array.

Striping: The process of recording data on several recording devices, distributing blocks of data on each device. The exact striping method depends upon the RAID configuration.

Stripe depth: The amount of data placed on a drive in the array during a transaction, measured in stripe units.

Stripe unit: A unit of data interleaving; the amount of physical data placed upon a disk drive before data flow is switched to the next disk drive in the array. Stripe units normally range from a sector to a track in length and are typically 512 bytes to 64K bytes long.

Throughput: The number of I/O requests completed in a unit of time. Usually expressed as requests per second.

Track density: The number of recording tracks per unit distance, measured perpendicularly to the direction of the recorded track. Usually given as TPI (tracks per inch).

Transaction rate (I/O per second): A transaction is the successful completion of a read or write request for a block of data. A data block access may require multiple reads or writes. Transaction rate is the number of successfully completed transactions per second. Often given with a qualification of workload mix as random requests, sequential requests, or mixed requests, and the read/write ratio.

Ultra SCSI: Also called "Fast-20"/"Fast-40". A faster version of the SCSI interface, with 20 megabyte per second transfers for 8 bit bus and 40 megabytes per second over a 16 bit bus. It uses the same interface as fast or fast/wide SCSI, and can be considered an intermediate step between SCSI and serial interface architectures.

Virtual disk drive: Virtual drives are not a single physical drive. They appear to the system as a single disk drive, but may in fact be implemented in software, semiconductor memory, or as a collection of drives, or even as a portion of a single drive. They are conceptual constructs, rather than physical entities.

Warm swap: Describes a situation where system operation must be halted in order to replace a defective component, but power need not be removed from the system. Frequently encountered in RAID-0 systems and older redundant arrays.

Write cache: A cache or cache segment used to accumulate data before writing to the disk on the theory that a single large write operation is more efficient than several smaller transfers. Can mask the write latency of the drives to the host system. Write cache is usually in semiconductor form, although IBM used a disk drive in its initial Model 9337 array models.

Write latency: As seen by the host system, the period of time between the initiation of a write transaction and the time at which the storage subsystem has indicated successful completion of write operations. If a write cache is present,

write latency is considerably shortened. Depending upon the array configuration, the write latency period may incorporate multiple reads and writes by individual drives in the array. See Read-modify-write cycle.

Write-back cache: Data is accumulated in the cache and the host system is told that the write operation is complete as soon as the cache is loaded. The cache contents are transferred to the disk when the optimum block size is available.

Write-through cache: Data placed in the cache is transferred to the disk when all data relevant to a transaction have been placed in the cache. The host system is notified the write is complete when all drives involved have signaled the completion of the transaction. Typically used for data base applications.

XOR (Exclusive OR): The logical operation used to recover data from an array when a drive has failed. The function may occur within the host, on the array controller, or at the drive level of an array architecture. System efficiency tends to increase as the site of the computation moves further from the host processor.

ARRAYS: SINGLE USER SYSTEMS

1995 DISK/TREND REPORT

ARRAYS: SINGLE USER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Advanced Technology Systems	AXRD-540A/S
APS Technologies	Arraid
FWB	SledgeHammer series
MaxConcept	SW-4100R
Micronet Technology	Raven Pro
Microtech International	Blue Streak
Mirror Technologies	Precision FT
MountainGate Data Systems	Passport XL
Nippon Texa	Texa RST-540
Optima Technology	4200W, 8200W
Raidtec	FlexArray MX
Ranger Plug 'N' Go	Plug 'N' Go
Seraph	Gemini SE
Spin Peripherals	Whirlwind

Board assembly (no drives)

Arco Electronics	AC1079MC
Aresys	IDACO-1000
ATON Systemes	AREKA I-10S
ATTO Technology	Silicon Express
CMD Technology	CRD-6560
Procom Technology	ISA SCSI Xelerator
Raidtec	RUAC MX
Silicon Valley Computer	ADP 104, 111
Tekram Technology	AHA 154X, 680C
Teledisk	DMS2000

Software arrays

ATTO Technology	Express Mirror
CharisMac Engineering	Anubis Raid
Cyranex	EZRAID Lite
NCL America	NCL 8825
Trillium Research	Remus Ltd.

Shipments in this product group started in 1990, with early software and board level arrays. All disk drive arrays used primarily with single personal computers or workstations are included in this product group. Although individual arrays offering RAID-3 or RAID-5 capability are included among the above subsystem, board and software arrays, they remain the exception, and in some

cases are intended for high-end workstations used for graphics and prepress applications. Most of the array products in this product group are designed for the very price sensitive personal computer markets, and use disk mirroring.

The majority of array products offered for single user computer systems are designed for the Macintosh market, with most offering RAID-0 and/or RAID-1 capability. The large data storage requirements for many graphics applications for which Macintosh systems are widely used have created a demand for both the high data rates offered by RAID-0 striping and the reliability provided by RAID-1 mirroring.

Market status

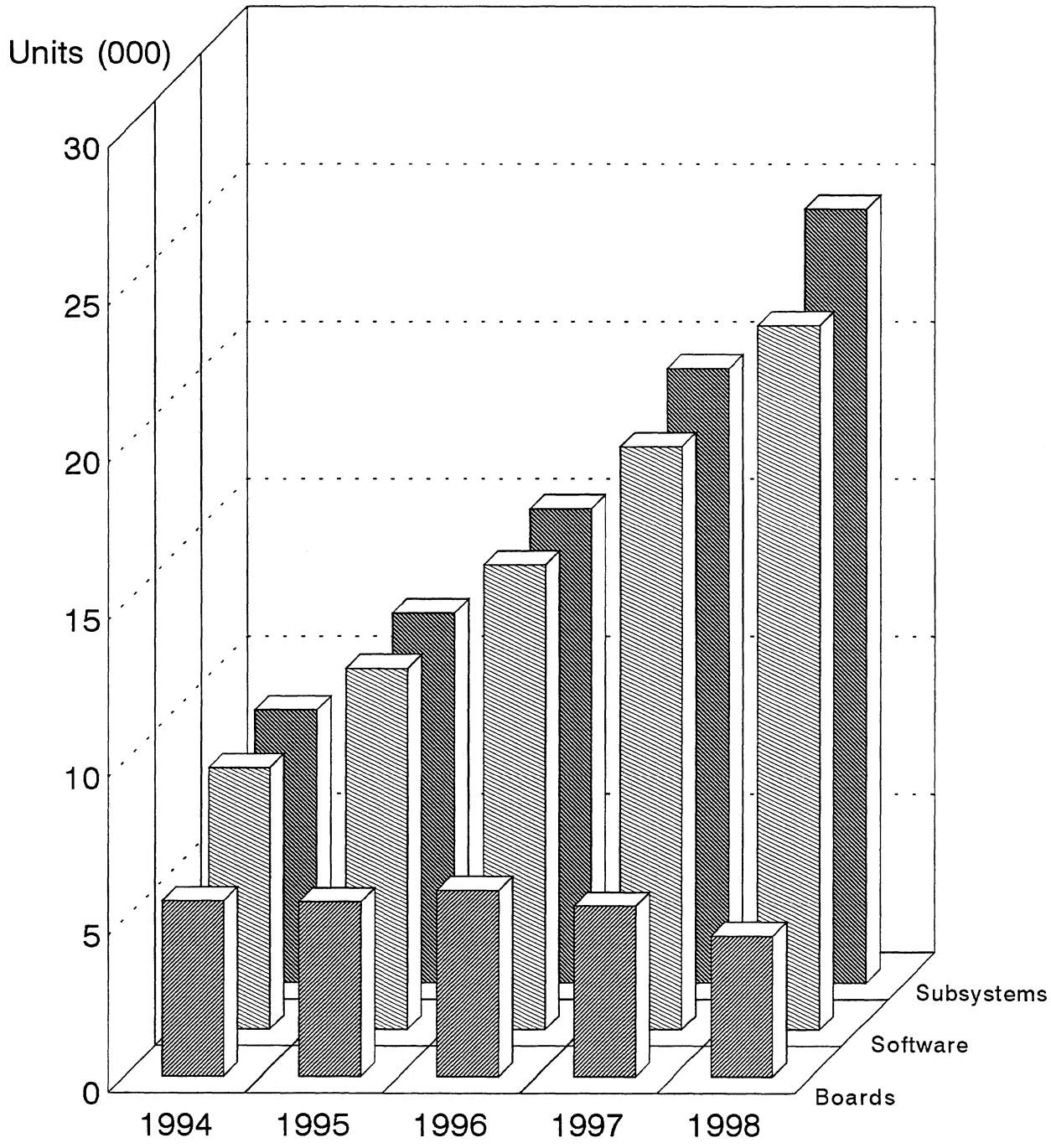
Although worldwide shipments of single user arrays increased 24.3% in 1994, for a total of 22,495 units, sales revenues were only $16.0 million, down 4.2% from the previous year, as all types of arrays in the product group were impacted by rapidly declining prices. A high percentage of array products specifically intended for single users are RAID-1 and RAID-0/1 products that have encountered increased price sensitivity during the last few years in both the Macintosh and IBM compatible personal computer markets.

A basic shift in product mix occurred in 1994, as array controller boards lost shipment leadership to complete subsystems, with 38.5% of the worldwide total, and to array software products, with 36.7%. Complete subsystems produced 83.2% of the product group's 1994 sales revenue, as many users responded to the improved values made possible by lower cost, higher capacity disk drives, plus the greater convenience of installing a complete subsystem. Software array products are now rivaling complete subsystems for leadership in unit shipments, but not in revenues due to very low unit prices. With most single user applications, there is usually no probability that the array software will overload the computer processor, so software products can provide a low cost, high performance array for the serious computer do-it-yourselfer.

FWB retained leadership in noncaptive unit shipments for single user arrays, capturing 30.6% of the 1994 worldwide total, with a continuing concentration on complete subsystems for the Macintosh market. Unitrol Data Protection Systems climbed to 18.7% with RAID-1 software for the IBM PC compatible market.

Figure 6

Single User System Arrays
Worldwide Shipments by Array Type



Marketing trends

Single user disk drive arrays are expected to remain the smallest of the four DISK/TREND array product groups in total revenues, with only .3% of the projected overall sales revenue total for 1998. Despite the continued rise in the projected share of the product group's shipments held by complete subsystems and the forecasted start of captive shipments, the continuing decline of average prices for all types of arrays in each market channel will hold the forecasted 1998 sales revenues for the group to only $51.4 million. Total unit shipments of single user arrays are forecasted to reach 51,370 units in 1998, an average increase for the 1996-98 period of 21.4% per year.

Complete subsystems are forecasted to continue their growth pattern through 1998, providing 47.9% of that year's unit shipments, a total of 24,555 units. Shipments of boards and board assemblies are currently flat, and are expected to decline to only 8.7% of the product group's overall 1998 shipments. Because of the relatively small capacity of single user arrays, it is believed that the majority will remain RAID-1 types, usually with RAID-0 capability, for the next few years, with some migration to RAID-5 complete subsystems, using 2.5" drives with higher capacities packaged in very small array enclosures. Software array products are also projected to maintain a growth pattern through 1998, reaching 43.4% of 1998's unit shipment total, and continuing to provide the lowest cost entry point for many individual users to the disk drive array market.

The single user array market remains an add-on market served primarily by independent peripheral vendors specializing in the Macintosh and IBM compatible personal computer markets. Array manufacturers headquartered in the U.S. have led in development of the growth markets for single user array subsystems and boards and are expected to retain 60.8% of 1998 worldwide revenues. The PCM/Reseller channel is expected to remain dominant in sales of arrays for single user systems, and is forecasted to capture 71.1% of 1998 total unit shipments for all types of single user arrays.

Technical trends

Today's developing market for single user arrays is made possible by the continuous improvement in disk drive areal density, which has provided the low cost, high capacity 3.5" drives used in most of the arrays in this product group.

During the next few years 3.5" drives are expected to remain dominant, while evolving to even lower prices and higher capacities. Most arrays intended for single user applications do not stretch the capabilities of the disk drives, software, controllers or other technology now employed, and the performance levels available are more than adequate for most single users.

A few manufacturers have taken advantage of the availability of 2.5" drives to offer multiple disk complete array subsystems in the form factor of full size 5.25" disk drives. This packaging provides array capability in a smaller space than usual, but not small enough for many single users, since most current personal computers are designed to use 3.5" drives. However, the physical size of these arrays can be decreased as time goes on, as the capacity of 2.5" drives increases. Individual 2.5" drives are already available in capacities over one gigabyte, and the capacities available in 2.5" drives will continue on an upward path. RAID-5 arrays with adequate capacity for many sophisticated single user applications will be cost-effective with high capacity 2.5" drives packaged in small enclosures.

Forecasting assumptions

1. The market for single user arrays will continue to grow, but will generate purchases from only a small segment of Macintosh, PC compatible and UNIX workstation users.

2. Complete subsystems will increase in shipments due to low disk drive costs and increasing demand for user convenience, and software array products will increase in shipments due to low cost and negligible degradation of system performance in typical single user applications.

3. U.S. manufacturers will continue to lead the worldwide market for single user arrays, due to aggressive product development and continuously changing competitive conditions.

TABLE 10

SINGLE USER SYSTEMS

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast							
	1995		1996		1997		1998			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	3.6	4.8	4.2	5.9	6.7	9.7
PCM/Reseller	10.1	14.9	8.8	12.4	9.7	13.8	10.4	14.9	9.9	14.4
OEM/Integrator	.1	.2	.1	.3	.4	.7	.7	1.0	1.2	1.8
TOTAL U.S. REVENUES	10.2	15.1	8.9	12.7	13.7	19.3	15.3	21.8	17.8	25.9
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	.3	.7	.3	7.6	1.2	10.1	1.9	12.8	2.8	15.9
OEM/Integrator	.1	.2	.2	.3	.3	.4	.3	.5	.4	.8
TOTAL NON-U.S. REVENUES	.4	.9	.5	7.9	1.5	10.5	2.2	13.3	3.2	16.7
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	10.6	16.0	9.4	20.6	15.2	29.8	17.5	35.1	21.0	42.6

TABLE 11

SINGLE USER SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1994		Forecast							
	Shipments		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	1,200	1,600	1,510	2,100	2,690	3,900
PCM/Reseller	12,100	17,455	13,900	19,135	14,870	20,695	17,025	24,105	17,760	25,520
OEM/Integrator	430	640	820	1,250	1,360	2,010	1,985	2,700	2,700	3,700
TOTAL U.S. SHIPMENTS	12,530	18,095	14,720	20,385	17,430	24,305	20,520	28,905	23,150	33,120
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	1,785	2,950	2,100	5,920	3,105	7,975	3,825	9,905	4,800	12,620
OEM/Integrator	950	1,450	1,700	2,400	2,380	3,400	3,065	4,570	3,665	5,630
TOTAL NON-U.S. SHIPMENTS	2,735	4,400	3,800	8,320	5,485	11,375	6,890	14,475	8,465	18,250
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	15,265	22,495	18,520	28,705	22,915	35,680	27,410	43,380	31,615	51,370
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	31	45	50	74	73	110	100	153	132	205

TABLE 12

SINGLE USER SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1994 Revenues			Forecast											
	1995			1996			1997			1998		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	--	--	--	--	--	--	4.8	--	--	5.9	--	--	9.7	--	--
PCM/Reseller	13.1	1.1	.7	10.5	1.0	.9	11.4	1.1	1.3	12.6	.9	1.4	12.2	.6	1.6
OEM/Integrator	--	.2	--	--	.3	--	.3	.3	.1	.8	.1	.1	1.6	.1	.1
TOTAL U.S. REVENUES	13.1	1.3	.7	10.5	1.3	.9	16.5	1.4	1.4	19.3	1.0	1.5	23.5	.7	1.7
NON-U.S. MANUFACTURERS															
PCM/Reseller	.2	--	.5	7.2	--	.4	9.5	.2	.4	12.1	.1	.6	15.1	.2	.6
OEM/Integrator	--	--	.2	--	--	.3	--	--	.4	.1	--	.4	.2	--	.6
TOTAL NON-U.S. REVENUES	.2	--	.7	7.2	--	.7	9.5	.2	.8	12.2	.1	1.0	15.3	.2	1.2
WORLDWIDE RECAP															
Captive	--	--	--	--	--	--	4.8	--	--	5.9	--	--	9.7	--	--
	--	--	--	--	--	--	--	--	--	+22.9%	--	--	+64.4%	--	--
PCM/Reseller	13.3	1.1	1.2	17.7	1.0	1.3	20.9	1.3	1.7	24.7	1.0	2.0	27.3	.8	2.2
	-2.9%	-50.0%	+100.0%	+33.1%	-9.1%	+8.3%	+18.1%	+30.0%	+30.8%	+18.2%	-23.1%	+17.6%	+10.5%	-20.0%	+10.0%
OEM/Integrator	--	.2	.2	--	.3	.3	.3	.3	.5	.9	.1	.5	1.8	.1	.7
	--	+100.0%	+100.0%	--	+50.0%	+50.0%	--	--	+66.7%	+200.0%	-66.7%	--	+100.0%	--	+40.0%
Total Revenues	13.3	1.3	1.4	17.7	1.3	1.6	26.0	1.6	2.2	31.5	1.1	2.5	38.8	.9	2.9
	-2.9%	-43.5%	+100.0%	+33.1%	--	+14.3%	+46.9%	+23.1%	+37.5%	+21.2%	-31.2%	+13.6%	+23.2%	-18.2%	+16.0%
ANNUAL SHARE, BY TYPE	83.2%	8.1%	8.7%	86.0%	6.3%	7.7%	87.3%	5.4%	7.3%	89.8%	3.1%	7.1%	91.2%	2.1%	6.7%

TABLE 13

SINGLE USER SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1994 Shipments			Forecast											
	1995			1996			1997			1998					
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	--	--	--	--	--	--	1,600	--	--	2,100	--	--	3,900	--	--
PCM/Reseller	8,540	5,335	3,580	8,710	5,100	5,325	9,510	4,910	6,275	11,485	4,750	7,870	12,215	3,530	9,775
OEM/Integrator	--	240	400	--	450	800	140	560	1,310	650	300	1,750	1,430	170	2,100
TOTAL U.S. SHIPMENTS	8,540	5,575	3,980	8,710	5,550	6,125	11,250	5,470	7,585	14,235	5,050	9,620	17,545	3,700	11,875
NON-U.S. MANUFACTURERS															
PCM/Reseller	90	--	2,860	3,000	--	2,920	3,770	455	3,750	5,025	370	4,510	6,530	770	5,320
OEM/Integrator	--	--	1,450	--	--	2,400	--	--	3,400	220	--	4,350	480	--	5,150
TOTAL NON-U.S. SHIPMENTS	90	--	4,310	3,000	--	5,320	3,770	455	7,150	5,245	370	8,860	7,010	770	10,470
WORLDWIDE RECAP															
Captive	--	--	--	--	--	--	1,600	--	--	2,100	--	--	3,900	--	--
	--	--	--	--	--	--	--	--	--	+31.3%	--	--	+85.7%	--	--
PCM/Reseller	8,630	5,335	6,440	11,710	5,100	8,245	13,280	5,365	10,025	16,510	5,120	12,380	18,745	4,300	15,095
	+45.3%	-35.5%	+101.3%	+35.7%	-4.4%	+28.0%	+13.4%	+5.2%	+21.6%	+24.3%	-4.6%	+23.5%	+13.5%	-16.0%	+21.9%
OEM/Integrator	--	240	1,850	--	450	3,200	140	560	4,710	870	300	6,100	1,910	170	7,250
	--	+300.0%	+193.7%	--	+87.5%	+73.0%	--	+24.4%	+47.2%	+521.4%	-46.4%	+29.5%	+119.5%	-43.3%	+18.9%
Total Shipments	8,630	5,575	8,290	11,710	5,550	11,445	15,020	5,925	14,735	19,480	5,420	18,480	24,555	4,470	22,345
	+45.3%	-33.0%	+116.4%	+35.7%	-.4%	+38.1%	+28.3%	+6.8%	+28.7%	+29.7%	-8.5%	+25.4%	+26.1%	-17.5%	+20.9%
ANNUAL SHARE, BY TYPE	38.5%	24.8%	36.7%	40.9%	19.3%	39.8%	42.2%	16.6%	41.2%	45.0%	12.5%	42.5%	47.9%	8.7%	43.4%

TABLE 14

SINGLE USER SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Subsystems	--	--	3,000	2,800	2,500
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	--	--	3,000	2,800	2,500
PCM/Reseller					
Subsystems	1,537	1,509	1,569	1,495	1,452
Boards	203	206	217	205	200
Software	163	158	173	158	142
PCM/Reseller Average	755	799	828	814	793
OEM/Integrator					
Subsystems	--	--	1,500	1,022	936
Boards	591	533	500	450	400
Software	104	95	93	92	85
OEM/Integrator Average	160	149	171	218	265

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 15

SINGLE USER SYSTEMS

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
FWB	4,920	--	--	4,920	32.2	6,890	--	--	6,890	30.6
Unitrol Data Protect.	--	--	2,650	2,650	17.4	--	--	4,210	4,210	18.7
Silicon Valley Comp.	--	1,320	--	1,320	8.6	--	2,200	--	2,200	9.8
Trillium Research	--	--	1,870	1,870	12.3	--	--	2,160	2,160	9.6
Other U.S.	900	2,300	1,220	4,420	29.0	1,650	3,375	1,820	6,845	30.4
Other Non-U.S.	--	--	85	85	.5	90	--	100	190	.9
TOTAL	5,820	3,620	5,825	15,265	100.0	8,630	5,575	8,290	22,495	100.0

ARRAYS: NETWORKS, MINICOMPUTERS, MULTIUSER SYSTEMS

1995 DISK/TREND REPORT

ARRAYS: NETWORKS/MINICOMPUTER/MULTIUSER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

AC Technology	Concorde
Acer	Altos 17000
Adjile Systems	Panther series
ADS International	ADS/2000
Advanced Logic Research	Data Station
Advanced Technology & Systems	ASRS-D1080S
Allodyne	A510, A1010
American Digital Systems	Masterdisk RAID
ANDATACO	Gigaraid GTS, GRS
Apple Computer	AppleRAID
Applied Digital Systems	A 510
Aresys	IDAC-IE
Artecon	LynxRAID+
AST Research	Manhattan series
ATON Systemes	AREKA VDS
Auspex Systems	NS-7000 series
Avcom Systems	Avcom RAID
Aviv	Duet, Mustang
Baydel	DAR3, DAR5 series
BoxHill	RAID Box 530
Cambex	Array/6000 series
Ciprico	NA6700, AD 6710
Clovis	MultiStor series
CMD Technology	CRD-5000, CSV-8150
Compaq Computer	ProLiant, ProSignia series
CompuAdd	DriveArray
Computer Marketplace	Acceleraider
CompuTrend Systems	Array option
Conley	SR2, SR3
Conner Storage Systems	CR611 series, CR622
Core International	COREarray, LA-4000
Dallas Digital	RAIDstor
Data General	CLARiiON series
Datalink	RSG 300, RSD 500
Dataram	DTM900, DTM4000
Data Storage Marketing	Datastor RAID
Dell Computer	DSA
Digital Equipment	HSC65 series, StorageWorks series
Direct Connect Systems	Guardian RAID
Disk Pack	DP.RAID series
DPT	SmartRAID series
DynaTek Automation Systems	RDR, XPRS series
ECCS	FFT series, Micro DFT

Complete subsystems, with disk drives (continued)

EMC	Harmonix, ModARRAY, Centriplex
Eurologic Systems	EL-RAID series
Falcon Systems	FalconRAID
Formation	9937 series, fd5000 series
Fujitsu	F7956, DynaRAID series
Future Computers	RAIDER-5
FWB	SledgeHammer series
Gain Systems	Superserver
Hewlett-Packard	C2440JA
High Performance Storage	Wildcat series
Hitachi	A-6511, HitRAID series
IBM	9337, 3514, 7135
ICL	PowerARRAY
Information Management Technologies	RAIDiance
Invincible Technologies	Ultimate 1, 5
IPL	Raidtower
La Cie	Joule RAID
Legacy Storage Systems	SmartArray
Lighthouse Technology	Rhapsody
Marner International	DSV-201
Media Integration	SMARTstor
Megabyte Memory Products	MegaRAID
Mega Drive Systems	MR/5, MR/10, MX/500
Micronet Technology	RAIDbank series
Micropolis	RAIDION, RAIDION LT series
Midori	MD-RAID
Morton Management	GBR-RD series
MTI Technology	FailSafe, Stingray series
NEC	N1137 series
NetFRAME	NF250 FT, NF450 FT
Network Appliance	FAServer series
Network Connection	T.R.A.C Array
Nippon Texa	DAF-4000, DAH-2000
Nissin Electric	PRORAID series
OMNI Technology	MacRAID, RAIDSTOR series
Optima Technology	HST 20000
PACE Technologies	PACE RAID-5
Pacific Micro Data	MAST VII, MAST VIII
Parity Systems	6000 series
PC Expanders	Arrayserver
Perisol Technology	RAIDsafe Plus
Phoenix International	Raidmaster
Polywell Computers	Supra RAID
Precision Computers	486-XX
Procom Technology	2000, LFRAID series
RAAC Technologies	ESP1000
Raid Power	UltraRAID2
R Squared	CR-11, EL-11
See First Technology	Array System
Seek Systems	S450
Sequent Computer Systems	Winserver 3000

Complete subsystems, with disk drives (continued)

Sequoia Systems	DS4003
Seraph	AU-1
Solid Computer	M10, M20
Spin Peripherals	Internal RAID
Storage Computer	CLx, D3x, D5x, R3x, R5x
Storage Concepts	Concept 750, Concept 810
Storage Dimensions	LANStor series
Storage Solutions	CM-02 series
StoragePath	SP-9BTHT
Storage Technology	Northfield
StorNet	Dynastor 8
Stratus Computer	D600 (K121)
Sun Microsystems	SPARCstorage series
Symbios Logic	3201, 3701, 6299
Tandem Computers	4500, 4510, 4570
Tangent Computer	Raid5Server, Multiserver
TEAC	TEAC-Stor series
Texas Microsystems	FTSA series
Total Tec Systems	Triad
Transoft	DataDock
Uni Solution	USI RAID
Unisys	MasCab-2, UCR-6000
Western Scientific	Cyclone, Hurricane
Winchester Systems	Flashdisk 3, FlashCluster
Xyratex	R9000
Zenith Data Systems	RAID option
ZZYXZ Workstations & Peripherals	ZRS-3000

Board assembly (no drives)

Adaptec	AHA-3980, AHA-3985
ADS International	ADS/3000
American Megatrends	MegaRAID 412
Aresys	IDACO-2000
ATEN International	AI-700
ATON Systemes	AREKA E-10F
BusLogic	BT-7952
Canary Communications	IDA3500
CMD Technology	CRD-5000, Trident
Conley	SHA-400
Consensys	RAIDIX/IDE
Control Data Systems	47008
Digi-Data	Model Z, Z9000
Digital Equipment	HSD05, HSD30
DPT	SmartCache series
Diverse Logistics	Windjammer
Dynatek Automation Systems	AddARRAY
ECCS	Vanity
Eclipse Technologies	920SD
Fujitsu	CTLR
Hewlett-Packard	C3609A

Board assembly (continued)

Hi-Data	SC-510, SC-550
INFOCOM Digital Systems	INF-961
Infortrend	IFT-1000, IFT-3000
Lomas Data Products	LDP Cache series
Micropolis	Gandiva
Mylex	DAC-960 series
OMNI Technology	RAIDstor
Perceptive Solutions	dataSHADOW, quickRAID
Raidtec	FlexArray, Ruac IX
Rose Datasystems	Rose-1000, Rose-7000
Seek Systems	SEEK Array
Silicon Valley Computer	ADP 120, ADP 130
Symbios Logic	3201, 3701
TD Systems	Omniserve 2, 3
Tricord Systems	PowerRaid, ISS
UltraStor	124F, 144F
Vortex Computersysteme (ICP-Vortex)	GTD2000, GTD6000
Winchester Systems	Flashserver

Software arrays

1776, Inc.	76SC34, 76SC34H
AT&T Global Information Solutions	Disk Array Plus
BusLogic	Chantal 5.0 NW
CLone Star Software	Reflect, Alter Ego
Concurrent Computer	SCSI DEXS
Conley	SoftRAID
Consensys	RAIDIX
Corel	Network Manager
Cyranex	EZRAID Pro
Digital Equipment	Volume Shadowing 6.0
FWB	RAID ToolKit
Nonstop Networks	No-Stop Network
Perceptive Solutions	quickSHADOW
Sun Microsystems	Online: DiskSuite 3.0
Trillium Research	REMUS 1.3
TwinCom	Dual Mirror, Network Mirror
Unitrol Data Protection Systems	Immunity 2
Veritas Software	VxVM, VxMirror

This product group includes disk drive arrays intended primarily for use with networks, minicomputers and multiuser systems. While mirrored disk, or RAID-1, implementations have been available for many years, the group has seen an explosion of product introductions of RAID-3 and RAID-5 arrays since the early pioneering efforts in the mid-1980s. Arrays have originated with system manufacturers, disk drive manufacturers, independent peripherals resellers and con-

troller manufacturers, network server manufacturers, software development firms, and startup companies founded for the sole purpose of making disk drive arrays.

The complete subsystems included in this product group cover a broad range of capabilities, from highly redundant fault tolerant superservers to small arrays of 2.5" drives packaged in the form factor of a 5.25" drive. Most of the subsystems are somewhere between these extremes, with a wide variation in physical size, price and redundancy of critical components.

A strong majority of the complete subsystems in this product group offer either RAID-3 or RAID-5 capability, or both -- and most of these were introduced during the last three years. A very high share of array subsystems shipped until now have been RAID-1 mirrored disk implementations. Many of the RAID-1 shipment leaders have offered RAID-1 subsystems on a captive basis with midrange minicomputers, such as Digital Equipment, Tandem Computers and Stratus Computer, with superservers available from Auspex and NetFRAME, and with plug compatible subsystems for the IBM AS/400 add-on market from EMC and IPL.

A high percentage of the array board assemblies also now provide RAID-3 and/or RAID-5 capability. This report groups boards, array assemblies complete with everything except disk drives, and all levels in between, in the board assembly product group. Customers for the board manufacturers typically include computer system manufacturers, plus independent storage subsystem and server manufacturers, which assemble the completed array subsystem, as well as sophisticated computer users with a do-it-yourself urge. Array software is also typically purchased or licensed by the same buyers. Although the majority of array software offerings are RAID-0/1 or RAID-1, RAID-5 software is available from multiple vendors.

Market status

1994 was another exceptional growth year for disk drive arrays intended for the networks/minicomputer/multiuser market. Shipments increased to 375,392 units, and sales revenues to $3.8 billion. However, while unit shipments increased 93.5%, revenues were up only 52.4%, revealing the extreme pressure on disk drive array manufacturers to reduce price levels.

81.0% of the 1994 sales revenues for this product group were generated by arrays sold on a captive basis by system manufacturers, a total of almost $3.1 billion. The two factors which boosted captive revenues to such a high level were very high captive shipments of complete subsystems, 74.9% of all subsystems for the entire product group, and the fact that captive arrays are sold at higher prices than arrays sold through noncaptive marketing channels. Captive arrays sold in this market not only earn the higher prices for products sold at the end user level, but tend to contain larger quantities of high capacity disk drives and are frequently designed for a higher level of fault tolerance, with mostly redundant key components. Strong shipments of all types of complete array subsystems by Compaq Computer, IBM, Data General, Hewlett-Packard, Digital Equipment, Dell Computer, Stratus Computer, Tandem Computer and Sun Microsystems have contributed to the high captive shipment total. Although overall shipments of all types of captive networks/minicomputer/multiuser arrays are expected to increase 20.9% in 1995, captive sales revenues are forecasted to be up only 6.5%, as average prices continue to fall.

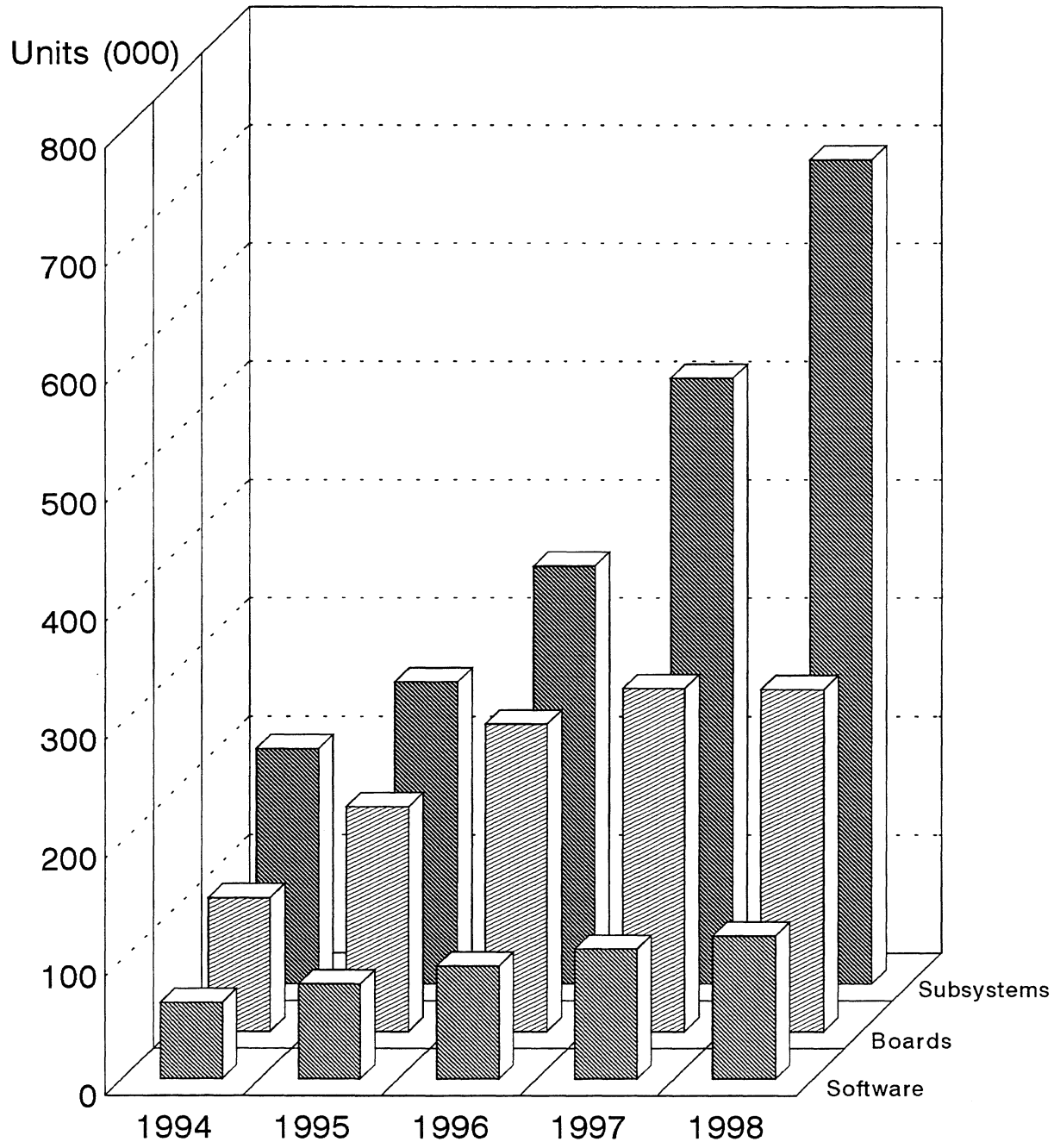
Arrays sold in the PCM/Reseller channel have a clear lead in noncaptive sales revenues and unit shipments, and are currently enjoying a strong growth year. PCM/Reseller revenues for 1994 were $493.4 million, with 1995 forecasted at $903 million. Complete subsystems provided 47.9% of PCM/Reseller unit shipments in 1994 and will generate 43.5% of the 1995 unit shipments, but well over 90% of the sales revenue total in each year. Most of the more than 100 companies now active in this segment are providing arrays for use with personal computer and UNIX workstation file servers, and a few are active in the IBM AS/400 add-on market. PCM/Reseller sales of array boards and board assemblies are also expected to double in 1995, as new marketing programs by significant producers take effect.

Although complete subsystems lead in OEM/Integrator sales revenues, array board level products dominate shipments. 92,785 boards were shipped in 1994, 74.4% of all OEM/Integrator unit shipments, with 144,820 boards forecasted for 1995, 76.0% of the total. The success of Compaq Computer in developing personal computer network markets for its family of array subsystems has prompted a high proportion of the other personal computer manufacturers to plunge into the array subsystem market, and the majority have turned to outside

Figure 7

Networks/Minicomputer/Multiuser System Arrays

Worldwide Shipments by Array Type



suppliers for array controller boards. In 1994, 58.5% of arrays in this product group were used with servers to which primarily personal computers were attached, and PC's are expected to utilize an increasing share of all networks/minicomputer/multiuser arrays.

Mylex has become the industry's array controller board success story, and the company has achieved a strong leadership position in board shipments for the networks/minicomputer/multiuser product group. Mylex' 67,000 boards were 33.2% of the worldwide noncaptive unit shipment total for 1994. An 8.6% share of unit shipments was held by AT&T Global Information Solutions (all boards) and Veritas held 7.9% (all software arrays).

Marketing trends

The networks/minicomputer/multiuser product group is destined to remain the largest array market in the 1996-98 period, with the highest growth rate for both sales revenues and unit shipments. Revenues are forecasted to top $10.2 billion in 1998 and worldwide shipments are projected at 1,106,220 units. It is clear that a very high percentage of computer networks will be equipped with file servers utilizing disk drive arrays by the end of this decade.

Although overall shipments and revenues for networks/minicomputer/multiuser arrays will continually increase through 1998, extensive changes in the industry's product mix are expected. Complete subsystems are projected to hold an increasing share of the product group's sales and shipments as more users move to completely assembled storage solutions, accounting for 63.1% of 1998 unit shipments and 95.8% of sales revenues. Individual software packages will continue to be interesting to some users who already have computer systems using multiple disk drives, and to those who acquire systems with bundled array software. On the other hand, the software array products favored by typical computer do-it-yourselfers are forecasted to continue their decline during the same period, with unit shipments at 10.8% of the 1998 total for the product group, and 1.9% of sales revenues. It is believed the typical end users will prefer to acquire and use complete array subsystems, to avoid the nuisance and complexity of separately purchasing software, disk drives, enclosures, cables, etc.

The sales outlook for array boards and board assemblies in the 1996-98 period is more complex. Significant new single chip and chip set array controller implementations for the networks/minicomputer/multiuser market are expected to become available in 1996, and these products are expected to displace array board sales in gradually increasing quantities in subsequent years. After 1997, board shipments in this product group are expected to start declining, with board sales revenues forecasted to drop 12.1% in 1998. The transition to array controller chips mounted on system motherboards will not occur overnight, but is expected to require several years. During the same period, many improvements in array architecture will make arrays more flexible and easier to use, and most of these innovations will be implemented first in board-level array products.

1998 captive sales revenues for the product group are forecasted to top $7.3 billion, with 97.7% derived from complete subsystems. PCM/Reseller 1998 revenues are projected to exceed $1.8 billion, almost four times greater than the 1994 level, also driven by subsystem sales, which are expected to be 95.8% of the 1998 total for the sales channel. 77.4% of the OEM/Integrator channel 1998 sales revenues are also expected to be derived from complete subsystems, but the picture for unit shipments is quite different. 68.6% of OEM/Integrator 1998 unit shipments are forecasted to be boards and board assemblies, with growth fueled by the demand for arrays from system manufacturers and network server manufacturers lacking the resources or time to develop their own arrays.

Average selling prices per unit are expected to decline continually during the 1996-98 period for each marketing channel. The average price increases realized by noncaptive subsystems during 1995 were caused by a general movement to array subsystems with a higher level of fault tolerance and more disk capacity in "client/server" applications, mostly in larger companies. This is expected to be a onetime step up in product positioning. Future price declines will be driven by high shipment levels and lower disk drive pricing.

Companies headquartered in the United States dominated sales revenues for the networks/minicomputer/multiuser product group in 1994, with 98.0% of the worldwide total. Although the array market is now spreading throughout the world, U.S. based companies are expected to retain 94.7% of the 1998 worldwide revenue total. The next three years will see continuous improvements in

disk array architecture, electronics, packaging and marketing techniques -- all areas of strength for most of the U.S. companies participating in development of the array market.

Technical trends

The possibility that disk drive array functions may be embedded in future operating systems or in chips mounted on system motherboards provides the major area of uncertainty for today's disk drive array manufacturers. It is expected that the first single chip RAID-5 implementation suitable for motherboard installation will be available in 1996, eliminating the need for a separate array controller board. Operating systems that include array functions are not included in the DISK/TREND Report shipment and revenue totals.

Limited array capabilities already have been included in some existing operating systems for minicomputers and mainframes by Digital Equipment and IBM. These operating system options allow users to mirror disks available on a system, or as with Novell's SFT III network system, to mirror complete file servers on a network. It is considered likely that some of the new operating systems expected to appear during the next few years will contain disk array features. However, their probable effect on the market for hardware based arrays and separate software array packages is expected to be modest, and has been anticipated in DISK/TREND Report forecasts.

Any software based array must use a portion of the processor's capabilities to perform its tasks, and in a heavily used system the penalty is an impact on system performance. This is an insignificant factor in most single user systems, but in the networks/minicomputer/multiuser market represented by this product group it is undesirable in many situations. Hardware based arrays will continue to have the performance advantage.

The existing hardware based arrays are expected to benefit from a continuous stream of improvements in architecture, to improve performance; in packaging, through smaller disk drives and reduced chip sets; and in user convenience, improved through internal software changes. Hewlett-Packard's 1995 introduction of AutoRAID, which uses a new method to map host block addresses to disk drive addresses, includes many of the expected improvements, includ-

ing dynamic data migration between RAID modes, the ability to expand array capacity on-line, and continuous utilization of hot spare drives.

Much of the future growth for RAID-5 arrays, especially in low-end configurations, will depend on better price comparisons with mirrored disk arrays. And larger RAID-5 arrays must minimize their price disadvantage compared to assemblies of individual disk drives, which are becoming more reliable every month. As with other electronics industry products, most of the contribution to lower costs will probably come from higher shipment volume and new product designs which lower the hardware parts count.

The impact on high-end network superservers will be higher capacity in smaller cabinets, with steadily improving price per megabyte. Midrange arrays, which today frequently sacrifice some fault tolerance for lower price tags, will combine higher reliability with even lower prices. The smallest arrays will be offered in even smaller physical packages, with new disk drives and reduced chip sets making possible complete arrays in the physical size of a typical 3.5" disk drive.

Forecasting assumptions

1. Networks for personal computer and workstation applications will continue to grow at a high rate.

2. U.S. manufacturers will continue to dominate the worldwide array market, due to aggressive product development and continuously changing competitive conditions.

3. Complete subsystems will achieve higher growth than software array products by providing users with the convenience of complete array subsystems and typically higher performance.

4. Growth in array board shipments will flatten starting in 1997, with declining revenues, due to competition from single chip array controllers to be introduced in 1996.

TABLE 16

NETWORKS/MINI/MULTIUSER

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994 Revenues		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	1,539.3	3,048.4	1,606.6	3,252.7	2,158.6	4,148.5	2,893.5	5,667.2	3,638.0	7,265.4
PCM/Reseller	308.0	475.5	598.1	886.0	734.1	1,102.3	942.2	1,435.5	1,139.2	1,760.7
OEM/Integrator	159.6	221.0	238.9	336.9	347.8	486.9	416.1	600.3	469.7	697.7
TOTAL U.S. REVENUES	2,006.9	3,744.9	2,443.6	4,475.6	3,240.5	5,737.7	4,251.8	7,703.0	5,246.9	9,723.8
Non-U.S. Manufacturers										
Captive	--	45.1	--	41.9	.3	67.8	1.3	99.8	2.0	126.9
PCM/Reseller	9.3	17.9	9.6	17.0	16.0	29.1	26.3	45.6	40.1	66.9
OEM/Integrator	4.8	13.1	101.3	133.4	165.3	219.8	217.1	291.2	260.3	352.3
TOTAL NON-U.S. REVENUES	14.1	76.1	110.9	192.3	181.6	316.7	244.7	436.6	302.4	546.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	2,021.0	3,821.0	2,554.5	4,667.9	3,422.1	6,054.4	4,496.5	8,139.6	5,549.3	10,269.9

TABLE 17

NETWORKS/MINI/MULTIUSER

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1994		Forecast							
	Shipments		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	89,800	170,575	104,728	206,980	146,800	281,710	205,985	402,505	273,600	544,890
PCM/Reseller	46,881	69,483	75,719	114,185	96,425	148,760	116,425	182,745	132,760	211,450
OEM/Integrator	92,720	121,227	134,080	165,300	176,370	222,380	197,635	255,975	202,070	269,405
TOTAL U.S. SHIPMENTS	229,401	361,285	314,527	486,465	419,595	652,850	520,045	841,225	608,430	1,025,745
Non-U.S. Manufacturers										
Captive	--	2,815	--	2,720	20	4,240	85	6,650	140	9,060
PCM/Reseller	4,145	7,877	5,460	10,325	6,905	14,040	8,715	17,655	10,590	20,820
OEM/Integrator	810	3,415	18,315	25,295	26,015	36,320	31,870	44,940	35,570	50,595
TOTAL NON-U.S. SHIPMENTS	4,955	14,107	23,775	38,340	32,940	54,600	40,670	69,245	46,300	80,475
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	234,356	375,392	338,302	524,805	452,535	707,450	560,715	910,470	654,730	1,106,220
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	403	658	741	1,183	1,194	1,890	1,755	2,801	2,409	3,907

TABLE 18

NETWORKS/MINI/MULTIUSER

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1994 Revenues			Forecast											
	1995			1996			1997			1998					
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	2,925.7	5.3	117.4	3,118.0	--	134.7	3,999.2	--	149.3	5,503.4	--	163.8	7,093.4	--	172.0
PCM/Reseller	451.0	18.5	6.0	825.3	52.9	7.8	1,028.7	67.0	6.6	1,361.1	67.6	6.8	1,693.6	60.5	6.6
OEM/Integrator	112.3	95.8	12.9	227.3	92.4	17.2	328.5	137.0	21.4	442.1	133.1	25.1	556.7	113.3	27.7
TOTAL U.S. REVENUES	3,489.0	119.6	136.3	4,170.6	145.3	159.7	5,356.4	204.0	177.3	7,306.6	200.7	195.7	9,343.7	173.8	206.3
NON-U.S. MANUFACTURERS															
Captive	45.1	--	--	41.9	--	--	67.8	--	--	99.8	--	--	126.9	--	--
PCM/Reseller	13.2	2.4	2.3	11.0	3.6	2.4	20.4	6.3	2.4	35.7	7.3	2.6	56.5	7.7	2.7
OEM/Integrator	.4	12.4	.3	99.4	33.6	.4	165.3	53.8	.7	234.9	55.2	1.1	301.0	49.9	1.4
TOTAL NON-U.S. REVENUES	58.7	14.8	2.6	152.3	37.2	2.8	253.5	60.1	3.1	370.4	62.5	3.7	484.4	57.6	4.1
WORLDWIDE RECAP															
Captive	2,970.8	5.3	117.4	3,159.9	--	134.7	4,067.0	--	149.3	5,603.2	--	163.8	7,220.3	--	172.0
	+53.1%	-1.9%	+5.6%	+6.4%	--	+14.7%	+28.7%	--	+10.8%	+37.8%	--	+9.7%	+28.9%	--	+5.0%
PCM/Reseller	464.2	20.9	8.3	836.3	56.5	10.2	1,049.1	73.3	9.0	1,396.8	74.9	9.4	1,750.1	68.2	9.3
	+37.2%	-3.7%	+56.6%	+80.2%	+170.3%	+22.9%	+25.4%	+29.7%	-11.8%	+33.1%	+2.2%	+4.4%	+25.3%	-8.9%	-1.1%
OEM/Integrator	112.7	108.2	13.2	326.7	126.0	17.6	493.8	190.8	22.1	677.0	188.3	26.2	857.7	163.2	29.1
	+177.6%	+159.5%	+676.5%	+189.9%	+16.5%	+33.3%	+51.1%	+51.4%	+25.6%	+37.1%	-1.3%	+18.6%	+26.7%	-13.3%	+11.1%
Total Revenues	3,547.7	134.4	138.9	4,322.9	182.5	162.5	5,609.9	264.1	180.4	7,677.0	263.2	199.4	9,828.1	231.4	210.4
	+53.0%	+95.3%	+17.5%	+21.9%	+35.8%	+17.0%	+29.8%	+44.7%	+11.0%	+36.8%	-.3%	+10.5%	+28.0%	-12.1%	+5.5%
ANNUAL SHARE, BY TYPE	92.9%	3.5%	3.6%	92.7%	3.9%	3.4%	92.8%	4.4%	2.8%	94.4%	3.2%	2.4%	95.8%	2.3%	1.9%

TABLE 19

NETWORKS/MINI/MULTIUSER

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1994 Shipments			Forecast											
				1995			1996			1997			1998		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	145,975	1,900	22,700	179,580	--	27,400	249,950	--	31,760	366,890	--	35,615	506,670	--	38,220
PCM/Reseller	36,524	15,765	17,194	53,545	41,290	19,350	70,950	55,820	21,990	97,220	61,380	24,145	125,450	60,500	25,500
OEM/Integrator	12,867	89,480	18,880	12,790	125,520	26,990	17,290	171,200	33,890	24,560	190,220	41,195	32,750	188,960	47,695
TOTAL U.S. SHIPMENTS	195,366	107,145	58,774	245,915	166,810	73,740	338,190	227,020	87,640	488,670	251,600	100,955	664,870	249,460	111,415
NON-U.S. MANUFACTURERS															
Captive	2,815	--	--	2,720	--	--	4,240	--	--	6,650	--	--	9,060	--	--
PCM/Reseller	512	2,250	5,115	745	3,700	5,880	1,410	5,710	6,920	2,550	7,240	7,865	4,180	8,080	8,560
OEM/Integrator	30	3,305	80	5,855	19,300	140	9,180	26,900	240	13,815	30,690	435	18,810	31,180	605
TOTAL NON-U.S. SHIPMENTS	3,357	5,555	5,195	9,320	23,000	6,020	14,830	32,610	7,160	23,015	37,930	8,300	32,050	39,260	9,165
WORLDWIDE RECAP															
Captive	148,790	1,900	22,700	182,300	--	27,400	254,190	--	31,760	373,540	--	35,615	515,730	--	38,220
	+76.5%	--	-3.8%	+22.5%	--	+20.7%	+39.4%	--	+15.9%	+47.0%	--	+12.1%	+38.1%	--	+7.3%
PCM/Reseller	37,036	18,015	22,309	54,290	44,990	25,230	72,360	61,530	28,910	99,770	68,620	32,010	129,630	68,580	34,060
	+96.6%	+73.6%	+155.8%	+46.6%	+149.7%	+13.1%	+33.3%	+36.8%	+14.6%	+37.9%	+11.5%	+10.7%	+29.9%	--	+6.4%
OEM/Integrator	12,897	92,785	18,960	18,645	144,820	27,130	26,470	198,100	34,130	38,375	220,910	41,630	51,560	220,140	48,300
	+736.9%	+146.9%	+164.3%	+44.6%	+56.1%	+43.1%	+42.0%	+36.8%	+25.8%	+45.0%	+11.5%	+22.0%	+34.4%	-.3%	+16.0%
Total Shipments	198,723	112,700	63,969	255,235	189,810	79,760	353,020	259,630	94,800	511,685	289,530	109,255	696,920	288,720	120,580
	+89.8%	+126.0%	+62.0%	+28.4%	+68.4%	+24.7%	+38.3%	+36.8%	+18.9%	+44.9%	+11.5%	+15.2%	+36.2%	-.3%	+10.4%
ANNUAL SHARE, BY TYPE	53.0%	30.0%	17.0%	48.7%	36.2%	15.1%	50.0%	36.7%	13.3%	56.3%	31.8%	11.9%	63.1%	26.1%	10.8%

TABLE 20

NETWORKS/MINI/MULTIUSER

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Subsystems	19,966	17,333	16,000	15,000	14,000
Boards	2,800	--	--	--	--
Software	5,175	4,917	4,700	4,600	4,500
Captive Average	17,841	15,711	14,744	14,094	13,344
PCM/Reseller					
Subsystems	12,532	15,405	14,500	14,000	13,500
Boards	1,161	1,253	1,190	1,089	994
Software	367	402	311	292	272
PCM/Reseller Average	6,376	7,251	6,950	7,389	7,867
OEM/Integrator					
Subsystems	8,739	17,527	18,653	17,640	16,635
Boards	1,165	869	962	852	741
Software	695	648	645	630	602
OEM/Integrator Average	1,878	2,467	2,731	2,962	3,281

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 21

NETWORKS/MINI/MULTIUSER

SERVER ARRAY ATTACHMENT ANALYSIS
Percentage of Worldwide Shipments

	1994 Estimate		1998 Projection	
ATTACHMENT	Units	%	Units	%
PERSONAL COMPUTER SERVERS Servers with primarily personal computers attached	219,477	58.5	735,636	66.5
WORKSTATION SERVERS Servers with primarily workstations attached	68,605	18.3	190,270	17.2
OTHER SERVERS Servers with primarily other terminal devices	87,220	23.2	180,314	16.3
Total	375,392	100.0	1,106,220	100.0

Notes: 1: Arrays are assigned to the server category indicated, based upon the predominant type of equipment attached to the associated server.

2: "Personal Computer" means IBM PC Compatible, Apple Macintosh or equivalent.

3: "Workstation" means Sun, Silicon Graphics, or functional equivalent.

4: "Other" means POS terminals, dumb terminals, specialized equipment, and terminals not otherwise categorized.

TABLE 22

NETWORKS/MINI/MULTIUSER

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Mylex	--	54,800	--	54,800	37.9	--	67,000	--	67,000	33.2
AT&T GIS	--	10,700	--	10,700	7.4	--	17,400	--	17,400	8.6
Veritas	--	--	11,000	11,000	7.6	--	--	16,000	16,000	7.9
Hewlett-Packard	8,200	--	--	8,200	5.7	14,800	--	--	14,800	7.3
FWB	7,870	--	1,960	9,830	6.8	11,830	--	2,800	14,630	7.2
Transoft	--	--	7,000	7,000	4.8	--	--	10,000	10,000	5.0
EMC	3,670	--	--	3,670	2.5	5,480	--	--	5,480	2.7
Other U.S.	12,892	16,105	5,404	34,401	23.8	17,281	20,845	7,274	45,400	22.5
Other Non-U.S.	245	800	3,910	4,955	3.5	542	5,555	5,195	11,292	5.6
TOTAL	32,877	82,405	29,274	144,556	100.0	49,933	110,800	41,269	202,002	100.0

Note: Shipments of software array manufacturers may not include shipments of array software licensed to some system manufacturers and produced by those manufacturers.

ARRAYS: MAINFRAME SYSTEMS

1995 DISK/TREND REPORT

ARRAYS: MAINFRAME SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Cambex	Cascade 3, 3X
Comparex	TETRAGON 2000
EMC	Symmetrix series
Encore Computer	Infinity SP30
Fujitsu	F6493
Hitachi	A-6591/A-6595
Hitachi Data Systems	7600, 7700
IBM	RAMAC Array
Macro Computer Products	Macro-RAID 7
Storage Technology	Iceberg, Nordique
Unisys	M9760, USP 5500

All disk drive arrays intended primarily for use with mainframe computer systems are included in this product group. Operating systems that include array functions, such as the ability to mirror individual disk volumes, are not included in this report or counted in the statistics. The earliest activity in the group was represented by the Control Data Systems shipments of its early RAID-3 disk drive array in 1989, now no longer available.

In the early 1990's, EMC's Symmetrix series of subsystems with RAID-1 mirrored disk capability became the dominant array product for the IBM mainframe plug compatible market, supplemented in mid-1993 with Hitachi Data Systems' 7600 subsystem with RAID-1 capability. In mid-1994, EMC increased the competitive pressure on IBM with RAID-1 Symmetrix models using Seagate's 9 gigabyte 5.25" drives at aggressive prices. The most publicized sequence of events in the mainframe array field was Storage Technology's failure to deliver the pioneering Iceberg array. However, after a costly and embarrassing two year delay in initial shipments, Storage Technology's Iceberg array became a significant participant in the mainframe array market in 1994.

After losing large segments of the mainframe disk storage market to competitive arrays, IBM finally entered the field with a major array program in late September, 1994, under the recycled RAMAC brand name. The RAMAC currently attaches to the IBM 3990-6 controller, with a maximum capacity of 180 gigabytes,

limiting the installation per controller to two RAMAC units, each with up to 64 3.5" drives with formatted capacities of 1.4 gigabytes. Despite the RAMAC controller capacity limitation, IBM has maintained a high shipment rate through mid-1995, effectively replacing the 10.8" 3390 disk drive series in mainframe applications, and offering a lower price per megabyte combined with higher reliability. IBM is expected to offer a new array controller in mid-1996, eliminating the 180 gigabyte limitation, and also to offer higher capacity disk drives, further improving price per megabyte.

Market status

During 1994 and 1995, shipments of disk drives into the mainframe market have been undergoing a rapid conversion from the traditional subsystems with individually addressable drives to subsystems with array capability, starting with RAID-0/1 and RAID-1, supplemented with RAID-5 and RAID-5 variations.

Complete subsystems are the only type of arrays which have been shipped in this product group. Mainframe users are not likely to constitute a market for board level arrays, nor have individual software array products been sold in significant quantities.

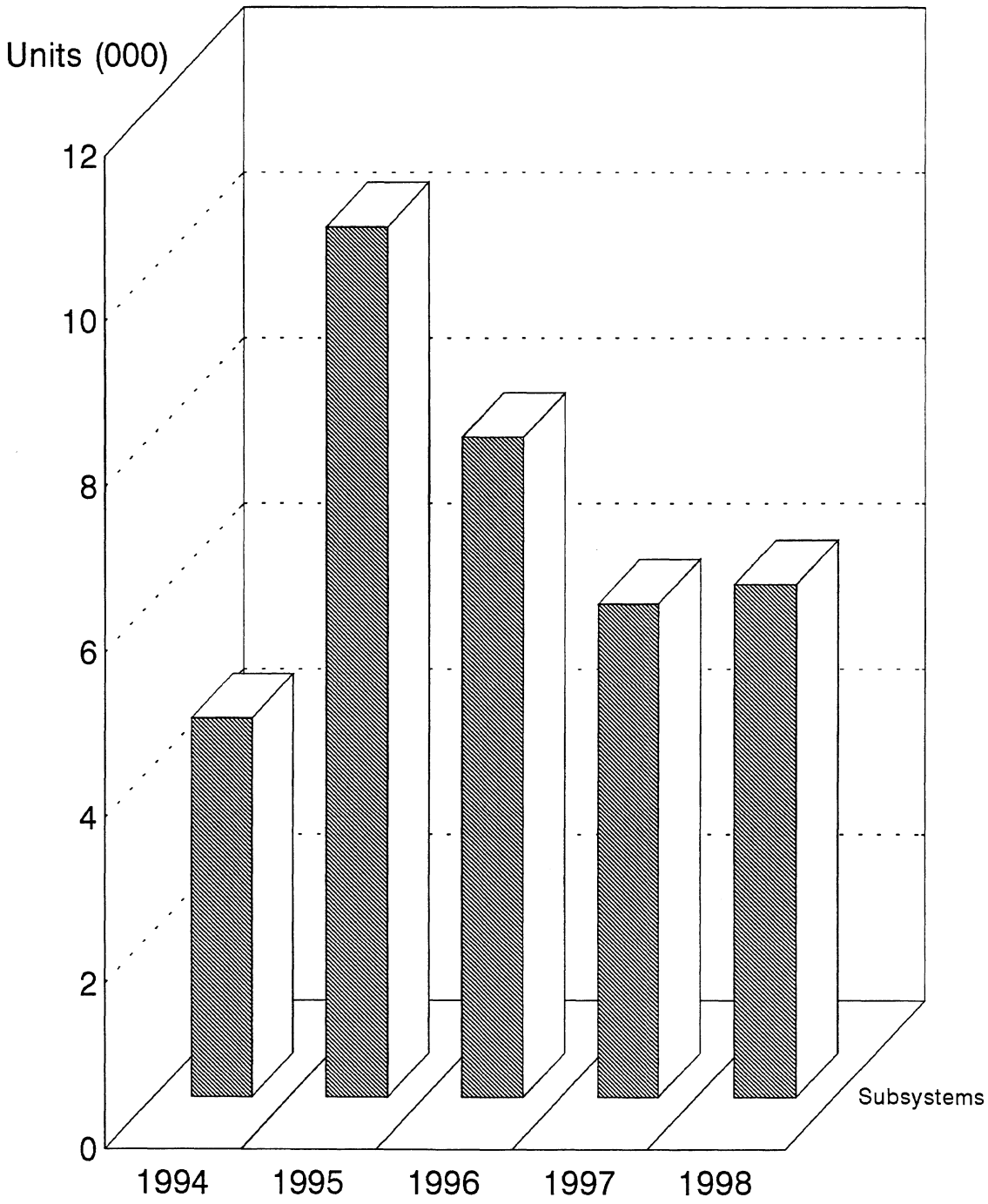
EMC's success with the Symmetrix subsystem (providing RAID-0/1 and RAID-1 capability) is the largest reason for the PCM/Reseller revenue levels achieved in 1994 by this product group, supplemented by Storage Technology's initial year of revenues for the Iceberg and Hitachi's sales of RAID-1 mainframe subsystems. PCM/Reseller sales revenues for 1994 were $1.4 billion, 76.9% of the worldwide total for the product group. It should be noted that while the disk storage subsystems shipped to date by both EMC and Hitachi Data Systems have the capability to operate in RAID-1 mode and are therefore included in DISK/TREND Report array totals, they are not necessarily continually operated as arrays by their purchasers.

With major RAMAC array shipments by IBM in the fourth quarter of 1994, the expected rapid growth of captive mainframe array sales revenues got under way. IBM's shipments produced $270 million in captive sales revenue in 1994, and the total for 1995 is projected to jump to more than $1.2 billion. Although 1995 forecasted captive sales revenue is similar to the forecast from last year's

Figure 8

Mainframe System Arrays

Worldwide Shipments by Array Type



DISK/TREND Report, the current unit shipment total is much higher than last year's forecast, since the array unit is smaller than expected, due to IBM's decision to limit each RAMAC unit to 64 drives of only 1.4 megabytes net capacity.

In 1994, EMC continued to dominate noncaptive shipments of disk storage subsystems with array capability for the mainframe market, including shipments in both the PCM/Reseller and OEM/Integrator sales channels. EMC held 67.9% of worldwide noncaptive shipments, followed by Hitachi Data Systems with 19.6% and Storage Technology with 12.0%.

Marketing trends

During the forecast period of this report, the future prospects for mainframe arrays will be defined by the future outlook for mainframe computer systems. Although much of the work previously accomplished by mainframe systems is now being diverted to "client/server" networks, the current market for new mainframe systems is strong and the new disk drive capacity consumed by this market, as measured in terabytes shipped, is higher than in recent years. In this report, it is assumed that the increase in total disk drive capacity to be shipped for mainframes will decline from 1995's peak, but will nevertheless increase at an average annual rate of 13.3% in the 1996-98 period.

Unit shipment totals are expected to follow an up-and-down pattern through 1998, as each generation of high capacity disk drives prompts leading array vendors to jump to a procession of new models. However, despite continual increases in the total number of terabytes shipped in mainframe array subsystems, sales revenues for the product group are expected to decline after peaking in 1996 at $3.4 billion, due to rapid drops in disk drive price per megabyte.

Both captive and noncaptive revenues are expected to decline after 1996, as disk drive price per megabyte falls faster than total demand increases for mainframe disk storage. PCM/Reseller sale revenues are forecasted to total more than $1.7 billion in 1998, 63.7% of the total for the product group. Captive sales revenues for 1998 are projected at $934.2 million, 33.9% of the product group total. In other words, IBM's dominance of the mainframe disk storage market, characterized by the 70%+ share of disk storage on its own mainframe systems it normally held during previous decades, seems to be coming to an end.

Technical trends

For the most part, add-on data storage peripherals in the mainframe market must exist within the limitations defined by IBM for channels, operating systems, disk controllers and storage architecture. IBM's mainframes provide the principal PCM market, and many of today's competitive mainframe computers use storage devices compatible with IBM's own subsystems. Anything new IBM does in the area affects everything in the competitive product offering.

For these reasons, much of the product development planning by independent peripherals suppliers will be affected by the details of IBM's future series of mainframe disk storage controllers. What will be the interrelationship with data compression at the system level? How soon will existing types of disk controllers be replaced with something new? What will be the relationship to IBM's System Managed Storage programs?

At this point, it appears that IBM has planned a new series of disk drive controllers for mid-1996, along with higher capacity 3.5" drives. However, given IBM's 1995 production problems with 4 gigabyte 3.5" drives, it is not clear whether the company will be able to maintain its track record during the 1990's of shipping drives at each new capacity level a year or more before the competition. It is less likely that IBM's aggressive investment in disk drive technology will provide a significant head start in the mainframe disk drive array market during the next few years.

Forecasting assumptions

1. In mid-1996, IBM will introduce a new controller for mainframe arrays, eliminating the 180 gigabyte per controller limitation, and will offer new RAMAC array models with 8-9 gigabyte 3.5" disk drives.

2. Manufacturers of PCM mainframe arrays will maintain aggressive product development and market introduction schedules, utilizing continually improved array architectures and higher disk drive capacities, on a timetable not significantly later than IBM's.

3. Total mainframe sales revenues will decline after 1996, due to slower growth in the demand for mainframe disk storage, combined with the rapidly falling disk drive price per megabyte.

TABLE 23

MAINFRAMES

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994		Forecast							
	Revenues		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	216.0	270.0	864.0	1,267.2	898.2	1,341.0	773.5	1,172.5	554.4	854.4
PCM/Reseller	675.5	1,180.5	777.1	1,287.7	921.0	1,536.8	855.4	1,424.8	812.3	1,356.2
OEM/Integrator	58.2	157.5	41.0	97.5	39.0	97.0	32.3	79.9	25.6	64.4
TOTAL U.S. REVENUES	949.7	1,608.0	1,682.1	2,652.4	1,858.2	2,974.8	1,661.2	2,677.2	1,392.3	2,275.0
Non-U.S. Manufacturers										
Captive	--	--	--	46.8	--	71.5	--	91.0	--	79.8
PCM/Reseller	147.0	245.0	188.7	315.1	220.7	366.5	254.3	423.1	238.0	398.0
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	147.0	245.0	188.7	361.9	220.7	438.0	254.3	514.1	238.0	477.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,096.7	1,853.0	1,870.8	3,014.3	2,078.9	3,412.8	1,915.5	3,191.3	1,630.3	2,752.8

TABLE 24

MAINFRAMES

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1994 Shipments		Forecast							
	1995		1996		1997		1998			
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	800	1,000	4,500	6,600	2,495	3,725	1,105	1,675	1,155	1,780
PCM/Reseller	1,327	2,308	1,520	2,517	1,630	2,720	1,645	2,740	1,710	2,855
OEM/Integrator	208	563	220	525	205	510	190	470	165	415
TOTAL U.S. SHIPMENTS	2,335	3,871	6,240	9,642	4,330	6,955	2,940	4,885	3,030	5,050
Non-U.S. Manufacturers										
Captive	--	--	--	60	--	110	--	130	--	145
PCM/Reseller	420	700	485	810	545	905	565	940	595	995
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	420	700	485	870	545	1,015	565	1,070	595	1,140
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	2,755	4,571	6,725	10,512	4,875	7,970	3,505	5,955	3,625	6,190
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	4	7	11	18	16	26	19	32	23	38

TABLE 25

MAINFRAMES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1994 Revenues Subsys.	Forecast --1995-- Subsys.	--1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.
U.S. MANUFACTURERS					
Captive	270.0	1,267.2	1,341.0	1,172.5	854.4
PCM/Reseller	1,180.5	1,287.7	1,536.8	1,424.8	1,356.2
OEM/Integrator	157.5	97.5	97.0	79.9	64.4
TOTAL U.S. REVENUES	1,608.0	2,652.4	2,974.8	2,677.2	2,275.0
NON-U.S. MANUFACTURERS					
Captive	--	46.8	71.5	91.0	79.8
PCM/Reseller	245.0	315.1	366.5	423.1	398.0
TOTAL NON-U.S. REVENUES	245.0	361.9	438.0	514.1	477.8
WORLDWIDE RECAP					
Captive	270.0 --	1,314.0 +386.7%	1,412.5 +7.5%	1,263.5 -10.5%	934.2 -26.1%
PCM/Reseller	1,425.5 +83.7%	1,602.8 +12.4%	1,903.3 +18.7%	1,847.9 -2.9%	1,754.2 -5.1%
OEM/Integrator	157.5 +72.1%	97.5 -38.1%	97.0 -.5%	79.9 -17.6%	64.4 -19.4%
Total Revenues	1,853.0 +113.6%	3,014.3 +62.7%	3,412.8 +13.2%	3,191.3 -6.5%	2,752.8 -13.7%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 26

MAINFRAMES

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1994 Shipments Subsys.	Forecast --1995-- Subsys.	--1996-- Subsys.	--1997-- Subsys.	--1998-- Subsys.
U.S. MANUFACTURERS					
Captive	1,000	6,600	3,725	1,675	1,780
PCM/Reseller	2,308	2,517	2,720	2,740	2,855
OEM/Integrator	563	525	510	470	415
TOTAL U.S. SHIPMENTS	3,871	9,642	6,955	4,885	5,050
NON-U.S. MANUFACTURERS					
Captive	--	60	110	130	145
PCM/Reseller	700	810	905	940	995
TOTAL NON-U.S. SHIPMENTS	700	870	1,015	1,070	1,140
WORLDWIDE RECAP					
Captive	1,000	6,660	3,835	1,805	1,925
	--	+566.0%	-42.4%	-52.9%	+6.6%
PCM/Reseller	3,008	3,327	3,625	3,680	3,850
	+75.5%	+10.6%	+9.0%	+1.5%	+4.6%
OEM/Integrator	563	525	510	470	415
	+81.0%	-6.7%	-2.9%	-7.8%	-11.7%
Total Shipments	4,571	10,512	7,970	5,955	6,190
	+125.7%	+130.0%	-24.2%	-25.3%	+3.9%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 27

MAINFRAMES

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Subsystems	270.0	197.2	368.3	700.0	485.2
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	270.0	197.2	368.3	700.0	485.2
PCM/Reseller					
Subsystems	473.9	481.7	525.0	502.1	455.6
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Reseller Average	473.9	481.7	525.0	502.1	455.6
OEM/Integrator					
Subsystems	279.6	185.7	190.0	170.0	155.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	279.6	185.7	190.0	170.0	155.0

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 28

MAINFRAMES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
EMC	1,245	--	--	1,245	63.7	2,425	--	--	2,425	67.9
Hitachi	420	--	--	420	21.5	700	--	--	700	19.6
Storage Technology	282	--	--	282	14.4	428	--	--	428	12.0
Other U.S.	8	--	--	8	.4	18	--	--	18	.5
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	1,955	--	--	1,955	100.0	3,571	--	--	3,571	100.0

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

1995 DISK/TREND REPORT

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Ciprico	AS6700, AS6710
Convex Computer	DAR-004, DAR-005
Cray Research	DA-60, ND-30, ND-40
Encore Computer	Infinity 90ES
Fujitsu	K6490
IBM	9570 series
MasPar Computer	6110, DA-6330
Maximum Strategy	Gen 4XL, Gen 5XL
Storage Concepts	Concept 910SW
Thinking Machines	CM-5

Arrays offered for use with very high performance computer systems include complete disk drive subsystems, now the dominant array type in this product group, plus arrays sold as board assemblies, which may include cabinets and other components.

Until about a year ago, most of the arrays in this product group were RAID-3 complete subsystems, responding to the need of supercomputers and high-end imaging systems for very high sustained data transfer rates. However, a majority of the arrays now offered in this product group offer RAID-5 capability, usually in combination with other RAID modes.

The firm with the most impressive array specification is Thinking Machines, the massively parallel supercomputer manufacturer which pioneered the disk drive array configuration which became known as RAID-2. In late 1992, however, Thinking Machines replaced the old array with a new model -- a RAID-3 array initially introduced with the theoretical capability to attach 3,072 3.5" drives, for a total available capacity of 3.2 terabytes. The specification has since been reduced to a maximum of 250 drives.

In addition to the arrays offered by supercomputer manufacturers, independent array manufacturers offer RAID-3 and RAID-5 subsystems which are sold on a noncaptive basis to manufacturers of specialized very high perform-

ance systems used in a variety of high-end technical workstation and imaging applications, as well as to system integrators and to end users with specialized requirements.

Market status

Both sales revenues and unit shipments of very high performance disk drive arrays achieved a higher level than expected during the 1994-95 period, reflecting expansion of specialized high performance markets and changes in product mix prompted by availability of high-end 3.5" disk drives. Captive revenues were down .7% from the previous year, but total 1994 revenues for the product group increased by 21.9% to $54.6 million and are expected to reach $73.2 million in 1995, up another 34.1%.

Although captive revenues were flat, captive unit shipments of complete subsystems more than doubled in 1994, as the movement to lower cost 3.5" drives stimulated the supercomputer market's appetite for more disk capacity. 1995 is expected to result in additional growth in unit shipments, but another year of flat revenue, as disk prices decline.

The nominal shipments of noncaptive board-level array controllers in the product group have little effect on the product group's sales revenues, but noncaptive subsystems will constitute an estimated 62.8% of the product group's 1995 total revenues, a major increase over the 31.3% share of two years ago. Shipments of 988 noncaptive subsystems are estimated for 1995, a mixture of RAID-3, RAID-5 and hybrid subsystems destined for usage with supercomputers, high-end imaging systems and a variety of other applications.

Ciprico continued to hold the lead in noncaptive shipments in 1994, with 64.7% of the worldwide unit total, composed entirely of subsystems. Storage Concepts held 31.1% of the total.

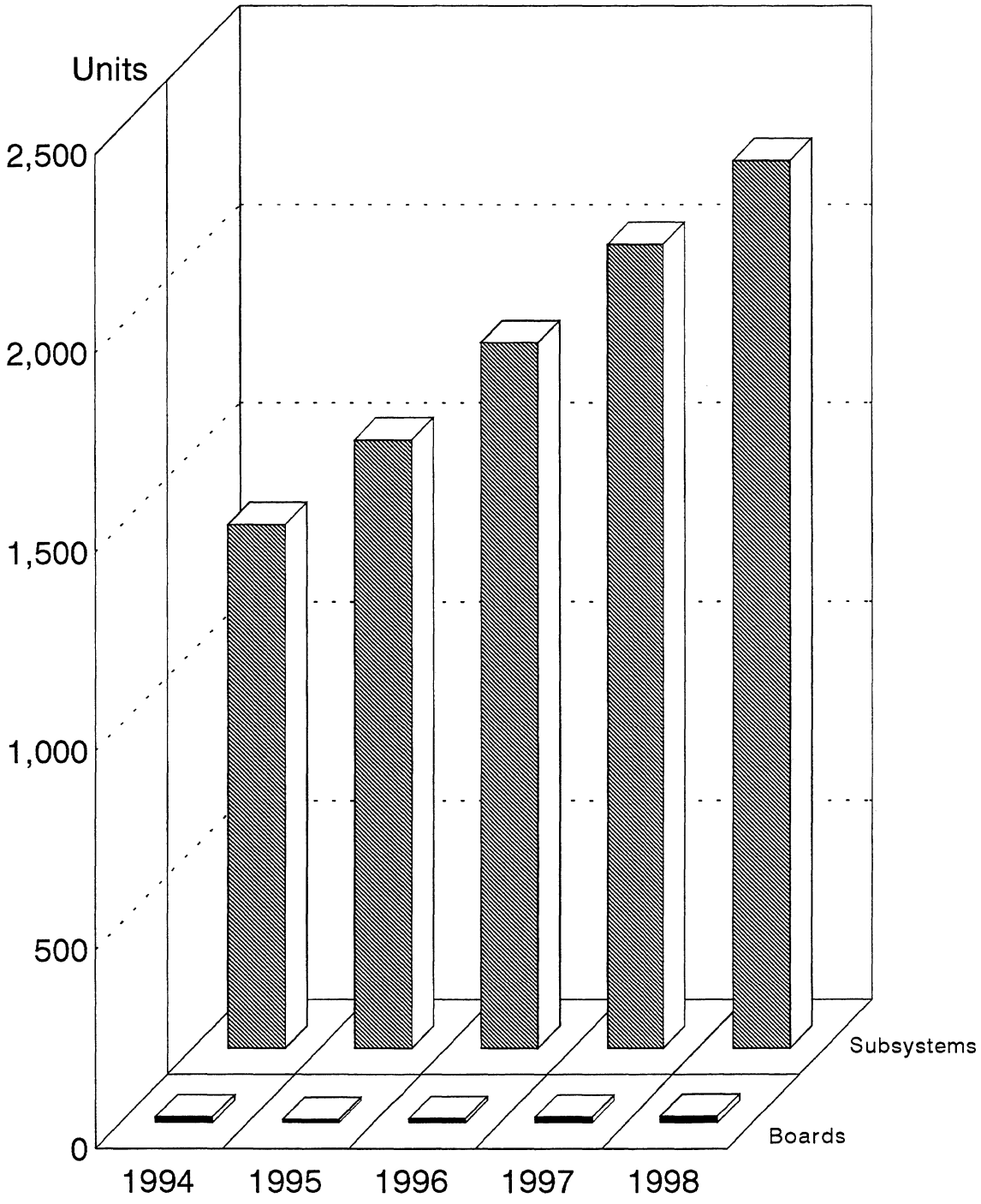
Marketing trends

Total sales revenues for very high performance disk drive arrays are projected to increase at an annual average of 10.0% during the 1996-98 period, and unit shipments are forecasted to grow at an annual average of 13.5% during the

Figure 9

Very High Performance System Arrays

Worldwide Shipments by Array Type



same period. The worldwide sales total for very high performance disk drive arrays is forecasted at $97.2 million, only .7% of the overall revenues for all disk drive array product groups. Complete subsystems will provide almost all of the expected growth for this product group, despite gradual growth for board assemblies.

Supercomputers have been the traditional market for disk drive arrays in this product group. Although supercomputers are expected to have only modest growth potential during the next few years, shipments of very high performance disk drive arrays for this application are expected to maintain growth through 1998, as a higher share of supercomputer disk storage moves to array configurations. Somewhat higher growth is seen for very high performance arrays in a variety of markets for video, imaging and other specialized servers.

Noncaptive arrays are projected to provide 65.7% of the 1998 shipments for the very high performance disk drive array product group, with 1,476 units. Shipments in the PCM/Reseller channel are now expected to grow at a significantly faster rate than in the OEM/Integrator channel, as independent producers of very high performance disk drive array subsystems explore specialized array markets. In many applications, independent storage subsystem companies will be able to develop array markets more cost-effectively than very specialized system manufacturers with limited capabilities to develop appropriate storage subsystems. By 1998, PCM/Reseller shipments are expected to be 68.4% of the noncaptive unit shipment total.

Technical trends

Several leading supercomputer companies introduced high-end RAID-3 arrays in late 1992, driven by the need for storage subsystem architectures that can sustain high data transfer rates. For these applications, there is no question that transfer rate is the key requirement, and the ability of RAID-3 array configurations to meet that requirement will keep them in the lead.

For supercomputer and other applications, however, there is enough demand for multimode arrays capable of operating in various combinations of RAID-0, RAID-1, RAID-3 and RAID-5 to justify products with these capabilities. A few manufacturers already offer arrays which include RAID-5 capability and more

are likely to follow. Although RAID-5 arrays in other product groups are usually designed for a balanced combination of fault tolerance, high transaction rates and data rates usable on personal computer and workstation networks, there is no reason why array designs cannot provide the higher transfer rates needed by very high performance systems.

It is believed that most of the improvements in arrays used with very high performance systems through 1998 will involve gradual refinements made possible by improved components. Reduced count chip sets and semiconductors with higher data rates will help with both packaging, costs and performance. 3.5" disk drives with ever-higher capacities, improved performance and lower cost per megabyte will also provide gains in packaging, costs and performance.

Forecasting assumptions

1. RAID-3 implementations will remain the most frequently used type of array for very high performance systems, supplemented by growth for RAID-5 arrays with high data rates.

2. Traditional supercomputers will remain the largest application for arrays in this product group, but will be challenged by higher growth rates for massively parallel computers and video/image servers.

3. Complete array subsystems will continue to dominate shipments in this product group.

TABLE 29

VERY HIGH PERFORMANCE

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1994		Forecast							
	Revenues		1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	16.5	26.7	15.7	24.8	16.4	27.4	17.2	28.8	18.2	30.4
PCM/Reseller	9.5	14.3	14.5	27.8	28.4	35.6	32.9	43.9	31.7	45.4
OEM/Integrator	8.3	11.5	16.1	19.4	13.6	20.2	13.8	20.9	13.8	20.9
TOTAL U.S. REVENUES	34.3	52.5	46.3	72.0	58.4	83.2	63.9	93.6	63.7	96.7
Non-U.S. Manufacturers										
Captive	--	2.1	--	1.2	--	1.0	--	.8	--	.5
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	--	2.1	--	1.2	--	1.0	--	.8	--	.5
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	34.3	54.6	46.3	73.2	58.4	84.2	63.9	94.4	63.7	97.2

TABLE 30

VERY HIGH PERFORMANCE

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1994 Shipments		Forecast 1995		1996		1997		1998	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	267	463	322	529	365	610	410	685	455	760
PCM/Reseller	455	555	535	670	630	790	685	915	705	1,010
OEM/Integrator	175	280	208	318	240	365	272	419	303	466
TOTAL U.S. SHIPMENTS	897	1,298	1,065	1,517	1,235	1,765	1,367	2,019	1,463	2,236
Non-U.S. Manufacturers										
Captive	--	32	--	20	--	18	--	16	--	12
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	--	32	--	20	--	18	--	16	--	12
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	897	1,330	1,065	1,537	1,235	1,783	1,367	2,035	1,463	2,248
Cumulative Shipments (Single units)										
WORLDWIDE TOTAL	1,467	2,100	2,532	3,637	3,767	5,420	5,134	7,455	6,597	9,703

TABLE 31

VERY HIGH PERFORMANCE

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1994 Revenues		Forecast 1995		1996		1997		1998	
	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards
U.S. MANUFACTURERS										
Captive	26.7	--	24.8	--	27.4	--	28.8	--	30.4	--
PCM/Reseller	14.3	--	27.8	--	35.6	--	43.9	--	45.4	--
OEM/Integrator	9.3	2.2	18.2	1.2	106.5	1.4	113.4	1.9	117.0	2.0
TOTAL U.S. REVENUES	50.3	2.2	70.8	1.2	169.5	1.4	186.1	1.9	192.8	2.0
NON-U.S. MANUFACTURERS										
Captive	2.1	--	1.2	--	1.0	--	.8	--	.5	--
TOTAL NON-U.S. REVENUES	2.1	--	1.2	--	1.0	--	.8	--	.5	--
WORLDWIDE RECAP										
Captive	28.8	--	26.0	--	28.4	--	29.6	--	30.9	--
	-.7%	--	-9.7%	--	+9.2%	--	+4.2%	--	+4.4%	--
PCM/Reseller	14.3	--	27.8	--	35.6	--	43.9	--	45.4	--
	+90.7%	--	+94.4%	--	+28.1%	--	+23.3%	--	+3.4%	--
OEM/Integrator	9.3	2.2	18.2	1.2	106.5	1.4	113.4	1.9	117.0	2.0
	+43.1%	+22.2%	+95.7%	-45.5%	+485.2%	+16.7%	+6.5%	+35.7%	+3.2%	+5.3%
Total Revenues	52.4	2.2	72.0	1.2	170.5	1.4	186.9	1.9	193.3	2.0
	+21.9%	+22.2%	+37.4%	-45.5%	+136.8%	+16.7%	+9.6%	+35.7%	+3.4%	+5.3%
ANNUAL SHARE, BY TYPE	96.1%	3.9%	98.5%	1.5%	99.3%	.7%	99.1%	.9%	99.1%	.9%

TABLE 32

VERY HIGH PERFORMANCE

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1994 Shipments		Forecast							
			1995		1996		1997		1998	
	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards
U.S. MANUFACTURERS										
Captive	463	--	529	--	610	--	685	--	760	--
PCM/Reseller	555	--	670	--	790	--	915	--	1,010	--
OEM/Integrator	266	14	310	8	355	10	405	14	450	16
TOTAL U.S. SHIPMENTS	1,284	14	1,509	8	1,755	10	2,005	14	2,220	16
NON-U.S. MANUFACTURERS										
Captive	32	--	20	--	18	--	16	--	12	--
TOTAL NON-U.S. SHIPMENTS	32	--	20	--	18	--	16	--	12	--
WORLDWIDE RECAP										
Captive	495	--	549	--	628	--	701	--	772	--
	+153.8%	--	+10.9%	--	+14.4%	--	+11.6%	--	+10.1%	--
PCM/Reseller	555	--	670	--	790	--	915	--	1,010	--
	+716.2%	--	+20.7%	--	+17.9%	--	+15.8%	--	+10.4%	--
OEM/Integrator	266	14	310	8	355	10	405	14	450	16
	+18.8%	-26.3%	+16.5%	-42.9%	+14.5%	+25.0%	+14.1%	+40.0%	+11.1%	+14.3%
Total Shipments	1,316	14	1,529	8	1,773	10	2,021	14	2,232	16
	+170.2%	-26.3%	+16.2%	-42.9%	+16.0%	+25.0%	+14.0%	+40.0%	+10.4%	+14.3%
ANNUAL SHARE, BY TYPE	99.0%	1.0%	99.6%	.4%	99.5%	.5%	99.4%	.6%	99.4%	.6%

TABLE 33

VERY HIGH PERFORMANCE

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1994	Forecast 1995	1996	1997	1998
Captive					
Subsystems	58.0	47.2	45.2	42.1	40.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	58.0	47.2	45.2	42.1	40.0
PCM/Reseller					
Subsystems	25.6	41.5	45.0	48.0	45.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Reseller Average	25.6	41.5	45.0	48.0	45.0
OEM/Integrator					
Subsystems	34.9	58.5	53.0	47.0	42.0
Boards	156.0	150.0	140.0	130.0	120.0
Software	--	--	--	--	--
OEM/Integrator Average	41.0	60.8	55.3	49.7	44.6

Note: Price per unit calculations represent estimated total sales revenues for each product type by the total yearly shipped quantity of all units of that type.

TABLE 34

VERY HIGH PERFORMANCE

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1994 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Array Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Ciprico	450	--	--	450	71.4	540	--	--	540	64.7
Storage Concepts	155	--	--	155	24.6	260	--	--	260	31.1
Other U.S.	11	14	--	25	4.0	21	14	--	35	4.2
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	616	14	--	630	100.0	821	14	--	835	100.0

ARRAY SPECIFICATIONS

1995 DISK/TREND REPORT

DISK DRIVE ARRAY SPECIFICATIONS

Coverage

This section includes most disk drive arrays produced by the original manufacturer of the array controller or software, which are now in new production or announced, arranged alphabetically by manufacturer. In a few cases, products are listed for which only preliminary announcements have been made because these are considered significant indicators of industry direction. Specifications are based upon data provided by manufacturers and are subject to change.

Also included, for identification purposes, are specifications on many array models purchased on an OEM basis from others or assembled with purchased controllers, software and other components, and resold by computer system manufacturers, storage subsystem manufacturers or distributors. Also included are many plug compatible arrays sold by major mainframe and midrange system PCM vendors, but which are manufactured by other firms. Not listed in some cases are captive arrays which are similar to OEM/Integrator models made by the same manufacturer.

Array type

Arrays are classified into three product types. Only products specifically intended to permit disk drives to operate as an array are included:

Subsystem: Complete array subsystems including disk drives.
Board: Controllers, or array subassemblies without drives.
Software: Implemented as program code executing in a host system.

Host platform and environment

The host platform is the equipment to which the array is capable of being attached. Environment refers to the operating systems and network software with which the array is compatible and supported. If the array will connect to any host system offering a SCSI port, platform is indicated as "SCSI host". Where the array can be connected to the large number of IBM PC compatible computers available, "PC compatible" is indicated.

RAID level

All Berkeley RAID levels supported by the array are given. If the manufacturer has used a non-Berkeley designation, it is indicated in quotes. Most such designations refer to enhanced RAID-5 operation. Also shown is the manner in which the RAID mode is selected; by commands through the host interface channel, by an operator panel, through a separate control port, or by presetting at the factory. If RAID-10 is indicated, the array can operate in a composite combined mirrored and striped mode.

Array capacity

If multiple capacities are shown for minimum or maximum array capacity, they correspond to the listed RAID modes. The order in which they are given matches the order in which the RAID modes are listed. User available capacity for each mode is provided. If only single minimum or maximum capacities are shown, it is typically the available user capacity for the lowest RAID mode listed. Where a variety of drives are used, array capacity is shown as "Drive dependent".

Drives per array

The minimum and maximum number of drives available for user data in the array. Where indeterminate, as in the case of a software array, "--" is used.

Concurrent host channels

Where more than one channel between the host and the array is available, the standard number of channels and maximum number of channels is given.

Drive channels

Where multiple channels between the array controller and drives are available, the minimum and maximum number of channels is given.

Array interface to host and drives

Interfaces which may be used for connection of the array to the host, and which drive interfaces are recognized.

Cache size and function

If the array contains a cache, the minimum and maximum available sizes are given. Also indicated is whether the cache is used for read operations, write operations or both. If no cache is used, then these fields are designated by "--".

Redundancy

If the array offers dual controllers that address a common drive set or dual controllers that mirror drive sets, then the controller redundancy will be indicated by "Yes", "Optional", or "Duplexed", depending upon the manufacturer's offerings and array configuration.

If the array is equipped with multiple fans providing sufficient cooling capacity so that the array can continue operation if a fan fails, then fan redundancy is indicated as "Yes", or "Optional" if the additional fan is an option.

If the array is equipped with multiple power supplies and can continue operation if any power supply in the array fails, then power supply redundancy is indicated as "Yes", or "Optional" if the additional power supply is an option.

Spare drive

If the array has no capability to support a spare drive to replace a failed drive with the system in operation, then "None" is indicated. If no spare drive is provided, but a failed drive can be hot swapped, than "Manual" is indicated. If a spare drive is provided and it is automatically used by the system in the event of an array drive failure, then "Auto" is indicated.

Transfer rate

The data burst transfer rates between host and array controller, and between array controller and drives are given.

Drives

Where the manufacturer has indicated specific drives used in an array, the drive formatted capacity, average seek time, and average rotational latency are

given. If a range of values is specified, the lowest and highest are given. An example for drive capacity, in megabytes: 300-1000. In many cases, manufacturers support a wide variety of drives, and in these situations the drive parameters are given as "Drive dependent" and the drive models are identified as "Various".

Array size

Where appropriate, the dimensions of the array are given. If a variety of sizes is available, "Varies" is indicated. In many cases, the array is packaged as part of a complete computer system or file server, in which case system overall dimensions are used.

Power

Power required is given in watts or KVA, identified appropriately. Also indicated is whether the array has internal power backup in the form of battery backup for the cache or an internal UPS for the array. If neither is present, then "None" is indicated.

Accuracy

All information in this section has been cross-checked for accuracy. However, it is anticipated that some errors may be included, since many manufacturers' published specifications do not cover all of the items listed, and numerous verbal inquiries have been required.

1995 DISK/TREND product groups for disk drive arrays

Product groups for the 1995 DISK/TREND Report on disk drive arrays include:

Single user system arrays

Networks/minicomputer/multiuser system arrays

Mainframe system arrays

Very high performance system arrays

MANUFACTURER	1776, INC.	1776, INC.	1776, INC.	AC TECHNOLOGY	ACER
ARRAY MODEL	76SC34	76SC34A	76SC34H	Concorde	Altos 700/P
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Software Software	Software Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible UNIX	PC compatible UNIX	PC compatible UNIX	Sun, RS/6000, H-P, SGI, DEC	Acer NetWare, XENIX, SCO UNIX
RAID level Configured by:	0/1/10* Host	0/1/10 Host	0/1/10* Host	0/3/5	0/1/5 Host
Array capacity (Gbytes) MIN MAX	NA Drive dependent	NA Drive dependent	NA Drive dependent	6 96	1/.5/1/1 10/5/8/8
Minimum drives per array	2	2	2	3	2/3
Maximum drives per array	60	56	56	28	21*
Concurrent host channels	1	2	1	1	1
Controller drive channels	4	4	4		3
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	NA	NA	NA	32 RD/1 WR	4
Cache function (Read, Write)				Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Supported N/A N/A	Supported N/A N/A	Supported N/A N/A	Yes Yes Yes	No Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	20 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	4000	1050-2100
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	N/A	N/A	N/A	Varies	23.2 x 7 x 23.2
POWER: Power backup	N/A	N/A	N/A	300 watts Cache option	350 watts UPS optional
FIRST CUSTOMER SHIPMENT	1990	1993	1993	4Q93	7/93
COMMENTS	*Multiple mirrored disks	Supports second host system concurr. active Auto backup switching. Host load bal.	*Multiple mirrored disks. Supports second host system in idle mode.	CMD controller	*With expansion cabinet Complete server Mylex controll.

MANUFACTURER	ACER	ACER	ADAPTEC	ADAPTEC	ADAPTEC
ARRAY MODEL	Altos 800/P	Altos 17000	AHA-3980	AHA-3980W	AHA-3985
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Acer NetWare, VINES, SCO UNIX	Acer NetWare, VINES, SCO UNIX	PC compatible NetWare	PC compatible NetWare	PC compatible NetWare
RAID level	0/1/5	0/1/5	0/1/5/10	0/1/5/10	0/1/5/10
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	1/5/1/1	1/5/1/1	Drive dependent	Drive dependent	Drive dependent
MAX	20/10/16/16	20/10/16/16	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2/3	2/3	2	2	2
Maximum drives per array	21*	21	16	16	16
Concurrent host channels	1	1	1	1	1
Controller drive channels	3	3	2	2	3
Array interface to host	EISA	EISA	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	--	--	--
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No)	No	No	--	--	--
Fan (Yes/No)	No	No	--	--	--
Power supply (Yes/No)	No	No	--	--	--
Spare drive (None/Auto/Manual)	Auto*	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	33	133	133	133
drive (MB/Sec)	10	10	10	20	10
DRIVES: Formatted capacity/drive(MB)	1050	1050	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	15.8 x 7.5 x 17.5	24.6 x 14 x 16	4.2 x 12.28	4.2 x 12.28	4.2 x 12.28
POWER: Power backup	200 watts UPS optional	500 watts UPS optional			
FIRST CUSTOMER SHIPMENT	1995	1991/1993*	3/95	5/95	3/95
COMMENTS	*With expansion cabinet Mylex controll.	*With Pentium. Complete server up to 4 processors. Mylex controll.			

MANUFACTURER	ADAPTEC	ADJILE SYSTEMS	ADJILE SYSTEMS	ADJILE SYSTEMS	ADS INTERNATIONAL
ARRAY MODEL	AHA-3985W	Adjile Mirror	CUDA Series	Panther F Panther FW Panther FWD	ADS/1000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare	SCSI host UNIX, Solaris	SCSI host UNIX, Solaris	SCSI host UNIX, Solaris	PC compatible UNIX, NetWare, DOS
RAID level Configured by:	0/1/5/10 Host	1 Panel, Port	0/3/5 Panel, Port	0/3/5 Panel, Port	0/1/4/5 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2/3	2/3	3
Maximum drives per array	16	6	28	28	21
Concurrent host channels	1	1	1	1, 3	1
Controller drive channels	3	Varies	Varies	Varies	3, 5
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	32 RD/2.5 WR	32 RD/2.5 WR	1, 16
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Yes Yes	Option Yes Yes	Option Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	133 20	10, 20 10, 20	20 20	10, 20 10, 20	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	1000,2000,4000
Nominal disk diameter (mm)	Drive dependent	95, 130	95, 130	95, 130	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Seagate Hawk
ARRAY SIZE: Inches: H x W x D	4.2 x 12.28	Varies	Varies	Varies	4.5 x 13
POWER: Power backup		Varies None	Varies Battery option	Varies Battery option	None
FIRST CUSTOMER SHIPMENT	5/95	1Q94	1Q94	1Q94	1993
COMMENTS		Various controllers used Manufacturer's own enclosure	Various controllers used Manufacturer's own enclosure	Various controllers used Manufacturer's own enclosure	Array enclosure available

MANUFACTURER	ADS INTERNATIONAL	ADS INTERNATIONAL	ADS INTERNATIONAL	ADS INTERNATIONAL	ADVANCED LOGIC RESEARCH
ARRAY MODEL	ADS/2000	ADS/3000	ADS/4000	ADS/5000	Data Station
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX	SCSI host	SCSI host	PC compatible UNIX, NetWare, OS/2	ALR NetWare, UNIX, NT, OS/2, other
RAID level Configured by:	0/1 Host	0/3/5 Panel, Port	0/1/3/5 Panel, Port	0/3/5 Panel, Port	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	3/1.5/2 12/6/8
Minimum drives per array	2	3	3	3	2/3
Maximum drives per array	35	35	35	35	6
Concurrent host channels	--	1, 5	1, 5	1, 5	1
Controller drive channels	--	1, 5	1, 5	1, 5	1, 3
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA, PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	2, 64	2, 64	2, 64	4, 32
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Option Option	-- -- --	-- -- --	No Option Option	No Yes Yes
Spare drive (None/Auto/Manual)	--	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	33, 132 10
DRIVES: Formatted capacity/drive(MB)	1000,2000,4000	1000,2000,4000	1000,2000,4000	1000,2000,4000	1000, 2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.6
Drive models	Seagate Hawk	Seagate Hawk	Seagate Hawk	Seagate Hawk	Conner
ARRAY SIZE: Inches: H x W x D	--	3.25 x 5.75 x 8	1.6 x 5.7 x 8.4	3.25 x 5.75 x 8.12	12.5 x 7.5 x 12.5
POWER: Power backup	-- None	26 watts None	10 watts Battery option	300 watts None	85 watts None
FIRST CUSTOMER SHIPMENT	1993	1993	1995	1993	9/94
COMMENTS	Software array	Array enclosure available Purchased controller	Array enclosure available Purchased controller	Purchased controller	Mylex controller External module

MANUFACTURER	ADVANCED LOGIC RESEARCH	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS
ARRAY MODEL	Quick Hot Swap	AXRD-A360S AXRD-A720S	AXRD-M540A AXRD-M810A	AXRD-M540S AXRD-M810S	AXRS-D1080S
DISK/TREND GROUP	Net/Mini/Multi	Single User	Single User	Single User	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	ALR NetWare, UNIX, NT, OS/2, other	SCSI host Various	PC host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5 Host	0/1/5 Jumper	0/1 Jumper	0/1 Jumper	0/1/5 Panel
Array capacity (Gbytes) MIN MAX	3/1.5/2 12/6/8	.720/1.08 1.44/2.16	.540 .810	.540 .810	1.08/2.16 3.24/5.4
Minimum drives per array	2/3	4	4	2	2
Maximum drives per array	6	4	4	2	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 3	2	1	1	2
Array interface to host	EISA, PCI	SCSI-2	IDE	SCSI-2	SCSI-2
Drive interface	SCSI-2	IDE	IDE	IDE	IDE
Cache size (min, max: MB)	4, 32	.256	--	.256	2, 8
Cache function (Read, Write)	Read, Write	Read, Write	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	None	None	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33, 132 10	10 8.3	8.3 8.3	10 8.3	10 8.3
DRIVES: Formatted capacity/drive(MB)	1000, 2000	360-720	540-810	540-810	1080
Nominal disk diameter (mm)	95	65	65	65	95
Average positioning time (msec)	9	13	14	14	10.5
Average rotational delay (msec)	5.6	7.5	7.9	7.9	5.6
Drive models	Conner	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	12.5 x 7.5 x 12.5	1.625 x 4 x 5.75	1 x 4 x 5.75	1 x 4 x 5.75	11.6 x 7.1 x 15.75
POWER: Power backup	85 watts None	10 watts None	7.5 watts None	7.5 watts None	.1 KVA None
FIRST CUSTOMER SHIPMENT	12/94	10/94	4/94	7/94	10/94
COMMENTS	Option for ALR system				

ASPEC-11

MANUFACTURER	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TECHNOLOGY & SYSTEMS	ADVANCED TELECOMMUNICA-TIONS MODULES	ALLODYNE	ALLODYNE
ARRAY MODEL	AXRS-D360S	AXRS-D720S	VS3200	A1010-120	A1010-80
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	ARM BASED ATMos TM	SCSI host Various	SCSI host Various
RAID level	0/1/5	0/1/5	3	3/5	3/5
Configured by:	Panel	Panel	Host	Port	Port
Array capacity (Gbytes) MIN	.360/.720	.720/1.44	8	12	8
MAX	1.08/1.8	2.16/3.6	16	12	8
Minimum drives per array	2	2	5	10	10
Maximum drives per array	6	6	5	10	10
Concurrent host channels	1	1	5	1	1
Controller drive channels	2	2	5	1	1
Array interface to host	SCSI-2	SCSI-2	32 bit bus(DMA)	SCSI-2	SCSI-2
Drive interface	IDE	IDE	SCSI-2	IDE	IDE
Cache size (min, max: MB)	2, 8	2, 8	Configurable	256	256
Cache function (Read, Write)	Read, Write	Read, Write	Configurable	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	Yes	No	No
Fan (Yes/No)	No	No	No	Yes	Yes
Power supply (Yes/No)	No	No	Yes	Option*	Option*
Spare drive (None/Auto/Manual)	Auto	Auto	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10		10	10
drive (MB/Sec)	8.3	8.3	20	10	10
DRIVES: Formatted capacity/drive(MB)	360	720	2100-4200	1500	1000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	12	12	9	10	10
Average rotational delay (msec)	6.7	6.7	4.17	5.56	5.56
Drive models	IBM	IBM	Conner 210SE & 2107E-4107E	Various	Various
ARRAY SIZE: Inches: H x W x D	11.6 x 7.1 x 15.75	11.6 x 7.1 x 15.75	12 x 8 x 16	10 x 5.75 x 8	10 x 5.75 x 8
POWER:	.1 KVA	.1 KVA	170 watts	85 watts	80 watts
Power backup	None	None	None	Battery	Battery
FIRST CUSTOMER SHIPMENT	7/94	7/94	3Q95	1Q95	1Q95
COMMENTS				*In external version	*In external version

MANUFACTURER	ALLODYNE	ALLODYNE	ALLODYNE	AMERICAN DIGITAL SYSTEMS	AMERICAN DIGITAL SYSTEMS
ARRAY MODEL	A510-20	A510-40	A510-60	MASTERDISK RAID	MASTERDISK RPS
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level	3/5	3/5	3/5	0/1/3/5	0/1/3/5
Configured by:	Port	Port	Port	Port, Panel	Port, Panel
Array capacity (Gbytes) MIN	2	4	6	Drive dependent	.500
MAX	2	4	6	Drive dependent	36.4
Minimum drives per array	5	5	5	2	1
Maximum drives per array	5	5	5	28	7
Concurrent host channels	1	1	1	3	3
Controller drive channels	1	1	1	4	4
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2, DEC	SCSI-2, DEC
Drive interface	IDE	IDE	IDE	SCSI-2	SCSI-1/2
Cache size (min, max: MB)	256	256	256	32	0, 256
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes-optional	Yes-optional
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Option*	Option*	Option*	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10	10	Up to 20
drive (MB/Sec)	10	10	10	10	20
DRIVES: Formatted capacity/drive(MB)	540	1000	1500	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	11	10	10	Drive dependent	Drive dependent
Average rotational delay (msec)	6.6	6.6	5.56	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5 x 5.75 x 8	5 x 5.75 x 8	5 x 5.75 x 8	5.25 x 19 x 25	5.25 x 19 x 25
POWER:	45 watts	45 watts	45 watts	26 watts+drives	12 watts+drives
Power backup	Battery	Battery	Battery	None	None
FIRST CUSTOMER SHIPMENT	3Q93	1Q94	1Q95	3Q93	1/95
COMMENTS	*In external version	*In external version	*In external version	CMD controller	CMD controller

MANUFACTURER	AMERICAN MEGATRENDS	ANDATACO	ANDATACO	APPLE COMPUTER	APPLIED DIGITAL SYSTEMS
ARRAY MODEL	MegaRAID 412	Gigaraid GRS	Gigaraid GTS	AppleRAID	A 510-40
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM	PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Software	Hardware
Host platform, software environment	PC compatible NetWare, DOS,NT Wind.,OS/2,UNIX	SCSI host UNIX, NT	SCSI host UNIX, NT	Apple servers	SCSI host Various
RAID level	0/1/3/5/10	0/3/5	0/3/5	0/1	0/3/5
Configured by:	Host	Host,Panel,Port	Host,Panel,Port	Host	Port
Array capacity (Gbytes) MIN	Drive dependent	2.5	2.5	2	
MAX	Drive dependent	24	80	4-8	4
Minimum drives per array	2	5	5	2	5
Maximum drives per array	45	9	28	4	5
Concurrent host channels	1	1, 3	1, 3	1	1
Controller drive channels	1, 3			2	1
Array interface to host	PCI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 128	8, 32	8, 32	.5/1	8
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read	Read, Write
Redundancy: Controller (Yes/No)	--	Cold spare	Cold spare	No	No
Fan (Yes/No)	--	Yes	Yes	No	Yes
Power supply (Yes/No)	--	Yes	Yes	No	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	10/20	10/20	10	10
drive (MB/Sec)	20	10/20	10/20	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	500-4000	500-4000	1000-4000	1000
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	11	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6/8.3	Drive dependent
Drive models	Various	Fujitsu, IBM, Seagate,Microp.	Fujitsu, IBM, Seagate,Microp.	Various	Seagate, Conner
ARRAY SIZE: Inches: H x W x D	4.2 x .5 x 12.3	8.8 x 16.2 x 16.75	29 x 10 x 22	N/A	17.5 x 9.5 x 17
POWER:	12 watts	300 watts	300 watts	N/A	
Power backup	Battery option	UPS option	UPS option		Cache battery
FIRST CUSTOMER SHIPMENT	1Q95	11/93	3/93	4Q94	3Q94
COMMENTS	Uses Intel 960	Modified CMD CRD5000 controller. Network attach module avail. 2Q94.	Modified CMD CRD5000 controller. Network attach module avail. 2Q94.	Sold only with Apple servers	

MANUFACTURER	APPLIED DIGITAL SYSTEMS	APS TECHNOLOGIES	ARCO ELECTRONICS	ARCO ELECTRONICS	ARESYS
ARRAY MODEL	A 510-80	Arraid	AC Mirror	AC1079MC	IDACO-1000
DISK/TREND GROUP	Net/Mini/Multi	Single User	Single User	Single User	Single User
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	SCSI host Various	Macintosh System 7	PC compatible DOS, OS/2, NetWare,Windows	PC compatible DOS, OS/2, NetWare,Windows	PC compatible DOS, Windows, OS/2
RAID level Configured by:	0/3/5 Port	0/1/5* Host	1 Preset	1 Preset	0/1
Array capacity (Gbytes) MIN MAX	8	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	10	2/3*	2	2	4
Maximum drives per array	10	4/7*	4	2	4
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 2	1, 2	1	1	1
Array interface to host	SCSI-2	SCSI-2	PC AT	Micro Channel	ISA
Drive interface	SCSI-2	SCSI-2	IDE	IDE	IDE
Cache size (min, max: MB)	8	--	--	--	.512, 16
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No No No	No No No	No No No	NA NA NA
Spare drive (None/Auto/Manual)	Auto	None	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	1.4 Drive dependent	1.4 Drive dependent	3 4.5
DRIVES: Formatted capacity/drive(MB)	1000	1000-4100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	65	65	Drive dependent
Average positioning time (msec)	Drive dependent	8	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6, 4.2	Drive dependent	Drive dependent	Drive dependent
Drive models		Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	17.5 x 9.5 x 17	5 x 7 x 9	3.5 x 11.5	3.5 x 11.5	.5 x 4.5 x 13.25
POWER: Power backup	Cache battery	None	6 watts+ drives None	6 watts+ drives None	NS NS
FIRST CUSTOMER SHIPMENT	3Q94	12/94	2Q95	10/92	3/93
COMMENTS		Use modified Remus software *RAID 5 in 2Q95		2 2.5" drives mount on card, or external drives	

MANUFACTURER	ARESYS	ARESYS	ARESYS	ARTECON	ARTECON
ARRAY MODEL	IDAC-I	IDAC-IE	IDACO-2000	LynxRAID LynxTower	LynxRAID+ LynxTower
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare, NT, UNIX, OS/2	PC compatible NetWare, NT, UNIX, OS/2	PC compatible NetWare, NT, UNIX, OS/2	Sun,SGI,IBM,H-P UNIX, NetWare, DOS, Apple	Sun,SGI,IBM,H-P UNIX, NetWare, DOS, Apple
RAID level Configured by:	0/1/4/5	0/1/4/5	0/1	0/3/5 Panel	0/1/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	4	4	4
Maximum drives per array	28	21	4	35	35
Concurrent host channels	1	1	1	1, 2, 3	1, 5
Controller drive channels	4	3	1	3, 7	1, 5
Array interface to host	PCI	PCI	ISA	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512, 64	.512, 64	.512, 16	4, 32	1, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	NA NA NA	No Yes Yes	NA NA NA	Option Yes, per drive Yes, per drive	Option Yes, per drive Yes, per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10	132 10	3 4.5	10/20 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1000,2100,4300	1000,2100,4300
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	5.6, 4.2	5.6, 4.2
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6, 4.2	5.6, 4.2
Drive models	Various	Various	Various	Seagate	Seagate
ARRAY SIZE: Inches: H x W x D	.5 x 4.2 x 12.283		.5 x 4.5 x 13.25	7 x 12 x 14*	7 x 12 x 14*
POWER: Power backup	NS None	NS None	NS NS	100 watts Battery	100 watts Battery
FIRST CUSTOMER SHIPMENT	1Q95	1Q95	3/93	12/94	2Q95
COMMENTS	Downloadable Firmware Internal UNS protection	Downloadable Firmware Internal UNS protection		*Also in rack mount CMD, other	*Also in rack mount

MANUFACTURER	AST RESEARCH	AST RESEARCH	AT&T GLOBAL INFORMATION SOLUTIONS	ATEN INTERNATIONAL	ATEN INTERNATIONAL
ARRAY MODEL	2003AE Manhattan P	4003AE Manhattan P2	Disk Array Plus	AI-500	AI-700
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Software	Board	Board
Implementation	Hardware	Hardware	Software	Hardware	Hardware
Host platform, software environment	Manhattan UNIX, NT, OS/2, NetWare	Manhattan UNIX, NT, OS/2, NetWare	SCSI host UNIX	PC compatible Various	PC compatible Various
RAID level	0/1/5	0/1/5	0/1/3/4/5/10/53	0/1/4/5	0/1/4/5
Configured by:	Host	Host	Host		
Array capacity (Gbytes) MIN	1/.5	2/1	Drive dependent	Drive dependent	Drive dependent
MAX	8/4/6.4	16/8/12.8	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	N/A	3	3
Maximum drives per array	6	6	N/A	28	28
Concurrent host channels	1	1	1-4	1	1
Controller drive channels	2	2	1		
Array interface to host	PCI	PCI	SCSI-2	ISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	--	4, 64	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	--	Read	Read
Redundancy: Controller (Yes/No)	No	No	N/A	--	--
Fan (Yes/No)	No	No	N/A	--	--
Power supply (Yes/No)	Option	Option	N/A	--	--
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	132	Host dependent	4	33
drive (MB/Sec)	10	10	Drive dependent	10	10
DRIVES: Formatted capacity/drive(MB)	1000	2000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	26 x 15 x 19	26 x 15 x 19	N/A		
POWER:	300 watts	300 watts	N/A		
Power backup	None	None		None	None
FIRST CUSTOMER SHIPMENT	12/94	12/94	6/92	4Q93	4Q93
COMMENTS			Online tuning. Single volume. Can span multiple drives and adapters		

MANUFACTURER	ATEN INTERNATIONAL	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES
ARRAY MODEL	AI-900	Areka I-10S	Areka E-10F	Areka P-10F	Areka VDS
DISK/TREND GROUP	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	Captive,OEM,PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Board	Board	Board	Board	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible Various	PC: ISA DOS, Windows, Windows NT	PC: EISA, DOS, Windows, Windows NT	PC: PCI DOS, Windows, Windows NT,UNIX	Various DOS, Windows, Windows NT
RAID level	0/1	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10
Configured by:		Host	Host	Host	Preset
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	10
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	280
Minimum drives per array	3	2	2	2	2
Maximum drives per array	35	7	7	7	35
Concurrent host channels	1	1	1	1	1
Controller drive channels		1	1	1	5
Array interface to host	EISA	ISA	EISA	PCI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	0	0	0, 128	0, 64
Cache function (Read, Write)	Read	--	--	Read	Read
Redundancy: Controller (Yes/No)	--	--	--	--	No
Fan (Yes/No)	--	--	--	--	Yes
Power supply (Yes/No)	--	--	--	--	Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	6	33	133	10
drive (MB/Sec)	10	5	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		--	--	--	16.9 x 8.7 x 16.5
POWER:		10 watts	14 watts	10 watts	.45 KVA
Power backup	None	--	--	--	None
FIRST CUSTOMER SHIPMENT	4Q93	1993	1993	1995	1994
COMMENTS					

MANUFACTURER	ATTO TECHNOLOGY	ATTO TECHNOLOGY	ATTO TECHNOLOGY	ATTO TECHNOLOGY	AUSPEX SYSTEMS
ARRAY MODEL	Express Mirror	Express Stripe	Silicon Express 2	Silicon Express 4	NS-7000/200 NS-7000/210 NS-7000/220
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Software Software	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	Macintosh	Macintosh	Macintosh	Macintosh	NFS (Sun)
RAID level Configured by:	1 Preset	0 Preset	0/1/3/4/5 Host	0/1/3/4/5 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	3.5 148
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	4	4	35
Concurrent host channels	1	1	1	1	1
Controller drive channels	--	--	1	1	7
Array interface to host	SCSI	SCSI	NuBus	NuBus	VME
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	64, 256
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option No No	No No No	Option No No	Option No No	No No No
Spare drive (None/Auto/Manual)	None	None	None	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 Drive dependent	10 Drive dependent	10 10	20 20	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	1750, 4250
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	10, 8-9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.5, 4.17
Drive models	Various	Various	Various	Various	Micropolis 2217 Seagate Barra.4
ARRAY SIZE: Inches: H x W x D	N/A	N/A	N/A	N/A	28.5 x 16 x 32.5
POWER: Power backup	N/A	N/A	N/A	N/A	Cache battery
FIRST CUSTOMER SHIPMENT	1/92	11/92	1/92	1/94	6/94
COMMENTS	Requires ATTO Silicon Express controller Can support 4 controllers	Requires ATTO Silicon Express controller Can support 4 controllers	Supports command tag queing, disc., asynch. I/O, scatter-gather	Supports command tag queing, disc., asynch. I/O, scatter-gather Req. array soft	1 expansion cabinet with model 210, 2 with model 220

MANUFACTURER	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AVCOM SYSTEMS	AVIV
ARRAY MODEL	NS-7000/500 NS-7000/502*	NS-7000/510 NS-7000/512*	NS-7000/600	Avcom RAID	Duet
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	NFS (Sun)	NFS (Sun)	NFS (Sun)	SCSI host Various	DEC Vax, Alpha, VMS,Ultrix,UNIX NetW., Wind. NT
RAID level	0/1	0/1	0/1	0/1/3/4/5	0/1
Configured by:	Host	Host	Host	Panel	Host
Array capacity (Gbytes) MIN	6	6	3.5	Drive dependent	4.2/2.1
MAX	174	534		Drive dependent	16.8/8.5/34.4
Minimum drives per array	2	2	2	5	2
Maximum drives per array	20	60	42	5	8
Concurrent host channels	1	1-3	1	1	1, 2
Controller drive channels	10	10	10	1-3	
Array interface to host	VME	VME	VME	SCSI-2	SCSI-2,DSSI,Eth
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 1280	64, 1280	64, 1280	4, 32	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No)	No	No	No	Option	No
Fan (Yes/No)	No	No	No	Option	Yes
Power supply (Yes/No)	Option*	Option*	Option	Option	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)				10, 20	20
drive (MB/Sec)	10	10	10	10, 20	10
DRIVES: Formatted capacity/drive(MB)	3000, 9000	3000, 9000	4290	500-9000	Drive dependent
Nominal disk diameter (mm)	130	130	95	95, 130	95
Average positioning time (msec)	11-12	11-12	8-9	Drive dependent	8-10
Average rotational delay (msec)	5.5, 5.5	5.5, 5.5	4.17	Drive dependent	4.7-5.6
Drive models	Micropolis 1936 Seagate Elite 9	Micropolis 1936 Seagate Elite 9	Seagate Barracuda 4	Various	Various
ARRAY SIZE: Inches: H x W x D	76 x 24 x 39.1	76 x 24 x 39.1	76 x 24 x 39.1	Varies	5.25 x 19 x 26.5(rack)
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	
FIRST CUSTOMER SHIPMENT	6/94	6/94	2Q95	1Q94	10/93
COMMENTS	*Can be expanded to 510/512 configuration	*Model 510 and 512 includes expansion cabinet	Can be expanded to 210 drives	CMD controller UPS option	QBUS, BI, CI option avail. Pedestal and tabletop options

MANUFACTURER	AVIV	BAYDEL LTD.	BAYDEL LTD.	BOXHILL SYSTEMS	BUSLOGIC
ARRAY MODEL	Mustang	DAR3-xxx	DAR5-xxx	RAID Box 530	BT-7952
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM, PCM	OEM, PCM	Captive, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	DEC VAX, VMS, Ultrix, NetWare UNIX, Wind. NT	SCSI host UNIX, others	SCSI host UNIX, others	Sun, H-P, other UNIX	PC compatible DOS, Windows, NetWare*
RAID level	0/3/5	3	3	0/3/5	0/1/5
Configured by:	Port	Preset	Preset	Preset	Host
Array capacity (Gbytes) MIN	4.2	Drive dependent	Drive dependent	4	Drive dependent
MAX	8.4/17.2	Drive dependent	Drive dependent	200	Drive dependent
Minimum drives per array	5	2 + parity	2 + parity	3	2
Maximum drives per array	5	28 + 7 parity	28 + 7 parity	28	14
Concurrent host channels	1	1 (2 optional)	1 (2 optional)	1	1
Controller drive channels		5	5		2
Array interface to host	SCSI-2,DSSI,Eth	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	PCI
Drive interface	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	1, 64	1, 64	--, 32	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Write (option)	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Option	Option	N/A
Fan (Yes/No)	Yes	Yes	Yes	Yes	N/A
Power supply (Yes/No)	Yes	Option	Yes	Yes	N/A
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	10/20	10/20	10	132
drive (MB/Sec)	10	5/10	5/10	10	20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	2000-8000	Drive dependent
Nominal disk diameter (mm)	95	95	130	Drive dependent	Drive dependent
Average positioning time (msec)	8-10	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.7-5.6	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 26.5(rack)	7.5 x 19 x 26	10.5 x 19 x 27	Varies	4.2 x 12.3
POWER: Power backup		250 watts Battery option	250 watts Battery option	450 watts None	5 watts
FIRST CUSTOMER SHIPMENT	10/93	1992	1993	1991	2Q95
COMMENTS	QBUS, BI, CI option avail. Pedestal and tabletop options	Subsystems without drives are available. Rack mount tower. Desktop options	Subsystems without drives are available Rack mount only		*Future support for Windows NT, OS/2, UNIX

MANUFACTURER	BUSLOGIC	CAMBEX	CAMBEX	CAMBEX	CAMBEX
ARRAY MODEL	Chantal 5.0 NW	ARRAY/6000-510	ARRAY/6000-910 ARRAY/6000-920	ARRAY/2000-600 ARRAY/6000-600 Centurion	ARRAY/2000-700 ARRAY/6000-700 Centurion
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible Novell 3.11, 3.12, 4.02	RS/6000 UNIX/AIX HACMP/6000	RS/6000 UNIX/AIX HACMP/6000	Sun UNIX, AIX, Solaris	Sun UNIX, AIX, Solaris
RAID level Configured by:	0/1/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	5 31.5/15.8/25/25	24/12/19/19 189/95/151/151	11/5/8/8 45/23/36/36	11/5/8/8 135/68/108/108
Minimum drives per array	2	5	15	5	5
Maximum drives per array	28	15	90	10	30
Concurrent host channels	1-4	2	2, 6	2, 4	2, 4
Controller drive channels				5	5
Array interface to host	Various	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	--	--	2, 128	2, 128
Cache function (Read, Write)	N/A	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A N/A N/A	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	20/40 2 channel 10	20/40 2 channel 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000,1600,2100	1600, 2100	2100, 4510	2100, 4510
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	10	10	9	9
Average rotational delay (msec)	Drive dependent	5.6	5.6	4.17	4.17
Drive models	Various	Various DEC	Various DEC	Various	Various
ARRAY SIZE: Inches: H x W x D	N/A	22.75 x 14 x 15.5	66 x 31 x 34	13 x 9 x 22	21 x 19 x 30
POWER: Power backup	N/A			750 watts Battery, UPS	750 watts Battery, UPS
FIRST CUSTOMER SHIPMENT	4Q94	12/92	12/92	6/95	3/95
COMMENTS	Includes smart drive reconstr. and performance monitor ASDI support		Dual AC feed Model 920 is for European installation	Pedestal	Deskside

MANUFACTURER	CAMBEX	CAMBEX	CAMBEX	CANARY COMMUNICATIONS	CHARISMAC ENGINEERING
ARRAY MODEL	ARRAY/2000-800 ARRAY/6000-800 Centurion	Cascade 3	Cascade 3X	IDA3500	Anubis RAID
DISK/TREND GROUP	Net/Mini/Multi	Mainframe	Mainframe	Net/Mini/Multi	Single User
MARKET	PCM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Software Software
Host platform, software environment	Sun UNIX, AIX, Solaris	IBM MVS, VM	IBM MVS, VM	SCSI host NetWare, OS/2, UNIX, VINES, NT	Macintosh System 7
RAID level Configured by:	0/1/3/5 Host	0/1 Host	0/1 Host	0/1/3/4/5 Host, Port	0/1 Host
Array capacity (Gbytes) MIN MAX	11/5/8/8 722/361/577/577	22.88 180/90	68 544/272	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	8	8	2	2
Maximum drives per array	160	64	64	35	10
Concurrent host channels	2, 4	4	4	1, 2	1
Controller drive channels	5	4	4	5	1
Array interface to host	SCSI-2	ESCON, Parallel	ESCON, Parallel	SCSI-2	Nubus, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 128	8, 256	8, 256	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Yes Yes	Option Yes Yes	Yes Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	4.5 10	4.5 10	10, 20 10	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	2100, 4510	2860	8500	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	130	Drive dependent	Drive dependent
Average positioning time (msec)	9			Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	5.6	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	70 x 19 x 30	70.5 x 44 x 32	70.5 x 44 x 32	7 x 19 x 20	--
POWER: Power backup	750 watts Battery, UPS	1.4 KVA	1.6 KVA	180 watts UPS	-- --
FIRST CUSTOMER SHIPMENT	3/95	6/95	8/95	4Q94	11/94
COMMENTS	Rack mount			20 MHz SPARC microprocessor	Supports FWB, ATTO, other

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MANUFACTURER	CIPRICO	CIPRICO	CIPRICO	CIPRICO	CLONE STAR SOFTWARE
ARRAY MODEL	NA6700	NA6710	AD6700 Spectra 6700	AD6710 Spectra 6710	ALTER EGO
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Very High Perf.	Net/Mini/Multi
MARKET	PCM	PCM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Software Software
Host platform, software environment	NetWare, SGI	NetWare, SGI	Various	Various	PC compatible MS-DOS
RAID level Configured by:	3 Preset	3 Preset	3 Preset	3 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	9	5	9	2
Maximum drives per array	5	9	5	9	2
Concurrent host channels	1	1	1	1	1
Controller drive channels					--
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	N/A
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	N/A
Cache size (min, max: MB)	N/A	N/A	N/A	N/A	--
Cache function (Read, Write)	N/A	N/A	N/A	N/A	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	No No Yes	No No Yes	NA NA NA
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 15	20 20	N/A N/A
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22	7 x 17 x 22	N/A
POWER: Power backup	200 watts --	300 watts --	200 watts --	300 watts --	N/A N/A
FIRST CUSTOMER SHIPMENT	1Q93	1Q93	1Q93	1Q93	1989
COMMENTS					

MANUFACTURER	CLONE STAR SOFTWARE	CLOVIS	CLOVIS	CLOVIS	CLOVIS
ARRAY MODEL	REFLECT	MultiStor 1	MultiStor 2	MultiStor 3	MultiStor 3FH
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible MS-DOS, NetWare	SCSI host VINES, NetWare, other	SCSI host VINES, NetWare, other	SCSI host VINES, NetWare, other	SCSI host VINES, NetWare, other
RAID level Configured by:	1 Preset	1 Panel	1 Panel	0/1/3/5 Panel	0/1/3/5 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	3	3
Maximum drives per array	2	2	2	28	28
Concurrent host channels	1	1	1	2	2
Controller drive channels	--	2	2	7	7
Array interface to host	N/A	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	N/A	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	4, 16	8, 16	8, 48	16, 48
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	NA NA NA	No No No	No No Option	No No Option	No No Option
Spare drive (None/Auto/Manual)	None	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	N/A N/A	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	N/A				
POWER: Power backup	N/A N/A	300 watts	300 watts	300 watts	50 watts/drive
FIRST CUSTOMER SHIPMENT	1988	9/91	11/93	8/93	11/94
COMMENTS					

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MANUFACTURER	CLOVIS	CLOVIS	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY
ARRAY MODEL	MultiStor 3R	MultiStor 3RM	CRD-6560	CRD-5000	CRD-5300
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	SCSI host VINES, NetWare, other	SCSI host VINES, NetWare, other	PCI host NetWare, DOS,NT OS/2, UNIX,oth.	SCSI host NetWare, UNIX, DOS, Wind. NT*	SCSI host Various
RAID level Configured by:	0/3/5 Panel	0/1/3/5 Panel	0/1/4/5/10 Port,Host,Pres.	0/3/5 Host,Panel,Port	0/1/4/5/10 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	3	2	3	2
Maximum drives per array	28	28	42	28	14
Concurrent host channels	1	2	1	1-3	1
Controller drive channels	7	7	2-6	3-7	2
Array interface to host	SCSI-2	SCSI-2	PCI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 32	16, 48	4, 128	0, 32	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Option	No No Option	-- -- --	Yes No No	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	133 10, 20	20 10	20 10, 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D			4.2 x 6.87	3.25 x 5.75 x 8.12	.6 x 5.25 x 5.5
POWER: Power backup	300 watts	300 watts	15-25 watts None	25-45 watts Cache battery	10-15 watts Cache battery
FIRST CUSTOMER SHIPMENT	1/95	12/94	6/95	4/93	4/95
COMMENTS			Custom drivers available	*Many hardware options and software systems supported	MIPS R3300 RISC processor 3.5" form factor

MANUFACTURER	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY	CMD TECHNOLOGY
ARRAY MODEL	CRD-5500 FHC	CRD-5500 SBC	CSV-050 TRIDENT	CSV-8150 TRIDENT	TRIDENT
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	DEC VMS, OSF	DEC VMS, OSF	DEC VMS
RAID level Configured by:	0/1/4/5/10 Panel,Port,Host	0/1/4/5/10 Port	3/5 Port, Panel	3/5 Port, Panel	3/5 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2			3
Maximum drives per array	56	56	42	42	28
Concurrent host channels	1, 2	1, 2	1	1, 2	1
Controller drive channels	2, 8	2, 8	1, 6	1, 5	4
Array interface to host	SCSI-2	SCSI-2	CI	CI, DSSI	CI, FDDI, DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 512	4, 512	--, 512	--, 512	8, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (Option) -- --	Yes (option) -- --	Yes (option) -- Yes	Yes (option) -- Yes	Yes (option) -- Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10, 20	20 10, 20	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8.1	1.5 x 6 x 10	5.2 x 19 x 24.5	5.2 x 19 x 24.5	5.2 x 19 x 24.5
POWER: Power backup	25-50 watts Battery	25-50 watts Battery	100 watts Battery	100 watts Battery	100 watts Battery
FIRST CUSTOMER SHIPMENT	4/95	5/95	4Q94	4Q94	4Q94
COMMENTS	MIPS R3300 RISC processor. Modular and expandable. CRD-5000 replacement.	MIPS R3300 RISC processor Host-plug board version of CRD-5500	RAID 0/1 also available in 2Q95	RAID 0/1 also available in 2Q95	RAID 0/1 also available in 2Q95

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	486/50-2100A ProLiant 2000	486/50-4200A ProLiant 2000	486DX2/66-2100A ProLiant 1000	5/100-4200A ProLiant 1500	5/60-2100A ProLiant 1000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN
RAID level	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5	0/1/4/5
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	2.1	4.2	2.1	4.2	2.1
MAX	21.5/301*	21.5/301*	21.5/241*	21.5/301*	21.5/241*
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	14	14	14	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	2	2	2
Array interface to host	EISA	EISA	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4**	4**	4**	4**	4**
Cache function (Read, Write)	Write	Write	Write	Write	Write
Redundancy: Controller (Yes/No)	With duplexing	With duplexing	With duplexing	With duplexing	With duplexing
Fan (Yes/No)	No	No	No	No	No
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	33	33	33	33
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1050-4300	2100-4300	1050-4300	2100-4300	1050-4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.5	9.5	10.5	9.5	10.5
Average rotational delay (msec)	5.5	4.7	5.5	4.7	5.5
Drive models	Fujitsu, H-P, Micropolis, IBM	H-P, Seagate	Fujitsu, H-P, Micropolis, IBM	H-P, Seagate	Various
ARRAY SIZE: Inches: H x W x D	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4
POWER:	445 watts	445 watts	300 watts	445 watts	300 watts
Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	4Q93	1Q95	4Q93
COMMENTS	*With external ProLiant storage systems	*With external ProLiant storage systems	*With external ProLiant storage systems	*With external ProLiant storage systems	*With external ProLiant storage systems
	**Mirrored 2 MB cache	**Mirrored 2 MB cache	**Mirrored 2 MB cache	**Mirrored 2 MB cache	**Mirrored 2 MB cache

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	5/66-2100A ProLiant 2000	5/66-4200A ProLiant 2000	5/75-4200A ProLiant 1500	5/90-2100A ProSignia 500	5/90-2100A ProLiant 2000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	Compaq UNIX,NetWare,NT OS/2,VINES,LAN
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	2.1 21.5/301*	4.2 21.5/301*	4.2 21.5/301*	2.1 17.2/301*	2.1 21.5/301*
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	14	14	14	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	2	2	2	2
Array interface to host	EISA	EISA	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4**	4**	4**	4**	4**
Cache function (Read, Write)	Write	Write	Write	Write	Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing No Yes	With duplexing No Yes	With duplexing No Yes	With duplexing No Yes	 Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	1050-4300	2100-4300	1050-4300	1050-4300	1050-4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.5	9.5	10.5	9-10.5	9.5
Average rotational delay (msec)	5.5	4.7	5.5	5.5-4.2	5.5
Drive models	Various	H-P, Seagate	H-P, Fujitsu, IBM, Micropolis	Various	Fujitsu, H-P, Micropolis, IBM
ARRAY SIZE: Inches: H x W x D	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4	21.93 x 8.96 x 17.25	21.93 x 8.96 x 17.25
POWER: Power backup	445 watts Cache battery	445 watts Cache battery	445 watts Cache battery	240 watts Cache battery	445 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	1Q95	4Q94	4Q94
COMMENTS	*With external ProLiant storage systems **Mirrored 2 MB cache	*With external ProLiant storage systems **Mirrored 2 MB cache	*With external ProLiant storage systems **Mirrored 2 MB cache	*With external ProLiant storage systems **Mirrored 2 MB cache	*With external ProLiant storage systems **Mirrored 2 MB cache

MANUFACTURER	COMPAQ COMPUTER	COMPAREX	COMPUADD	COMPUTER MARKETPLACE	COMPUTREND SYSTEMS
ARRAY MODEL	5/90-4200A ProLiant 2000	TETRAGON 2000	DriveArray DriveArray 2	Acceleraider	Array Option
DISK/TREND GROUP	Net/Mini/Multi	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Compaq UNIX,NetWare,NT OS/2,VINES,LAN	HDS/IBM mainframe MVS, VS, VSE	SCSI host DOS, OS/2, UNIX Novell, other	SCSI host Various	CompuTrend Premio
RAID level	0/1/4/5	5	0/1/5	0/3/5	0/1/5
Configured by:	Host	Preset	Host	Panel, Port	Host
Array capacity (Gbytes) MIN	4.2	22.7	1/.5/2	Drive dependent	Drive dependent
MAX	21.5/301*	723.7	8/4/8	Drive dependent	Drive dependent
Minimum drives per array	2	7*	2	2	2
Maximum drives per array	14	224*	5	7	14
Concurrent host channels	1	8, 16	1	1	1
Controller drive channels	2	1-32	1	1	1, 2
Array interface to host	EISA	IBM	SCSI-2	SCSI-2	PCI
Drive interface	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4**	256, 8192	--	0, 64	64
Cache function (Read, Write)	Write	Read, Write**	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	With duplexing	Yes	No	No	--
Fan (Yes/No)	No	Yes	Yes	Yes	Yes-option
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes-option
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	17	10	10, 20	132
drive (MB/Sec)	10	20	10	10	10
DRIVES: Formatted capacity/drive(MB)	2100-4300	4360	500, 1000, 2000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	11.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.7	4.7	Drive dependent	Drive dependent	Drive dependent
Drive models	H-P, Seagate	Hitachi	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	21.93 x 8.96 x 17.25	70.5 x 51.2 x 31.5	15.5 x 15.5 x 15.5		
POWER: Power backup	445 watts Cache battery	2.2 KVA Battery	N/A None		300 watts None
FIRST CUSTOMER SHIPMENT	4Q94	5/95	5/93	1994	1Q95
COMMENTS	*With external ProLiant storage systems **Mirrored 2 MB cache	*Plus hot spares **Duplexed cache	Raidtec controller		Mylex controller

MANUFACTURER	CONCORDE TECHNOLOGIES	CONCURRENT COMPUTER	CONLEY	CONLEY	CONLEY
ARRAY MODEL	SDHP 9000	SCSI DEXS	SHA-400 SHA-450 With SoftRAID	SoftRAID	SR2 SR3
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	Captive	PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Software Software	Board Software	Software Software	Subsystem Hardware
Host platform, software environment	SCSI host Various	MAXION MAX/OS Solaris	Macintosh, Power PC, Quadra	Macintosh, Power PC, Quadra	Sun, Macintosh, SCSI host
RAID level Configured by:	0/1/3/5 Panel	0/1	0/1	0/1	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	10 315
Minimum drives per array	3	2	2	2	3
Maximum drives per array	75	4	12	12	35
Concurrent host channels	1, 2	--	2	1	2
Controller drive channels	5	--	--		5
Array interface to host	SCSI-2	N/A	SCSI-2	--	SCSI-2/3
Drive interface	SCSI-2	SCSI	SCSI-2	--	SCSI-2
Cache size (min, max: MB)	--	--	--	--	32
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	N/A N/A N/A	NA NA NA	NA NA NA	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	20 10
DRIVES: Formatted capacity/drive(MB)	2100, 4300	Drive dependent	Drive dependent	Drive dependent	1000-9000
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	--	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	--	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Seagate
ARRAY SIZE: Inches: H x W x D	15.75 x 15.6 x 15.6	--	NA	N/A	28 x 9 x 22
POWER: Power backup	150 watts None	-- --	NA	N/A	350 watts
FIRST CUSTOMER SHIPMENT	1994	4Q94	1994	11/93	
COMMENTS	RAIDTEC controller Rack mount or desktop	Supports concurrent mirroring, striping and dual porting	SoftRAID is software option compatible with Conley accelerator cards		SR3 has up to 128/MB cache

MANUFACTURER	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS
ARRAY MODEL	CR12	CR611DE	CR611DM	CR611DP	CR612DE
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem Hardware
Host platform, software environment	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	PC compatible NetWare, DOS, NT, other
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	6/3/5 25/12/23	6.3/3.2/5.3 12.6/6.4/10.6	6.3/3.2/5.3 12.6/6.4/10.6	6.3/3.2/5.3 12.6/6.4/10.6	6.3/3.2/5.3 12.8/6.4/10.7
Minimum drives per array	6	6	6	6	6
Maximum drives per array	12	6	6	6	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	--	--	--	1
Array interface to host	SCSI-2	EISA	MCA	PCI	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	--	--	--	4, 32
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	Host dependent 10	Host dependent 10	Host dependent 10	33 10
DRIVES: Formatted capacity/drive(MB)	1062, 2147	1062, 2147	1062, 2147	1062, 2147	1062, 2147
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.5 RD/9.0 WR*	9.5	9.5	9.5	9
Average rotational delay (msec)	5.6	5.55	5.55	5.55	5.55
Drive models	Conner CFP-1060 CFP-2107	Conner CFP-1060 CFP-2105	Conner CFP-1060 CFP-2105	Conner CFP-1060 CFP-2105	Conner CFP-1060 CFP-2105
ARRAY SIZE: Inches: H x W x D	18.75 x 7 x 23	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5
POWER: Power backup	140 watts	85 watts None	85 watts None	85 watts None	85 watts None
FIRST CUSTOMER SHIPMENT	1/95	1/94	1/94	1/94	8/94
COMMENTS	Rack mount available Mylex controller. *2 GB drive	Uses modified BusLogic RAID software. Inclues array management software	Uses modified BusLogic RAID software. Includes array management software	Uses modified BusLogic RAID software. Includes array management software	Mylex controller Includes array management software

MANUFACTURER	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS
ARRAY MODEL	CR622DE	CR6411DE	CR6411DP	CR6421DE	CR6421DP
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	6.3/3.2/5.3 12.8/6.4/10.7	4/2/3 12/6/10	4/2/3 12/6/10	8/4/6 12/6/10	8/4/6 12/6/10
Minimum drives per array	6	4	4	4	4
Maximum drives per array	6	6	6	6	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	--	--	--	--
Array interface to host	EISA	EISA	PCI	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10/20	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2147	1062, 2147	1062, 2147	2147	2147
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9 RD/9.5 WR	9 RD/9.5 WR	9.5	9.5
Average rotational delay (msec)	5.55	5.6	5.6	5.55	5.55
Drive models	Conner CFP-2105	Conner CFP-1060 CFP-2105	Conner CFP-1060 CFP-2105	Conner CFP-2105	Conner CFP-2105
ARRAY SIZE: Inches: H x W x D	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5
POWER: Power backup	85 watts None	85 watts None	85 watts None	85 watts None	85 watts None
FIRST CUSTOMER SHIPMENT	9/94	7/94	7/94	9/94	9/94
COMMENTS	Mylex controller	Uses modified BusLogic RAID software. Includes array management software	Uses modified BusLogic RAID software. Includes array management software	Uses modified BusLogic RAID software. Includes array management software	

MANUFACTURER	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONSENSYS
ARRAY MODEL	CR6422DE	CR6621DE	CR6621DM	CR6621DP	RAIDIX
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software	Software Software
Host platform, software environment	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	Various UNIX, SCO, Solaris, other
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	8/4/6 12/6/9	8/4/6 12/6/10	8/4/6 12/6/10	8/4/6 12/6/10	Drive dependent Drive dependent
Minimum drives per array	4	6	6	6	--
Maximum drives per array	6	6	6	6	--
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	--	--	--	1
Array interface to host	EISA	EISA	MCA	PCI	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IDE, SCSI
Cache size (min, max: MB)	4, 64	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	N/A N/A N/A
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	Host dependent 10	Host dependent 10	Host dependent 10	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	2147	2147	2147	2147	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	9.5	9.5	9.5	9.5	Drive dependent
Average rotational delay (msec)	5.55	5.55	5.55	5.55	Drive dependent
Drive models	Conner CFP-2105	Conner CFP-2105	Conner CFP-2105	Conner CFP-2105	Various
ARRAY SIZE: Inches: H x W x D	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	12.5 x 7.5 x 12.5	--
POWER: Power backup	85 watts None	85 watts None	85 watts None	85 watts None	-- --
FIRST CUSTOMER SHIPMENT	9/94	9/94	9/94	9/94	1993
COMMENTS	Includes array management software				

MANUFACTURER	CONSENSYS	CONSENSYS	CONTROL DATA SYSTEMS	CONVEX COMPUTER	CONVEX COMPUTER
ARRAY MODEL	RAIDIX/IDE	RAIDIX/SCSI	47008	DAR-004	DAR-005
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Very High Perf.
MARKET	PCM	OEM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Software Software	Board Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	PC compatible UNIX, Solaris	PC compatible	SGI, MIPS UNIX	Convex C3 series	Convex C3 series
RAID level Configured by:	0/1/5*	0/1/5*	0/3 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	2.4 64	34	67
Minimum drives per array	2	2	2	12	24
Maximum drives per array	8	8	32	32	32
Concurrent host channels	1	1	2	4	4
Controller drive channels	1	1			
Array interface to host	EISA	EISA	VME	IPI-2	IPI-2
Drive interface	IDE	SCSI	IPI-2	IPI-2E	IPI-2E
Cache size (min, max: MB)	--	--	None	--	--
Cache function (Read, Write)	--	--	--	None	None
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	Option -- --	Yes No No	No No No	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 Drive dependent	33 10	25 7.5	45 7.5-12	45 7.5-12
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	2800	2800
Nominal disk diameter (mm)	95	Drive dependent	130	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	11	11	11
Average rotational delay (msec)	Drive dependent	Drive dependent	5.55	5.56	5.56
Drive models	Various	Various	Seagate ST41201K,41800K	Seagate Elite III 2HP	Seagate Elite III 2HP
ARRAY SIZE: Inches: H x W x D	4.25 x 13	4.25 x 13	7 x 19	70 x 25.1 x 39.3	70 x 25.1 x 39.3
POWER: Power backup	5 watts+ drives None	2 watts+ drives None	85 watts(Board) None	N/A	N/A
FIRST CUSTOMER SHIPMENT	1993	1993	8/91	7/93	7/93
COMMENTS	*Combined RAID 0/1 available	*Combined RAID 0/1 available Requires SCSI controller		Drives use 2 parallel heads	

MANUFACTURER	CONVEX COMPUTER	CORE INTERNATIONAL	CORE INTERNATIONAL	CORE INTERNATIONAL	CORE INTERNATIONAL
ARRAY MODEL	DAR-007	LA-2000	LA-4000	COREarray Micro 2000	COREarray 20000
DISK/TREND GROUP	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Implementation					
Host platform, software environment	Convex C3 series	SCSI host NetWare, UNIX, OS/2, DOS	NetWare, UNIX, OS/2, DOS	SCSI host NetWare, UNIX, OS/2, DOS, NT	SCSI host NetWare, UNIX, OS/2, DOS, NT
RAID level	0/1/5	3/5	3/5	3/5	3/5
Configured by:	Host	Port	Host, Port	Host, Port	Host, Port
Array capacity (Gbytes) MIN		2	4	1/1	2/2
MAX	89	2	4	2/2	20/20
Minimum drives per array	32	5	5	3	3
Maximum drives per array	32	5	5	5	42*
Concurrent host channels	4	1	1	1	2
Controller drive channels		6	6	5	6
Array interface to host	IPI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IPI-2E	IDE	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	2	2	2	2
Cache function (Read, Write)	None	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	Yes	Yes	No	No
Power supply (Yes/No)	No	Yes	Yes	No	Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	45	5	5	10	20
drive (MB/Sec)	7.5-12	6	6	10	10
DRIVES: Formatted capacity/drive(MB)	2800	540	1000	524	1000,2000,4000
Nominal disk diameter (mm)	130	95	95	65	95
Average positioning time (msec)	11	12	10	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56	6.8	5.6	Drive dependent	Drive dependent
Drive models	Seagate Elite III 2HP	Fujitsu	Micropolis	Various	Various
ARRAY SIZE: Inches: H x W x D	70 x 50.2 x 39.3	8.25 x 12.5 x 18	8.25 x 12.5 x 18	3.25 x 5.75 x 8	8 x 13.7 x 18
POWER:	N/A	108 watts	144 watts		53 watts
Power backup		None	None	None	None
FIRST CUSTOMER SHIPMENT	7/93	2/93	2/93	3Q94	3Q94
COMMENTS				Expandable with up to 30 external drives	*6 drives per cabinet

MANUFACTURER	COREL	CRAY RESEARCH	CRAY RESEARCH	CRAY RESEARCH	CRAY RESEARCH
ARRAY MODEL	Network Manager	DA-301	DA-302	DA-60	ND-30
DISK/TREND GROUP	Net/Mini/Multi	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	OEM, PCM	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Software Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare 3.1X, NetWare 4.X	Cray Unicos	Cray Unicos	Cray Unicos	Cray Unicos
RAID level Configured by:	4/5 Host	3 Host	3 Host	3 Host	1/5 Console
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	5.51 44.08	7.2 57.6	7.84 62.72	30.1 68.8
Minimum drives per array	3	5	5	5	8
Maximum drives per array	16	40	40	40	16
Concurrent host channels	1	1	1	1	2
Controller drive channels	Cont. dependent				
Array interface to host	SCSI-2	Proprietary	Proprietary	Proprietary	IPI-3 (HIPPI)
Drive interface	SCSI-2	IPI-2	IPI-2	IPI-2	SCSI
Cache size (min, max: MB)	--	--	--	--	20
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Yes Yes	No Yes Yes	No No No	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	32 8.2	36 8.2	80 20	3.5-7.6
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1377	1800	1960	4300
Nominal disk diameter (mm)	Drive dependent	95	95	210	95
Average positioning time (msec)	Drive dependent	11	11	12	8 RD/9 WR
Average rotational delay (msec)	Drive dependent	5.56	5.56	8.3	4.17
Drive models	Various	IBM 0664 (2 head parallel)	IBM	Seagate Sabre 6 PTD 9 head	Seagate Cuda 4
ARRAY SIZE: Inches: H x W x D	-- --			60.75 x 24 x 40.8	
POWER: Power backup	-- --	167 watts/drive None	167 watts/drive None	275 watts/drive None	
FIRST CUSTOMER SHIPMENT	1Q94*	1/93	3/95	12/92	6/95
COMMENTS	*Shipped as Corel RAID in 3Q93	DCA-3 channel adapter controls up to 8 DA-301 array groups	DCA-3 channel adapter controls up to 8 DA-302 array groups	DCA-3 channel adapter controls up to 8 DA-60 array groups	

MANUFACTURER	CRAY RESEARCH	CYRANEX	CYRANEX	DALLAS DIGITAL	DATA GENERAL
ARRAY MODEL	ND-40	EZRAID Lite	EZRAID Pro	RAIDstor	1100 CLARiiON
DISK/TREND GROUP	Very High Perf.	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	PCM	OEM, PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Software	Software	Subsystem	Subsystem
Implementation	Hardware	Software	Software	Hardware	Hardware
Host platform, software environment	Cray Unicos	PC compatible OS/2	PC compatible OS/2	SCSI host Various	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net
RAID level	1/5	0/1	0/1/4/5	0/1/3/5	0/1/3/5/10
Configured by:	Console	Host	Host	Panel, Port	Host, Port
Array capacity (Gbytes) MIN	85	Drive dependent	Drive dependent	3	3
MAX	376	Drive dependent	Drive dependent	112	40
Minimum drives per array	24	2	2	3	3
Maximum drives per array	96	2	7 per control.	28	10
Concurrent host channels	4	1	1	3	1, 2
Controller drive channels		1	1	7	
Array interface to host	IPI-3 (HIPPI)	Various	Various	SCSI-2/3	SCSI-2
Drive interface	SCSI	Various	Various	SCSI-2	SCSI-2
Cache size (min, max: MB)	20	--	.03-2*	32	8, 16, 32, 64
Cache function (Read, Write)	Read, Write	--	Read, Write	Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	--	--	Yes	Yes
Fan (Yes/No)	Yes	--	--	Yes	Yes
Power supply (Yes/No)	Yes	--	--	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	None	Auto		Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	Up to 160	Host dependent	Host dependent	14	20
drive (MB/Sec)	3.5-7.6	Drive dependent	Drive dependent	20	10
DRIVES: Formatted capacity/drive(MB)	4300	Drive dependent	Drive dependent	4100	1000,2000,4000
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	8 RD/9 WR	Drive dependent	Drive dependent	9	8.5-9.4
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	5.5	4.17
Drive models	Seagate Cuda 4	Various	Various	Seagate Hawk	Various
ARRAY SIZE: Inches: H x W x D	36.5 x 29.5 x 72	--	--	10.5 x 19 x 17*	24.8 x 10.5 x 30
POWER:	Up to 4.85 KVA	--	--		575 watts
Power backup	Int. UPS	-	--	UPS option	Battery
FIRST CUSTOMER SHIPMENT	12/94	1994	11/94	4/94	1/94
COMMENTS			*In driver	*Array height varies	Concurrent RAID levels, mirrored cache

MANUFACTURER	DATA GENERAL	DATA GENERAL	DATA GENERAL	DATA STORAGE MARKETING	DATALINK
ARRAY MODEL	1300 CLARiiON	2000/2200 CLARiiON	2300 CLARiiON	Datastor RAID	RSD 500
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AViiON,DG, Eclips.,RS/6000 AS/400,OS/2,Net	SCSI host Various	SCSI host UNIX, Novell VAX
RAID level Configured by:	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/3/5 Host	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	5 40	3 80	5 80	Drive dependent Drive dependent	4 216
Minimum drives per array	5	3	5	5	3
Maximum drives per array	10	20	20	28	28
Concurrent host channels	1, 2	1, 2	1, 2	1, 3	1, 3
Controller drive channels				5-7	5, 7
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 16, 32, 64	8,16,32,64,128	8,16,32,64,128	8, 32	0-32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Write	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 20	20 10	10, 20 Drive dependent	10-20 10
DRIVES: Formatted capacity/drive(MB)	1000,2000,4000	1000,2000,4000	1000,2000,4000	Drive dependent	2000,4000,9000
Nominal disk diameter (mm)	95	95	95	Drive dependent	95, 130
Average positioning time (msec)	8.5-9.4	8.5-9.4	8.5-9.4	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	4.2-5.5
Drive models	Various	Various	Various	Various	H-P, Quantum, Seagate
ARRAY SIZE: Inches: H x W x D	24.8 x 10.5 x 30	24.8 x 14 x 30	24.8 x 14 x 30	Varies	Pedestal, Rack
POWER: Power backup	575 watts Battery	880 watts Battery	880 watts Battery	Cache battery	1 KVA UPS
FIRST CUSTOMER SHIPMENT	3/94	6/92	3/94	9/93	1/94
COMMENTS	Concurrent RAID levels, mirrored cache	Concurrent RAID levels, mirrored cache	Concurrent RAID levels, mirrored cache	CMD CRD-5000 controller	CMD controller

MANUFACTURER	DATALINK	DATALINK	DATARAM	DATARAM	DATARAM
ARRAY MODEL	RSE 600	RSG 300	DTM900	DTM1000	DTM4000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, Novell NFS, NT	SCSI host Novell, Mac, UNIX, other	Sun, DEC, H-P VMS, UNIX	DEC, Sun, H-P, VMS, UNIX Solaris	Sun Solaris, H-P/UX, DEC (OSF/1)
RAID level Configured by:	0/3/5 Port	0/1/3 Panel	0/1 Port, Panel	0/3/5 Port, Panel	0/1/3/5/10 Port
Array capacity (Gbytes) MIN MAX	4 387	2 20	2 25	3 29	10 130
Minimum drives per array	3	3	2	3	5
Maximum drives per array	42	5	6	7	30
Concurrent host channels	1, Dual initiat	1	1, 2	1, 3	1, 2
Controller drive channels	6, 6	5, 5	7	7	5
Array interface to host	SCSI	SCSI	SCSI, DSSI	SCSI, DSSI	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	--	--	8, 16, 32	2, 128
Cache function (Read, Write)	Read, Write	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	Option Yes No	No Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10-20 10	10 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2000,4000,9000	1000,2000,4000	1000, 2000	1054,2139,4294	1054,2139,4294
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	11/9.5/9.5	11/9.5/9.5	8 RD/9 WR
Average rotational delay (msec)	4.2-5.5	4.2-5.5	5.56	5.6/4.2	4.17
Drive models	H-P, Quantum, Seagate	H-P, Quantum, Seagate	Seagate	Seagate	IBM
ARRAY SIZE: Inches: H x W x D	34 x 19 x 21	15 x 15 x 15	5.22 x 17.65 x 22.5	5.22 x 17.65 x 22.5	13.9 x 19 x 30.1
POWER: Power backup	1 KVA UPS	.25 KVA UPS	-- --	-- Cache battery	.9 KVA Cache battery
FIRST CUSTOMER SHIPMENT	10/94	2Q94	1994	4Q93	1Q95
COMMENTS	DEC StorageWorks	Raidtec controller	TD Systems controller	StorageWorks compatible disk canisters CMD controller	Symbios Logic controller

MANUFACTURER	DELL COMPUTER	DIGI-DATA	DIGI-DATA	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	DSA	Model Z	Model Z9000	RAID Array 410 StorageWorks	HS111
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	OEM	OEM	Captive, PCM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Dell Lanman 2.2,Dell UNIX, NetWare	SCSI-2 host Various	SCSI-2 host Various	Digital, Open Systems UNIX	Alpha, Open VMS
RAID level Configured by:	0/1/4/5/10 Host	0/3/5 Port	0/3/5 Port	0/3/5/10 Host	0/1/3/5
Array capacity (Gbytes) MIN MAX	2/1/2/2/1 57/28/46/46/28	Drive dependent Drive dependent	Drive dependent Drive dependent	3.15 180.6	3.15 180.6
Minimum drives per array	2	5	5	3	3
Maximum drives per array	14	35	35	42	42
Concurrent host channels	1, 2	1	1	1	1, 2
Controller drive channels	2	1	1, 5	6	6
Array interface to host	EISA	SCSI-2	SCSI-2	SCSI-2	FDDI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5	--	4, 128	32	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Option Option	No No No	No No No	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	20 10	20 10	20 10	12 10
DRIVES: Formatted capacity/drive(MB)	1050-4100	Drive dependent	Drive dependent	1050,2100,4300	1050,2100,4300
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	9.5	Drive dependent	Drive dependent	9.5/9.5/8	9.5/9.5/8
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	5.6/5.6/4.2	5.6/5.6/4.2
Drive models	DEC, Seagate, IBM	Various	Various	Quantum, Seagate	RZ26L, RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	Varies	3.25 x 5.75 x 8	3.25 x 5.75 x 8	33 x 18.75 x 19	67 x 31 x 34.5
POWER: Power backup	Host dependent None	26 watts+drives None	26 watts+drives None		
FIRST CUSTOMER SHIPMENT	11/92	4/92	3/94	12/94	1Q95
COMMENTS	RAID 1/0 shipped 11/92; other models added in 3/93				

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HS121	HSC65 SCSI	HSC95 SCSI	HSD30	HSD05
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Alpha, Open VMS	VAX, Alpha, VMS	VAX, Alpha, VMS ULTRIX	VAX, Alpha, VMS	VAX, Alpha, VMS
RAID level	0/1/3/5	0/1	0/1	0/3/5	0/1
Configured by:		Host	Host	Host	
Array capacity (Gbytes) MIN	3.15	1	1	2.1	2.1
MAX	309.6	44.1	117.6	77.4	25.8
Minimum drives per array	3	1	1	3	2
Maximum drives per array	72	21	56	21	6
Concurrent host channels	1, 2	1, 3	1, 8	1	1
Controller drive channels	12	3	8		
Array interface to host	FDDI	CI	CI	DSSI	DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	2, 32	64, 64	64, 64	32	--
Cache function (Read, Write)	Read, Write	Read	Read	Read,Write(opt)	--
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Option	--
Fan (Yes/No)	Yes	No	No		--
Power supply (Yes/No)	Yes	No	No		--
Spare drive (None/Auto/Manual)	Auto	Auto (option)	Auto (option)		--
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	12	4	4	4	4
drive (MB/Sec)	10	2.8, 10	2.8, 10	10	10
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1000, 2000	1000, 2000	1050,2100,4300	1050,2100,4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5/9.5/8	9.5	9.5	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6/5.6/4.2	5.6	5.6	Drive dependent	Drive dependent
Drive models	RZ26L, RZ28, RZ29	RZ26, RZ28	RZ26, RZ28	RZ26, RZ28, RZ29	RZ26, RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	67 x	41.7 x	41.7 x		--
	31 x 34.5	21.3 x 35	21.3 x 35		
POWER:		785 watts	785 watts		--
Power backup		None	None		--
FIRST CUSTOMER SHIPMENT	1Q95	3/93	3/93		1/94
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSJ30 StorageWorks	HSJ40 StorageWorks	HSJ42 StorageWorks	HSJ44 StorageWorks	QL-0MHA*-AA QL-2YFA*-AA QL-0MGAA-3B StorageWorks
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Software Software
Host platform, software environment	VAX, Alpha, VMS OSF	VAX, Alpha, VMS OSF	VAX, Alpha, VMS OSF	VAX, Alpha, VMS OSF	Open VMX VAX
RAID level Configured by:	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5	0/1/5 Host
Array capacity (Gbytes) MIN MAX	4.2 77.4	4.2 154.8	4.2 309.6	4.2 619.2	-- --
Minimum drives per array	2	2	2	2	--
Maximum drives per array	18	36	36/72	72/144	7 + parity
Concurrent host channels	1, 8	1, 8	1, 8	1, 8	--
Controller drive channels					
Array interface to host	CI	CI	CI	CI	Varies
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Varies
Cache size (min, max: MB)	0, 32	16, 32	32, 64	64, 128	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	-- -- --
Spare drive (None/Auto/Manual)					--
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4-6 10	4-6 10	4-6 10	4-6 10	-- --
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050,2100,4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5/9.5/8	9.5/9.5/8	9.5/9.5/8	9.5/9.5/8	9.5/9.5/8
Average rotational delay (msec)	5.6/5.6/4.2	5.6/5.6/4.2	5.6/5.6/4.2	5.6/5.6/4.2	5.6/5.6/4.2
Drive models	RZ26, RZ28 RZ29	RZ26, RZ28, RZ29	RZ26, RZ28, RZ29	RZ26, RZ28, RZ29	Various
ARRAY SIZE: Inches: H x W x D	Various configurations	Various configurations	Various configurations	Various configurations	--
POWER: Power backup	1300-3140 watts	1300-3140 watts	1300-3140 watts	1300-3140 watts	-- --
FIRST CUSTOMER SHIPMENT	1Q94	3Q93	1Q94	1Q94	12/93
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	RAID 211 Controller	RAID 213 Controller	RAID Array 210 StorageWorks	RAID Array 110 StorageWorks	RAID Array 230
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare, NT, SCO UNIX	PC compatible NetWare, NT, SCO UNIX	PC compatible NetWare, NT	Digital, Sun, PC servers, VMS NetWare, UNIX	Open VMS, Alpha Digital UNIX, Wind. NT, NetW.
RAID level	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10	0/1/5/10
Configured by:	Host	Host	Host	Host	
Array capacity (Gbytes) MIN	3.15	3.15	3.15	5.25	3.15
MAX	30.1	90.3	90.3	73.5	90.3
Minimum drives per array	3	3	3	5	3
Maximum drives per array	7	21	21	35	21
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	3	1, 3	5	3
Array interface to host	EISA	EISA	EISA	SCSI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	4, 32	1	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Option	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto (option)	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	14	14	14	20	
drive (MB/Sec)	10	10	10	10	20
DRIVES: Formatted capacity/drive(MB)	1050,2100,4300	1050,2100,4300	1050,2100,4300	1050, 2100	1050,2100,4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5/9.5/8	9.5/9.5/8	9.5/9.5/8	9.5	9.5/9.5/8
Average rotational delay (msec)	5.6/5.6/4.2	5.6/5.6/4.2	5.6/5.6/4.2	5.6	5.6/5.6/4.2
Drive models	RZ26L, RZ28, RZ29	RZ26L, RZ28, RZ29	RZ26L, RZ28, RZ29	RZ26, RZ28	RZ26L, RZ28, RZ29
ARRAY SIZE: Inches: H x W x D	22.2 x 8.2 x 17	22.2 x 8.2 x 17	22.2 x 8.2 x 17	24 x 14 x 15	22.2 x 8.2 x 17
POWER:	150 watts	150 watts	150 watts	131 watts	
Power backup	Battery option	Battery option	Battery option.	Battery option	
FIRST CUSTOMER SHIPMENT	7/94	7/94	7/94	5/93	1Q95
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIRECT CONNECT SYSTEMS
ARRAY MODEL	RM HSC95 SCSI	SC-4600/HA2400C	SC4600	Volume Shadowing, Version 6.0	Guardian Array
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	OEM	OEM	Captive	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Software Software	Subsystem Hardware
Host platform, software environment	VAX, Alpha, VMS			VAX, Alpha	DEC, Sun, AT&T UNIX, OS/2, NetWare
RAID level Configured by:	0/1 Host	0/1/3/5	0/1/3/5	1	3
Array capacity (Gbytes) MIN MAX	1.05 58.8	3.15 103		-- 464	Drive dependent Drive dependent
Minimum drives per array	1	3	3	1	3
Maximum drives per array	56	24	36	130 x 3	6
Concurrent host channels	1, 8	1, 2	1, 2	1, 130	1
Controller drive channels		6	6		1
Array interface to host	Digital prop.	SCSI-2	SCSI-2	DSSI, SCSI, CI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	DSSI, SCSI, CI	SCSI-2
Cache size (min, max: MB)	64, 64	32	32	DSSI, SCSI, CI	--
Cache function (Read, Write)	Read	Read, Write		--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No Yes	Yes Yes Yes	-- -- --	-- -- --	No Yes Yes
Spare drive (None/Auto/Manual)	Auto (option)	Auto	Auto	--	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4 10	20 20	20 20	Drive dependent Drive dependent	10 10
DRIVES: Formatted capacity/drive(MB)	1050, 2100	1050,2100,4300	1050,2100,4300	Drive dependent	1600-2000
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	9.5	9.5/9.5/8	9.5/9.5/8	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6/5.6/4.2	5.6/5.6/4.2	Drive dependent	Drive dependent
Drive models	RZ26L, RZ28	Various		Various	Digital 3160 Seagate Barrac.
ARRAY SIZE: Inches: H x W x D	67 x 31 x 34.5	34 x 19 x 21		--	22.25 x 7.5 x 23
POWER: Power backup	785 watts Battery			-- --	170 watts None
FIRST CUSTOMER SHIPMENT	3/93	4Q94	4Q94	1990	10/93
COMMENTS					Raidtec controller Rack mount option available

MANUFACTURER	DIRECT CONNECT SYSTEMS	DIRECT CONNECT SYSTEMS	DIRECT CONNECTIONS	DISK PACK	DISK PACK
ARRAY MODEL	Guardian Duplex	Guardian RAID	DC3400W	DP.RAID FX	DP.RAID iX
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	DEC, Sun, AT&T UNIX, OS/2, NetWare	DEC, Sun, AT&T UNIX, OS/2, NetWare	Macintosh System 7	SCSI host	SCSI host
RAID level Configured by:	1	0/3/5	0/1/4/5 Host	0/1/3/5 Port	0/1/3/5 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	4.2/2.1/2.1/2.1 15/7.5/ /	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	3	2/3	5	5
Maximum drives per array	12	28	7	5	5
Concurrent host channels	1, 2	1, 3	1	1	1
Controller drive channels	2	1, 4	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	32	--	--	--
Cache function (Read, Write)	--	Read	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Option Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto (option)	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	20 20	20 10	10 10
DRIVES: Formatted capacity/drive(MB)	1600-2000	1600-2000	2100	270-4613	270-4613
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	Drive dependent	Drive dependent
Drive models	Digital 3160 Seagate Barrac.	Digital 3160 Seagate Barrac.	Seagate Barracuda 2	Quantum, Seagate	Quantum, Seagate
ARRAY SIZE: Inches: H x W x D	22.25 x 7.5 x 23	22.25 x 7.5 x 23	Varies		
POWER: Power backup	170 watts None	170 watts None	None		
FIRST CUSTOMER SHIPMENT	10/93	9/93	1Q94	1994	1994
COMMENTS	TD Systems controller Rack mount option available	CMD CRD-5000 Rack mount option available	Remus software ATTO controller	Raidtec controller	Raidtec controller

MANUFACTURER	DISK PACK	DIVERSE LOGISTICS	DPT	DPT	DPT
ARRAY MODEL	DP.RAID MX	Windjammer	DM4000 SmartCache III Disk Array Module	DM401X SmartCache Plus Disk Array Module	EISAPSC SmartRAID Subsystem
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Board	Board	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host NetWare, UNIX	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetWare, OS/2, NT, UNIX, other
RAID level Configured by:	0/1 Port	0/1 Panel, Port	0/1/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	14	7	7	3
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	2	1	1	1, 2, 3
Array interface to host	SCSI-2	SCSI-2	PCI, EISA, ISA	EISA, ISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	4, 16	1, 64	1, 16	1, 64
Cache function (Read, Write)	--	Read	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	Yes	Yes	Yes
Fan (Yes/No)	Yes	No	No	No	No
Power supply (Yes/No)	Yes	No	No	No	No
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	20	133/33/10	33/10	33
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	270-4613	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Quantum, Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		1.625 x 5 x 8	Adapter dependent	Adapter dependent	22.2 x 8.2 x 17
POWER:		8 watts+ drives	10 watts+drives	10 watts+drives	94 watts
Power backup		None	None	None	None
FIRST CUSTOMER SHIPMENT	1993	1/94	3Q93	3Q93	3Q94
COMMENTS	Raidtec controller Internal version available	Byte striping in RAID 0	SmartCache Plus SCSI controller option. CM4000 cache module is prerequisite	SmartCache Plus SCSI controller option. CM401X cache module is prerequisite	

MANUFACTURER	DPT	DPT	DPT	DPT	DPT
ARRAY MODEL	EISATWR SmartRAID Subsystem	ISAPSC SmartRAID Subsystem	ISATWR SmartRAID Subsystem	PCIPSC SmartRAID Subsystem	PCITWR SmartRAID Subsystem
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetWare, OS/2, NT, UNIX, other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	0/1/5
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	6	3	6	3	6
Concurrent host channels	2	1	2	1	2
Controller drive channels	1, 2, 3	1	1	1, 2, 3	1, 2, 3
Array interface to host	EISA	ISA	ISA	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 64	1, 64	1, 64	1, 64	1, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	No	Yes	No	Yes
Power supply (Yes/No)	Yes	No	Yes	No	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	10	10	133	133
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1100, 2100	Drive dependent	1100, 2100	Drive dependent	1100, 2100
Nominal disk diameter (mm)	95	Drive dependent	95	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		22.2 x 8.2 x 17		22.2 x 8.2 x 17	
POWER:	164 watts	94 watts	164 watts	94 watts	164 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	3Q94	1/95	1/95	3Q94	3Q94
COMMENTS					

MANUFACTURER	DPT	DPT	DPT	DPT	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	PM3021 SmartRAID Controller	PM3222 SmartRAID Controller	PM3224 SmartRAID Controller	PM3224W SmartRAID Controller	AddARRAY
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Board	Board	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	
Host platform, software environment	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	PC compatible NetW.,VINES,NT, OS/2,UNIX,other	SCSI host Various
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	0/1/10
Configured by:	Host	Host	Host	Host	Panel
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	37*	37*	45	6
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1, 2, 3	1, 2, 3	1, 2, 3	1
Array interface to host	ISA	EISA	PCI	PCI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 64	1, 64	1, 64	1, 64	4
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	No
Fan (Yes/No)	No	No	No	No	No
Power supply (Yes/No)	No	No	No	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	33	133	133	10
drive (MB/Sec)	10	10/20	10/20	20	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					13.3 x 26 x 26
POWER:	10 watts+drives	12 watts+drives	11 watts+drives	11 watts+drives	10 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1/95	3Q94	3Q94	1/95	9/94
COMMENTS		Environmental monitor sensor 68030 140 MHz processor. *37 w/ SX4000W expander option	Environmental monitor sensor 68030 140 MHz processor. *37 w/ SX4000W expander option	Environmental monitor sensor 68030 140 MHz processor	

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	IIR 1.0QI	IIR 2.0QI	IIR 480Q	IIR 500QI	RDR 2.0
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare, SCO, UNIX	PC compatible NetWare, SCO, UNIX	PC compatible NetWare, SCO, UNIX	PC compatible NetWare, SCO, UNIX	RS/6000 NetWare, OS/2
RAID level	0/5	0/5	0/5	0/1/4/5	0/1/3/5
Configured by:				Host	Host
Array capacity (Gbytes) MIN	2.1/1.05	4.2/2.1	.72/.48	.6/.3/.4/.4	1.5/.8/1/1
MAX				.6/.3/.4/.4	2.6/1.3/2.1/2.1
Minimum drives per array	3	3	3	3	3
Maximum drives per array	3	3	3	3	5
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	1	1
Array interface to host	SCSI-2	EISA	EISA	EISA	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	No	No	Per drive
Power supply (Yes/No)	No	No	No	No	Per drive
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10	10	10
drive (MB/Sec)	10	20	10	10	5
DRIVES: Formatted capacity/drive(MB)	525	1050	245	200	520
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10	8.6 RD/10.1 WR	16	16	12
Average rotational delay (msec)	6.7	5.6		7	6.8
Drive models	Quantum 525S LPS	IBM 0662-S12	Quantum	Quantum 240S LPS	Fujitsu M2624
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8.9	3.25 x 5.75 x 8.9	3.25 x 5.75 x 8.9	3.25 x 5.75 x 8	19 x 12 x 20.25
POWER:	60 watts	60 watts	60 watts	60 watts	250 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1993	1993	1994	1993	2Q92
COMMENTS	DPT controller	DPT controller			

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	RDR 4.0F	RDR 4.0I	RDR 8.0I	RDR 8.0Q	XPRS 2.0F
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host NetWare	SCSI host NetWare	SCSI host NetWare	SCSI host NetWare	SCSI host Various
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	3/1.5/2/2 5/2.5/4/4	3/1.5/2/2 5/2.5/4/4	6/3/4/4 10/5/8/8	6/3/4/4 10/5/8/8	3.6/1.8/2.4/2.4 12/6/9.6/9.6
Minimum drives per array	3	3	3	3	2
Maximum drives per array	5	5	5	5	5
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	1	1
Array interface to host	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Per drive Per drive	No Per drive Per drive	No Per drive Per drive	No Per drive Per drive	No Per drive Per drive
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1084	1052	2014	2100	520
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.35	9.95	9.5	12
Average rotational delay (msec)	5.6	5.6	5.6	5.6	6.8
Drive models	Fujitsu	IBM	IBM	Quantum	Fujitsu M2624
ARRAY SIZE: Inches: H x W x D	19 x 12 x 20.25	19 x 12 x 20.3	19 x 12 x 20.3	19 x 12 x 20.3	19 x 12 x 20.25
POWER: Power backup	250 watts None	250 watts None	250 watts None	250 watts None	500 watts None
FIRST CUSTOMER SHIPMENT	2Q92	1Q93	1Q93	1Q93	1/94
COMMENTS					Digi-Data controller

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	ECCS
ARRAY MODEL	XPRS 4.0F	XPRS 4.0I	XPRS 8.0I	XPRS 8.0Q	FFT-1
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host OS/2, UNIX, NetWare, VINES	SCSI host OS/2, UNIX, other	SCSI host OS/2, UNIX, other	SCSI host OS/2, UNIX, other	SCSI host UNIX, NetWare, Windows NT
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	1/10 Preset
Array capacity (Gbytes) MIN MAX	3/1.5/2/2 5/2.5/4/4	5 10	8.2 16.4	8.2 16.4	2.1-12.6
Minimum drives per array	3	2	2	2	2
Maximum drives per array	5	5	5	5	6
Concurrent host channels	1	1	1	1	1, 2, 3
Controller drive channels	1	1	1	1	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	None
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Per drive Per drive	No Per drive Per drive	No Per drive Per drive	No Per drive Per drive	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1084	1052	2014	2100	2100-4200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.35	9.95	9.5	Drive dependent
Average rotational delay (msec)	5.6	5.6	5.6	5.6	Drive dependent
Drive models	Fujitsu	IBM	IBM	Quantum	Various
ARRAY SIZE: Inches: H x W x D	19 x 12 x 20.3	19 x 12 x 20.25	19 x 12 x 22	19 x 12 x 22	8.75 x 19 x 22
POWER: Power backup	500 watts None	500 watts None	500 watts None	500 watts None	350 watts None
FIRST CUSTOMER SHIPMENT	1/94	1/94	1/94	1/94	3/93
COMMENTS	Digi-Data controller	Digi-Data controller	Digi-Data controller	Digi-Data controller	ECCS controller

MANUFACTURER	ECCS	ECCS	ECCS	ECCS	ECCS
ARRAY MODEL	FFT-1035	Micro DFT-1R	Micro DFT-1E	Micro DFT-1	Synchronix
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NetWare, Solaris, Win NT	AT&T, H-P, Sun, RS/6000, NCR, NetWare, Win NT	AT&T, H-P, Sun, RS/6000 NetWare, Win NT	SCSI host UNIX, NetWare, Windows NT	AT&T, H-P, Sun, SCI,RS/6000,Win NT,UNIX,NetWare
RAID level Configured by:	0/1/10/3/5 Preset	1/10	1/10 Preset	1/10 Preset	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	10.5 42	1.05 16.8	1.05 4.2	1.05 4.2	10.5 126
Minimum drives per array	5	2	2	2	5
Maximum drives per array	20	8	2	2	30
Concurrent host channels	1, 2	1, 2, 4	1, 2	1, 2	1, 2*
Controller drive channels					
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	None	None	None	None	8-224
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	No No No	No N/A N/A	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	20 10
DRIVES: Formatted capacity/drive(MB)	2100	1070-4200	1000,2100,4200	1050-4200	2100-4200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	29 x 13 x 30	5.88 x 17 x 16	5.75 x 9.25 x 13.08	3.25 x 5.75 x 8	7-17.5 x 17.5 x 24
POWER: Power backup	250 watts None	300 watts None	70 watts None	70 watts None	350-1050 watts UPS option
FIRST CUSTOMER SHIPMENT	7/92	10/94	2/94	6/93	12/94
COMMENTS	Symbios Logic controller	ECCS controller	ECCS controller	ECCS controller	Dual AC feed. NEBS compliant. *Dual ported. 33 MHz. i960 processor. HSM support.

MANUFACTURER	ECCS	ECLIPSE TECHNOLOGIES	EMC	EMC	EMC
ARRAY MODEL	Vanity	920SD	Centriplex	HX3 Harmonix	HX3C Harmonix
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX	SCSI host Various	RS/6000,HP/9000 Sun, UNIX, NetW NT, OS/2, VINES	AS/400	AS/400
RAID level	1/10	0/1/3/4/5	0/1/5	0/1	0/1
Configured by:	Preset	Host, Port			
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	54	1.7/.8	3.4/1.7
MAX	Drive dependent	Drive dependent	432	6.8/3.4	6.8/3.4
Minimum drives per array	2	2	6	2	2
Maximum drives per array	2	35	48	8	4
Concurrent host channels	1	1	Up to 8	1	1
Controller drive channels		1, 2			
Array interface to host	SCSI-2	SCSI-2	SCSI-2	IPI-3	IPI-3
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	32, 512	16, 512	4, 512
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Yes	No	No	No
Fan (Yes/No)	No	Yes	Yes	Yes	Yes
Power supply (Yes/No)	No	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	20	10	10	10
drive (MB/Sec)	5	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	8750	857	1750
Nominal disk diameter (mm)	Drive dependent	95	130	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	12	10.5	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	5.6	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		7.5 x 19 x 20	72 x 25 x 38	5.25 x 17.5 x 28	5.25 x 17.5 x 28
POWER:		180 watts	3.2 KVA	.26 KVA	.26 KVA
Power backup		None	Battery	None	None
FIRST CUSTOMER SHIPMENT	4Q92	1/95	11/94	12/92	6/93
COMMENTS		Firmware in flash memory			

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	HX3HA Harmonix	HX3SC-20 Harmonix	HX3SC-40 Harmonix	HX3SR-20 Harmonix	HX3SR-40 Harmonix
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	AS/400	AS/400	AS/400	AS/400	AS/400
RAID level	0/1	0/1	0/1	0/1/5	0/1/5
Configured by:					
Array capacity (Gbytes) MIN	3.4/1.7	1.9/.9	7.9/3.9	1.9/.9/1.5	7.8/3.9/6.2
MAX	6.8/3.4	6.8/3.4	13.8/6.9	7.8/3.9/6.2	15.7/7.8/12.5
Minimum drives per array	2	2	4	2	4
Maximum drives per array	8	8	8	8 + spare	8 + spare
Concurrent host channels	1	1	1	1	1
Controller drive channels					
Array interface to host	IPI-3	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 512	4	4	6, 452	6, 452
Cache function (Read, Write)	Read, Write	Read	Read	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	None	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10	20	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1750	970	1980	970	1980
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.5	10.5	10.5	10.5	10.5
Average rotational delay (msec)	5.6	5.6	5.6	5.6	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 17.5 x 28	5.25 x 17.5 x 28	5.25 x 17.5 x 28	5.25 x 17.5 x 28	5.25 x 17.5 x 28
POWER:	.26 KVA	.26 KVA	.26 KVA	.26 KVA	.26 KVA
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	6/93	8/93	8/93	5/94	5/94
COMMENTS					

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MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	HX3SR-44 Harmonix	HX3SR-48 Harmonix	ModARRAY	4204 Symmetrix	42XX-2S Symmetrix
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Mainframe
MARKET	PCM	PCM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	AS/400	AS/400	SCSI host UNIX	IBM mainframes	IBM mainframes
RAID level Configured by:	0/1/5	0/1/5	0/1/3/5 Host	0/1 Preset	0/1 Preset
Array capacity (Gbytes) MIN MAX	7.8/3.9/6.2 15.7/7.8/12.5	16.8/8.4/13.4 33.5/16.7/26.8	10 200	4/2 8/4	7.5/3.8 15.1/7.5
Minimum drives per array	4	4	4	4	4
Maximum drives per array	8 + spare	8 + spare	48	4	8
Concurrent host channels	1	1	2, 4	4	4
Controller drive channels			8		
Array interface to host	SCSI-2	SCSI-2	SCSI-2	BMX	BMX
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI-2
Cache size (min, max: MB)	20, 452	20, 452	4	64, 1280	128, 1280
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Option Yes Yes	Yes Yes No	Yes Yes No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	20 20	20 10	3/4.5 Drive dependent	3/4.5 Drive dependent
DRIVES: Formatted capacity/drive(MB)	1980	4190	2100	1000	1890
Nominal disk diameter (mm)	95	95	95	130	95
Average positioning time (msec)	10.5	10.5	9	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 17.5 x 28	5.25 x 17.5 x 28	19.75 x 7 x 29	31.4 x 11.56 x 33.31	31.4 x 11.56 x 33.31
POWER: Power backup	.26 KVA None	.26 KVA None	2.45 KVA UPS	Varies Battery	.46-.44 KVA Battery
FIRST CUSTOMER SHIPMENT	2/95	2/95	1995	8/90	9/93
COMMENTS				Remote diagnostics	Remote diagnostics

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	4424 Symmetrix	48XX Symmetrix	5100-9 Symmetrix	5100-9M Symmetrix	5200-3 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	IBM mainframes	IBM mainframes	IBM mainframes All OS	IBM mainframes All OS	IBM mainframes All OS
RAID level	0/1	0/1	0/1/"S"	1	0/1
Configured by:	Preset	Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	8/4	10/5	68/34/51	34	45
MAX	30/15	90/45	136/68/102	68	90
Minimum drives per array	8	8	8	8	16
Maximum drives per array	24	32	16	16	32
Concurrent host channels	8	8, 12	4, 8	4, 8	4, 16
Controller drive channels					
Array interface to host	BMX	BMX/ESCON	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI
Drive interface	SCSI	SCSI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	256, 3072	256, 3072	512, 2048	512, 2048	512, 4096
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	No	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3/4.5	3/4.5	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	1000, 1260	1260,1890,2830	8530	8530	2830
Nominal disk diameter (mm)	130	95, 130	130	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	67.9 x 24.1 x 33	67.9 x 24.1 x 33	42 x 21 x 36	42 x 21 x 36	73.62 x 24.25 x 36.4
POWER:	Varies	1.39-2.3 KVA	1.39-1.63 KVA	1.39-1.63 KVA	1.96-2.65 KVA
Power backup	Battery	Battery	Battery	Battery	Battery
FIRST CUSTOMER SHIPMENT	8/90	1Q92	4/95	4/95	5/94
COMMENTS					Unisys/Bull version available

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	5200-9 Symmetrix	5200-9M Symmetrix	5230-4 Symmetrix	5500-2 Symmetrix	5500-3 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	IBM mainframes All OS	IBM mainframes All OS	IBM mainframes All OS	IBM mainframes All OS	IBM mainframes All OS
RAID level	0/1/"S"	1	0/1/"S"	0/1	0/1
Configured by:	Preset	Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	68/34/51	34	45/22/34	90/45	136/68
MAX	272/136/204	136	363/181/272	242/121	363/181
Minimum drives per array	8	16	12	48	48
Maximum drives per array	32	32	96	128	128
Concurrent host channels	4, 16	4, 16	4, 16	8, 16	8, 16
Controller drive channels					
Array interface to host	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI	BMX/ESCON/SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	512, 4096	768, 4096	512, 4096	1792, 4096	1792, 4096
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17	3/4.5/10/17
drive (MB/Sec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
DRIVES: Formatted capacity/drive(MB)	8530	8530	3750	1890	2830
Nominal disk diameter (mm)	130	130	95	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	73.6 x 24.3 x 36.4	73.62 x 24.25 x 36.4	73.6 x 24.3 x 36.4	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4
POWER: Power backup	1.62-2.65 KVA Battery	1.96-2.65 KVA Battery	2.0-2.61 KVA Battery	5.36-8.81 KVA Battery	5.36-8.81 KVA Battery
FIRST CUSTOMER SHIPMENT	5/95	5/94	4/95	11/92	1093
COMMENTS		Unisys/Bull version available		Unisys/Bull version available	Unisys/Bull version available

MANUFACTURER	EMC	EMC	ENCORE COMPUTER	ENCORE COMPUTER	ENCORE COMPUTER
ARRAY MODEL	5500-9 Symmetrix	5500-9M Symmetrix	Infinity SP30	Infinity 90ES	Infinity 90SA
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Very High Perf.	Very High Perf.
MARKET	PCM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	IBM mainframes All OS	IBM mainframes All OS	IBM mainframes (3990), Encore, other	Encore UMAX V, UNIX Syst V	Encore UMAX V, UNIX Syst V
RAID level	0/1/"S"	1	0/1/5	0/1/5	0/1/5
Configured by:	Preset	Preset		Host	Host
Array capacity (Gbytes) MIN	102/51/76	136	48	12	12
MAX	1088/544/816	544	450	240 (TB)	1000
Minimum drives per array	12	32	12	6	6
Maximum drives per array	128	128	108*	--	--
Concurrent host channels	8, 16	8, 16	4-32	324	324
Controller drive channels			--	--	--
Array interface to host	BMX/ESCON/SCSI	BMX/ESCON/SCSI	IBM, SCSI-2	IBM, SCSI-2	IBM, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1024, 4096	1024, 4096	512, 4096	64, 1024	64, 1024
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes (option)	Yes (option)
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	3/4.5/10/17	3/4.5/10/17	4.5**	4.5*, 53**	4.5*, 53**
drive (MB/Sec)	Drive dependent	Drive dependent	10	10	10
DRIVES: Formatted capacity/drive(MB)	8530	8530	4200	4200	4200
Nominal disk diameter (mm)	130	130	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	8	8	8
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	74.9 x 68.7 x 36.4	74.9 x 68.7 x 36.4	79 x 41 x 39	79 x 41 x 34	61 x 53 x 34.1
POWER: Power backup	3.81-8.81 KVA Battery	4.67-8.81 KVA Battery	UPS	Opt UPS	Opt UPS
FIRST CUSTOMER SHIPMENT	5/95	5/94	4Q94	10/92	11/93
COMMENTS		Unisys/Bull version available	Redundant cache *324 with expans. cabinet **Per IBM block mux channel	Interphase 4220 controller *Per IBM block mux channel. **Per memory channel	Interphase 4220 controller *Per IBM block mux channel. **Per memory channel

MANUFACTURER	EUROLOGIC SYSTEMS LIMITED	EUROLOGIC SYSTEMS LIMITED	EUROLOGIC SYSTEMS LIMITED	FALCON SYSTEMS	FALCON SYSTEMS
ARRAY MODEL	EL-RAID 201	EL-RAID 202	EL-RAID 300	FalconRAID(C)	FalconRAID(M)
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NetWare, other	SCSI host UNIX, NetWare, other	SCSI host UNIX, NetWare, other	RS6000, H-P, DEC, SGI, Sun UNIX, AIX	RS6000, H-P, DEC, SGI, Sun UNIX, AIX
RAID level Configured by:	0/3/5 Panel, Port	0/3/5 Panel, Port	0/3/5 Panel, Port	0/1/3/5 Host,Panel,Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	5 30	7 60	7 120	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	7	7	4	3
Maximum drives per array	7	14	28	28	21
Concurrent host channels	1-3	1-3	1-3	1, 3	1
Controller drive channels	5-7	7	7	1, 4	1, 3
Array interface to host	SCSI-2*	SCSI-2*	SCSI-2*	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	4, 32	8, 32	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Yes Yes Yes	Option Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10/20 10/20	10/20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D			40.9 x 23 x 26	48 x 12 x 30	48 x 12 x 30
POWER: Power backup	600 watts Cache battery	600 watts Cache battery	600 watts Cache battery	200 watts None	200 watts None
FIRST CUSTOMER SHIPMENT	1994	1994	1993	8/93	1994
COMMENTS	CMD controller Optional dual AC *Optional DSSI, CI	CMD controller Optional dual AC *Optional DSSI, CI	CMD controller Optional dual AC *Optional DSSI, CI	CMD controller Many custom configurations	Mylex controller Many custom configurations

MANUFACTURER	FORMATION	FORMATION	FORMATION	FORMATION	FORMATION
ARRAY MODEL	9937-225	9937-240	9937-480	fd5000-200	fd5000-400
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	IBM AS/400 IBM RS/6000	IBM AS/400 IBM RS/6000	IBM AS/400 IBM RS/6000	IBM RS/6000	IBM RS/6000
RAID level Configured by:	0/5 Panel	0/5 Panel	0/5 Panel	0/5 Panel	0/5 Panel
Array capacity (Gbytes) MIN MAX	2.9 6.69	5.9 13.77	12.58 33.58	5.90 15.74	12.58 33.55
Minimum drives per array	4	4	4	4	4
Maximum drives per array	8 + spare	8 + spare	8 + spare	8 + spare	8 + spare
Concurrent host channels	1	1	1	1	1
Controller drive channels	4	4	4	4	4
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 128	4-128 RD/1-4 WR	4-128 RD/1-4 WR
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	10/20 10	10/20 10	10/20 10
DRIVES: Formatted capacity/drive(MB)	1000	2000	4198	1967	4198
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.8	8.94	8	8.94	8
Average rotational delay (msec)	5.56	4.69	4.69	4.69	4.17
Drive models			4.17	Various	Various
ARRAY SIZE: Inches: H x W x D	8.75 x 17 x 29	8.75 x 17 x 29	8.75 x 17 x 29	8.75 x 17 x 29	8.75 x 17 x 29
POWER: Power backup	250 watts	250 watts	250 watts	250 watts	250 watts
FIRST CUSTOMER SHIPMENT	3/94	3/94	1/95	2Q94	2Q94
COMMENTS	PCM IBM 9337 Up to 1 MB write cache	PCM IBM 9337 Up to 1 MB write cache	PCM IBM 9337 Up to 4 MB write cache		

MANUFACTURER	FORMATION	FORMATION	FUJITSU	FUJITSU	FUJITSU
ARRAY MODEL	fd6000	fd6000 Extended	CTLR DynaRAID II	DynaRAID I	F7956B1 Willow
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	IBM RS/6000,H-P Sun,DEC,Novell, Windows NT,SCO	IBM RS/6000,H-P Sun,DEC,Novell, Windows NT,SCO	SCSI host Various	Any SCSI host UNIX, NetWare, DOS, Windows	Workstations UNIX
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	0/1/3/5 Host	3 Port	3 Preset
Array capacity (Gbytes) MIN MAX	4 72	4 144	Drive dependent Drive dependent	Drive dependent Drive dependent	2.0 4.1
Minimum drives per array	2	2	4	5	6
Maximum drives per array	18	36	36	35	12
Concurrent host channels	2	4	2	2	2
Controller drive channels	6	6			
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16-64RD/.512-4W	16-64RD/.512-4W	256	4, 64	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Yes N/A N/A	Option-manual No Yes	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	20 10	10 or 20 10	10 3
DRIVES: Formatted capacity/drive(MB)	1967	4198	Drive dependent	Drive dependent	500
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.94/8	8.94/8	Drive dependent	Drive dependent	12
Average rotational delay (msec)	4.69/4.17	4.69/4.17	Drive dependent	Drive dependent	6.8
Drive models	Various	Various	Various	Varies	M2628SC Picobird-4
ARRAY SIZE: Inches: H x W x D	28 x 23 x 36	28 x 23 x 36		6.4 x 19 x 27	28 x 10 x 30
POWER: Power backup	680 watts	1360 watts	Cache battery	140 watts Battery	620 watts --
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	5/95	1Q94	2Q92
COMMENTS				Synchronized spindles	Synchronized spindles

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUJITSU
ARRAY MODEL	F7956C1 Cottonwood	Series I DynaRAID II	Series II DynaRAID II	F6493 F1710	F6490A/B DIA
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Very High Perf.
MARKET	Captive	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Workstations UNIX	SCSI host Various	SCSI host Various	Fujitsu M series, VP series	VP2000 UNIX, proprietary
RAID level Configured by:	3 Preset	0/1/3/5 Host	0/1/3/5 Host	0/3 Host	3 Preset
Array capacity (Gbytes) MIN MAX	4.1 8.2	Drive dependent Drive dependent	Drive dependent Drive dependent	5.04 181.44	15 120
Minimum drives per array	11	4	4	5	10
Maximum drives per array	22	48	36	96	80
Concurrent host channels	2	2	2	4-16 (F1710)	2, 4, 8
Controller drive channels				2-16	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	Proprietary,OEM	Proprietary
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IPI-2
Cache size (min, max: MB)	--	4	256		--
Cache function (Read, Write)	--	Read, Write	Read, Write		--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 3	20 10	20 10	20 20	36 4.5
DRIVES: Formatted capacity/drive(MB)	500	Drive dependent	Drive dependent	Drive dependent	1890
Nominal disk diameter (mm)	95	95	95	95	210
Average positioning time (msec)	12	Drive dependent	Drive dependent	Drive dependent	12
Average rotational delay (msec)	6.8	Drive dependent	Drive dependent	Drive dependent	6.9
Drive models	M2628SC Picobird-4	Various	Various	Various	M2671PA Swallow-7
ARRAY SIZE: Inches: H x W x D	21 x 22 x 24				66 x 22 x 32
POWER: Power backup	860 watts --	UPS option None	Cache battery		2.2 KVA --
FIRST CUSTOMER SHIPMENT	1Q93	2/95	6/95	3Q95	1Q92
COMMENTS	Synchronized spindles	Purchased controllers		Sold in Japan Up to 4 F6493 can be attached to F1710A controller	Synchronized spindles

MANUFACTURER	FUTURE COMPUTERS	FWB	FWB	FWB	FWB
ARRAY MODEL	RAIDER-5	2000FMF SledgeHammer	1950FMF SledgeHammer	8200FMF Wide SledgeHammer	8200FMFII SledgeHammer
DISK/TREND GROUP	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac
RAID level	3	0/1	0/1	0/1	0/1
Configured by:	Preset	Host	Host	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	2/1	1.95/9.75	8.2/4.1	8.2/4.1
MAX	Drive dependent				
Minimum drives per array	5	2	2	2	2
Maximum drives per array	5	2	2	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	1	1	1	1
Array interface to host	SCSI-2	SCSI, NuBus	SCSI, NuBus	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 64	2	2	2	2
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	--	No	No	No	No
Power supply (Yes/No)	Yes	No	No	No	No
Spare drive (None/Auto/Manual)	None	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10/20	10/20	10/20	10/20
drive (MB/Sec)	10	10/20	10/20	10/20	10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000	975	4100	4100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	8.5	8.5	8.5	8.5
Average rotational delay (msec)	Drive dependent	5.56	4.17	5.56	5.56
Drive models	Various	Seagate Hawk	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D		4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75
POWER:		20 watts	20 watts	20 watts	20 watts
Power backup	Battery option	None	None	None	None
FIRST CUSTOMER SHIPMENT	1993	1992	9/94	9/94	9/94
COMMENTS	Baydel controller				

MANUFACTURER	FWB	FWB	FWB	FWB	FWB
ARRAY MODEL	17400FMF Wide SledgeHammer	FT8000 SledgeHammer FT	FT16000 SledgeHammer FT	3500II SledgeHammer	3500W SledgeHammer
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Macintosh	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac
RAID level Configured by:	0/1	0/1/5 Host	0/1/5 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	17.4	 8.2	 16.4	3.5/1.75	3.5/1.75
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	5 + spare	5 + spare	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	3	3	1	1
Array interface to host	SCSI-2, NuBus	SCSI-2, NuBus	SCSI-2, NuBus	SCSI,PCI,NuBus	SCSI, NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	8, 32	8, 32	2	2
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	No No No	No No No
Spare drive (None/Auto/Manual)	None	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	10/20 10/20	15.9 20	11.6 20
DRIVES: Formatted capacity/drive(MB)	8700	2000	4000	1750	1750
Nominal disk diameter (mm)	130	95	95	95	95
Average positioning time (msec)	11	8.5	8.5	8.5	8.5
Average rotational delay (msec)	5.6	4.17	4.17	4.17	4.17
Drive models	Seagate Elite	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D				4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75
POWER: Power backup				30 watts None	30 watts None
FIRST CUSTOMER SHIPMENT	9/94	4Q94	4Q94	6/94	6/94
COMMENTS		Includes DAT tape drive	Includes DAT tape drive		

MANUFACTURER	FWB	FWB	FWB	FWB	FWB
ARRAY MODEL	4100FMF SledgeHammer	8000FT SledgeHammer	8200FMF SledgeHammer	RAID ToolKit	SledgeHammer VS
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Software	Subsystem
Implementation	Hardware	Hardware	Hardware	Software	Software
Host platform, software environment	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh	Macintosh, Quadra, Power Mac	Macintosh, Power Mac
RAID level	0/1	0/1/5	0/1	0/1	0/1
Configured by:	Host	Host		Host	Host
Array capacity (Gbytes) MIN	4.1/2.05	4/2/--	8.2	Drive dependent	14.3
MAX		10/5/8			28.7
Minimum drives per array	2	2	2	2	7
Maximum drives per array	2	5	2	2	7
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	1	1
Array interface to host	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	5	2	Drive dependent	1*
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Drive dependent	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	Yes	No	No	No
Power supply (Yes/No)	No	Yes	No	No	No
Spare drive (None/Auto/Manual)	None	Auto	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	10/20	10/20	Drive dependent	10/20
drive (MB/Sec)	10/20	10/20		Drive dependent	10/20
DRIVES: Formatted capacity/drive(MB)	2050	2000	4100	Drive dependent	2050, 4100
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	8.5	8.5	8.5	Drive dependent	8.5
Average rotational delay (msec)	4.17	4.17	4.17	Drive dependent	4.17
Drive models	Seagate Barracuda	Seagate Barracuda	Seagate Barracuda	Various	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	4.5 x 9.5 x 9.75	7 x 19 x 21		--	
POWER:	30 watts	150 watts	32 watts	--	50 watts
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1993	1994	9/94	1993	1995
COMMENTS		Purchased controller		Operates with FWB controllers	*On drive

MANUFACTURER	GAIN SYSTEMS	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
ARRAY MODEL	Superserver	C2258HA C2259HA	C2439JA C2439JZ	C2440JA C2440JZ	C3609A
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	Captive	Captive	Captive	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	IBM compatible NetWare, UNIX	H-P 3000 H-P 9000/800	H-P 9000/800 H-P 9000/700 H-P UX	H-P 9000/800 H-P 9000/700 H-P UX	PC compatible Various
RAID level Configured by:	0/1/5	3	0/3/5 Preset	0/3/5 Preset	0/1/5/10
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	4 8	5/4/4 35/28/28	10/8/8 70/56/56	10/4/8/4
Minimum drives per array	2	3	3	5	2
Maximum drives per array	20	5	5	5	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 3				2
Array interface to host	EISA, SCSI-2	HP-FL	SCSI-2*	SCSI-2*	EISA
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64	1	.5, 1	.5, 1	4
Cache function (Read, Write)	Read, Write	Read	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No Yes No	No Yes No	No Yes No	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/33 5/10	5 4.2	20 10	20 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2003	2003	2003	Drive dependent
Nominal disk diameter (mm)	95	130	95	95	Drive dependent
Average positioning time (msec)	Drive dependent	11.5	8.9	8.9	Drive dependent
Average rotational delay (msec)	Drive dependent	5.5	4.17	4.17	Drive dependent
Drive models	Various Barracuda,other	H-P	H-P	H-P	Various
ARRAY SIZE: Inches: H x W x D	32 x 22 x 10	10.5 x 16.7 x 26.1	10.5 x 16.7 x 21.6	10.5 x 16.7 x 21.6	
POWER: Power backup	750 watts None	200 watts None	155** None	155** None	
FIRST CUSTOMER SHIPMENT	1993	2Q93	9/93	9/93	
COMMENTS	Mylex or BusLogic controller		*Fast, wide differential **Minimum configuration	*Fast, wide differential **Minimum configuration	

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
ARRAY MODEL	C3609A-C3317A	C3609A-C3318A	C3609A-C3321A	Disk Array	NetServer LF NetServer LM
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	Captive, PCM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetW., OS/2,DOS SCO,VINES,NT	PC compatible NetWare, VINES, OS/2,DOS,SCO,NT	PC compatible NetWare, VINES, OS/2,DOS,SCO,NT	PC compatible Various	H-P NetWare, VINES, OS/2,DOS,SCO,NT
RAID level Configured by:	0/1/5/6 Host	0/1/5/6 Host	0/1/5/6 Host	0/1/5/10	0/1/5/6 Host
Array capacity (Gbytes) MIN MAX	3 10	6 20	10 20	2/1/1.5/1 10/4/8/4	1.5 20
Minimum drives per array	3	3	5	2	3
Maximum drives per array	10	10	10	5	5
Concurrent host channels	1	1	1	1	8
Controller drive channels	2	2	2	2	
Array interface to host	EISA	EISA	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	4	4	.128, 4
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No		No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 3.1	10 3.7	10 3.1	33 10	33 3.1/3.7
DRIVES: Formatted capacity/drive(MB)	1000	2000	2000	510-2000	510, 1050, 2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.7	10.7	8.9	9.7-10.7	Drive dependent
Average rotational delay (msec)	5.56	5.56	4.69	5.56	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	14.6 x 7.6 x 16.1	14.6 x 7.6 x 16.1	14.6 x 7.6 x 16.1	14.6 x 7.6 x 16.1	19.3 x 13.7 x 18.1
POWER: Power backup	24 watts None	24 watts None	24 watts None		654 watts None
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94		6/94
COMMENTS					Complete server

MANUFACTURER	HI-DATA	HI-DATA	HI-DATA	HIGH PERFORMANCE STORAGE	HIGH PERFORMANCE STORAGE
ARRAY MODEL	SC-510	SC-520	SC-550	Wildcat II Tabletop	Wildcat IV Tabletop
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host	SCSI host
RAID level Configured by:	0/3/10/"53"* Host	0/3/10/"53"* Host	0/3/10/"53"* Host	0/1/3/5* Port	0/1 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 20	2 24
Minimum drives per array	5	5	5	5	2
Maximum drives per array	35	75	75	5	6
Concurrent host channels	1, 2	1, 2	1, 2	1	1
Controller drive channels	5	5	5	5	1
Array interface to host	SCSI-2	SCSI-2	Fibre	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2.5	5	10	N/A	16, 256
Cache function (Read, Write)	Read	Read	Read	N/A	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes -- --	Yes -- --	Yes -- --	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 20	50 20	10 10	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	525-4200	1000-4200
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Array size dependent	Array size dependent	Array size dependent	18 x 9.5 x 17	9 x 9 x 12
POWER: Power backup	20 watts+drives	20 watts+drives	20 watts+drives	.2 KVA None	.2 KVA Battery
FIRST CUSTOMER SHIPMENT	1990	3/92	3/93	2Q93	2Q95
COMMENTS	*RAID 53 is combined RAID 5 and RAID 3	*RAID 53 is combined RAID 5 and RAID 3	*RAID 53 is combined RAID 5 and RAID 3	*Also combined RAID 1/RAID 0	

MANUFACTURER	HIGH PERFORMANCE STORAGE	HIGH PERFORMANCE STORAGE	HIGH PERFORMANCE STORAGE	HITACHI	HITACHI
ARRAY MODEL	Wildcat V Deskside	Wildcat II Deskside	Wildcat III Deskside	A-6511-100	A-6511-100H
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	SCSI host	SCSI host	Hitachi	Hitachi
RAID level Configured by:	0/1 Port	0/1/3/5* Port	0/1/3/5* Port	3/5 Port	3/5 Port
Array capacity (Gbytes) MIN MAX	2 48	1 21	2 42	 103.4	 103.4
Minimum drives per array	2	5	5		
Maximum drives per array	12	12	12	36 + 9	36 + 12
Concurrent host channels	2	1	1	3	3
Controller drive channels	1	5	5	5	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 256	N/A	16,256 (option)	--	--
Cache function (Read, Write)	Read, Write	N/A	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10 10	20 10	10-20 10	10-20 10
DRIVES: Formatted capacity/drive(MB)	1000-4200	525-4200	1000-4200	2870	2870
Nominal disk diameter (mm)	95	95	95	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	12.8	12.8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	5.6
Drive models	Various	Various	Various	DK517C-37	DK517C-37
ARRAY SIZE: Inches: H x W x D	29 x 14 x 30	29 x 14 x 30	29 x 14 x 30	70.5 x 47.2 x 35.4	70.5 x 47.2 x 35.4
POWER: Power backup	.4 KVA Battery	.4 KVA None	.4 KVA Battery	6 KVA None	6 KVA None
FIRST CUSTOMER SHIPMENT	2Q95	2Q93	2Q94	1Q95	1Q95
COMMENTS		*Also combined RAID 1/RAID 0	*Also combined RAID 1/RAID 0		

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	A-6511-11	A-6511-12	A-6511-130	A-6511-130H	A-6511-17
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Hitachi	Hitachi	Hitachi	Hitachi	Hitachi
RAID level Configured by:	3/5 Port	3/5 Port	3/5 Port	3/5 Port	3/5 Port
Array capacity (Gbytes) MIN MAX	11.2	11.4	137.9	137.9	17.2 17.2
Minimum drives per array	8 + 2	4 + 1			7 + 1
Maximum drives per array	8 + 2	4 + 1	48 + 12	48 + 16	7 + 1
Concurrent host channels	1	1	4	4	1
Controller drive channels	5	5	5	5	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10-20 10	10-20 10	10-20 10	10-20 10	10-20 10
DRIVES: Formatted capacity/drive(MB)	1430	2870	2870	2870	2870
Nominal disk diameter (mm)	95	130	130	130	130
Average positioning time (msec)	11.8	12.8	12.8	12.8	12.8
Average rotational delay (msec)	6.7	5.6	5.6	5.6	5.6
Drive models	DK315C-14	DK517C-37	DK517C-37	DK517C-37	DK517C-37
ARRAY SIZE: Inches: H x W x D	23.6 x 9.8 x 23.6	27.6 x 22.4 x 31.5	70.5 x 47.2 x 35.4	70.5 x 47.2 x 35.4	27.6 x 22.4 x 31.5
POWER: Power backup	.7 KVA None	1.5 KVA None	6 KVA None	6 KVA None	1.7 KVA None
FIRST CUSTOMER SHIPMENT	1Q95	1Q95	1Q95	1Q95	1993
COMMENTS					

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MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	A-6511-2	A-6511-34	A-6511-4	A-6511-5	A-6511-90
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Hitachi	Hitachi	Hitachi	Hitachi	Hitachi
RAID level	3/5	3/5	3/5	3/5	3/5
Configured by:	Port	Port	Port	Port	Port
Array capacity (Gbytes) MIN	2.2	34.4	4.5	5.6	91.9
MAX		34.4			
Minimum drives per array	4 + 1	14 + 2	8 + 2	4 + 1	
Maximum drives per array	4 + 1	14 + 2	8 + 2	4 + 1	32 + 8
Concurrent host channels	1	1	1	1	4
Controller drive channels	5	5	5	5	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10-20	10-20	10-20	10-20	10-20
drive (MB/Sec)	5	10	5	10	10
DRIVES: Formatted capacity/drive(MB)	573	2870	573	1430	2870
Nominal disk diameter (mm)	95	130	95	95	130
Average positioning time (msec)	12.4	12.8	12.4	11.8	12.8
Average rotational delay (msec)	6.7	5.6	6.7	6.7	5.6
Drive models	DK325C-57	DK517C-37	DK325C-57	DK315C-14	DK517C-37
ARRAY SIZE: Inches: H x W x D	23.6 x 9.8 x 23.6	27.6 x 22.4 x 31.5	23.6 x 9.8 x 23.6	23.6 x 9.8 x 23.6	70.5 x 47.2 x 35.4
POWER:	.7 KVA	1.3 KVA	.7 KVA	.7 KVA	6 KVA
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1Q95	1993	1Q95	1Q95	1Q95
COMMENTS					

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	DF-100-2 DF-100-4	HitRAID-5 DF100-5	HitRAID-11 DF100-11	HitRAID-12 DF100-12	A-6591/A-6595 H-6591/H-6595
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Mainframe
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	IBM, Hitachi mainframe, MVS, VSVM, VSE, VOS3
RAID level Configured by:	3/5 Port	3/5 Port	3/5 Port	3/5 Port	5 Preset
Array capacity (Gbytes) MIN MAX	2.2 8.6	5.6 5.6	11.2 11.2	11.4 11.4	22.7 (23.3) 723.7 (747.6)
Minimum drives per array	5	5	10	5	7*
Maximum drives per array	20	20	20	10	224*
Concurrent host channels	1	1	1	1	8, 16
Controller drive channels	5	5	5	5	1-32
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IBM, Hitachi
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	256, 8192
Cache function (Read, Write)	--	--	--	--	Read, Write**
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10-20 10	10-20 10	10-20 10	10-20 10	17 20
DRIVES: Formatted capacity/drive(MB)	540	1400	1400	2870	4360
Nominal disk diameter (mm)	95	95	95	130	95
Average positioning time (msec)	12.4	11.8	11.8	12.8	11.5
Average rotational delay (msec)	6.7	6.7	6.7	5.6	4.7
Drive models	DK325C-57	DK315C-14	DK315C-14	DK517C-37	Hitachi
ARRAY SIZE: Inches: H x W x D	23.6 x 9.8 x 23.6	23.6 x 9.8 x 23.6	23.6 x 9.8 x 23.6	23.6 x 9.8 x 23.6	--
POWER: Power backup	.660 KVA None	.660 KVA None	.660 KVA None	.660 KVA None	11.66 KVA Battery
FIRST CUSTOMER SHIPMENT	8/93	4Q93	4Q93	4Q93	3Q95
COMMENTS	Sold only in Japan				*Host spares **Duplexed cache for write data

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MANUFACTURER	HITACHI DATA SYSTEMS	HITACHI DATA SYSTEMS	IBM	IBM	IBM
ARRAY MODEL	7600 Disk Storage Subsystem	7700 Array Subsystem	3514-001	3514-004	3514-008
DISK/TREND GROUP	Mainframe	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	Captive	Captive,OEM,PCM	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	HDS/IBM mainframe	HDS/IBM mainframe MVS, VS, VSE	PS/2, RS/6000 NetWare, OS/2	PS/2, RS/6000 NetWare, OS/2	PS/2, RS/6000 NetWare, OS/2
RAID level	1	5	5	5	5
Configured by:	Host	Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	11.35 (7693)	22.7	.769	1.97	3.935
MAX	272.4 (7699)	723.7	2.79	6.9	13.774
Minimum drives per array	4	7*	3	3	3
Maximum drives per array	32	224*	8	8	8
Concurrent host channels	4/8	8, 16	1	1	1
Controller drive channels		1-32			
Array interface to host	IBM	IBM	SCSI-2	SCSI-2	SCSI-2
Drive interface	Proprietary	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	128, 1024	256, 8192	--	--	--
Cache function (Read, Write)	R,W,Fast Write	Read, Write**	--	--	--
Redundancy: Controller (Yes/No)	Yes	Yes	No	No	No
Fan (Yes/No)	Yes	Yes	No	No	No
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	None	Auto	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	4.5/6/10/17	17	10	10	10
drive (MB/Sec)	4200/3900	20	2	10	10
DRIVES: Formatted capacity/drive(MB)	2838, 8514	4360	398	986	1967
Nominal disk diameter (mm)	6.5"	95	95	95	95
Average positioning time (msec)	13.5/16.5	11.5	11.5	9.4 RD/11.4 WR	9.4 RD/11.4 WR
Average rotational delay (msec)	7.1/15.2	4.7	6.95	6.95	5.6
Drive models	7693 (2838 MB) 7699 (8514 MB)	Hitachi	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	70.5 x 36.4 x 31.5	70.5 x 51.2 x 31.5	24 x 13.5 x 31.5	24 x 13.5 x 31.5	24 x 13.5 x 31.5
POWER: Power backup	Dual AC	2.2 KVA Battery	.37 KVA None	.37 KVA None	.37 KVA None
FIRST CUSTOMER SHIPMENT	6/93	3Q95	11/92	11/92	4/93
COMMENTS		*Plus hot spares **Duplexed cache for write data	PS/2 RS/6000 support starting 4/94	PS/2 RS/6000 support starting 4/94	PS/2 RS/6000 support starting 4/94

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	3514-212	3514-213	7135-110 RAIDIANT	7137-412 7137-512	7137-413 7137-513
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	RS/6000	RS/6000	RS/6000 AIX 6000	RS/6000 AIX, H-P UNIX, Sun	RS/6000 AIX, H-P UNIX, Sun
RAID level Configured by:	0/5	0/5	0/1/3/5 Host	0/5	0/5
Array capacity (Gbytes) MIN MAX	1.973 6.906	3.935 13.774	4/2/8/8* 133/67/108/108	2.96/1.97 7.89/6.91	5.90/3.94 15.74/13.77
Minimum drives per array	3	3	2	3	3
Maximum drives per array	8	8	30	8	8
Concurrent host channels	1	1	1, 4	1	1
Controller drive channels					
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	1	--	1, 4	
Cache function (Read, Write)	Write	Write	--	Write	Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No Yes	Yes (option) Yes Yes	No Yes	No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20	20	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	986	1967	1300,2200,4500	986	1967
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.4 RD/11.4 WR	9.4 RD/11.4 WR	7.8/9.5	7.5	7.5
Average rotational delay (msec)	5.6	5.6	5.56	4.17	4.17
Drive models	IBM	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	24 x 13.5 x 31.5	24 x 13.5 x 31.5	10.5 x 17.4 x 26.2	24 x 8.3 x 32.3	24 x 8.3 x 32.3
POWER: Power backup	.35 KVA None	.35 KVA None	660 watts None	.35 KVA None	.35 KVA None
FIRST CUSTOMER SHIPMENT	4/94	4/94	3Q93	4Q94	4Q94
COMMENTS			For RS/6000 *With 2 GB drives	Dual AC feed -512 is rack mount	Dual AC feed -513 is rack mount

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MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7137-414 7137-514	8640-1YO PC Server 320	8640-1YT PC Server 320	8641-0YR PC Server 500	8641-0YS PC Server 500
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	RS/6000, H-P, Sun AIX, UNIX	PC Server 320 OS/2, NT, UNIX, NetWare	PC Server 320 OS/2, NT, UNIX, NetWare	IBM PC Server 500, OS/2,VINES NT,NetWare,UNIX	IBM PC Server 500, OS/2,VINES NT,NetWare,UNIX
RAID level Configured by:	0/5	0/1/5	0/1/5	0/1/5	0/1/5
Array capacity (Gbytes) MIN MAX	12.58/8.39 33.55/29.36	2.25 13.5	2.25 13.5	3.4 20.3	6.8 40.5
Minimum drives per array	3	2	2	3	3
Maximum drives per array	8	6	6	18	18
Concurrent host channels	1	1, 4	1, 4	1	1
Controller drive channels					
Array interface to host	SCSI-2	PCI	PCI	MCA	MCA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 4	4	4	4	4
Cache function (Read, Write)	Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes	Yes No No	Yes No No	Yes No No	Yes No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	132 20	132 20	40 20	40 20
DRIVES: Formatted capacity/drive(MB)	4197	1120		1, 120	2, 250
Nominal disk diameter (mm)	95	95		95	
Average positioning time (msec)	8	6.9	6.9	6.9	7.5
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
Drive models	IBM	IBM	IBM	DFHS-31080	DFHS-32160
ARRAY SIZE: Inches: H x W x D	24 x 12.2 x 32.3	24.5 x 7.5 x 18.6	24.5 x 7.5 x 18.6	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7
POWER: Power backup	.35 KVA None	300 watts UPS	300 watts UPS	434 watts UPS option	434 watts UPS option
FIRST CUSTOMER SHIPMENT	4Q94	6/95	6/95	4Q94	4Q94
COMMENTS	Dual AC feed -514 is rack mount				

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	8642-2ZS PC Server 720	8642-4ZS PC Server 720	9336-025	9337-125	9337-140
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC Server 720 OS/2, NT, UNIX, NetWare	PC Server 720 OS/2, NT, UNIX, NetWare	AS/400	AS/400 9406	AS/400 9406
RAID level Configured by:	0/1/5	0/1/5	0/1 Preset	5	5
Array capacity (Gbytes) MIN MAX	4.5 40.5	9 40.5	3.4 3.4	2.91 5.82	5.901 11.802
Minimum drives per array	2	2	4	4	4
Maximum drives per array	18	18	4	7	7
Concurrent host channels	1, 3	1, 3	1	1	1
Controller drive channels					
Array interface to host	MC	MC	IPI-3	IBM 2611 IOP	IBM 2611 IOP
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	--	--	--
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	No No No	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Auto	Auto	None	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	80 20	80 20	5.7 10	10 5	10 5
DRIVES: Formatted capacity/drive(MB)	2250	2250	857	970	1967
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	7.5	7.5	8.9	8.9	9.8
Average rotational delay (msec)	4.17	4.17	5.6	5.6	5.6
Drive models	IBM	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	24.5 x 13.9 x 29.7	24.5 x 13.9 x 29.7		8.75 x 19 x 28.2	8.75 x 19 x 28.2
POWER: Power backup	690 watts UPS	690 watts UPS	-- None	.35 KVA Typ. None	.35 KVA Typ. None
FIRST CUSTOMER SHIPMENT	7/95	7/95	3/94	9/93	1993
COMMENTS			Array software required	AS/400	AS/400

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MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9337-225	9337-240	9337-420	9337-440	9337-480
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	AS/400 9406	AS/400 9406	AS/400 9406	AS/400 9406	AS/400 9406
RAID level	5	5	5	5	5
Configured by:					
Array capacity (Gbytes) MIN	2.91	5.90	2.91	5.90	12.58
MAX	6.79	13.76	6.79	13.76	29.36
Minimum drives per array	4	4	4	4	4
Maximum drives per array	8	8	8	8	8
Concurrent host channels	1	1	1	1	1
Controller drive channels					
Array interface to host	IBM 6501 IOP	IBM 6501 IOP	IBM 6501 IOP	IBM 6501 IOP	IBM 6501 IOP
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1 MB NV Write	1 MB NV Write	4 MB NV Write	4 MB NV Write	4 MB NV Write
Cache function (Read, Write)	Write	Write	Write	Write	Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	No	No	No	No	No
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	20	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	970	1967	970	1967	4194
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.9	9.5	8.9	7.8	8.3
Average rotational delay (msec)	5.6	5.6	5.6	4.17	4.17
Drive models	IBM	IBM	IBM	IBM	IBM
ARRAY SIZE: Inches: H x W x D	8.75 x 19 x 28.2	8.75 x 19 x 28.2	8.75 x 19 x 28.2	8.75 x 19 x 28.2	8.75 x 19 x 28.2
POWER:	.35 KVA	.35 KVA Typ.	.35 KVA Typ.	.35 KVA Typ.	.35 KVA Typ.
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	11/93	11/93	10/94	10/94	10/94
COMMENTS	AS/400	AS/400			

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9595-3NG 9595-3PG 9595-3QG PS/2 Server 95	9595-3NT 9595-3PT 9595-3QT PS/2 Server 95	Array DASD RAMAC	Array Subsystem RAMAC	9570 (3.5)
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Mainframe	Very High Perf.
MARKET	Captive, PCM	Captive, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	IBM PS/2 Server OS/2, NetWare, LAN Server	IBM PS/2 Server OS/2, NetWare, LAN Server	System/390 MVS, VM, VSE, TPF	System/390 MVS, VM, VSE, TPF	RS/6000,ES/9000 MVS (ES/9000), AIX
RAID level Configured by:	0/1/5 Host	0/1/5 Host	5* Preset	5 Preset	0/1/3/5 Port, Host
Array capacity (Gbytes) MIN MAX	1.5/.75/1.1 3/1.5/2.2	3/1.5/2 6/3/4	11.3 90.8	9 90.8	12.9 232*
Minimum drives per array	3	3	6 (+2)	6 (+2)	10
Maximum drives per array	6	6	48 (+16)	48 (+16)	160
Concurrent host channels	1	1	**	4, 8	1-2
Controller drive channels					
Array interface to host	MCA	MCA	ESCON Parallel	ESCON Parallel	HIPPI (IPI-3)
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IPI-2
Cache size (min, max: MB)	4	4	64, 2048	64, 2048	10, 20
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto*	Auto*,Man-backg	Auto (option)	Auto (option)	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 10	40 10/20	17 20	17 20	30-60 5
DRIVES: Formatted capacity/drive(MB)	540	1052	2048	2048	1700
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8.7	8.6	9.2 RD/10.7 WR	9.2 RD/10.7 WR	9.4 RD/11 WR
Average rotational delay (msec)	4.76	5.56	5.6	5.6	5.6
Drive models		IBM Spitfire	IBM	IBM	Allicat P10
ARRAY SIZE: Inches: H x W x D	19.75 x 8 x 20	19.75 x 8 x 20	67.2 x 29.5 x 38.5	67.2 x 29.5 x 38.5	62 x 29.5 x 38.5
POWER: Power backup	560 watts	560 watts	4.1 KVA Battery	3.98 KVA Battery	.85-2.95 KVA None
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	9/94	10/94	3/93
COMMENTS	*In RAID-1 mode only Mylex controller	*In RAID-1 mode only Mylex controller	Compat.w/3390-3 *3990 has "dual copy" RAID-1 capability. **Attaches to 3990-3/6.	Compat.w/3380-K 3390 or 9340 Attaches directly to system	*4 boxes

MANUFACTURER	IBM	ICL	ICL	ICL	INFOCOM DIGITAL SYSTEMS
ARRAY MODEL	9570 (5.25)	DiskMANAGER	PowerARRAY	PowerARRAY PLUS	INF-961
DISK/TREND GROUP	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Board
Implementation	Hardware	Software	Hardware	Hardware	Hardware
Host platform, software environment	RS/6000,ES/9000 MVS (ES/9000), AIX	ICL UNIX SVR4.2	ICL SCO UNIX, OS/2, NetWare	ICL UNIX NetWare	PC compatible DOS, UNIX, OS/2 NetWare, NT
RAID level	3	0/1	0/1/5	"53"	0/1/5
Configured by:	Port, Host				
Array capacity (Gbytes) MIN	10.4	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	91.6*	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	5 (4 + parity)	2	2	15	2
Maximum drives per array	40	112	14	30	7
Concurrent host channels	1-2	1	1	2	1
Controller drive channels		--	1, 2	5	1
Array interface to host	HIPPI (IPI-3)	SCSI-2	SCSI-2	SCSI-2	PCI
Drive interface	IPI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	10, 20	--	8	4	.5, 16
Cache function (Read, Write)	Read	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Yes	No	Yes	--
Fan (Yes/No)	Yes	Yes	Yes	Yes	--
Power supply (Yes/No)	Yes	Yes	Yes	Yes	--
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	--
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	25-55	10	10	10	132
drive (MB/Sec)	4.4	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	1500	525-1000	525-1000	1000-2000	Drive dependent
Nominal disk diameter (mm)	130	95	95	95	Drive dependent
Average positioning time (msec)	12	8-11	8-11	8-11	Drive dependent
Average rotational delay (msec)	5.58	5.56	5.56	5.56	Drive dependent
Drive models	9345	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	62 x 29.5 x 38.5			37 x 18 x 37	4.5 x 13
POWER:	3.4 KVA				23 watts
Power backup	None	None	UPS option	UPS option	None
FIRST CUSTOMER SHIPMENT	11/91	1993	1993	2Q94	1Q95
COMMENTS	*4 boxes	Software array			

MANUFACTURER	INFOCOM DIGITAL SYSTEMS	INFORMATION MANAGEMENT TECHNOLOGIES	INFORMATION MANAGEMENT TECHNOLOGIES	INFORTREND	INFORTREND
ARRAY MODEL	INF-962	RAIDiance EX	RAIDiance	IFT-1000	IFT-2000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible DOS, UNIX, OS/2 NetWare, NT	SCSI host Various UNIX	SCSI host Various UNIX	PC compatible DOS, NT, OS/2, UNIX, NetWare	SCSI host DOS, NT, OS/2, UNIX, NetWare
RAID level	0/1/5	1/3/5	3/5	0/1/4/5	0/1/3/5
Configured by:		Host	Host	Port	Port
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	4	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	8	Drive dependent	Drive dependent
Minimum drives per array	2	5	5	2	2
Maximum drives per array	14	35	5	21	21
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	1	1	3	2, 3, 4
Array interface to host	PCI	SCSI-2	SCSI-2	EISA	PCI
Drive interface	SCSI-2	SCSI-2	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5, 16	--	--	4, 16	2, 32
Cache function (Read, Write)	Read, Write	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	--	No	No	--	--
Fan (Yes/No)	--	Yes	No	--	--
Power supply (Yes/No)	--	Yes	Yes	--	--
Spare drive (None/Auto/Manual)	--	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	10	10	33	132
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000, 2000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Conner, DEC, Micropolis	Conner, DEC, Micropolis	Various	Various
ARRAY SIZE: Inches: H x W x D	4.5 x 13	3.25 x 5 x 8	3.25 x 5 x 8	5.04 x 13.4	4.2 x 12.28
POWER:	23 watts	--	--	20 watts	15 watts
Power backup	None	None	None	None	Battery option
FIRST CUSTOMER SHIPMENT	1Q95	10/93	2Q94	10/93	6/95
COMMENTS		Digi-Data controller	Allodyne controller	Flash memory Firmware	Flash memory Firmware

MANUFACTURER	INFORTREND	INFORTREND	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES	INVINCIBLE TECHNOLOGIES
ARRAY MODEL	IFT-3000	IFT-3001	Ultimate 1	Ultimate 1/FX	Ultimate 5
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host	SCSI host	Sun, H-P, DEC, RS/6000	DEC, Sun, Novell, Windows NT	DEC, Sun, Novell
RAID level Configured by:	0/1/3/5 Port, Panel	0/1/3/5 Port, Panel	1 Preset	0/1/10 Host, Panel	0/1/3/5/10 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	1 12	1 17.5	6 80
Minimum drives per array	2	2	2	2	5
Maximum drives per array	21	14	12	8	20
Concurrent host channels	1, 5	1, 2	1, 2	1	1, 2
Controller drive channels	3, 6	2, 3		2	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2, DSSI	SCSI-2, SE, FWD	SCSI,DSSI,FWD,C
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 64	2, 32	*	16	8, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	Yes Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 20 10, 20	10, 20 10, 20	10 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000, 2000	1000,2000,4300	1000,2000,4000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate, DEC	IBM, Seagate	IBM, Seagate
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.4	1.57 x 3.94 x 5.9	10 x 19 x 27	18 x 9.25 x 17.1	25 x 14 x 27.5
POWER: Power backup	10 watts Battery option	7.5 watts None	400 watts None	400 watts None	590 watts BBU
FIRST CUSTOMER SHIPMENT	3/94	4/94	6/93	3/95	1994
COMMENTS	Flash memory Firmware	Flash memory Firmware	Rack mount Tower available *Cache avail. in 1H 1994		DG CLARiiON modified to use redund. contrl. in DEC interfc. Mirrored write cache

MANUFACTURER	IPL	IPL	IPL	LA CIE	LEGACY STORAGE SYSTEMS
ARRAY MODEL	ENTERPRISE STORAGE SERVER	RAIDTOWER 7037-E4X	RAIDTOWER 7037-E8X	Joule RAID	Smart Array
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	RS/6000, H-P, Sun, NetWare, Wind NT, AS/400	RS/6000, H-P, Sun, NetWare, Wind NT, AS/400	RS/6000, H-P, Sun, NetWare, Wind NT, AS/400	Macintosh System 7	Misc. networks NetWare, NT, OS/2, UNIX
RAID level Configured by:	0/1/5	0/1/5	0/1/5	0/1/4/5 Host	0/1/3/5/10
Array capacity (Gbytes) MIN MAX	6 268	6 30	12 60	2 16.8	2 32
Minimum drives per array	4	4	4	2	3
Maximum drives per array	64	14	14	6	9
Concurrent host channels	16	2	2	1	1, 4
Controller drive channels	16	2	2	1	1, 2, 3, 5
Array interface to host	SCSI	SCSI	SCSI	SCSI-2	EISA,ISA,MCA,PC
Drive interface	SCSI	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 4100	16, 512	16, 512	--	0, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No No No	Yes (option) Yes Yes (option)
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	Auto (option)
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	10 10	33 10
DRIVES: Formatted capacity/drive(MB)	2000, 4000	2000	4000	1060-2100	1000,2000,4000
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	8.5	9.5	8.5	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	5.6	4.17	Drive dependent	Drive dependent
Drive models	IBM, Seagate, Seagate	Quantum	IBM, Seagate	Quantum Empire Conner CF1060	Various
ARRAY SIZE: Inches: H x W x D	Std. 19" Rack	Deskside: 24.12 x 7.5 x 28.3	Deskside: 24.12 x 7.5 x 28.3	*	21.4 x 8.4 x 20.6
POWER: Power backup	1.6 KVA	.20 KVA	.20 KVA		250-750 watts
FIRST CUSTOMER SHIPMENT	1/95	7/94	1/95	2Q94	8/93
COMMENTS				*Stackable modules REMUS software	Optical & tape drive options. Software-based subsystem. RAID-3/5 option

MANUFACTURER	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS	LIGHTHOUSE TECHNOLOGY	LOMAS DATA	LOMAS DATA
ARRAY MODEL	Smart Array/RM	Smart Array/XE	Rhapsody	LDP CACHE IIP	LDP CACHE V
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	PCM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware
Host platform, software environment	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX	SCSI host UNIX	ISA, EISA NetWare, UNIX, DOS, OS/2	PC compatible NetWare, UNIX, DOS, OS/2
RAID level Configured by:	0/1/3/5/10	0/1/3/5/10	0/1/3/5 Panel	0/1	1 Preset
Array capacity (Gbytes) MIN MAX	2 32	2 48	Drive dependent Drive dependent	.1 16	Drive dependent Drive dependent
Minimum drives per array	3	2	3	2	2
Maximum drives per array	8	13	7	4	4
Concurrent host channels	1, 4	1, 6	1, 3	1	1
Controller drive channels	1, 2, 3, 5	1, 2, 3, 5	1, 4	1	1
Array interface to host	EISA,ISA,SCSI,P	EISA,ISA,SCSI,P	SCSI-2	ISA	ISA, VESA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	0, 64	0, 64	4, 32	1, 16	2, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes (option)	Yes (option) Yes Yes (option)	Option Yes Yes	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto (option)	Auto (option)	Auto	Manual-foregrnd	Manual-foregrnd
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	10/20 10/20	Host dependent 5	6 10
DRIVES: Formatted capacity/drive(MB)	1000,2000,4000	1000,2000,4000	1000,2000,4000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate, other	Various	Various
ARRAY SIZE: Inches: H x W x D	10.5 x 19 x 22	21.4 x 8.4 x 20.6		4.7 x 13.4	4.7 x 13.4
POWER: Power backup	200-250 watts	250-750 watts	Battery	8 watts None	7 watts None
FIRST CUSTOMER SHIPMENT	2/95	12/93	5/94	1989	12/94
COMMENTS	RAID-3/5 optional Rack mount	RAID-3/5 optional Tower	CMD controller		

MANUFACTURER	LOMAS DATA	MACRO COMPUTER PRODUCTS	MARNER INTERNATIONAL	MARNER INTERNATIONAL	MARNER INTERNATIONAL
ARRAY MODEL	LDP CACHE IV	Macro-RAID 7	DSV-201	DSV-202	DSV-57
DISK/TREND GROUP	Net/Mini/Multi	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare, UNIX, DOS, OS/2	Unisys A, V Other SCSI UNIX	Marner UNIX, NetWare	Marner UNIX, NetWare	Marner UNIX, NetWare
RAID level	1	"7"	0/1/3/5	0/1/3/5	0/1/3/5
Configured by:	Preset	Preset	Panel, Port	Panel, Port	Panel, Port
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	1.05	1.05	1.05
MAX	Drive dependent	Drive dependent	135	135	30
Minimum drives per array	2	3	2	2	2
Maximum drives per array	4	48	28	28	7
Concurrent host channels	1	1, 12	2 (5 max.)	4 (10 max.)	2 (5 max.)
Controller drive channels	1	1, 12	4 (5 max.)	4 (5 max.)	4 (5 max.)
Array interface to host	ISA	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 16	4, 256	2, 64	2, 64	2, 64
Cache function (Read, Write)	Read, Write	Read,Write(opt)	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Yes	Yes	Yes
Fan (Yes/No)	--	Yes	Yes	Yes	Yes
Power supply (Yes/No)	--	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual-foregrnd	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	6	10/20	20	20	20
drive (MB/Sec)	5	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000-9090	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95, 130	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Seagate, H-P	IBM Starfire ST15150N	IBM Starfire, Seagate	IBM Starfire Seagate
ARRAY SIZE: Inches: H x W x D	4.7 x 13.4	Varies with configuration	28 x 17 x 21	28 x 17 x 21	21 x 7 x 20
POWER:	9 watts	1.3 KVA	2000 watts	2000 watts	600 watts
Power backup	None	None	UPS	UPS	UPS
FIRST CUSTOMER SHIPMENT	4Q93	3Q91	1Q94	1Q94	1Q94
COMMENTS		Storage Computer controller. Nonvolatile memory option available 2Q94			

MANUFACTURER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER
ARRAY MODEL	DA-6110	DA-6220	DA-6330	DA-6440	DA-6SXX*
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Maspar OSF/1	Maspar OSF/1	Maspar OSF/1	Maspar OSF/1	Maspar OSF/1
RAID level Configured by:	5*	5*	5*	5*	5
Array capacity (Gbytes) MIN	32	64	96	32	128
MAX				128	3500
Minimum drives per array	8 + 1 + 1	16 + 2 + 2	24 + 3 + 3	32 + 4 + 4	32 + 4 + 4
Maximum drives per array	8 + 1 + 1	16 + 2 + 2	24 + 3 + 3	32 + 4 + 4	896 + 112 + 112
Concurrent host channels	4	4	4	4	16
Controller drive channels	10	10	10	10	280
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32, 128	32, 128	32, 128	32, 128	128, 512
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	Yes	Yes	Yes	Yes
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)			60	60	240
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	4070	4070	4070	4070	4070
Nominal disk diameter (mm)				95	95
Average positioning time (msec)	7.8 RD/9.3 WR	7.8 RD/9.3 WR	7.8 RD/9.3 WR	7.8 RD/9.3 WR	7.8 RD/9.3 WR
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
Drive models	IBM Starfire DFHF	IBM Starfire DFHF	IBM Starfire DFHF	IBM Starfire DFHF	IBM Starfire DFHF
ARRAY SIZE: Inches: H x W x D	57.57 x 23 x 32.5	57.57 x 23 x 32.5	57.57 x 23 x 32.5	57.75 x 23 x 32.5	*
POWER:	258 watts	517	775	1034 watts	Varies
Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	5/95	5/95	5/95	5/95	9/95
COMMENTS	*Striped across multiple arrays	*Striped across multiple arrays	*Striped across multiple arrays	*Striped across multiple arrays	*Multicabinet configuration: up to 28 6440s

MANUFACTURER	MAXCONCEPT	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY
ARRAY MODEL	SW-4100R	Gen 4L	Gen 4XL	GEN 5L proFILE L	GEN 5XL proFILE XL
DISK/TREND GROUP	Single User	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Implementation					
Host platform, software environment	Macintosh System 7	IPI-3 compatible	IPI-3 compatible	Cray, IBM, SGI, Sun, Convex UNIX	Cray, IBM, SGI, Sun, Convex UNIX
RAID level	0/1/3/5	0/1/3/5	0/1/3/5	0/1/5	0/1/5
Configured by:	Host	Host	Config. by host	Host, Panel	Host, Panel
Array capacity (Gbytes) MIN	Drive dependent	9.5	12	30	94
MAX	Drive dependent	29.8	59	60	376
Minimum drives per array	2/3	8	20	8	24
Maximum drives per array	6	16	40	16	96
Concurrent host channels	1	1	2	1-2	1-4
Controller drive channels	1	8	16	8	24
Array interface to host	SCSI-2	HIPPI	HIPPI	HIPPI, FCS, ATM	HIPPI, FCS, ATM
Drive interface	SCSI-2	IPI-2	IPI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	N/A	N/A	16, 24	48, 120
Cache function (Read, Write)		N/A	N/A	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes	Yes
Fan (Yes/No)	No	No	No	Yes	Yes
Power supply (Yes/No)	No	No	No	Yes	Yes
Spare drive (None/Auto/Manual)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	55	88	100, 133, 19	100, 133, 19
drive (MB/Sec)	20	4 or 8	5.52	20	20
DRIVES: Formatted capacity/drive(MB)	1600-4100	1000, 1400	1520	4300	4300
Nominal disk diameter (mm)	95	95	130	95	95
Average positioning time (msec)	12	11	11	8	8
Average rotational delay (msec)	4.17	5.5	5.5	4.17	4.17
Drive models	Seagate Barracuda	IBM P16 IBM P17	Seagate Elite ST41800K	Seagate Barracuda	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	Varies	24.5 x 19 x 27	75 x 25 x 41	22.5 x 19 x 24.75	72 x 29.5 x 36.5
POWER:	Varies	900 watts	3000 watts	.9-1.2 KVA	3.3-4.8 KVA
Power backup		None	None	None	Integral UPS
FIRST CUSTOMER SHIPMENT	3Q94	1/94	9/92	3/95	12/94
COMMENTS				proFILE L is complete TCP/IP server	proFILE XL is complete TCP/IP server

MANUFACTURER	MEDIA INTEGRATION	MEDIA INTEGRATION	MEDIA INTEGRATION	MEDIA INTEGRATION	MEGA DRIVE SYSTEMS
ARRAY MODEL	DataKnight	SMARTstor Rack	SMARTstor Tower	SMARTstor Server	MK/5
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level	0/3/5	0/1/5	0/1/5	0/1/5	0/3/5
Configured by:	Host	Host	Host	Host	Host
Array capacity (Gbytes) MIN	2	1	1.5	2	2
MAX	82	12	12	24	21
Minimum drives per array	2/3/3	2/2/3	2/2/3	2/2/3	2
Maximum drives per array	42	7	7	14	5
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels	6	1	1	2	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	32	4, 16, 64	4, 16, 64	4, 16, 64	0, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Yes	No	No	No	No
Fan (Yes/No)	Yes	Yes	Yes	No	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10, 20	10	10	10	20
drive (MB/Sec)	10	10	10	10, 20	10
DRIVES: Formatted capacity/drive(MB)	1000-4000	1000-4000	1000-4000	1000-4000	1050-4294
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8-10
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17-5.6
Drive models	Quantum, Seagate	DEC, H-P, Seagate	DEC, H-P, Seagate	DEC, H-P, Seagate	Various
ARRAY SIZE: Inches: H x W x D	33 x 18.75 x 19	22.5 x 19 x 18	22.25 x 19 x 18	25.5 x 24 x 17	17 x 7 x 18
POWER:	1.4 KVA	250 watts	250 watts	450 watts	200 watts
Power backup	UPS option	Option	Option	None	None
FIRST CUSTOMER SHIPMENT	1Q95	3Q93	3Q93	3Q93	4Q93
COMMENTS	DEC 410 controller Dual AC	Mylex controller	Mylex controller	Mylex controller	Modified purchased controller. Rack mount. i960 RISC processor

MANUFACTURER	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGABYTE MEMORY PRODUCTS
ARRAY MODEL	MR/5	MR/10	Enterprise	MX/500	MegaRAID
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	Sun, H-P, DEC, SGI UNIX
RAID level Configured by:	0/3/5 Host	0/3/5 Host	0/1/5/10 Host	0/3/5	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	2 21	2 42	1 36	45 315	Drive dependent Drive dependent
Minimum drives per array	2	5	2	3	2
Maximum drives per array	5	10	8	31	27
Concurrent host channels	1	1	1	2	1
Controller drive channels	5	5	3	5	1-3
Array interface to host	SCSI-2	SCSI-2	SCSI-2, other*	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 128	128	0, 32	0, 128	16, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 20	20 10	10 10
DRIVES: Formatted capacity/drive(MB)	1050-4294	1050-4294	535-4294	9090	Drive dependent
Nominal disk diameter (mm)	95	95	95, 130	130	Drive dependent
Average positioning time (msec)	8-10	8-10	8-11	11	Drive dependent
Average rotational delay (msec)	4.17-5.6	4.17-5.6	4.17-5.6	5.6	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	17 x 7 x 18	15.5 x 20.5 x 19	17.3 x 7 x 14	16.89 x 13.95 x 20.5	18.25 x 8.75 x 16.75
POWER: Power backup	200 watts None	200 watts None	200 watts None	300 watts None	120 watts* None
FIRST CUSTOMER SHIPMENT	4Q92	4Q92	1Q95	1Q95	5/93
COMMENTS	Modified purchased controller i960 RISC processor	Modified purchased controller i960 RISC processor	*EISA, MCA, PCI with adapter Numerous options	i960 processor Expandable to 2.2 TB	CMD controller *5 drive version

MANUFACTURER	MEGABYTE MEMORY PRODUCTS	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY
ARRAY MODEL	MegaRAID-1	Raven Pro	Raven	RAIDbank	RAIDbank Plus
DISK/TREND GROUP	Net/Mini/Multi	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem Hardware
Host platform, software environment	Sun, H-P, DEC, SGI UNIX	Macintosh	Macintosh	PC compatible Various	PC compatible NetWare, UNIX, Windows NT
RAID level Configured by:	1 Preset	0/1	0 Preset	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	3.6 55	2.0 17.3	1/.5/1 24/12/20	1/.5/1 24/12/20
Minimum drives per array	2	2	2	2/2/3	2/2/3
Maximum drives per array	8	6	2	6 + spare	6 + spare
Concurrent host channels	1	1	1	1	1, 2
Controller drive channels	1	2	2	1, 2	1, 2
Array interface to host	SCSI-2	NuBus	SCSI-2	SCSI-2,EISA,MCA	SCSI-2, EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 32	--	--	--	4, 64
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No No No	No No No	Yes No Yes	No No Yes
Spare drive (None/Auto/Manual)	Manual	None	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	Host dependent 20	Host dependent 10	Host dependent 10	11.2 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1800-8670	1000-8670	1020-4000	1020-4000
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	9, 10.5	8, 15	9, 10.5	9, 10.5
Average rotational delay (msec)	Drive dependent	4.8, 6.8	4.8, 6.8	5.6	5.6
Drive models	Various	Varies	Various	Seagate 3160NC, 12400NC,31200NC	Seagate 3160NC, 12400NC,31200NC
ARRAY SIZE: Inches: H x W x D	18.25 x 8.75 x 16.75	6.5 x 7.75 x 12	6.5 x 7.75 x 12*	6.5 x 18 x 18	6.5 x 18 x 18
POWER: Power backup	120 watts* None	50 watts None	50 watts None	54 watts None	54 watts None
FIRST CUSTOMER SHIPMENT	1/93	3/94	3/90	4Q93	5/94
COMMENTS	CMD controller *6 drive version	Uses Conley software	*Size may vary depending upon drives supplied	Uses single connector drives Software array	Uses single connector drives

MANUFACTURER	MICRONET TECHNOLOGY	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
ARRAY MODEL	RAIDbank Pro	AV Server 50 AV Server 100 Av Server 200	GANDIVA	RAIDION LS 18000	RAIDION LT 4200
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	PC compatible NetWare, UNIX, Windows NT	SCSI host Various	SCSI host Various	SCSI host NetWare, OS/2	SCSI host NetWare, OS/2
RAID level Configured by:	0/1/3/5 Preset	0/5 Host	0/1/5	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	1/.5/1/1 112/66/90/90	9/6 84/81	N/A N/A	18.1 245	4.2 56
Minimum drives per array	2/2/3/3	3	2	2/3	2/3
Maximum drives per array	28	28	28	28*	28*
Concurrent host channels	2, 4	1	2	1, 4	1
Controller drive channels	2, 1	4	4	1	1
Array interface to host	SCSI-2	SSA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SSA	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	8, 64	8	.512 per drive	.512 per drive
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No Yes-per drive Yes per drive	N/A N/A N/A	No Yes-per drive Yes per drive	No Per drive Per drive
Spare drive (None/Auto/Manual)	Auto	Auto		Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	100 10	20 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1020-4000	3000	N/A	9100	2100
Nominal disk diameter (mm)	95	130	N/A	130	95
Average positioning time (msec)	8, 14	13	N/A	12	9
Average rotational delay (msec)	4.8, 6.8	5.6	N/A	5.6	4.2
Drive models	Various	Micropolis AV	N/A	RM 9100	Taurus II
ARRAY SIZE: Inches: H x W x D	6.5 x 7.75 x 12*	22.75 x 19 x 10	N/A	5.5 x 11 x 13.8**	
POWER: Power backup	50 watts None	30 watts None	N/A N/A	50 watts None	30 watts/drive
FIRST CUSTOMER SHIPMENT	1/95	2Q95	8/94	8/94	11/94
COMMENTS	*Size may vary depending upon drives supplied	Complete storage server	Used with Micropolis RAIDION LT,LTX, RTX to provide hardware based arrays	*32 with NetWare **Per module	Software array *32 with NetWare

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS
ARRAY MODEL	RAIDION LT 8600	RAIDION LTX 12.9	RAIDION LTX 4.2	RAIDION LTX 6.3	RAIDION LTX 8.6
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Software	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host NetWare, OS/2	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level	0/1/5	0/1/5	0/1/5	0/1/5	0/1/5
Configured by:	Host	Host, Panel	Host, panel	Host, Panel	Host, Panel
Array capacity (Gbytes) MIN	8.6	12.9	4.2	6.3	8.6
MAX	116	116	56	56	116
Minimum drives per array	2	2	3	4	3
Maximum drives per array	28*	28	28	28	28
Concurrent host channels	1	2	1	1	1
Controller drive channels	1	4	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512 per drive	8	8, 256	8, 256	8, 256
Cache function (Read, Write)	N/A	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Per drive	Per drive	Per drive	Per drive	Per drive
Power supply (Yes/No)	Per drive	Per drive	Per drive	Per drive	Per drive
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	20	20	20	20
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	4300	4300	2100	2100	4300
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9	9	8.9	8.9	9
Average rotational delay (msec)	4.2	4.2	4.2	4.2	4.2
Drive models	Capricorn IV	Capricorn IV	Taurus II	Taurus II	Capricorn IV
ARRAY SIZE: Inches: H x W x D					
POWER:	30 watts/drive	30 watts/drive	30 watts	30 watts	30 watts
Power backup			None	None	None
FIRST CUSTOMER SHIPMENT	11/94	11/94	1/94	1/94	11/94
COMMENTS	Software array *32 with NetWare	Rack mount available Micropolis GANDIVA controller	Rack mount available	Rack mount available	Rack mount available

MANUFACTURER	MICROPOLIS	MICROTECH INTERNATIONAL	MIDORI	MIRROR TECHNOLOGIES	MIRROR TECHNOLOGIES
ARRAY MODEL	RAIDION VOD 101	Blue Streak RAID	MD-RAID	Precision	Precision FT
DISK/TREND GROUP	Net/Mini/Multi	Single User	Net/Mini/Multi	Single User	Single User
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Software	Subsystem Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	SCSI host Various	Macintosh System 7	SCSI host	Macintosh System 7	Macintosh System 7
RAID level Configured by:	0/5 Host	0/1 Host	1/5 Panel	0/1	0/1/4/5
Array capacity (Gbytes) MIN MAX	9/6 84/81	Drive dependent Drive dependent	5	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	2	2	2	2
Maximum drives per array	28	7	5	4	10
Concurrent host channels	1	1	1	1	1
Controller drive channels	4	1	1	1	1
Array interface to host	SCSI-2	NuBus	SCSI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 64	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes-per drive Yes per drive	No No Per drive	No No No	No No No	No Yes Per drive
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 10	5 5	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	3000	1000-4000	1000	1000-9090	1000-9090
Nominal disk diameter (mm)	130	95	95	95, 130	95, 130
Average positioning time (msec)	13	8-10	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6, 4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Micropolis AV	Quantum, Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.75 x 19 x 10	4 x 12.8	19.7 x 7.9 x 17.7		
POWER: Power backup	30 watts None	5 watts+drives None	280 watts None	None	None
FIRST CUSTOMER SHIPMENT	2Q94	4/95	1994	4Q94	4Q94
COMMENTS	For video servers	ATTO software		Trillium array software	Trillium array software

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MANUFACTURER	MORTON MANAGEMENT	MORTON MANAGEMENT	MOUNTAINGATE DATA SYSTEMS	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	GBR-RD-6000	GBR-RD-NC	PASSPORT XL	FailSafe 44	FailSafe 44-F
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Hardware	Subsystem Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	ISA, EISA, VESA MCA UNIX	VAX-CI cluster VMS	VAX-CI cluster VMS
RAID level Configured by:	5	0/1/3/5	0/1 Host	5+* Preset	5+* Preset
Array capacity (Gbytes) MIN MAX	12	6.5 6.5	Drive dependent Drive dependent	38 44	38 44
Minimum drives per array	7	6	2	13 (2 arrays)	13 (2 arrays)
Maximum drives per array	7	6	4	13 (2 arrays)	13 (2 arrays)
Concurrent host channels	1	1	1	2 (dual ports)	2 (dual ports)
Controller drive channels	1	1	1		
Array interface to host	EISA, ISA,UChan	EISA	Host dependent	CI-Bus/FDDI	CI-Bus/FDDI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	--	N/A	N/A
Cache function (Read, Write)	N/A	N/A	--	N/A	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No No No	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	None	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 10	Host dependent 10	10/12 10	10/12 10
DRIVES: Formatted capacity/drive(MB)	2000	1300	170-1000	1900	1050
Nominal disk diameter (mm)	95	95	95	130	130
Average positioning time (msec)	Drive dependent	Drive dependent	14-9.5	12.9	12.9
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	8.3	8.3
Drive models	Various	Various	PASSPORT Series	Seagate Wren 9	Seagate Wren 9
ARRAY SIZE: Inches: H x W x D	7 x 198 x 19	7 x 198 x 19	1.625 x 5 x 8	62 x 35 x 37	62 x 35 x 37
POWER: Power backup	350 watts None	350 watts None	6 watts None	4600 watts None**	4600 watts None**
FIRST CUSTOMER SHIPMENT	1993	1994	8/94	4/92	4/94
COMMENTS	Software based array	Digi-Data controller	1776 software array "Immunity"	*RAID 5 plus synch. spindles dual parity **Dual AC feed	*RAID 5 plus synch. spindles dual parity. **Dual AC feed. FDDI available 3Q94

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	FailSafe 60	Raiders Edge	RE 3150 Raiders Edge	RE 374 Raiders Edge	Stingray DS StorageWare
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	VAX-CI cluster VMS	VAX, DEC, Sun, IBM RS/6000, SGF, UNIX, oth.	DEC, Sun, RS/6000, VMS UNIX, other	DEC, Sun, RS/6000, VMS UNIX, other	DEC, Sun, IBM, VMS, UNIX, other
RAID level	5+*	3	3	3	0/3/5
Configured by:	Preset	Preset			
Array capacity (Gbytes) MIN		4.1/7.4			Drive dependent
MAX	60	10	15	7.4	Drive dependent
Minimum drives per array	13 (2 arrays)	5 (4+1)	5 (4+1)	5 (4+1)	2
Maximum drives per array	13 (2 arrays)	5 (4+1)	5 (4+1)	5 (4+1)	
Concurrent host channels	2 (dual ports)	1, 2	1, 2	1, 2	1, 2
Controller drive channels					1
Array interface to host	DEC CI Bus	CI, DSSI,SCSI-2	CI, DSSI,SCSI-2	CI, DSSI,SCSI-2	DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	16, 64	16, 64	16, 64	16, 128
Cache function (Read, Write)	N/A	Read, Write	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No)	Yes	Option	Option	Option	No
Fan (Yes/No)	Yes	No	No	No	Option
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Option
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	10	10	4
drive (MB/Sec)	10	5	10	10	10
DRIVES: Formatted capacity/drive(MB)	1900	1200-3557	1200-3557	1200-3557	Drive dependent
Nominal disk diameter (mm)	130	95	95	95	Drive dependent
Average positioning time (msec)	12.9	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	8.3	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate Wren 9	IBM 0663-E15 Seagate	IBM 0663-E15 Seagate	IBM 0663-E15 Seagate	
ARRAY SIZE: Inches: H x W x D	62 x 35 x 37	7 x 19 x 27	7 x 19 x 27	7 x 19 x 27	7 x 19 x 26
POWER: Power backup	None**	300 watts	300 watts	300 watts	60 watts None
FIRST CUSTOMER SHIPMENT	4/92	1/93			
COMMENTS	*RAID 5 plus synch. spindles dual parity **Dual AC feed	Baydel controller	Baydel controller	Baydel controller	

MANUFACTURER	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY	MTI TECHNOLOGY
ARRAY MODEL	Stingray FDDI StorageWare	Stingray III StorageWare	StingRay NFS	SWRD-21F StorageWare	SWRD-43F StorageWare
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	DEC, Sun, IBM, VMS, UNIX, other	DEC, Sun, IBM, VMS, UNIX, other	NFS	DEC, Sun, IBM, VMS, UNIX, other	DEC, Sun, IBM, VMS, UNIX, other
RAID level	0/3/5	0/3/5	4	3/5	3/5
Configured by:			Preset		
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	14		
MAX	Drive dependent	Drive dependent	20	8.4	17.2
Minimum drives per array	2	2	7	5	5
Maximum drives per array			14	5	5
Concurrent host channels	1, 2	1, 2	1, 2	--	--
Controller drive channels	3	3		--	--
Array interface to host	FDDI	CI	NI	CI, DSSI,SCSI-2	CI, DSSI,SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 128	16, 128	--	16, 128	16, 128
Cache function (Read, Write)	Read	Read	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Option	Option	Option	Yes	Yes
Power supply (Yes/No)	Option	Option	Option	Yes	Yes
Spare drive (None/Auto/Manual)	None	None	Manual	N/A	N/A
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	8	8	10	10	10
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2100-4300	2100	4300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9	8	9.5
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	4.17	4.17
Drive models			ST12400N Seagate	Seagate ST1550N	Seagate ST15150N
ARRAY SIZE: Inches: H x W x D	7 x 19 x 26	7 x 19 x 26	31 x 13 x 22	5.25 x 19 x 25	5.25 x 19 x 25
POWER:	122 watts	122 watts	287 watts		
Power backup	None	None		Battery	Battery
FIRST CUSTOMER SHIPMENT					
COMMENTS			NAC product		

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960-X	DAC960-3	DAC960-5	DAC960E-X	DAC960P-X
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare, OS/2 NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT,UNIX,Banyan	PC compatible NetWare, OS/2, NT, UNIX
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7, 14	21	35	7, 14, 21	7, 14, 21
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 2	3	5	1, 2, 3	1, 2, 3
Array interface to host	EISA	EISA	EISA	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 64	2, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No -- --	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 20	33 10	33 10	33 10	132 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Hewlett-Packard Seagate,Fujitsu	Various	Various
ARRAY SIZE: Inches: H x W x D	4.25 x 13	4.25 x 13	4.25 x 13	4.25 x 13	4.5 x 13
POWER: Power backup	20 watts None	20 watts None	20 watts None	20 watts Cache battery	20 watts Cache battery
FIRST CUSTOMER SHIPMENT	1Q93	1Q93	2Q92	2Q94	2Q94
COMMENTS					

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC960PD-X	DAC960PL-X	DAC960M	DAC960SI-X	DAC960SE-X
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare, OS/2, NT, UNIX	PC compatible NetWare, OS/2, NT, UNIX	Microchannel PC NetWare,OS/2,NT SCO UNIX 3.24	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Port,Panel,Host	0/1/5/10 Port,Panel,Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7, 14, 21	7, 14, 21	14	14, 35*	14, 35*
Concurrent host channels	1	1	1	1, 2*	1, 2*
Controller drive channels	1, 2, 3	1, 2, 3	2	2, 5*	2, 5*
Array interface to host	PCI	PCI	MCA	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	2, 32	4, 64	4, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	No N/A N/A	No -- --	No -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 20	132 20	40 20	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4.5 x 13	4.5 x 13		3.5 x 5.75 x 7.5	7.25 x 7.5 x 12
POWER: Power backup	20 watts Cache battery	20 watts Cache battery	20 watts+drives	20 watts Cache battery	70 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q94	1Q95	3Q94	2Q94	2Q95
COMMENTS		Mirrored cache		*With DB960S upgrade	*With DB960S upgrade

MANUFACTURER	MYLEX	NCL AMERICA COMPUTER PRODUCTS	NCL AMERICA COMPUTER PRODUCTS	NEC	NEC
ARRAY MODEL	DAC960S DBT960S	NCL 8825	NCL 8839	N1137-32	N1137-33
DISK/TREND GROUP	Net/Mini/Multi	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Software Software	Software Software	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	PC compatible DOS, OS/2	PC compatible DOS, OS/2	OPA A-VX	OPA A-VX
RAID level Configured by:	0/1/5/10 Host,Port,Panel	1 Preset	1 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	.7 .7	1.3 1.3
Minimum drives per array	2	2	2	5	5
Maximum drives per array	14, 35*	2	2	5	5
Concurrent host channels	1, 2*	1	1	1	1
Controller drive channels	2, 5*	2	2		
Array interface to host	SCSI-2	ISA	ISA	SCSI-2	SCSI-2
Drive interface	SCSI-2	EIDE	EIDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	.032	.032	--	--
Cache function (Read, Write)	Read, Write	Read	Read	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto	None	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	4 Drive dependent	4 Drive dependent	5 5	5 5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	165	331
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	16.5	14
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	8.3	8.3
Drive models	Various	Various	Various	D3865	D3872
ARRAY SIZE: Inches: H x W x D	5.5 x 8	4 x 9.5	4 x 6.5	17.8 x 7.7 x 14.5	17.8 x 7.7 x 14.5
POWER: Power backup	20 watts Cache battery	None	None	-- --	-- --
FIRST CUSTOMER SHIPMENT	2Q94	1Q95	1Q95	2Q92	2Q92
COMMENTS	*With DB960S upgrade	Array software from Unitrol and Pro Engineering	Array software from Unitrol and Pro Engin. Used with existing controller		

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MANUFACTURER	NEC	NEC	NEC	NEC	NETFRAME
ARRAY MODEL	N1137-34	N7759-89	RISCserver 2200	SV-98 Model 2 98 Server	8400
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	PCM	Captive	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software
Host platform, software environment	OPA A-VX	UP4800 UNIX	RISCserver 2200 Windows NT, NTAS	NEC PC-9800, PC NetWare, DOS, Windows NT	NetFRAME NetWare, UNIX, OS/2
RAID level Configured by:	3 Preset	3 Preset	0/1/5 Host	5	0/1
Array capacity (Gbytes) MIN MAX	1.7 1.7	1.7 1.7	2/1/- 42/21/30	12	4/2 224/112
Minimum drives per array	5	5	2	3	3
Maximum drives per array	5	5	21	7	120
Concurrent host channels	1	1	1	1	1, 8
Controller drive channels			3		
Array interface to host	SCSI-2	SCSI-2	EISA	SCSI-2	NetFRAME
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	4, 64		4, 32
Cache function (Read, Write)	--	--	Read, Write		Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --			Duplexing Yes Yes
Spare drive (None/Auto/Manual)	None	None			Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 5	5 5	33 10	10 10	12.5 5, 20
DRIVES: Formatted capacity/drive(MB)	425	425	1000, 2000	1000, 2000	2000
Nominal disk diameter (mm)	95	95	95, 130	95	95
Average positioning time (msec)	14	14		9.5	9.5
Average rotational delay (msec)	8.3	8.3	4.2		5.6
Drive models	D3881	D3881			Hitachi, H-P, Seagate
ARRAY SIZE: Inches: H x W x D	17.8 x 7.7 x 14.5	27.6 x 13.6 x 30	23.25 x 7.25 x 23.25		
POWER: Power backup	-- --	-- --	300 watts None	215 watts	
FIRST CUSTOMER SHIPMENT	2Q92	4Q92			
COMMENTS			Complete server		

MANUFACTURER	NETFRAME	NETFRAME	NETFRAME	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION
ARRAY MODEL	8500	NF250 FT	NF450 FT	FAServer 450	FAServer 1400
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Software	Subsystem Software	Subsystem* Hardware	Subsystem* Hardware
Host platform, software environment	NetFRAME NetWare, UNIX, OS/2	NetFRAME NetWare, UNIX, OS/2	NetFRAME NetWare, UNIX, OS/2	Network Applia. NFS	Network Applia. NFS
RAID level Configured by:	0/1	0/1/5** Host	0/1/5** Host	4 Preset	4 Preset
Array capacity (Gbytes) MIN MAX	4/2 224/112	4/2 90/45	4/2 224/112	2 52	2 52
Minimum drives per array	3	3	3	2	2
Maximum drives per array	120	45	120	14	14
Concurrent host channels	1, 8	1, 3	1, 8	4**	4**
Controller drive channels				2	2
Array interface to host	NetFRAME	NetFRAME	NetFRAME	EISA*	EISA*
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 12	4, 32	64, 256	64, 256
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Duplexing Yes Yes	Duplexing Yes No	Duplexing Yes Yes	No No No	No Yes Option
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	12.5 5, 20	12.5 5, 20	12.5 5, 20	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	2000	2000	2000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	9.5	9.5	9.5	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	5.6	Drive dependent	Drive dependent
Drive models	Hitachi, H-P, Seagate	Hitachi, H-P, Seagate*	Hitachi, H-P, Seagate*	Quantum, Seagate	Quantum, Seagate
ARRAY SIZE: Inches: H x W x D		26 x 19 x 19	42 x 19 x 19	31 x 13 x 22	16.6 x 19 x 20
POWER: Power backup		500 watts UPS option	1500 watts UPS option	0.6 KVA Cache battery	0.6 KVA Cache battery
FIRST CUSTOMER SHIPMENT		3/94	3/94	3/94	4/94
COMMENTS		*Optional drives 200 MB-2 GB **Requires Novell software	*Optional drives 200 MB-2 GB **Requires Novell software	*Includes NFS server and network interfaces to FDDI, CDDI, Ethernet **To network	*Includes NFS server and network interfaces to FDDI, CDDI, Ethernet **To network

MANUFACTURER	NETWORK CONNECTION	NISSIN ELECTRIC	NISSIN ELECTRIC	NISSIN ELECTRIC	NISSIN ELECTRIC
ARRAY MODEL	T.R.A.C. Array	A100-510T PRORAID	A100-520T PRORAID	A100-540T PRORAID	A200-510T PRORAID
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	T.R.A.C. DOS, OS/2, UNIX NetWare, other	UNIX, Windows, DOS, NetWare	UNIX, Windows, DOS, NetWare	UNIX, Windows, DOS, NetWare	UNIX, Windows, DOS, NetWare
RAID level	0/1/4/5	3/5	3/5	3/5	3/5
Configured by:		Preset	Preset	Preset	Preset
Array capacity (Gbytes) MIN	Drive dependent	1	2	4	1
MAX	Drive dependent	1	2	4	1
Minimum drives per array	2	5	5	5	5
Maximum drives per array	35	5	5	5	5
Concurrent host channels	1	1	1	1	1
Controller drive channels		1	1	1	1
Array interface to host	EISA	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	IDE	IDE	IDE	IDE
Cache size (min, max: MB)	--	.256	.256	.256	.256
Cache function (Read, Write)	--	Write	Write	Write	Write
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	No	No	No	No
Power supply (Yes/No)	Yes	No	No	No	No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	33	10	10	10	10
drive (MB/Sec)	10	7.5	10	11.1	7.5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	343	541	1080	343
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	13	12	10.5	13
Average rotational delay (msec)	Drive dependent	15	13.3	11.1	15
Drive models	Seagate Quantum	Conner CFA340A	Conner CFA540A	IBM DPEA-31080	Conner CFA340A
ARRAY SIZE: Inches: H x W x D	Varies	5 x 5.75 x 8	5 x 5.75 x 8	5 x 5.75 x 8	7.1 x 6.3 x 14.2
POWER:	250 watts	56 watts	73 watts	78 watts	.2 KVA
Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	6/92	1995	1995	1995	1Q94
COMMENTS					

MANUFACTURER	NISSIN ELECTRIC	NISSIN ELECTRIC	NONSTOP NETWORKS	OMNI TECHNOLOGY	OMNI TECHNOLOGY
ARRAY MODEL	A200-520T PRORAID	A200-540T PRORAID	No-Stop Network	MacRAID T-3	RAIDSTOR
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	OEM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Software Software	Subsystem Hardware	Board Hardware
Host platform, software environment	UNIX, Windows, DOS, NetWare	UNIX, Windows, DOS, NetWare	PC compatible DOS, Windows, NetWare	Mac Quadra System 7	SCSI host Solaris, UNIX, NetWare
RAID level Configured by:	3/5 Preset	3/5 Preset	1 Preset	0/3/5 Host, Preset	0/3/5 Host, Preset
Array capacity (Gbytes) MIN MAX	2 2	4 4	Drive dependent Drive dependent	5 50	7.5/6/6 70/56/56
Minimum drives per array	5	5	2	5	5
Maximum drives per array	5	5	20	35	35
Concurrent host channels	1	1	1	1, 5	1
Controller drive channels	1	1		1, 5	1, 5
Array interface to host	SCSI-2	SCSI-2	--	NuBus	SCSI-2
Drive interface	IDE	IDE	--	SCSI-2	SCSI-2
Cache size (min, max: MB)	.256	.256	--	8, 64	8, 64
Cache function (Read, Write)	Write	Write	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	-- -- --	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 11.1	Drive dependent Drive dependent	10 10	20 10
DRIVES: Formatted capacity/drive(MB)	541	1083	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
Average positioning time (msec)	12	10.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	13.3	11.1	Drive dependent	Drive dependent	Drive dependent
Drive models	Conner CFA540A	IBM DPEA-31080	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	7.1 x 6.3 x 14.2	7.1 x 6.3 x 14.2	--	3.25 x 5.75 x 8	3.25 x 5.75 x 8
POWER: Power backup	.2 KVA None	.2 KVA None	-- --	25 watts*	25 watts* None
FIRST CUSTOMER SHIPMENT	1Q94	3Q94	1990	8/92	4/92
COMMENTS			Mirrored drives can be in different hosts	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power

MANUFACTURER	OMNI TECHNOLOGY	OMNI TECHNOLOGY	OMNI TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY
ARRAY MODEL	RAIDSTOR-F5	RAIDSTOR-SLT3	RAIDSTOR-T3	18000W Concorde	3600DHW DisKovery
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User
MARKET	OEM	OEM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Software	Software
Host platform, software environment	SCSI host Solaris, UNIX, NetWare	SCSI host Solaris, UNIX, NetWare	SCSI host Solaris, UNIX, NetWare	Macintosh	Macintosh
RAID level	0/3/5	0/3/5	0/3/5	0/1	0/1
Configured by:	Host, Preset	Host, Preset	Host, Preset	Host	Host
Array capacity (Gbytes) MIN	7.5/6/6	7.5/6/6	7.5/6/6	18	3.6
MAX	140/112/112		70/56/56	18	3.6
Minimum drives per array	5	5	5	2	2
Maximum drives per array	35	5	35	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 5	1	1, 5	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2, NuBus	SCSI-2, NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 64	8, 64	8, 64	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No)	Option	Option	Option	No	No
Fan (Yes/No)	Yes	Yes	Yes	No	No
Power supply (Yes/No)	Yes	Yes	Yes	No	No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	15	18.6
drive (MB/Sec)	10	10	10	20	20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	9000	1800
Nominal disk diameter (mm)	130	95	95	130	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	11	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	4.17
Drive models	Various	Various	Various	Seagate Elite 9	Various
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8	8.52 x 11.42 x 10.21	4.9 x 11.42 x 10.21
POWER: Power backup	25 watts*	25 watts*	25 watts*		
FIRST CUSTOMER SHIPMENT	1/93	1/93	4/92	9/94	9/94
COMMENTS	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power	Software array	Software array

MANUFACTURER	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY	OPTIMA TECHNOLOGY
ARRAY MODEL	4200W DisKovery	8200W DisKovery	HST 10000 HST 10000/DAT DiskArray	HST 20000 HST 20000/DAT DiskArray	HST 6000 HST 6000/DAT DiskArray
DISK/TREND GROUP	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Software	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Macintosh	Macintosh	Macintosh, PC	Macintosh, PC	Macintosh, PC
RAID level Configured by:	0/1 Host	0/1 Host	0/1/5/10 Panel	0/1/5/10 Panel	0/1/5/10 Panel
Array capacity (Gbytes) MIN MAX	4.2 4.2	8.2 8.2	10.5/5.3/8.4 14.7/7.4/11.8	20.5/10.3/16.4 28.7/14.4/22.3	6.3/3.2/4.2 14.7/7.4/11.8
Minimum drives per array	2	2	3	3	3
Maximum drives per array	2	2	8	8	8
Concurrent host channels	1	1	1, 2	1, 2	1, 2
Controller drive channels	1	1	2-5	2-5	2-5
Array interface to host	SCSI-2, NuBus	SCSI-2, NuBus	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	4, 32	4, 32	4, 32
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	12.6 20	13.9 20	20 20	20 20	20 20
DRIVES: Formatted capacity/drive(MB)	2100	4100	2100	4100	2100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	8	8	8	8	8
Average rotational delay (msec)	4.17	4.17	4.17	4.17	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4.9 x 11.42 x 10.21	4.9 x 11.42 x 10.21	23.5 x 9.25 x 20.25	23.5 x 9.25 x 20.25	23.5 x 9.25 x 20.25
POWER: Power backup			300 watts	300 watts	300 watts
FIRST CUSTOMER SHIPMENT	9/94	9/94	4Q94	4Q94	4Q94
COMMENTS	Software array	Software array	DAT tape is option	DAT tape is option	DAT tape is option

MANUFACTURER	PACE TECHNOLOGIES	PACIFIC MICRO DATA	PACIFIC MICRO DATA	PARITY SYSTEMS	PARITY SYSTEMS
ARRAY MODEL	Pace RAID-5	MAST VII	MAST VIII	6000	6010
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Pace Various	ISA, EISA, MCA NetWare, UNIX, DOS, OS/2, oth	ISA, EISA, MCA NetWare, UNIX, DOS, OS/2, oth	Sun, H-P, SGI, IBM UNIX	Sun, H-P, SGI, IBM UNIX
RAID level	0/3/5	0/1/3/5	0/1/3/5	0/3/5	0/3/5
Configured by:	Host	Host	Host	Port, Panel	Port, Panel
Array capacity (Gbytes) MIN	Drive dependent	1	1	Drive dependent	Drive dependent
MAX	Drive dependent	13	16	Drive dependent	Drive dependent
Minimum drives per array	5	2	2	2	2
Maximum drives per array	20	7	8	7	7
Concurrent host channels	1	1	1	1, 3	1, 3
Controller drive channels	1, 5	1-3	1-3	1, 3	1, 3
Array interface to host	SCSI, SCSI-2	PCI, EISA	PCI, EISA	SCSI-2	SCSI-2
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 128	4, 64	4, 64	32	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	Option	Option	Option
Fan (Yes/No)	No	Yes	Yes	Yes	Yes
Power supply (Yes/No)	No	Per drive	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	10	10	10/20	10/20
drive (MB/Sec)	10	Various	Various	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1050-4000	1050-4000	1000-9100	1000-9100
Nominal disk diameter (mm)	Drive dependent	95	95	95, 130	95, 130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	20 x 14.5 x 12	8.75 x 17.75 x 16	Varies	Varies
POWER:	20 watts+drives	250 watts	250 watts		
Power backup	None	None	None	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1/93	2/93	1Q94	1Q93	1Q93
COMMENTS	Digi-Data controller	Mylex controller	Mylex controller	CMD controller	CMD controller Rack mount version of 6000

MANUFACTURER	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS
ARRAY MODEL	6100	6200	6210	6610 6620	6700
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Sun, H-P, SGI, IBM UNIX	Sun, H-P, SGI, IBM UNIX	SGI, Sun, H-P, IBM UNIX	Sun, H-P, SGI, IBM UNIX	SGI UNIX
RAID level Configured by:	0/3/5 Port, Panel	0/3/5 Port, Panel	0/3/5 Panel, Port	0/3/5 Port, Panel	3 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	3
Maximum drives per array	21	28	28	28	7
Concurrent host channels	1, 3	1, 3	1, 3	1, 3	1
Controller drive channels	1, 3	1, 3	1, 3	1, 3	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	32	32	32	1, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	Option Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10	10/20 10	10/20 10	10/20 10	10/20 10
DRIVES: Formatted capacity/drive(MB)	1000-9100	1000-9100	1000-4100	1000-9100	1000-4100
Nominal disk diameter (mm)	95, 130	95, 130	95	95, 130	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	20 x 19 x 14*	Varies	
POWER: Power backup	Cache battery	Cache battery	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	1Q93	1Q94	1994	1Q95	2Q95
COMMENTS	CMD controller	CMD controller Dual AC power	CMD controller *28 drives Rack mount version of 6200	CMD controller Rack mount	Baydel controller

MANUFACTURER	PC EXPANDERS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS
ARRAY MODEL	ARRAYSERVER	dataSHADOW	PATHFINDER	quickRAID 300QR	quickSHADOW
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Software	Board Hardware	Board Hardware	Software Software
Host platform, software environment	PC compatible UNIX, Windows, NetWare, NT	PC compatible UNIX, PTPLANS OS/2, DOS	PC compatible Various	PC compatible Various	PC compatible Various
RAID level Configured by:	0/1/4/5 Host	1 Preset	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	24	4	2	4
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1, 4	2	2	2
Array interface to host	EISA	VESA, ISA, PCI	ISA, VESA, PCI	ISA, VESA, PCI	--
Drive interface	SCSI-2	SCSI	IDE	IDE	IDE, SCSI
Cache size (min, max: MB)	--	1, 16	--	.5, 8	8*
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	N/A N/A N/A	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	Host dependent 2-5	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	25 x 9 x 18	N/A	4 x 14	4 x 14	N/A
POWER: Power backup	250 watts None	N/A None	N/A N/A	N/A None	N/A None
FIRST CUSTOMER SHIPMENT	1Q93	1Q90	4Q94	1Q93	1Q94
COMMENTS		Operates in Perceptive easyCACHE, Pathfinder and Ultima controllers	Requires PSI software for RAID 1		*With PSI controller

MANUFACTURER	PERISOL TECHNOLOGY	PHOENIX INTERNATIONAL	POLYWELL COMPUTERS	POLYWELL COMPUTERS	POLYWELL COMPUTERS
ARRAY MODEL	RAIDSafe Plus	RAIDMASTER	SUMA	SUPRA RAID	SURA RAID
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, OSF/1, VMS,NT	SCSI host UNIX, other	PC compatible NetWare, OS/2, SCO UNIX, NT	PC compatible NetWare, OS/2, SCO UNIX, NT	PC compatible NetWare, OS/2, SCO UNIX, NT
RAID level	0/1/3/5	0/3/5	0/1/5	0/1/5	0/1/5
Configured by:	Panel	Port, Panel	Host	Host	Host
Array capacity (Gbytes) MIN	4	4.3	2.4/1.2/--	2.4/1.2/--	2.4/1.2/--
MAX	12	20.6	8.4/3.6/7.2	8.4/3.6/7.2	8.4/3.6/7.2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	28	6	8	17	17
Concurrent host channels	1, 3	1	1	1	1
Controller drive channels	5, 7	3	1	1-5	1-5
Array interface to host	SCSI-2	SCSI-2	EISA, PCI	EISA, PCI	EISA, PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2, SCSI-3	SCSI-2, SCSI-3	SCSI-2, SCSI-3
Cache size (min, max: MB)	32	32	4, 64	4, 64	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	Option	No	No	No
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10	10	33, 133	33, 133	33, 133
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000-4300	1000-4300	1000-4300	1000-4300
Nominal disk diameter (mm)	95	95	95, 130	95, 130	95, 130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Quantum, H-P, Seagate, IBM	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 7.5 x 23	7 x 19 x 20	29 x 10 x 22	29 x 10 x 22	29 x 10 x 22
POWER: Power backup	300 watts Cache battery	300 watts Cache battery	750 watts UPS option	750 watts UPS option	750 watts UPS option
FIRST CUSTOMER SHIPMENT	3Q93	9/94	2Q94	3Q93	2Q94
COMMENTS	CMD controller	CMD controller Dual AC Rack mount	Mylex controller	Mylex controller For 486 based systems	Mylex controller For Pentium based systems

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MANUFACTURER	PRECISION COMPUTERS	PRECISION COMPUTERS	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	486-XX EISA	Pentium-XX	ISA SCSI Xelerator	1050	2000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	NetWare, UNIX, DOS OS/2	NetWare, UNIX, DOS OS/2	PC compatible DOS, Windows, NetWare, OS/2	Macintosh System 7	Macintosh System 7
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1* Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	2 4	2 4	Drive dependent Drive dependent	2.1/1.05	4/2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	5	5	7	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1	1	1	1
Array interface to host	EISA	EISA	SCSI, SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Option	No Yes Option	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual-foregrnd	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1052-2000	1052-2000	Drive dependent	1050	2000
Nominal disk diameter (mm)	95	95	Drive dependent	95	95
Average positioning time (msec)	10.5	10.5	Drive dependent	5	5
Average rotational delay (msec)	5.56	5.56	Drive dependent	5.5	5.5
Drive models	Hewlett-Packard Seagate	Hewlett-Packard Seagate	Various		
ARRAY SIZE: Inches: H x W x D	33.75 x 10.83 x 23.75	33.75 x 10.83 x 23.75	4.75 x 10.72 x 0.875	8 x 6 x 10	8 x 6 x 10
POWER: Power backup	225 watts None	225 watts None	3.8 watts None	125 watts	125 watts
FIRST CUSTOMER SHIPMENT	11/92	1Q94	12/92		
COMMENTS	Mylex controller	Mylex controller	*Supports concurrent RAID 0 and RAID 1		

MANUFACTURER	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	LFRAID/1.1	LFRAID/2.1	LFRAID/24	LFRAID/4.2	LFRAID/4.4
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other	SCSI host Various	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other
RAID level Configured by:	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel	0/1/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	2.4/1.2/1.6/1.6	3.2/1.6/2.1/2.1	28/14/24/24	6.3/3.2/4.2/4.2	6.6/3.3/4.4/4.4
Minimum drives per array	2	2	7	2	2
Maximum drives per array	7	7	7	7	7
Concurrent host channels	1, 2	1, 2	1, 2	1, 2	1, 2
Controller drive channels	7	7	1	7	7
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--*	8*	32	16	32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	540	1050	4100	2100	2200
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44	22.25 x 7.29 x 22.44
POWER: Power backup	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	3Q94	4Q93	4Q93
COMMENTS	CMD controller *Optional cache	CMD controller *Optional cache	CMD controller	CMD controller	CMD controller

MANUFACTURER	PROCOM TECHNOLOGY	R SQUARED	R SQUARED	R SQUARED	RAAC TECHNOLOGIES
ARRAY MODEL	RAIDRax	CR-I	CR-II	EL-II	ESP200
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host Various	SCSI host UNIX	SCSI host UNIX	SCSI host UNIX	PC compatible Various
RAID level	0/3/5	3/5	0/1/3/5	0/3/5	0/1
Configured by:	Panel, Port	Port	Host, Port	Panel	Preset
Array capacity (Gbytes) MIN	Drive dependent	10.5	6.3	2	Drive dependent
MAX	Drive dependent	129	180.6	214	Drive dependent
Minimum drives per array	2	5	4	3	2
Maximum drives per array	28	35	48	28	4
Concurrent host channels	1, 2	1	1, 4	1, 3	1
Controller drive channels	4	5	8	3, 7	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA/ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	16, 64	4, 8	--, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	Option	Yes	Yes	Yes	Option
Fan (Yes/No)	Yes	Yes	Yes	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	20	20	20	4/5	33
drive (MB/Sec)	20	9	10	9	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	2000, 4000	2000, 4000	2000, 9000	Drive dependent
Nominal disk diameter (mm)	95, 130	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Varies	Varies	Varies	Various
ARRAY SIZE: Inches: H x W x D	77 x 25.25 x 36	7 x 17.75 x 28	7 x 17.75 x 28	Varies	10.5 x 19 x 17
POWER: Power backup	Battery	200-1400 watts Battery	200-1200 watts UPS	300-1200 watts UPS	375 watts None
FIRST CUSTOMER SHIPMENT	11/94	1Q94	3/95	2Q94	2Q94
COMMENTS	CMD controller Multiple AC feed	Fujitsu DynaRAID	Fujitsu DynaRAID	CMD controller	DPT controller Ruggedized

MANUFACTURER	RAAC TECHNOLOGIES	RAAC TECHNOLOGIES	RAID POWER	RAIDTEC	RAIDTEC
ARRAY MODEL	ESP500	ESP1000	UltraRAID2 HP-SS	FlexArray MX	RUAC MX
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User
MARKET	PCM	PCM	PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware
Host platform, software environment	PC compatible Various	PC compatible Various	SCSI host NetWare, AUX Syst.7,VMS,oth.	Various DOS, UNIX, OS/2 NetWare, Syst.7	SCSI host
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5/6	0/1 Panel	0/1 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	4 256	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	8	35	14	14
Concurrent host channels	1	1	1, 2	1	1
Controller drive channels	1	1	25	1, 2	1, 2
Array interface to host	EISA/ISA	EISA/ISA	SCSI-2	SCSI, SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	64	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Option Yes Yes	No Yes Yes	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	20 20	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000-9000	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	95	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate, H-P	Various	Various
ARRAY SIZE: Inches: H x W x D	35.25 x 19 x 19	44 x 19 x 19	22.25 x 7.29 x 22.44	6.5 x 9.25 x 12.75	1.625 x 5.75 x 8.12
POWER: Power backup	-- None	400 watts None	100 watts UPS & battery	120 watts	7.5 watts
FIRST CUSTOMER SHIPMENT	2Q94	1992	4Q94	3Q94	3Q94
COMMENTS	DPT controller Ruggedized	DPT controller Ruggedized		3 SCSI channels including host	3 SCSI channels including host

MANUFACTURER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	FlexArray RX	FlexArray FX	FlexArray	FlexArray IX	RUAC FX
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Board Software	Board Hardware	Board Hardware
Host platform, software environment	SCSI host Various	SCSI host Various	Various DOS, UNIX, OS/2 NetWare, Syst.7	Various DOS, UNIX, OS/2 Netware, Syst.7	SCSI host Various
RAID level Configured by:	0/1/3/5/10 Panel	0/1/3/5/10 Panel, Port	0/1/3/5 Host	0/1/3/5 Panel	0/1/3/5/10 Panel, Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	5	6	6	6	75
Concurrent host channels	1	1	1	1	1
Controller drive channels	1	1-5	1	1, 5	1-5
Array interface to host	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10/20	20 20	10 10	10 10	20 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	15.75 x 15.6 x 15.6	15.75 x 15.6 x 15.6	15.75 x 15.6 x 15.6	15.75 x 15.6 x 15.6	3.8 x 16.6 x 13
POWER: Power backup	300 watts	300 watts	300 watts	300 watts	140 watts
FIRST CUSTOMER SHIPMENT	3Q94	3Q94	3Q92	1Q93	3Q94
COMMENTS	Requires RUAC controller	RUAC II controller	Requires array software, no internal array controller	6 SCSI channels including host	6 SCSI channels including host

MANUFACTURER	RAIDTEC	RAIDTEC	RANGER PLUG 'N' GO	RANGER PLUG 'N' GO	RANGER PLUG 'N' GO
ARRAY MODEL	RUAC II	Ruac IX	Drive Card	Plug & Go	Plug & Go/Apple
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User	Single User
MARKET	OEM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	SCSI host Various	Various DOS, UNIX, OS/2 Netware, Syst.7	PC compatible DOS, UNIX Netware	PC compatible DOS, Windows	Apple
RAID level Configured by:	0/1/3/5/10 Panel, Port	0/1/3/5 Panel	0/1/3/5 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	75	35	2	2	2
Concurrent host channels	1	1	1	1	1
Controller drive channels	1-5	1, 5	1	1	1
Array interface to host	SCSI-2	SCSI, SCSI-2	ISA,EISA,PCI*	Parallel port	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE	SCSI-2
Cache size (min, max: MB)	--	--	--	--	Option
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No Yes Yes	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	10 10	Bus dependent 10	Bus dependent 10	Bus dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	250-5300	250-5300	250-5300
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8.5 x 10.5	3.8 x 16.6 x 13	4.5 x 1.25 x 13.25	1.75 x 5 x 8	1.75 x 5 x 8
POWER: Power backup	140 watts	140 watts	5 watts+drives None	5 watts+drives None	5 watts+drives None
FIRST CUSTOMER SHIPMENT	3Q94	1Q94	6/93	6/93	2Q95
COMMENTS	6 SCSI channels including host	6 SCSI channels including host	Uses array software *VESA also available	Uses array software External mount Portable array	Uses array software External mount Portable array

MANUFACTURER	RANGER PLUG 'N' GO	ROSE DATASYSTEMS	ROSE DATASYSTEMS	ROSE DATASYSTEMS	ROSE DATASYSTEMS
ARRAY MODEL	Plug & Go S	ROSE-1000	ROSE-2000	ROSE-3000	ROSE-7000
DISK/TREND GROUP	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible DOS, OS/2, Windows	PC compatible Various	PC compatible Various	SCSI host Various	SCSI host Various
RAID level Configured by:	1 Preset	0/1/4/5 Host,Panel,Port	0/1/3/5 Host,Panel,Port	0/1/3/5 Host,Panel,Port	0/1/3/5 Host,Panel,Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	21	21	14	35
Concurrent host channels	1	1	1	1	1, 5
Controller drive channels	1	3	3	2, 3	1, 5
Array interface to host	Parallel port	EISA	PCI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	Option	4, 16	4, 16	2, 32	2, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	None	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Bus dependent 10	33 10	132 10	10, 20 10, 20 (option)	10 10
DRIVES: Formatted capacity/drive(MB)	250-5300	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	1.75 x 5 x 8	5 x 1 x 7.3	4.2 x 12.3	1.57 x 3.94 x 6.02	1.6 x 5.7 x 8.4
POWER: Power backup	5 watts+drives None	20 watts None	15 watts None	7.5 watts None	10 watts Cache battery
FIRST CUSTOMER SHIPMENT	6/93	4Q94	2Q95	2Q95	4Q94
COMMENTS	Uses array software External mount Portable array	Manufactured for Rose by Infortrend	Manufactured for Rose by Infortrend	Manufactured for Rose by Infortrend	Manufactured for Rose by Infortrend

MANUFACTURER	SEE FIRST TECHNOLOGY	SEEK SYSTEMS	SEEK SYSTEMS	SEEK SYSTEMS	SEQUENT COMPUTER SYSTEMS
ARRAY MODEL	Array System	S440	S450	SEEK Array	WINSERVER 3000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	DEC, Sun, SGI, HP, RS/6000,oth UNIX, NetWare	SCSI host	SCSI host	SCSI host Various, UNIX	Sequent Windows NTAS, UNIX
RAID level Configured by:	1/3/5 Panel	0/3/5 Panel, Port	0/3/5 Panel, Port	1/3/5 Port	0/1/5/10
Array capacity (Gbytes) MIN MAX	1.25 8	Drive dependent Drive dependent	Drive dependent Drive dependent	5 100	1/.5/1/.5 207/101/166/101
Minimum drives per array	5	7	5	5	2/3
Maximum drives per array	7	28	35	60	96
Concurrent host channels	1	1, 2	1	1, 4	1
Controller drive channels	1	4	5	10	4
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-3	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-3	SCSI-2
Cache size (min, max: MB)	32	32	16, 128	32, 1000	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option Yes Yes (option)	No Yes Yes (option)	Yes Yes Yes (option)	Option Yes Yes
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10, 20 10, 20	10, 20 10, 20	10, 20 10, 20	33 10
DRIVES: Formatted capacity/drive(MB)	1000-2000	Drive dependent	Drive dependent	Drive dependent	500-2100
Nominal disk diameter (mm)	95	95	95	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	DEC, IBM	Seagate	Seagate	Various	Various
ARRAY SIZE: Inches: H x W x D	21.5 x 10 x 14	Varies	Varies		36.5 x 34.3 x 33.5
POWER: Power backup	120 watts None	37 watts	37 watts	45 watts Cache battery	1.3 KVA None
FIRST CUSTOMER SHIPMENT	8/93	1994	1993	12/94	1993
COMMENTS	CMD controller	CMD controller	Digi-Data controller		May include up to 6 CPUs

MANUFACTURER	SEQUENT COMPUTER SYSTEMS	SEQUOIA SYSTEMS	SEQUOIA SYSTEMS	SERAPH	SERAPH
ARRAY MODEL	WINSERVER 3500	DD5003	DS4003	Gemini SE	AU-1
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi
MARKET	PCM	Captive, OEM	Captive, OEM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software
Host platform, software environment	Sequent Windows NTAS, UNIX	Sequoia series 40 Wilt Topix	Sequoia series 40 Wilt Topix	Macintosh System 7	Apple Appletalk
RAID level Configured by:	0/1/5/10	1 Preset	1 Preset	0/1/4/5 Host	0/1/4/5
Array capacity (Gbytes) MIN MAX	1/.5/1/.5 207/101/166/101	1.8 176	.880 88	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2/3		2	2	5
Maximum drives per array	99*	100	100	2	7
Concurrent host channels	1	2	2	1-5	1-5
Controller drive channels	4				
Array interface to host	EISA	VME	VME	NuBus, PCI	NuBus, PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	1, variable	1, variable	--	--
Cache function (Read, Write)	--	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Yes Yes Yes	Yes Yes Yes	No No No	No No Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	None	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	20 5.2	20 3.5	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	500-2100	1800	880	500-2900	1000-4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	9	10	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	5.6	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Seagate ST31200 ST12400 Barrac.	Seagate ST31200 ST12400 Barrac.
ARRAY SIZE: Inches: H x W x D	36.5 x 22.3 x 33.5	5.5 x 17 x 17	5.5 x 17 x 17	4 x 10 x 10.5	21 x 7.5 x 18
POWER: Power backup	1.3 KVA None	300 watts Battery	300 watts Battery	60 watts None	300 watts None
FIRST CUSTOMER SHIPMENT	3Q94	1994	1994	8/93	10/93
COMMENTS	*With expansion cabinet			BusLogic controller with Seraph drives Trillium array software	BusLogic controller with Seraph drives Trillium array software

MANUFACTURER	SILICON VALLEY COMPUTER	SILICON VALLEY COMPUTER	SILICON VALLEY COMPUTER	SILICON VALLEY COMPUTER	SOLID COMPUTER
ARRAY MODEL	ADP 104 ADP 108*	ADP 111	ADP 120	ADP 130	M10
DISK/TREND GROUP	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	PC compatible DOS, UNIX, OS/2 Windows	PC compatible DOS, UNIX, OS/2 Windows	SCSI host Various	SCSI host Various	Sun, RS/6000 DG AViiON NetWare, UNIX
RAID level Configured by:	0/1 Preset	0/1 Preset	0/1/3 Host	0/1/3 Host	0/1/3/5/10
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	5.2 40
Minimum drives per array	2	2	2	2	3
Maximum drives per array	4	4*	5	5	10
Concurrent host channels	1	1	1	1	1
Controller drive channels	--	--	1	1	2
Array interface to host	16 bit ISA Bus	32 bit VESA	SCSI-2	PCI	SCSI-2
Drive interface	IDE	IDE	IDE	IDE	SCSI-2
Cache size (min, max: MB)	.016, .032	.032	1, 64	1, 64	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	Yes Yes Yes
Spare drive (None/Auto/Manual)	None	None	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	3 max. 9 max.	3 max. 9 max.	20 16 max.	132 16 max.	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	2000, 4000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.9, 9.2
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	5.6, 4.17
Drive models	Various IDE drives	Various IDE drives	Various IDE drives	Various IDE drives	Various
ARRAY SIZE: Inches: H x W x D	4.75 x 13	4.75 x 13	7 x 9	7 x 9	63 x 26.7 x 76.2
POWER: Power backup	2 watts None	2 watts None	4 watts Cache battery	4 watts Cache battery	575 watts
FIRST CUSTOMER SHIPMENT	9/92	4Q93	4Q94	4Q94	
COMMENTS	*Includes floppy controller	*Also supports 2 additional nonmirrored IDE channels			CLARiiON controller

MANUFACTURER	SOLID COMPUTER	SOLID COMPUTER	SPIN PERIPHERALS	SPIN PERIPHERALS	STORAGE COMPUTER
ARRAY MODEL	M20	M6	Whirlwind	Internal RAID	CLx
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Hardware
Host platform, software environment	Sun, RS/6000, DG AViiON NetWare, UNIX	Sun,RS/6000,SGI H-P,Apple,PowPC NetWare, UNIX	Macintosh System 7	Mac Quadra 800/840AV Power Mac	Most PC & UNIX networks, plus midrange syst.
RAID level Configured by:	0/1/3/5/10 Port	0/3/5	0/1/4/5 Host	0/1/4/5 Host	"7" Preset
Array capacity (Gbytes) MIN MAX	10.5 80	5.2 20	Drive dependent Drive dependent	Drive dependent Drive dependent	2 420
Minimum drives per array	5	3	2	2	3
Maximum drives per array	20	5	7	7*	48
Concurrent host channels	1	1	1	1	1 to 12
Controller drive channels	5	1	1	1	3 to 48
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-1/2
Cache size (min, max: MB)	4, 64	4, 128	--	--	16-256
Cache function (Read, Write)	Read, Write	Read, Write	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	No -- --	No -- --	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	None	None	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 20	20 20	10 or 20 Drive dependent
DRIVES: Formatted capacity/drive(MB)	2000, 4000	2000, 4000	1000-4000	1000-4000	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95, 130
Average positioning time (msec)	6.9, 9.2	7.2, 9.6	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6, 4.17	5.6, 4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate ST31225,550W	Quantum XP34300W	Various
ARRAY SIZE: Inches: H x W x D	63.5 x 35.6 x 69.9	39 x 25 x 42	--	--	14 x 16.5 x 15.5
POWER: Power backup	660 watts	250 watts	Varies None	Varies None	2.160 KVA --
FIRST CUSTOMER SHIPMENT			2Q95	2Q95	4Q92
COMMENTS	CLARiiON controller	Digi-Data controller	Trillium software ATTO controller	Trillium software *Only 2 drives mount internally	UPS required

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE CONCEPTS
ARRAY MODEL	D3x	D5x	R3x	R5x	Concept 750
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.	SCSI host Various
RAID level Configured by:	"7" Preset	"7" Preset	"7" Preset	"7" Preset	3/5 Host
Array capacity (Gbytes) MIN MAX	2 45	2 99	2 106	2 230	8 50
Minimum drives per array	3	3	3	3	5
Maximum drives per array	12	12	27	27	28
Concurrent host channels	1 or 2	1, 2	1 to 4	1 to 4	2
Controller drive channels	3 to 12	3 to 12	3 to 9	3 to 9	7
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-1/2	SCSI-1/2	SCSI-1/2	SCSI-1/2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 256	4, 256	8, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	Optional Yes Yes, optional
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent	Up to 20 Varies
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4000
Nominal disk diameter (mm)	95	130	95	130	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	8
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	4.17
Drive models	Various	Various	Various	Various	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	14 x 16.5 x 15.5	14 x 16.5 x 15.5	14 x 19 x 28.5	14 x 19 x 28.5	24 x 10 x 14
POWER: Power backup	1.440 KVA --	1.440 KVA --	2.160 KVA --	2.160 KVA --	Optional UPS*
FIRST CUSTOMER SHIPMENT	2Q92	2Q92	1Q92	1Q92	3/94
COMMENTS	UPS required	UPS required	UPS required	UPS required	*Battery backup of write buffer

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	Concept 810 Concept 810SW	Concept 812SW	Concept 910SW	LANStor MFX (MegaFlex)	LANStor MFX-RDC (MegaFlex)
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host, VME, PC AT	SCSI host Proprietary	SCSI host Various	PC compatible NetWare, NT	PC compatible NetWare, OS/2, NT
RAID level Configured by:	3 Host, Preset	3 Host, Port	3 Port	0/1 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	2 16	8 40	16 504	9 63	18 126
Minimum drives per array	4	2	9	2	3
Maximum drives per array	5	10	63	7	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	5	5	9	1	1, 2
Array interface to host	VME,PCAT,SCSI-2	SCSI-2	SCSI-2	SCSI-3	SCSI-3
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-3	SCSI-3
Cache size (min, max: MB)	2	2	4	1	4, 64
Cache function (Read, Write)	Read, Write	N/A	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 peak* 5	20+ 5	40 5	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	4000	4000	4000, 8000	9090	9090
Nominal disk diameter (mm)	95	95	95	130	130
Average positioning time (msec)	8.3	8	8.3	11	11
Average rotational delay (msec)	4.17	4.17	4.17	5.56	5.56
Drive models	Seagate ST12550	Seagate Barracuda	Seagate Barracuda	Seagate ST410800	Seagate ST410800
ARRAY SIZE: Inches: H x W x D	3.5 x 19 x 21	5.25 x 19 x 21	7 x 19 x 21	8.6 x 17.5 x 22.5	8.6 x 17.5 x 22.5
POWER: Power backup	250 watts	250 watts Dual power supp	325 watts	250 watts Optional UPS	250 watts Optional UPS
FIRST CUSTOMER SHIPMENT	1Q94	3/95	1/95	2/95	2/95
COMMENTS	*Concept 810SW has SCSI-2 interface i960 processor			Software array version available Dual AC feed	Dual AC

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	LANStor MFX-RDF (MegaFlex)	LANStor RFX (Reflex)	LANStor RFX-RC (Reflex)	LANStor SFX (SuperFlex)	LANStor SFX-RDC (SuperFlex)
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare, NT	PC compatible NetWare	PC compatible NetWare, OS/2	PC compatible NetWare, NT	PC compatible NetWare, OS/2, NT
RAID level Configured by:	0/1/5/10 Host, Port	0/1 Host	0/1/5/10 Host	0/1 Host	0/1/5/10 Host
Array capacity (Gbytes) MIN MAX	18 126	2 28	2 48	1 28	2 48
Minimum drives per array	3	2	3	2	3
Maximum drives per array	14	7	14	7	14
Concurrent host channels	1	1	1	1	1
Controller drive channels	2	1, 5	1, 2	1	1, 2
Array interface to host	SCSI-3	SCSI-2	SCSI-2	SCSI-3	SCSI-3
Drive interface	SCSI-3	SCSI-2	SCSI-2	SCSI-3	SCSI-3
Cache size (min, max: MB)	4, 32	1	4, 64	1	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10 10	10 10	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	9090	1050,2105,4300	1050,2105,4300	1050,2105,4300	1050,2105,4300
Nominal disk diameter (mm)	130	95	95	95	95
Average positioning time (msec)	11	8	8	8	8
Average rotational delay (msec)	5.56	4.17	4.17	4.17	4.17
Drive models	Seagate ST410800	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8.6 x 17.5 x 22.5	7 x 17 x 20	7 x 17 x 20	7 x 17.5 x 20	7 x 17.5 x 20
POWER: Power backup	250 watts Opt. UPS, Batt.	250 watts Optional UPS	250 watts Optional UPS	250 watts Optional UPS	250 watts Optional UPS
FIRST CUSTOMER SHIPMENT	2/95	1993	1993	1994	1994
COMMENTS	Dual AC	Software array version available		Software array version available Dual AC feed	Dual AC feed

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MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	LANStor SFX-RDF (SuperFlex)	MFX (MegaFlex for UNIX)	MFX-RDF (MegaFlex for UNIX)	MiniFlex for UNIX	SFX (SuperFlex for UNIX)
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	PC compatible NetWare, NT	RS/6000, Sun, HP9000, Solaris AIX, HP UX	RS/6000, Sun, HP9000, Solaris AIX, HP UX	RS/6000, Sun, HP9000, Solaris AIX, HP UX	RS/6000, Sun, HP9000, Solaris AIX, HP UX
RAID level	0/1/5/10	0/1	0/1/5/10	0/1	0/1
Configured by:	Host, Port	Host	Host, Port	Host	Host
Array capacity (Gbytes) MIN	2	18	18	1	2
MAX	48	63	126	8	28
Minimum drives per array	3	2	2	2	2
Maximum drives per array	14	7	14	2	7
Concurrent host channels	1	1, 2	1, 2	1, 2	1, 2
Controller drive channels	2	1, 2	2	1, 2	1, 2
Array interface to host	SCSI-3	SCSI-2/3	SCSI-2/3	SCSI-2/3	SCSI-2/3
Drive interface	SCSI-3	SCSI-2/3	SCSI-2/3	SCSI-2/3	SCSI-2/3
Cache size (min, max: MB)	4, 32	--	4, 32	--	--
Cache function (Read, Write)	Read, Write	--	Read, Write	--	--
Redundancy: Controller (Yes/No)	No	No	No	No	No
Fan (Yes/No)	Yes	Yes	Yes	No	Yes
Power supply (Yes/No)	Yes	Yes	Yes	No	Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Auto	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	10/20	10/20	10/20	10/20
drive (MB/Sec)	10/20	10/20	10/20	10/20	10/20
DRIVES: Formatted capacity/drive(MB)	1050,2105,4300	9090	9090	1050,2105,4300	1050,2105,4300
Nominal disk diameter (mm)	95	130	130	95	95
Average positioning time (msec)	8	11	11	8	8
Average rotational delay (msec)	4.17	5.56	5.56	4.17	4.17
Drive models	Various	Seagate ST410800	Seagate ST410800	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17.5 x 20	8.6 x 17.5 x 22.5	8.6 x 17.5 x 22.5	7.25 x 6.75 x 11.75	7 x 17.5 x 20
POWER:	250 watts	250 watts	250 watts	125 watts	250 watts
Power backup	Opt. UPS, Batt.	Optional UPS	Opt. UPS, Batt.	Optional UPS	Optional UPS
FIRST CUSTOMER SHIPMENT	1994	2/95	2/95	2/95	2/95
COMMENTS	Dual AC feed	Software array version available Dual AC feed	Dual AC feed	Software array version available	Software array version available Dual AC feed

MANUFACTURER	STORAGE DIMENSIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS	STORAGE TECHNOLOGY
ARRAY MODEL	SFX-RDF (SuperFlex for UNIX)	CM2 RACa-ray	CM2 Plus RACa-ray	CM2 Plus (Rack) RACa-ray	Northfield 9638
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	RS/6000, Sun, HP9000, Solaris AIX, HP UX	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	SCSI host DOS,Wind,NT,Mac OS/2,Net,Sun,UN	AS/400, OS/400
RAID level	0/1/5/10	0/3/5	0/3/5	0/3/5	0/1/5
Configured by:	Host, Port	Serial Port	Serial Port	Serial Port	OP Panel
Array capacity (Gbytes) MIN	2	3	3	3	5.9
MAX	56	78 (65)	78 (65)	182 (150)	33.5
Minimum drives per array	2	3	3	3	4
Maximum drives per array	14	15	15	35	9
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels	2	5	5	5	
Array interface to host	SCSI-2/3	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2/3	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	--	4, 128	4, 128	4-64
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	Yes	No
Fan (Yes/No)	Yes	No	No	Yes	Yes
Power supply (Yes/No)	Yes	Yes	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	10/20	20	20	20	20
drive (MB/Sec)	10/20	10	10	20	10
DRIVES: Formatted capacity/drive(MB)	1050,2105,4300	1050,2160,4320	1050,2160,4320	1050,2160,4320	1967, 4193
Nominal disk diameter (mm)	95	95	95	95	95, 95
Average positioning time (msec)	8	8.5/9.2/8.4/8	8.5/9.2/8.4/8	8.5/9.2/8.4/8	8/9, 8/9
Average rotational delay (msec)	4.17	5.6/5.6/4.2/5.6	5.6/5.6/4.2/5.6	5.6/5.6/4.2/5.6	4.17, 4.17
Drive models	Various	Various	Various	Various	Seagate Barracuda
ARRAY SIZE: Inches: H x W x D	7 x 17.5 x 20	18.3 x 8.1 x 14.5	18.3 x 8.1 x 14.5	10.5 x 19 x 13.5	8.75 x 17 x 29
POWER: Power backup	250 watts Opt. UPS, Batt.	180-420 watts	180-420 watts	250-500 watts	.4 KVA
FIRST CUSTOMER SHIPMENT	2/95	6/93	2/95	6/94	4/94
COMMENTS	Dual AC	Digi-Data controller	Digi-Data controller	Digi-Data controller	

MANUFACTURER	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGEPATH	STORAGEPATH	STORAGEPATH
ARRAY MODEL	Iceberg 9200	Nordique 9100	SP-18BTHT	SP-9BRHT	SP-9BTHT
DISK/TREND GROUP	Mainframe	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	IBM mainframe MVS/XA-ESA, VM/XA-ESA	IBM mainframe MVS/XA-ESA, VM/XA-ESA*	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host UNIX, VMS, NT, NetWare, DOS	SCSI host UNIX, VMS, NT, NetWare, DOS
RAID level Configured by:	5+ Host	5 Service func.	0/3/5 Host	0/3/5 Host	0/3/5 Host
Array capacity (Gbytes) MIN MAX	100* 400*	15 120	2.5 45	2.5 45	2.5 45
Minimum drives per array	32	10	2	2	2
Maximum drives per array	128/string	80	15	7	7
Concurrent host channels	12	4	1	1	1
Controller drive channels			1	1	1
Array interface to host	IBM	IBM, SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-1/2
Cache size (min, max: MB)	64, 1024	128, 1024	--	--	--
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No Per drive Yes	No Per drive Yes	No Per drive Yes
Spare drive (None/Auto/Manual)	Auto	None	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 10	4.5 6	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	1450	1890	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)		8 RD/9 WR	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	4.17	4.17	Drive dependent	Drive dependent	Drive dependent
Drive models	H-P	Seagate Barracuda	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	72 x 27.7 x 32	72 x 34 x 74	20 x 24 x 24	8.75 x 19 x 21	20 x 11.5 x 24
POWER: Power backup	3.3 KVA	5.5 KVA	500 watts	500 watts	500 watts
FIRST CUSTOMER SHIPMENT	4/94		4Q94	4Q94	4Q94
COMMENTS	*Assumes 2.6x data compression	Disk array drawer. Mfg. by Data G. *Also UNIX, Sun Novell, RS/6000 Windows NT.		Rack mount	

MANUFACTURER	STORNET	STORNET	STRATUS COMPUTER	STRATUS COMPUTER	SUN MICROSYSTEMS
ARRAY MODEL	Dynastor 16	Dynastor 8	D600 (K121)	D700 (K450)	Online: DiskSuite 3.0
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Software Software
Host platform, software environment	SCSI host UNIX	SCSI host UNIX	Stratus VOS/FTX	Stratus VOS/FTX	Sun SPARC Solaris
RAID level Configured by:	0/1/3/5 Panel, Port	0/1/3/5 Panel, Port	1 Preset	1 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	16	8	1.46 Varies by syst.	1 Varies by syst.	Drive dependent Drive dependent
Minimum drives per array	2/3	2/3	2	2	2
Maximum drives per array	6	6	Varies by syst.	Varies by syst.	128
Concurrent host channels	1	1	2, 10	2, Varies	--
Controller drive channels	1	1	2, 4	2, 4	--
Array interface to host	SCSI-2	SCSI-2	Proprietary	Proprietary	--
Drive interface	SCSI-2	SCSI-2	SCSI	SCSI-2	--
Cache size (min, max: MB)	4, 32	4, 32	.256	.256	--
Cache function (Read, Write)	Read, Write	Read, Write	Read	Read	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes	Yes Yes Yes	Yes Yes Yes	Option -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	5 Drive dependent	20 Drive dependent	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	4000	2000	Varies	Varies	Drive dependent
Nominal disk diameter (mm)	95	95	Varies	Varies	Drive dependent
Average positioning time (msec)		Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)		Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	D602, D603, D604, D605	D701, D702	Various
ARRAY SIZE: Inches: H x W x D			Varies	Varies	--
POWER: Power backup	100 watts Cache battery	100 watts Cache battery	Drive dependent Battery	Drive dependent Battery	-- --
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	3/91	1Q95	9/91
COMMENTS	CMD controller	CMD controller			

MANUFACTURER	SUN MICROSYSTEMS	SUN MICROSYSTEMS	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	SPARCstorage Model 100	SPARCstorage Model 200	3101-000	3201	3601-XXX Series 3
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SPARC servers Solaris	SPARC servers Solaris	PC compatible UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other
RAID level	0/1/5*	0/1/5*	0/1/3/5	0/1/3/5	0/1/3/5
Configured by:	Host	Host	Host, Port	Host, Port	Host, Port
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	6	12	2	2	2
Maximum drives per array	30	36	45	30	35
Concurrent host channels	1, 2	1, 2	1	1	1
Controller drive channels	6	6	1, 2, or 3	2	5
Array interface to host	S-bus/Fibre	S-bus/Fibre	PCI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	4	2, 64	2, 64	2, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No)	No	No	No	No	Option
Fan (Yes/No)	Yes	Yes	--	--	--
Power supply (Yes/No)	No	No	--	--	--
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	25/50 duplexed	25/50 duplexed	133	20/10	20
drive (MB/Sec)	20	20	40	20/10	10
DRIVES: Formatted capacity/drive(MB)	1050, 2100	2100,2900,9000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	130	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	9	9	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56/4.2	5.56	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8.94 x 21.06 x 19.46		12.3 x 4.2	1.625 x 4 x 5.75	9.75 x 8.5
POWER: Power backup	.65 KVA Cache battery	4.8 KVA Cache battery	Battery option	Battery option	26 watts Battery option
FIRST CUSTOMER SHIPMENT	2Q94	1Q95	3Q95	1Q95	4Q94
COMMENTS	*Can operate as combined RAID 1/RAID 0	*Can operate as combined RAID 1/RAID 0	25 MHz 486 microprocessor	25 MHz 486 microprocessor	33 MHz 486 microprocessor

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	3620-XXX Series 3	3701	5299/93-02	6210 3201 Series 3	6298-2000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM, PCM	OEM	Captive, OEM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	SCSI host UNIX, NT, DOS, NetWare, other	Fibre Channel UNIX	AT&T 3400, 3500 UNIX, Solaris, AIX, NetWare	SCSI host UNIX, NT, DOS, NetWare, other	AT&T 3400, 3500 NT UNIX, NetWare
RAID level	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5	0/1/3/5
Configured by:	Host, Port	Host, Port	Host	Host, Port	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	5.2/2.6/4.2/4.2	4/2/4/4	5.2/2.6/4.2/4.2
MAX	Drive dependent	Drive dependent	42/21/34/34	40/20/32/32	21/12/16.8/16.8
Minimum drives per array	2	2	5	2	5
Maximum drives per array	75	30	20	10	20
Concurrent host channels	1	1	2	1	1
Controller drive channels	5	5	5	2	5
Array interface to host	SCSI-2	Fibre Channel	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2, 128	2, 128	N/A	2, 64	--
Cache function (Read, Write)	Read, Write	Read, Write	N/A	Read, Write	--
Redundancy: Controller (Yes/No)	Option	Yes	Yes	No	Yes (option)
Fan (Yes/No)	--	--	Yes	Yes	Yes
Power supply (Yes/No)	--	--	Yes	Yes	Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	40	100	20	20	20
drive (MB/Sec)	40	40	10	20	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1050, 2100	2000, 4000	1050
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	9.7	8.25	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	4.17	5.6
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	11.75 x 8.5	11.75 x 8.5	13.94 x 18.97 x 30.13	7 x 19 x 19	29 x 12 x 28
POWER: Power backup	26 watts Battery option	Battery option	None	.6 KVA Cache battery	618 watts None
FIRST CUSTOMER SHIPMENT	3Q95	3Q95	4/94	2Q95	1992
COMMENTS	66 MHz 486 microprocessor	66 MHz 486 microprocessor Optical or copper connect to host	ADP-93-02 controller Rack mountable. Uses 40 MHz 68030 chip	Series 3 3201 controller	25 MHz 68020

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC
ARRAY MODEL	6298-3000	6298-4000	6299 3601 Series 3	6299 3620 Series 3	6299 3701 Series 3
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, OEM	Captive, OEM	OEM, PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	AT&T 3400, 3500 other UNIX	AT&T 3400, 3500 other UNIX	SCSI host UNIX, NT, DOS, NetWare, other	SCSI host UNIX, NT, DOS, NetWare, other	Fibre Channel UNIX
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host, Port	0/1/3/5 Host, Port	0/1/3/5 Host, Port
Array capacity (Gbytes) MIN MAX	5.2/2.6/4.2/4.2 21/12/16.8/16.8	10.5/5/8.5/8.5 42/21/34/34	10/5/8/8 80/40/64/64	10/5/8/8 120/60/96/96	10/5/8/8 120/60/96/96
Minimum drives per array	5	5	5	5	5
Maximum drives per array	20	20	20	30	30
Concurrent host channels	1	1	1, 2	1, 2	1, 2
Controller drive channels	5	5	5	5	5
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Fibre Channel
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	2, 64	2, 128	2, 128
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes (option) Yes Yes	Yes (option) Yes Yes	Yes (option) Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	40 20	100 40
DRIVES: Formatted capacity/drive(MB)	1050	2100	2000, 4000	2000, 4000	2000, 4000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	10.5	9.7	8.25	8.25	8.25
Average rotational delay (msec)	5.6	5.6	4.17	4.17	4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	29 x 12 x 28	29 x 12 x 28	14 x 19 x 30.12	14 x 19 x 30.12	14 x 19 x 30.12
POWER: Power backup	618 watts None	618 watts None	.8 KVA-UPS Cache battery	1 KVA-UPS Cache battery	1 KVA-UPS Cache battery
FIRST CUSTOMER SHIPMENT	1992	1993	4Q94	3Q95	3Q95
COMMENTS	Uses 40 MHz 68030 chip	Uses 40 MHz 68030 chip	Rack mount	Series 3 3620 controller	Series 3 3701 controller

MANUFACTURER	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	SYMBIOS LOGIC	TANDEM COMPUTERS
ARRAY MODEL	6299DS 3601 Series 3	ADP-93-01	ADP-93-02	ADP-93-04	4500
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	Captive,OEM,PCM	OEM	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NT, DOS, NetWare, other	Various UNIX, OS/2, AIX NetWare	Various UNIX, OS/2, AIX NetWare	Various UNIX, OS/2, AIX NetWare	Tandem Nonstop
RAID level Configured by:	0/1/3/5 Host, Port	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	1 Host
Array capacity (Gbytes) MIN MAX	10/5/8/8 80/40/64/64	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	2 6
Minimum drives per array	5	1/2/3/3	1/2/3/3	1/2/3/3	2
Maximum drives per array	20	35	35	35	6
Concurrent host channels	1, 2	1	1	1	2
Controller drive channels	5	5	5	5	
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI over fiber
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	2, 64	--	--	--	1, 56
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes (option) Yes Yes	Yes No No	Yes Supported Supported	Yes No No	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20 10	1.9 2.4
DRIVES: Formatted capacity/drive(MB)	2000, 4000	Drive dependent	Drive dependent	Drive dependent	1000
Nominal disk diameter (mm)	95	Drive dependent	Drive dependent	Drive dependent	130
Average positioning time (msec)	8.25	Drive dependent	Drive dependent	Drive dependent	15
Average rotational delay (msec)	4.17	Drive dependent	Drive dependent	Drive dependent	8.3
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.5 x 15.25 x 31	5.1 x 14.4	9.75 x 8.5	5.1 x 14.4	10.5 x 25 x 36
POWER: Power backup	.8 KVA-UPS Cache battery	30 watts None	30 watts None	30 watts None	180 watts Dual AC
FIRST CUSTOMER SHIPMENT	4Q94	1993	1992	1993	4Q91
COMMENTS	Pedestal	Uses 40 MHz 68030 chip Multiple SCSI initiator support	Uses 40 MHz 68030 chip Multiple SCSI initiator support	Uses 40 MHz 68030 chip Multiple SCSI initiator support	

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MANUFACTURER	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANGENT COMPUTER
ARRAY MODEL	4510	4560	4570	INTEGRITY	Multiserver-2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	Tandem Nonstop	Tandem Nonstop	Tandem Nonstop	Tandem Nonstop UNIX	Tangent NetWare, UNIX, OS/2, NT, Other
RAID level Configured by:	1 Host	1 Host	1 Host	0/1/3/5 Host	0/1/10 Host
Array capacity (Gbytes) MIN MAX	4 12	4 16	8 32	4 96	Drive dependent Drive dependent
Minimum drives per array	2	2	7	4	2
Maximum drives per array	6	8	8	48	10
Concurrent host channels	2	2	2	1, 2*	1, 4
Controller drive channels	--	--	--		1, 2
Array interface to host	SCSI over fiber	SCSI over fiber	SCSI over fiber	SCSI-2	EISA
Drive interface	SCSI	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min,. max: MB)	1, 56	1, 128	1, 128	--	.512, 16
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes* Yes Yes	Duplexing Option Option Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	2.5 4.5	2.5 4.5	2.5 5.5	10 10	33 10
DRIVES: Formatted capacity/drive(MB)	2000	2000	4000	2100, 4300	Drive dependent
Nominal disk diameter (mm)	130	95	95	95	95
Average positioning time (msec)	12	10	10	10	Drive dependent
Average rotational delay (msec)	5.6	5.6	4.17	4.17	Drive dependent
Drive models	Various	Various	Various	IBM	Seagate, DEC
ARRAY SIZE: Inches: H x W x D	10.5 x 25 x 36	7 x 19 x 28	7 x 19 x 28		Varies
POWER: Power backup	180 watts Dual AC	400 watts Dual AC	400 watts Dual AC		300 watts None
FIRST CUSTOMER SHIPMENT	3Q93	8/94	3/95	4/95	1993
COMMENTS				EMC controller *After 7/95	

MANUFACTURER	TANGENT COMPUTER	TANGENT COMPUTER	TANGENT COMPUTER	TANGENT COMPUTER	TD SYSTEMS
ARRAY MODEL	Driveserver-2	Just'N Case	Multiserver-3	Raid5server	OMNISERVE 2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Board Hardware
Host platform, software environment	Tangent NetWare, UNIX, OS/2, NT, Other	Tangent NetWare, UNIX, OS/2, NT, Other	Tangent NetWare, UNIX, OS/2, NT, Other	Tangent NetWare, UNIX, OS/2, NT, Other	All SCSI hosts Various
RAID level Configured by:	0/1/10 Host	0/1/10	0/1/10 Host	0/1/4/5 Host	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	1	2
Maximum drives per array	10	14	10	35	14
Concurrent host channels	1, 4	1	1, 4	1	1, 2
Controller drive channels	1, 2	1, 2	1, 2	5	
Array interface to host	EISA	PCI	EISA	EISA	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512, 16	--	.512, 16	--	--
Cache function (Read, Write)	Read, Write	--	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Duplexing Option Option	Duplexing Yes Yes	Duplexing Option Option	Option Option Option	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	132 10	33 10	33 10	Up to 10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate, DEC	Seagate, DEC	Seagate, DEC	Seagate, DEC	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	Varies	Varies	1.625 x 5.75 x 8.25
POWER: Power backup	300 watts None	300 watts None	300 watts None	450 watts None	10-20 watts --
FIRST CUSTOMER SHIPMENT	1993	1994	1994	1993	1/93
COMMENTS	External mount version of Multiserver-2		Pentium based	Software array Tower or rack mount	Options to connect up to 5 hosts; dual ported controllers

MANUFACTURER	TD SYSTEMS	TEAC	TEKRAM	TEKRAM	TEKRAM
ARRAY MODEL	OMNISERVE 3	TR-403K TR-404K TR-405K TEAC-STOR	600CF	680C	690C
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Subsystem Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	All SCSI hosts Various	SCSI host Various	PC compatible DOS, Windows	PC compatible DOS, Windows	PC compatible DOS, Windows
RAID level Configured by:	1 Preset	3/5 Port	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	1 2.1	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	5	2	2	2
Maximum drives per array	28	5	4	4	4
Concurrent host channels	1, 2	1	1	1	1
Controller drive channels		1	1, 2	1, 2	1, 2
Array interface to host	SCSI-2	SCSI-2	ISA	VESA	PCI
Drive interface	SCSI-2	IDE	IDE	IDE	IDE
Cache size (min, max: MB)	--	256			
Cache function (Read, Write)	--	Read, Write			
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Yes Option	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	None	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Up to 20 20	10 10	5 5	20 5	33 5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	250, 360, 540	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	11/17	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	8.3/7.14	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	TR-250D/360D/ 540D	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8.25	3.2 x 5.75 x 8.9			
POWER: Power backup	10-20 watts --	18.1 watts	None	None	None
FIRST CUSTOMER SHIPMENT	1Q94		1Q95	1Q95	1Q95
COMMENTS	Options to connect up to 5 hosts; dual ported control. Fast and wide SCSI version				

MANUFACTURER	TEKRAM	TEKRAM	TELEDISK	TEXA	TEXA
ARRAY MODEL	AHA 154X	E-Z RAID 1	DMS2000	RST-05S RST-10W RST-20W	RST-1000W RST-2000W RST-4000W
DISK/TREND GROUP	Single User	Single User	Single User	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	PCM	Captive, OEM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host Various	PC compatible Various	SCSI host UNIX, Windows, DOS,NetWare,oth	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT
RAID level Configured by:	1 Preset	1 Preset	1 Preset	0/3/5 Host, Panel	0/3/5 Host, Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1.5/3.6 1/2/4
Minimum drives per array	2	2	2	3	3
Maximum drives per array	8	4	6	3	3
Concurrent host channels	1	1	1	1	1
Controller drive channels	1, 2	1, 2	1	3	3
Array interface to host	SCSI-2	PC AT	SCSI-2	SCSI	SCSI
Drive interface	SCSI-2	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16	--	--	.5, 2	1
Cache function (Read, Write)			--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	None	None	Manual	Manual	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)			10 10	10, 20, 20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	540,1000,2000
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	12/9/9
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.6/5.5/5.5
Drive models	Various	Various	Various	Various	Seagate, Quantum
ARRAY SIZE: Inches: H x W x D				9.3 x 6.7 x 9.5	9.3 x 6.7 x 9.5
POWER: Power backup	None	None	None	100 watts None	100 watts None
FIRST CUSTOMER SHIPMENT	1994	1994	1Q94	10/94	9/94
COMMENTS				Syquest drive	

MANUFACTURER	TEXA	TEXA	TEXA	TEXAS MICROSYSTEMS	TEXAS MICROSYSTEMS
ARRAY MODEL	RST-540 RST-1000	DAF-4000 DAF-8000 DAF-16000	DAH-2000 DAH-4000	FTSA-ES	FTSA-LT
DISK/TREND GROUP	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	SCSI host UNIX, NetWare, DOS, Mac, NT	Texas Micro DOS, OS/2, NT	Texas Micro DOS, OS/2, NT
RAID level Configured by:	0/3/5 Host, Panel	0/3/5 Host, Panel	0/3/5 Host, Panel	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	.8/1.5 .5/1	5/10/20 4/8/16	2.7/5 2/4	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	5	5	2	2
Maximum drives per array	3	5	5	3	4
Concurrent host channels	1	1	1	1	1
Controller drive channels	3	5	5		
Array interface to host	SCSI-2	SCSI	SCSI	EISA	ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5	1, 4	1, 4	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No Yes	No No Yes	No No No
Spare drive (None/Auto/Manual)	Manual	Manual	Manual	None	None
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 10	20 10	33 10	8 5
DRIVES: Formatted capacity/drive(MB)	270, 540	1000,2000,4000	540, 1000	540-2000	540-2000
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	12	9	12/9	Drive dependent	Drive dependent
Average rotational delay (msec)	6.6	6.6/5.5/5.5	6.6	Drive dependent	Drive dependent
Drive models	Quantum	Seagate, Quantum	Seagate, Quantum	Various	Various
ARRAY SIZE: Inches: H x W x D	9.3 x 6.7 x 9.5	23.3 x 10.6 x 16.2	6.9 x 15 x 18.5	7 x 16.9 x 16	7 x 16.9 x 16
POWER: Power backup	100 watts None	250 watts None	200 watts None	110 watts Internal UPS	100 watts Internal UPS
FIRST CUSTOMER SHIPMENT	9/94	3/94	5/94	1993	1Q94
COMMENTS				Rack mount option	Rack mount option

MANUFACTURER	TEXAS MICROSYSTEMS	THINKING MACHINES	TOTAL TEC SYSTEMS	TRICORD SYSTEMS	TRICORD SYSTEMS
ARRAY MODEL	FTSA-PC	CM-5 Scalable Disk Array	TRAID	DPT 2122	DPT 3224
DISK/TREND GROUP	Net/Mini/Multi	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	Captive	PCM	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Board Hardware	Board Hardware
Host platform, software environment	Texas Micro DOS, OS/2, NT	CM-5 system UNIX NFS	DEC, SCSI host UNIX, NT, NetWare, VMS	DS 1500 UNIX,OS/2,VINES NetWare,Wind.NT	DS 2700 UNIX,OS/2,VINES NetWare,Wind.NT
RAID level Configured by:	0/1 Host	3 Host	0/3/5 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	16 500	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	8	5	2	2
Maximum drives per array	3	250	28	7	7
Concurrent host channels	1	8, 32	1, 3	--	--
Controller drive channels		32, 128	1, 3	1	1 or 2
Array interface to host	ISA	Proprietary(NI)	SCSI-2, DSSI	EISA	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	32	4, 64	4
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	No No No	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	None	Manual	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 5	150 5	10, 4 10	133 10	133 20
DRIVES: Formatted capacity/drive(MB)	540-2000	2000	Drive dependent	1000-4300	1000-2100
Nominal disk diameter (mm)	95	95	95	95	95
Average positioning time (msec)	Drive dependent	9.2	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	IBM Allicat 0664-M1H	Seagate, DEC RZ	DSD1000FT DSD2100,4300ST	DSD1000DWS DSD2100DWS
ARRAY SIZE: Inches: H x W x D	7 x 16.9 x 16	Varies	22.25 x 7.25 x 22.5	--	--
POWER: Power backup	110 watts Internal UPS	Varies None	170 watts Cache battery	-- UPS	-- --
FIRST CUSTOMER SHIPMENT	1993	10/92	4Q93	9/94	4/95
COMMENTS	Rack mount option	Scalable	CMD controller Rack mount version available	Board mounts on subsystem motherboard	Board mounts on subsystem motherboard

MANUFACTURER	TRICORD SYSTEMS	TRICORD SYSTEMS	TRILLIUM RESEARCH	TRILLIUM RESEARCH	TWINCOM
ARRAY MODEL	ISS-2	PowerRaid/ Enhanced IIOP	REMUS LTD.	REMUS 1.3	Dual Mirror
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Software Software	Software Software	Software Software
Host platform, software environment	ES/3000, UNIX,OS/2,VINES NetWare,Wind.NT	Model 30/40 UNIX,OS/2,VINES NetWare,Wind.NT	Power PC, Macintosh System 7	Power PC, Macintosh System 7	Various Most UNIX versions
RAID level Configured by:	0/1/4/5/10 Host	0/1/4/5/10 Host	0/1 Host	0/1/4/5 Host	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent 70	Drive dependent 70	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	180	14	6	6	32
Concurrent host channels	--	--	1	1, 2	1, 2
Controller drive channels	2	2	Board dependent	Board dependent	--
Array interface to host	Proprietary	Proprietary	NuBus, SCSI	NuBus, SCSI	Host dependent
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Drive dependent
Cache size (min, max: MB)	8	--	--	--	Host dependent
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	N/A N/A N/A	N/A N/A N/A	-- -- --
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Manual	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	267 20	133 10	Board dependent Drive dependent	Board dependent Drive dependent	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	520-9000	520-9000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	DD500FT, DD1000FT*	DD500FT, DD1000FT*	Various	Various	Any supported by OS
ARRAY SIZE: Inches: H x W x D	--	--	N/A	N/A	--
POWER: Power backup	-- UPS	-- UPS	N/A	N/A	-- --
FIRST CUSTOMER SHIPMENT	4/93	6/92	1Q94	3Q93	1986
COMMENTS	Board mounts to syst.back panel Battery backed hot-plug. cache *Also DD2100, 4300, 9000SWT	Board mounts on subsystem motherboard *Also DD2100, 4300, 9000SWT	Operates with controller from ATTO, FWB, Seraph,BusLogic other	Operates with controller from ATTO, FWB, Seraph,BusLogic other	

MANUFACTURER	TWINCOM	ULTRASTOR	ULTRASTOR	ULTRASTOR	ULTRASTOR
ARRAY MODEL	Network Mirror	124F UltraArray	144EZ UltraArray	144F UltraArray	144N UltraArray
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Software	Board	Board	Board	Board
Implementation	Software	Hardware	Hardware	Hardware	Hardware
Host platform, software environment	Various Most UNIX versions	PC compatible UNIX, NetWare, OS/2, DOS	SCSI host UNIX, NetWare, OS/2, DOS	SCSI host UNIX, NetWare, OS/2, DOS	PC compatible NetWare
RAID level	1	0/1/3/4/5	0/1/3/4/5	0/1/3/4/5	0/1/3/4/5
Configured by:	Preset	Host	Host, Panel	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
MAX	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	1	2
Maximum drives per array	32	35	35	35	35
Concurrent host channels	1, 4	1	1	1	1
Controller drive channels	--	3, 5	5		5
Array interface to host	Host dependent	EISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	Drive dependent	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	Host dependent	--*	--*	*	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No)	--	--		No	--
Fan (Yes/No)	--	--		No	--
Power supply (Yes/No)	--	--		No	--
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	Host dependent	33	20	20	20
drive (MB/Sec)	Drive dependent	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Any supported by OS	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	4.25 x 13	1.625 x 5.75 x 8	1.625 x 5.75 x 8	1.625 x 5.75 x 8
POWER:	--	15 watts	15 watts	15 watts	15 watts
Power backup	--				
FIRST CUSTOMER SHIPMENT	1992	2/92	12/94	12/92	12/92
COMMENTS	Mirrors over a network	*1 MB buffer	*1 MB buffer	*1 MB buffer Supports command tag queing	*1 MB buffer

MANUFACTURER	ULTRASTOR	UNI SOLUTION	UNISYS	UNISYS	UNISYS
ARRAY MODEL	154 UltraArray	USI RAID	MasCab-2	OSS 8000	QCIC/PBAY
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Implementation	Hardware	Hardware	Software	Hardware	Software
Host platform, software environment	PC compatible UNIX, NetWare, OS/2, DOS	SCSI host UNIX, Open VMS, Solaris, other	Unisys UNIX	Unisys U6000 UNIX SVR4 1100 O/S	Unisys UNIX
RAID level	0/1/3/4/5	0/3/5	0/1	0/1/3/5	0/1
Configured by:	Host	Panel	Host	Host	Host
Array capacity (Gbytes) MIN	Drive dependent	7	Drive dependent	6	Drive dependent
MAX	Drive dependent	28*	Drive dependent	154	Drive dependent
Minimum drives per array	2	2	2	4	2
Maximum drives per array	35	7*	33	48	96
Concurrent host channels	1	1-3	5	2-4	16
Controller drive channels	5	1-3	5	8	12
Array interface to host	PCI	SCSI-2	EISA	SCSI-2	Proprietary
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 32	32 RD/2-5 WR	--	4	--
Cache function (Read, Write)	Read, Write	Read, Write	--	Read	--
Redundancy: Controller (Yes/No)	--	Option	Option	Option	Option
Fan (Yes/No)	--	Yes	No	Yes	No
Power supply (Yes/No)	--	Yes	No	Yes	No
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec)	132	10	10	20	10
drive (MB/Sec)	10	10	10	10	10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000-4000	Drive dependent	2100-4000	Drive dependent
Nominal disk diameter (mm)	Drive dependent	95	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	8	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	4.17	Drive dependent
Drive models	Various	Various	Various	Seagate Barracuda 2	Various
ARRAY SIZE: Inches: H x W x D	4.25 x 13	Varies	26.5 x 12 x 17	7 x 19 x 28	22.75 x 19 x 30
POWER:	15 watts	240 watts	300watts+drives		500 watts
Power backup		Cache battery	None	UPS option	None
FIRST CUSTOMER SHIPMENT	10/95	1/94	5/92	4Q94	4/92
COMMENTS		*Can be expanded to 252 GB CMD controller	Veritas software	Purchased controller Dual AC power	Veritas software

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNISYS	UNISYS
ARRAY MODEL	UCR 6000	M9760	USP 2010	USP 5500	USR 3000
DISK/TREND GROUP	Net/Mini/Multi	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	Captive	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Software	Subsystem Software	Subsystem Software
Host platform, software environment	U6000 UNIX SVR4	Unisys 2200, 1100 1100 O/S	Unisys 2200 series 051100	Unisys 2200 series 1100 O/S	Unisys A,V,2200 series MCP, 051100
RAID level Configured by:	3 Preset	0/1 Host	0/1 Host	0/1	0/1 Host
Array capacity (Gbytes) MIN MAX	4 16	11.36 90.92	15.8	96/48 384/192	2.4 6
Minimum drives per array	4 + parity	4	5	32	7
Maximum drives per array	8 + 2 parity	32	20	128	7
Concurrent host channels	1	4	4	8	1, 2
Controller drive channels	1	16	8	32	1
Array interface to host	SCSI-2	BMCFIPS6I	BMCFIPS6I, SCSI	BMCFIPS61	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	16, 64	128, 3072	--	--	--
Cache function (Read, Write)	Read, Write	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	NA Option Option
Spare drive (None/Auto/Manual)	Manual	Auto	Auto	Auto	Manual
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	4.5 5	4.5 5	4.5 20	10 10
DRIVES: Formatted capacity/drive(MB)	1000-2000	Drive dependent	1970	3000	805-1970
Nominal disk diameter (mm)	95	130	95	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	11	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	Drive dependent
Drive models	Seagate	Various	Various	Seagate Elite 3	Various
ARRAY SIZE: Inches: H x W x D	7 x 19 x 26.5*	67.9 x 24.1 x 33	70 x 34 x 36	74.9 x 68.7 x 36.4	5.1 x 19 x 29.7
POWER: Power backup	150 watts Battery	.7-2.79 KVA Battery	1.17 KVA None	4.8-8.8 KVA Battery	.13 KVA None
FIRST CUSTOMER SHIPMENT	3/94	2Q92	2Q94	4Q94	1994
COMMENTS	*Rack mount tower also available	EMC controller Dual AC power	Software based array Dual AC power	EMC controller Dual AC power	Software based array Optional dual AC power

MANUFACTURER	UNISYS	UNISYS	UNITROL DATA PROTECTION SYSTEMS	VERITAS SOFTWARE	VERITAS SOFTWARE
ARRAY MODEL	USR 4000	VLT 2010	Immunity 2	VxMirror	VxVM
DISK/TREND GROUP	Mainframe	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	PCM, OEM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Software	Subsystem Software	Software Software	Software Software	Software Software
Host platform, software environment	Unisys 2200 series	Unisys 2200 series 051100	IBM PC Compat. PC/MS-DOS, most LANs, Windows	Various UNIX	Various,Solaris 2.X , SCO UNIX, UNIX SVR4.X
RAID level Configured by:	0/1 Host	0/1 Host	1 Preset	0/1 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	1.6 4	45/22.5 180/90	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	5	2	2	2
Maximum drives per array	5	20	2	Host dependent	Host dependent
Concurrent host channels	1, 2	4	1, 2	Host dependent	Host dependent
Controller drive channels	1	8	1, 2	Host dependent	Host dependent
Array interface to host	SCSI-2	BMCFIPS61	IDE, SCSI	--	Various
Drive interface	SCSI-2	SCSI-2	IDE, SCSI	--	SCSI, ESDI, IDE
Cache size (min, max: MB)	--	--	1, host depend.	--	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	NA Option Option	Yes Yes Yes	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual	Auto	Manual-foregrnd	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	4.5 10	-- Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	805-1970	9000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	130	--	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	11	--	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	5.6	--	Drive dependent	Drive dependent
Drive models	Various	Seagate Elite 9	Various	Various	Drive dependent
ARRAY SIZE: Inches: H x W x D	6.9 x 19 x 32	70 x 34 x 36	--	--	--
POWER: Power backup	.4 KVA None	None	-- --	-- --	-- --
FIRST CUSTOMER SHIPMENT	1993	4Q94	1990	1993	1991
COMMENTS	Software based array Dual AC power	Software based array Dual AC power	Error logging to good disk Duplexing adapter avail. Network support		Can mirror logical disks Device driver and controller independent

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT2000	GDT2020	GDT3000A	GDT3000B	GDT3010A
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1	0/1/4/5	0/1	0/1/4/5	0/1/4/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	14	35	7	7
Concurrent host channels	1-2	2	2-5	1	1
Controller drive channels	1-2	2	2-5	1	1
Array interface to host	ISA	ISA	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 64	4, 64	4, 128	1, 64	4, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 10	8 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1992	1993	1992	1993	1993
COMMENTS	RAID 4/5 upgradable		RAID 4/5 upgradable	Array operation requires upgrade to basic board	

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT3020A	GDT3050A	GDT6000	GDT6000B	GDT6010
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Board Hardware	Board Hardware	Board Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.
RAID level Configured by:	0/1/4/5	0/1/4/5	0/1	0/1/4/5	0/1/4/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	35	14	7	7
Concurrent host channels	2-5	5	2-5	1	1
Controller drive channels	2-5	5	2-5	1	1
Array interface to host	EISA	EISA	PCI	PCI	PCI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	4, 128	2, 32	2, 32	4, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	33 10	132 10	132 10	132 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1993	1993	1994	1994	1994
COMMENTS			RAID 4/5 upgradable	Array operation requires upgrade to basic board	

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	WESTERN SCIENTIFIC	WESTERN SCIENTIFIC	WESTERN SCIENTIFIC
ARRAY MODEL	GDT6020	GDT6050	AD6700	Cyclone	Hurricane
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Board Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	SCSI host UNIX	SCSI host UNIX	SCSI host UNIX
RAID level Configured by:	0/1/4/5	0/1/4/5	3	0/1/3/4/5	0/1/3/4/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	4 34.4	2.2 21.2	36.4 127.4
Minimum drives per array	2	2	3	2	2
Maximum drives per array	14	35	9	5	14
Concurrent host channels	2-5	2-5	1	1	1
Controller drive channels	2-5	2-5	1-2	1	1-2
Array interface to host	PCI	PCI	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	4, 32	8	64	64
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No			
Spare drive (None/Auto/Manual)	Auto	Auto			
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10	132 10	10, 20 10, 20	10, 20 10, 20	10, 20 10, 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	Drive dependent	Drive dependent	95	95	130
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D					
POWER: Power backup					
FIRST CUSTOMER SHIPMENT	1994	1994			
COMMENTS			Ciprico controller	Purchased controller	Purchased controller

MANUFACTURER	WESTERN SCIENTIFIC	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS
ARRAY MODEL	Tornado	Flash RAID	FlashCluster CI	FlashDisk 3	FlashDisk SCSI
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	SCSI host UNIX	VAX, Alpha, Sun RS/6000,H-P,SGI	VAX, Alpha Open VMS	PC compatible DOS, OS/2, NetWare, UNIX	SCSI host
RAID level Configured by:	0/1/3/4/5	0/3/5 Host, Panel	0/1/3/5 Host	1 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	11.2 73.1	3 112	1 1136	1 63	1 882
Minimum drives per array	2	3	1	1	1
Maximum drives per array	17	28	284	7	98
Concurrent host channels	1	1, 21	1, 6		1
Controller drive channels	1-3				2
Array interface to host	SCSI-2	SCSI-2, DSSI	CI, DSSI	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64	--, 32	--, 512	16, 256	4, 64
Cache function (Read, Write)	Read, Write	Read	Read	Read, Write*	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)		Option Option Option	Option Option Option	No Yes Yes	No Option Option
Spare drive (None/Auto/Manual)		Auto	Auto		Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 20 10, 20	10 10	8.75/4 10		20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter (mm)	95	95	95	95, 140	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		*	*	*	*
POWER: Power backup		Drive dependent Drive dependent	Drive dependent Drive dependent	Battery*	Drive dependent Drive dependent
FIRST CUSTOMER SHIPMENT		1Q94	12/93	11/94	1995
COMMENTS	Purchased controller	*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units. Uses PCMCIA drv to auto backup write cache	*Varies with tabletop, rack, pedestal units

MANUFACTURER	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	XYRATEX	ZENITH DATA SYSTEMS
ARRAY MODEL	FlashDisk Array	FlashCluster DSSI	FlashServer EISA	R9000	RAID Option
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware	Board Hardware	Subsystem Hardware	Subsystem Hardware
Host platform, software environment	PC compatible DOS, OS/2, NetWare, UNIX	VAX, Alpha Open VMS	PC compatible DOS, OS/2, UNIX NetWare	SCSI host Netware	PC compatible NetWare, NT, UNIX, other
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	1 280	1 1372	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	1	1	2	4
Maximum drives per array	14	343	28	14	8
Concurrent host channels	5	5	1	1	1
Controller drive channels				1, 2	1, 2
Array interface to host	EISA, ISA	SCSI-2, DSSI	EISA	SCSI-2	PCI, EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 128	--, 128	4, 128	64	4, 64
Cache function (Read, Write)	Read, Write	Read	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Option Option	Option Option Option	-- -- --	No Yes Yes	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Manual	Auto	Auto
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	24 10	10, 4 10	33 6	10/20 10/20	133 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1000,2000,4000	500-4000
Nominal disk diameter (mm)	Drive dependent	95	Drive dependent	95	95
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent		Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent		Drive dependent
Drive models	Various	Various	Various		Seagate, Conner
ARRAY SIZE: Inches: H x W x D	*	*	5.1 x 14.4		Varies
POWER: Power backup	Drive dependent Drive dependent	Drive dependent Drive dependent	N/A None	300 watts UPS optional	20 watts+drives None
FIRST CUSTOMER SHIPMENT	12/93	12/93	1993	6/95	1Q94
COMMENTS	*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units			Mylex controller

MANUFACTURER	ZZYXZ WORKSTATIONS & PERIPHERALS	ZZYXZ WORKSTATIONS & PERIPHERALS			
ARRAY MODEL	ZRS-3000	ZRS-5000			
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi			
MARKET	PCM	PCM			
ARRAY CONFIGURATION: Type Implementation	Subsystem Hardware	Subsystem Hardware			
Host platform, software environment	Sun, H-P, SGI, other	Sun, H-P, SGI, other			
RAID level Configured by:	0/3/5 Host,Panel,Port	0/3/5 Host,Panel,Port			
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent			
Minimum drives per array	2	2			
Maximum drives per array	28	28			
Concurrent host channels	1-3	1-3			
Controller drive channels	1-3	1-3			
Array interface to host	SCSI-2	SCSI-2			
Drive interface	SCSI-2	SCSI-2			
Cache size (min, max: MB)	8, 32	8, 32			
Cache function (Read, Write)	Read, Write	Read, Write			
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	Option Yes Yes			
Spare drive (None/Auto/Manual)	Auto	Auto			
ARRAY PERFORMANCE:					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 20 10	10, 20 10			
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent			
Nominal disk diameter (mm)	95	130			
Average positioning time (msec)	Drive dependent	Drive dependent			
Average rotational delay (msec)	Drive dependent	Drive dependent			
Drive models	Micropolis, Seagate	Micropolis, Seagate			
ARRAY SIZE: Inches: H x W x D	24 x 24 x 30	24 x 24 x 30			
POWER: Power backup	-- Cache battery	-- Cache battery			
FIRST CUSTOMER SHIPMENT	7/93	7/93			
COMMENTS	CMD CR-5000 controller	CMD CR-5000 controller			

MANUFACTURER PROFILES

1995 DISK/TREND REPORT

MANUFACTURER PROFILES

All manufacturers now producing disk drive arrays, or those which are expected to enter the market, are listed in this section. DISK/TREND estimates the annual disk drive array sales by manufacturers with a high level of disk drive array sales in 1994. "1994 total net sales" covers the fiscal year ending in 1994 for each firm unless noted otherwise, or for the parent company if the disk drive array manufacturer is a subsidiary. The fiscal year of listed firms ends on December 31, 1994, unless otherwise noted.

Except for Canadian firms, manufacturers located in the United States that have majority owners headquartered in other countries are grouped in the geographical area in which the owner's home office is located. Canadian array manufacturers are grouped with the U.S. companies for convenience.

Exchange rates

The exchange rates used in converting the financial data of non-U.S. manufacturers to dollars are given below. The average exchange rate for 1994 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Canada	Canadian dollar	1.37
France	French franc	5.55
Germany	Deutschmark	1.62
Japan	Yen	102.2
Taiwan	Taiwan dollar	26.5
United Kingdom	Pound	.652

Use caution in making year to year comparisons of revenue and income figures, as they are significantly impacted by exchange rate changes.

U.S. Manufacturers

1776, INC.
8632 S. Sepulveda Blvd.
Los Angeles, CA 90045

1776, Inc. was founded in December, 1986, for the purpose of providing specialized large data storage hardware systems. In 1989, the company completed a change to become a software supplier to the users of SCO UNIX. Its current products include "1776 Disk Array Software" which is specifically designed for the Intel-architecture microcomputer UNIX environment.

A second product of 1776, Inc., is "Multi-Host", which offers a unique method of using microcomputers in mission critical applications. Multi-Host combines the high performance and fault tolerance of "1776 Disk Array Software" together with the ability for a second host computer to back up the primary UNIX system.

1776, Inc., markets its software products directly to OEMs and through distributors. The company has been successful in installations with numerous major companies currently utilizing UNIX applications.

AC TECHNOLOGY
8201 Greensboro Drive
McLean, VA 22102

Specializing in UNIX systems, AC Technology is a system integrator serving the Sun, SGI, IBM RS/6000 and other midrange system markets. The firm employs the CMD controller line in its array storage subsystems.

ADAPTEC,INC.
691 South Milpitas Boulevard
Milpitas, CA 95035

Adaptec was an early leader in SCSI adapter boards and has become the industry leader in SCSI chip sets. While Adaptec initially did not offer a board level array product, it did offer array software bundled with some controllers, using software products from Integra and other firms.

The company has now entered the array controller market more directly with a series of array products that combine host-executed code with hardware augmentation, to minimize cost while maintaining acceptable performance. These array controllers are being aggressively priced, in an attempt to rapidly capture a significant share of the entry level market.

ADJILE SYSTEMS
5816 Roseville Road, Suite 2
Sacramento, CA 95842

Privately held Adjile was founded in 1993 as a storage subsystem integrator. The firm produces customized array subsystems using a variety of drives and controllers. Adjile also manufactures a line of array enclosures, which it uses in its own subsystems and also markets to other array producers. The firm's business splits evenly between the two product lines.

ADS INTERNATIONAL (AMERICAN DIGITAL DATA ASSOCIATES)
434 Cloverleaf Drive
Baldwin Park, CA 91706

ADDA was founded in 1983 to develop, manufacture and sell a family of PC motherboards for the systems integration market. The company then broadened its product line over the years to include a range of products from the low-end X-Terminal to high-end super servers including 386 and 486 based systems, with emphasis on the UNIX system user. In January, 1992, ADDA introduced its first RAID product, the model ADS 1000. It featured RAID levels 0, 1, 4 and 5 through the utilization of an UltraStor RAID controller bundled with various disk drives. In June, 1992, the company introduced it's second RAID offering. The product featured UNIX support for RAID levels 0 and 1 through packaging of the RAID software module from 1776, Inc., coupled with various disk drives. In January 1993, ADDA introduced its model ADS 3000 which supports RAID levels 0, 3 and 5 using the Digi-Data controller, combined with various high performance disk drives. The ADS 5000, which uses a CMD controller, also offers RAID levels 0, 3 and 5, but includes read and write cache in the controller. In 1993, the organization began to de-emphasize system sales and the ADDA brand and concentrate upon storage subsystems marketed under the ADS name.

ADVANCED LOGIC RESEARCH
9401 Jeronimo
Irvine, CA 92718

ALR is a producer of IBM compatible PC systems. Both internal and external array options are available on the firm's servers, both based on the Mylex controller. RAID modes 0, 1, and 5 are included.

ADVANCED SYSTEMS PRODUCTS, INC. (ADVANSYS)
1150 Ringwood Court
San Jose, CA 95131

The company was formed in March, 1993 by several engineers with experience in the controller and software industries. Host adapters have always been

the focus of AdvanSys' energies, with the first product shipped in June of 1994. The close coupling between the design of a proprietary controller processor and software driver permit the use of only one driver per operating environment across a range of platforms, simplifying system configuration and improving performance. Controllers are available for ISA, EISA, and PCI bus attachment.

Production of an array controller board based upon the existing SCSI drive controllers is anticipated in the second half of 1995.

ALLODYNE, INC.
5317 Randall Place
Fremont, CA 94538

Founded in April, 1991, Allodyne has developed an innovative array controller using ASICs of its own design. The firm has worked with disk drive producers to create array products using multiple 3.5" and 2.5" drives packaged in a 5.25" form factor. The array operates in RAID-3 or RAID-5 mode, and efficiently handles large data blocks by operating in a combined RAID-3/RAID-5 mode, avoiding excessive read-modify-write cycles. Tagged command queuing and a battery backed cache are included. The array is capable of hot swapping and rebuilds in background mode. Allodyne is actively seeking additional potential strategic partners for development or product marketing, and has already obtained significant OEM commitments.

AMERICAN DIGITAL SYSTEMS
490 Boston Post Road
Sudbury, MA 01776

A storage subsystems integrator, ADS serves primarily the DEC market, but also supports other UNIX-based systems with RAID 0, 1, 3 and 5 level arrays. Third party controllers are used. The firm markets directly to large U.S. financial organizations, institutions and government agencies. Non-U.S. sales are through representatives.

AMERICAN MEGATRENDS, INC.
6145-F Northbelt Parkway
Norcross, GA 30071

American Megatrends was founded in the Fall of 1985 as a supplier of software design services and BIOS software. The firm has since added peripheral controllers and utility software to its product line. Active participation in the disk drive array market began in late 1994, at which time the firm introduced a PCI bus array controller operating in RAID-0/1/3/5/10 modes.

AMERIQUEST TECHNOLOGY (Formerly CMS Enhancements)
2722 Michelson Drive
Irvine, CA 92715

The firm started as CMS Enhancements, a manufacturer and distributor of computer add-on and add-in equipment and software. The firm has undergone recent management changes and changed its name to Ameriquest Technology in early 1994. Disk drive array products include the "Platinum" array subsystems based upon third party software arrays and 5.25" drives.

ANDATACO
10140 Mesa Rim Road
San Diego, CA 92121

ANDATACO is a system integrator and storage subsystem producer that concentrates on Sun, Hewlett-Packard, Silicon Graphics and certain UNIX-based IBM and DEC platforms. Array products include two array subsystems based on CMD controllers. A variety of drive manufacturers are supported and drives from 500 megabytes to 4 gigabytes are available. RAID-0, RAID-3, and RAID-5 are supported, with array capacities from 2.5 to 80 gigabytes available.

APPLE COMPUTER
20525 Mariani Avenue
Cupertino, CA 95014

Apple is one of the pioneers of the personal computer industry and has succeeded in creating a loyal and enthusiastic customer base among individual users. As part of its efforts to improve penetration of corporate markets, Apple began to offer disk drive arrays for its servers, beginning in late 1994, with a software based mirrored array using software licensed from Conley. Apple is widely expected to include hardware array support for its line of servers, probably in late 1995.

APPLIED DIGITAL SYSTEMS
30 State Street
Fairport, NY 14450

ADS is an integrator of storage systems that got its start in 1984 as a DEC system integrator. Storage was added to the product line in 1987. A variety of array subsystems are available based upon a variety of controllers, and much of the firm's array production is done on a customized basis.

APS TECHNOLOGIES
6131 Deramus Avenue
Kansas City, MO 64120

APS began as an integrator of storage subsystems for the Apple Macintosh in 1985 and has become a sizable presence in the Apple aftermarket. Most customers are end users, largely in the U.S. The firm offers an Apple attached software array operating in RAID-1 and RAID-0 modes, and also does some custom work in the IBM PC compatible segment of the market. APS is gradually shifting its orientation, placing increasing emphasis on the PC compatible segment of its activities and plans to migrate towards more complex subsystems.

ARTECON
2460 Impala Drive
Carlsbad, CA 92008

Artecon is a subsystems and systems integrator specializing in SUN and other UNIX platforms, using a modular subsystem design approach. The firm was founded in 1984. In late 1994, the firm began shipping a modular array based upon CMD controllers. A new array family using a different controller is scheduled for introduction in mid-1995.

ASA COMPUTERS
2354 Calle Del Mundo
Santa Clara, CA 95054

ASA is a supplier of complete systems usable as file servers. The firm began as a PC assembly operation and a distributor of computer components, and gradually evolved into a system integrator and manufacturer. Besides its line of file servers, the firm also offers Sun workstation clones. ASA systems support RAID-0/1/5 or RAID-0/1/4/5, depending upon which controller is used. RAID-0 and -1 functionality is provided by Novell NetWare.

AST RESEARCH, INC.
16215 Alton Parkway
Irvine, CA 92713-9658

1994 total net sales: $2,367,274,000 (FY ending 7/2/94) Net income: $53,501,000

AST Research was founded in 1987 to develop, manufacture and market high-performance computer systems for large corporations, small businesses and individual users. The AST product mix is broad, offering performance oriented computer systems for a wide range of applications.

AST Research's sales strategy centers on selling products through networks of VADs, VARs, national distributors, systems integrators, and large retailers. In 1991, AST made a significant move into mass merchandising with the introduction of the "Advantage!" line of personal computers developed specifically for distribution through electronic "superstore" chains.

In early 1992, AST introduced its first disk array product, offered on its Premium CS line of computer systems. Along with a RAID level 0, 1 and 5 capability, the product also features a "RAID-6" implementation (RAID level 0 striping and RAID level 1 mirroring capability). In late 1992, AST began offering this RAID subsystem on its new Manhattan series of high performance computer systems, and in late 1993 added a similar array to the Premia-SE series. AST obtains its array controllers from third parties.

AT&T GLOBAL INFORMATION SOLUTIONS (Formerly NCR)
1700 South Patterson Road
Dayton, OH 45479

1994 total net sales: $75,094,000,000 Net income: $4,710,000,000

NCR was founded in 1884 as the National Cash Register company and evolved to become one of the leading mainframe and minicomputer suppliers, although the firm was unable to keep up with IBM and Digital Equipment. AT&T purchased NCR in 1991 to improve its capabilities in combining communication and computing technologies. In early 1994, NCR became AT&T Global Information Solutions. In late 1994, Hyundai Electronics announced it would purchase the AT&T Microelectronics Product Division, including the Wichita operation. The acquired business units operate as a wholly owned subsidiary under the name of Symbios Logic. A software array product, Disk Array Plus, was retained by AT&T and is supported from the AT&T Naperville, Illinois, facility.

Disk Array Plus operates at RAID levels 0, 1 and 5. AT&T hardware array implementations operate at RAID levels 0, 1, 3 and 5, and can do so concurrently. AT&T array controllers do not currently provide cache on the controller, relying upon the processor to provide caching functions, but may do so in future products. However, they do support communication with multiple hosts.

ATTO TECHNOLOGY
1576 Sweet Home Road
Amherst, NY 14228

ATTO, founded in 1988, is today a producer of solid state disk drives, external cache subsystems, and SCSI host adapters for PC compatible and Macintosh computers. ATTO has also developed mirroring and striping software for use with its controllers on the Macintosh personal computers. Up to 4 drives may be striped or mirrored. Because there has been relatively little competition for disk arrays on Apple products until recently, ATTO has had an opportunity to

hold significant market share in the Macintosh array segment as the market develops. Shipments of mirroring software began in early 1992, while striping capability was added in late 1992.

AUSPEX SYSTEMS, INC.
2952 Bunker Hill Lane
Santa Clara, CA 95054

1994 total net sales: $83,280,000 (FY ending 6/30/94) Net income: $8,318,000

Auspex is a manufacturer of UNIX based network servers that employ a sophisticated architecture and a high speed internal VME bus to obtain unusually high performance. RAID-0 and RAID-1 are supported, with only two drives assigned to a SCSI channel for optimized response. Auspex systems employ multiple processor/controller boards dedicated to controlling the array and can provide duplexing and drive spanning as well as mirroring and striping. Drives can be partitioned and array functions assigned to specific partitions. Auspex has steadily expanded the size of its arrays, and now can support array subsystems containing over 200 disk drives. While Auspex could probably add other RAID levels to its arrays, the firm prefers to restrict itself to RAID-1 and RAID-0 in order to optimize system performance.

Providing server services for networks of Sun Microsystems workstations is a major objective of Auspex, and the company has also licensed the controller used by IBM in the 7051 RS/6000 file server.

AUSTIN COMPUTER SYSTEMS, INC.
10300 Metric Boulevard
Austin, TX 78758

Austin Computer Systems, established in 1984, manufactures a variety of 386 and 486 based EISA and ISA bus computers. In late 1992, the firm introduced a RAID-5 file server for NetWare applications, using a controller from UltraStor, but did not follow through with the product and while not actively marketing arrays as of early 1995, was considering doing so later in the year.

AVCOM SYSTEMS
573 Maude Court
Sunnyvale, CA 94086

Avcom has been selling workstations and related items since 1984. Disk drive arrays based upon CMD's controllers were introduced in early 1994. The firm also resells CLARiiON arrays and others. Many subsystems are customized for specific customers.

AVIV CORPORATION
4 Fourth Avenue
Burlington, MA 01803

Aviv offers data storage subsystems for DEC and other UNIX-based computing systems. Disk drives, tape drives, optical disk drives and automated libraries are included in the firm's subsystems. Array products include Aviv's own array controller, which provides RAID-3, RAID-5 and RAID-0 operating modes.

BOTTOM LINE
4544 South LaMar Boulevard
Austin, TX 78745

Bottom Line is a Macintosh VAR/integrator, offering a software based array operating in RAID-1 or RAID-0 mode.

BOXHILL SYSTEMS CORPORATION
161 Avenue of the Americas
New York, NY 10013

Privately held BoxHill was founded in 1987 as a producer of storage subsystems for the UNIX based systems market. The current array product is a RAID-5 configuration designed around a purchased controller that supports several popular midrange systems.

BUSLOGIC INC.
4151 Burton Drive
Santa Clara, CA 95054

BusLogic was founded in 1988, but until 1992, the BusLogic product line was limited to Ethernet controllers, SCSI host adapter boards and SCSI drivers, rather than arrays. Upon the purchase of Chantal in 1992, which became the Chantal Systems Division, BusLogic began to shift its strategy to include array support in future products and to include Chantal in joint promotion of board and software packages. The Chantal Division was subsequently consolidated into BusLogic's main location.

The Chantal software is a RAID-0, 1 or 5 implementation aimed at 386 and 486 class computer platforms. In the Novell NetWare environment, up to 4 SCSI host adapters and up to 28 SCSI disk drives of various capacities and performance may be connected. With a UNIX platform, up to 3 host adapters and 21 SCSI disk drives are supported. The Chantal software is compatible with systems utilizing IBM PC and PC compatible bus architectures.

BusLogic's original disk controllers did not include specific support for arrays, and the firm introduced array controllers in the Spring of 1994 with RAID-

0, 1, 3 and 5 functionality. The initial introduction misfired and few were shipped. A new version of the controller with a PCI host interface is expected in mid-1995.

CAMBEX CORPORATION
360 Second Avenue
Waltham, MA 02154

1994 total net sales: $40,549,000 (FY ending 8/31/94) Net income: $590,000

Founded in 1968 to supply add-in semiconductor memory systems for the IBM mainframe market, Cambex has grown to become a leading supplier in that field. In recent years, the firm has established the Enterprise Systems Division to address its traditional market for central and expanded IBM mainframe memory systems and the Open Systems Division, which offers storage software products as well as disk, tape and semiconductor memory hardware products for the IBM RS/6000 workstation market. Cambex shipped its ARRAY/6000 subsystem with RAID-0/1/3/5 capability in December, 1992. Designed for RS/6000 applications, the ARRAY/6000 provides a high level of redundancy for all component parts and offers up to 96 gigabytes capacity, using 1.6 megabyte 3.5" drives. The Cascade series, offering RAID-0/1 for mainframe markets, is scheduled for June, 1995, delivery.

CANARY COMMUNICATIONS, INC.
1851 Zanker Road
San Jose, CA 95112

Canary is best known for its line of local area network related products, including concentrators, repeaters, transceivers and adapters. In late 1994, the firm started shipments of a disk array subsystem providing RAID-0/1/3/5 capabilities, using drives, fans and power supplies which can be hot swapped. The array attaches to SCSI interfaced hosts and operates with UNIX, Windows NT, or OS/2.

CHARISMAC ENGINEERING
66 P&S Lane, Suite D
Newcastle, CA 95658

Founded in 1986 as a developer of disk storage utility software for the Apple Macintosh, CharisMac has developed a number of support products for the Mac market, including RAID-0/RAID-1 software arrays. The array software is available as an option for the Anubis Storage Suite. The firm currently markets almost exclusively to resellers in the U.S.

CIPRICO, INC.
2800 Campus Drive
Plymouth, MN 55441

1994 total net sales: $13,121,000 (FY ending 9/30/94) Net income: ($321,000)

Ciprico was established in 1978, and produces disk drive arrays, adapters, and disk and tape drive controller boards for the workstation, network server and very high performance storage markets. Products are sold directly to system manufacturers and through a variety of resellers to end users. Ciprico introduced its first disk drive array in 1990, and succeeding product generations have expanded the firm's product line of RAID-3 arrays for SCSI based host platforms with high performance requirements, such as medical imaging and video applications. Current models utilize 5 to 9 drives, with capacity dependent upon a variety of possible drive models.

CLONE STAR SOFTWARE
24102 Palo Dura
Hockley, TX 77447

CLone Star Software has produced specialized networking products since 1988, selling through VARs and system integrators. The company has developed REFLECT, a software array providing mirroring of drives located on either a local system or on a remote server. REFLECT operates with most PC based local area networks.

CLOVIS, INC.
25 Porter Road
Littleton, MA 01460

The company now operating under the Clovis name is the result of the merger of Impulse Technologies, Inc., and Clovis, Inc., in 1993. Impulse Technologies was the company which resulted from the purchase of Alloy Computer's assets from Chapter 11 bankruptcy proceedings by some of the Alloy management personnel. Clovis was founded in 1987 by former Wang employees, and specialized in add-on products for Wang systems. Clovis developed an array operating in RAID modes 1, 3 and 5, with the mirroring mode compatible with Novell NetWare, SCO UNIX, DOS, OS/2 and Banyan VINES. Clovis still sells some of the Alloy products, but the majority of revenues are now from the Clovis server, previously marketed under the Intellistor name, since renamed MultiStor. Clovis is expanding its sales program by adding distributors, an effort which started in late 1993 and is continuing.

CMD TECHNOLOGY INC.
1 Vanderbilt
Irvine, CA 92718

CMD Technology was founded in 1986 to develop and market SCSI adapters for the DEC marketplace. The company has expanded its product line to address other SCSI based systems opportunities, and its products can now be found on a variety of UNIX, Novell, Windows NT and MS-DOS platforms. The company sells worldwide through OEMs, VARs and other resellers.

In January, 1993, the company introduced its first RAID-3/5 disk array product, the model CRD-5000. Offering the user a choice of RAID level 0, 3 or 5, the CRD-5000 provides support for up to 28 individual disk drives and can service up to 3 host channels simultaneously. Utilizing the FAST SCSI-2 bus, the CDR-5000 can transfer data to the host system at up to 10 megabytes/second. In order to further enhance the overall system performance, up to 32 megabytes of write cache can be implemented in the subsystem configuration. A mirrored disk controller, the SCEA/S was first shipped in February, 1993.

CMD array controllers have been broadly accepted by system integrators, but competitive pressures forced CMD to develop a higher performance, cost reduced line of products that is expected to be in production in the second half of 1995.

COMPAQ COMPUTER CORPORATION
20555 SH 249
Houston, TX 77070

1994 total net sales: $10,866,000,000 Net income: $867,000,000

Compaq is a major participant in the IBM PC compatible computer market, offering a broad product line ranging from notebook computers to multiprocessor systems intended for use as servers.

The firm was the first to offer disk drive arrays (other than mirroring) on personal computers. The company's first arrays were shipped in 1989, and Compaq currently has shipped more array subsystems than any other supplier. The array product line underwent extensive revision in 1993, with almost all array based systems being replaced with newer versions. A similar extensive upgrading is expected in 1995.

Compaq designs its own array controllers and supports them with storage subsystem management tools that can be operated over a network. All of the Compaq arrays are sold with Compaq computers and attach directly to the host processor EISA or PCI (in the future) bus. RAID levels 0, 1, 4, and 5 are supported. An unusual feature of the Compaq arrays is that only write cache is provided. The processor makes use of cache elsewhere in the system for read operations. The write cache is mirrored, and includes battery backup.

COMPUADD CORP.
12303 Technology Boulevard
Austin, TX 78727

Best known as a mail order source for personal computers, CompuAdd offers an array based upon a third party controller. RAID modes 0/1/3/5 are supported. CompuAdd expects to continue to offer disk drive arrays but will continue to rely upon outside suppliers for the array controller for the foreseeable future.

COMPUTER MARKETPLACE
1490 Railroad Street
Corona, CA 91720

Computer Marketplace is a national reseller of computer systems and subsystems, peripherals, and related products. The firm also integrates a line of disk drive arrays, mostly based upon the Digi-Data controller, which are made to customer specifications. The company is publicly traded.

COMPUTREND SYSTEMS
1306 John Reed Court
City of Industry, CA 91745

CompuTrend Systems is a producer of IBM compatible computers. A disk drive array option, using a Mylex controller, is among the storage options offered for the firm's line of computing systems.

CONCORDE TECHNOLOGIES
6370 Lusk Boulevard, Suite F100
San Diego, CA 92121

Concorde, founded in 1989, is a system integrator and reseller specializing in solutions based on Hewlett-Packard equipment. However, the company's disk array, which integrates a purchased controller with the drives, will attach to most SCSI interfaced host platforms operating under UNIX.

CONCURRENT COMPUTER CORPORATION
2 Crescent Place
Oceanport, NJ 07757

1994 total net sales: $179,031,000 (FY ending 6/30/94) Net income: ($39,824,000)

Concurrent started life as Interdata, a supplier of minicomputers, in 1966. The firm was subsequently purchased by Perkin-Elmer and operated as a sub-

sidiary before regaining its independence and its current name in 1984. The firm specializes in high performance minicomputers and networked systems running under the UNIX operating system. RAID-0/1 arrays implemented in software are included in Concurrent's systems. An earlier hardware implementation has been discontinued.

CONLEY CORPORATION
420 Lexington Avenue
New York, NY 10017

Conley offers redundant RAID-0/1/3/5 array subsystems for Apple systems and networks as well as for UNIX-based servers and networks. Fault tolerance is stressed in systems design, with a high level of redundancy in various types of hardware used in array design. A software array for use with a Conley controller was added in late 1993, offering RAID-1, RAID-0 and combined RAID-1/0 modes.

Conley has licensed its array technology to several other firms, including Apple Computer, Micronet, and others.

CONNER STORAGE SYSTEMS GROUP
36 Skyline Drive
Lake Mary, FL 32746

Established when Conner Peripherals acquired Archive, Conner SSG provides add-on and add-in products incorporating disk drives, tape drives and storage management software for personal computer systems and networks.

In January, 1994, Conner SSG announced its CR6-RAID system, a prepackaged array intended for resale through distributors and easy attachment by end users. Included is an array management utility. The array includes six 1 gigabyte Conner drives, the array management software, a BusLogic controller and an enclosure. Array software from a third party provides the required array functionality. A second version of the array uses a hardware array controller. The larger CR12, also hardware based, began shipping in early 1995.

CONSAN, INC.
7676 Executive Drive
Eden Prairie, MN 55344

Storage devices and customized subsystems are the main business of Consan, a distributor serving VARs in the mid-western U.S. The firm was founded in 1988. Customized disk drive arrays are built to specific VAR requirements. Most arrays are manufactured for workstation servers, but software based arrays for the Macintosh are also provided.

CONSENSYS COMPUTERS, INC.
35 Riviera Drive
Markham, Ontario L3R 8N4
Canada

Consensys offers an array controller that can support 8 IDE drives, plus a software driven SCSI array package. Most of the Consensys activity has been in the SCO UNIX-based systems market, but operation with SVR4 and Solaris is also supported.

CONTROL DATA SYSTEMS, INC.
4201 Lexington Avenue North
Arden Hills, MN 55126

1994 total net sales: $524,227,000 Net income: ($94,403,000)

The existing Control Data Systems organization resulted from the breakup of the previous Control Data Corporation, for many years a major manufacturer of mainframe and very high performance computers, and once the leading disk drive manufacturer. After the disk drive operations were sold to Seagate Technology in 1989, the parent company's name was changed to Ceridian Corporation. Ceridian spun off the computer business into newly formed Control Data Systems, Inc., effective July 31, 1992. Control Data Systems' products include mainframe computers, UNIX-based servers and workstations, peripherals, system software and application hardware. The firm is undergoing a planned transition from a computer manufacturer to an open systems integrator. Since 1986, Control Data has had an agreement with Silicon Graphics, under which it sells SGI workstations and servers, and this arrangement was expanded in 1992 with an investment by Silicon Graphics in Control Data Systems.

Since the mid-1980s, CDC had been developing a high-end disk drive array subsystem, and this program was not included in the sale of the disk drive business to Seagate, but was later included in the products turned over to Control Data Systems. Array products are RAID-0/3 configurations, used originally with both mainframes and UNIX networks, with the ability to utilize up to 32 high performance 5.25" and 8" drives. The firm is expected to exit the disk drive array business by the end of 1995, as it phases out hardware production.

CONVEX COMPUTER CORPORATION
3000 Waterview Parkway
Richardson, TX 75080

1994 total net sales: $144,180,000 Net income: ($61,022,000)

CONVEX Computer Corporation is a leading manufacturer of air-cooled supercomputers that address the needs of scientific, engineering and technical users. CONVEX systems are used to solve complex problems in such diverse

areas as seismic processing, computational chemistry, computer-aided engineering, image processing, aerospace simulations and molecular biology.

The company was founded in 1982 and by 1985 had introduced its first supercomputer, the C1, which sold for $300,000. In March, 1992, CONVEX and Hewlett-Packard announced extensive business and technology agreements which included a 5% ownership in CONVEX by Hewlett-Packard. Part of this agreement was that CONVEX would adopt Hewlett-Packard's PA-RISC (Precision Architecture Reduced-Instruction Set Computing) technologies in its massively parallel processing (MPP) supercomputer under development. In October, 1992, CONVEX introduced the Meta Series, a cluster system that links CONVEX supercomputers with Hewlett-Packard's PA-RISC processing nodes.

In the second quarter of 1992, the company introduced a RAID level 0, 1 or 5 disk subsystem offering up to 80 gigabytes of data on-line to the user. The array utilizes parallel head, IPI-2 disk drives which yield a sustained host bus data transfer rate of over 36 megabytes/second. Each array subsystem can support up to 32 disk drives and utilizes 4 host I/O channels as a standard configuration. The company is expected to resell high performance arrays in the future, rather than depending upon internally designed and produced models.

CORE INTERNATIONAL
7171 North Federal Highway
Boca Raton, FL 33487

CORE began in 1979 as a manufacturer of peripherals and became an early marketer of disk drives for the IBM 5100 desktop computer series, which preceded the PC. The company became a supplier of peripherals for the IBM PC market during most of the 1980s, and in 1987 introduced an early mirrored disk capability for the Novell market. Aiwa Co., Ltd., a Japanese manufacturer of consumer electronics products which is controlled by Sony, purchased a 23% minority interest in CORE International in 1992 and acquired control of the company in 1993. Since 1991, CORE has participated in the array market for personal computers, workstations and networks with RAID-3/5 subsystems. The firm's innovative "MicroArray" uses 2.5" drives packaged with an array controller in the form factor of a full size 5.25" drive. Aiwa has assumed marketing and manufacturing responsibilities for the arrays (production is in Singapore) and Core is now responsible primarily for product development.

COREL CORPORATION
1600 Carling Avenue
Ottawa, Ontario K1Z 8R7
Canada

Corel is a well known supplier of graphics software and SCSI support software. In 1993, Corel introduced Corel RAID, a software package usable with a

variety of SCSI controllers. The product was only marginally successful and was subsequently bundled into the CorelSCSI Network Manager, a SCSI controller package for servers that also supports optical drives and libraries.

CRANEL, INC.
8899 Gemini Parkway
Columbus, OH 43240

Founded in 1985, Cranel is a specialized distributor of storage products and subsystems. Disk drive arrays are customized for individual customers, most of which are VARs and system integrators. A few standard configurations are offered, based upon DEC's StorageWorks modules.

CRAY RESEARCH, INC.
655A Lone Oak Drive
Eagan, MN 55121

1994 total net sales: $921,609,000 Net income: $55,696,000

Cray Research was founded in 1972 and claims two thirds of the worldwide market for supercomputers. With over 5,400 employees, the company has transitioned through several generations of supercomputers, with continually increasing performance demands on the disk drives used with most of their installations. Cray Research's original DCA-3 RAID-3 disk array channel adapter for IPI-2 8" parallel transfer drives, has been supplemented with newer high performance arrays using high capacity 3.5" drives covering users RAID-3 and RAID-1/5 requirements.

CYRANEX CORP. (Formerly Pro Engineering)
1145 Hunt Club Road
Ottawa, Ontario K1V OY3
CANADA

Founded in May, 1992, the company provides a variety of hardware and software storage solutions for attachment to PC compatible systems, marketing to OEMs and through distribution. The firm's first array product, EZRAID for OS/2, is a software array offering RAID levels 0, 1, 4 and 5. The array software operates with most host adapters and interfaces. A change of name, for marketing reasons, occurred in March, 1995.

DALLAS DIGITAL
624 Krona St, Suite 160
Plano, TX 75074

Dallas Digital is a system reseller and storage subsystem integrator. Together with Datalink, Dallas Digital is a member of the Tripac joint venture that creates products salable by both companies, including disk drive arrays. The firm resells disk drive arrays as well as integrating its own arrays.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01580

1994 total net sales: $1,120,505,000 (FY ending 9/24/94) Net income: ($87,693,000)

Founded in 1968, Data General became a leading minicomputer manufacturer, but suffered the same softening of the market for classic minicomputers that hit the entire market segment in the mid-1980s. Despite declines in its traditional market, Data General appears headed for recovery on the strength of the AViiON line of RISC servers and workstations using UNIX. Overall, the company's range of products currently includes data base servers, communications and network servers, workstations, desktop and portable systems, mass storage and many related software products.

Data General's 1990 introduction of RAID-0/1/3/5 subsystems for the AViiON family resulted in a successful storage subsystem for captive sales, and the 1992 establishment of a new Data General organization to pursue noncaptive array markets. The CLARiiON Business Unit is responsible for development of array markets with other system manufacturers and independent peripherals suppliers and integrators. The first result was a CLARiiON resale agreement with Groupe Bull, followed by numerous others, including Memorex/Telex, Amdahl, Storage Technology, and Silicon Graphics. The CLARiiON unit has become increasingly visible and has developed a market identity distinct from that of Data General.

DATALINK
7423 Washington Avenue South
Minneapolis, MN 55439

Datalink is a system reseller and storage subsystem integrator. Together with Dallas Digital and Cranel Corporation, Datalink is a member of the Tripac joint venture that creates products salable by all three companies. In the spring of 1994, Datalink announced four subsystems containing disk drive arrays. These include both software and hardware array implementations.

DATARAM CORPORATION
Route 571 Princeton Road
West Windsor Township
Princeton, NJ 08543

Dataram was established in 1967 as a supplier of memory subsystems for computers. The Dataram disk drive array attaches to Sun, DEC, H-P and other UNIX-based systems, providing RAID-3, RAID-5, and RAID-0 operating modes. Purchased controllers are used. A new generation of products offering RAID modes 0,1,3,5 and 10 began shipping in early 1995. Also in early 1995, Dataram and Symbios Logic announced a strategic partner relationship for disk drive array product development.

DATA STORAGE MARKETING
5718 Central Avenue
Boulder, CO 80303

Data Storage Marketing, founded in 1987, is a storage subsystems integrator and distributor that makes heavy use of telemarketing to sell its products. The firm's disk drive arrays have been based upon CMD controllers, Seagate drives and a variety of array enclosures.

DELL COMPUTER CORPORATION
9505 Arboretum Blvd.
Austin, TX 78758

1994 total net sales: $3,475,343,000 (FY ending 1/29/95) Net income: $149,177,000

Dell Computer, founded in 1984 to sell PCs via mail order has become legendary in the computer industry. In November of 1992, the company began shipping its first disk array product, the model DAS which offers RAID-0 and RAID-1 capabilities. In 1993, the subsystem was upgraded to support RAID levels 4 and 5, and in 1994 support for hot sparing of drives was added. Dell is expected to be among the companies planning to make use of the SSA serial interface in future array products likely to be first shipped in 1996.

DIGI-DATA CORPORATION
8589 Dorsey Run Road
Jessup, MD 20794

Digi-Data has been active since 1962 as a manufacturer of tape cassette and cartridge drives, with an emphasis on military markets. In recent years the firm's product line has been broadened to cover a variety of commercial applications for tape drives for the Digital Equipment, Data General, Hewlett-Packard and IBM

markets. Since April, 1992, Digi-Data has also been actively promoting its RAID-0/3/5 array, sold as a board-level product for a variety of host environments. The model Z-9000, an upgrade to the original model Z, includes up to 128 megabytes of cache.

DIGITAL EQUIPMENT CORPORATION
146 Main Street
Maynard, MA 01754

1994 total net sales: $13,450,790,000 (FY ending 7/2/94) Net income: ($2,156,063,000)

Digital Equipment was a veteran disk drive manufacturer, with production starting more than 20 years ago, during the firm's early days as a minicomputer manufacturer. Digital phased out older large diameter disk drives during the last few years, and by 1994 had become a specialist in high capacity 3.5" drives, for both captive and OEM sales. Driven by the parent company's hunger for cash, the Digital Equipment disk drive business was sold to Quantum Corporation, with the deal consummated in October, 1994. Digital Equipment retained its storage subsystems programs and has become a major buyer of disk drives from Quantum and other manufacturers.

For several years, Digital has offered a variety of disk mirroring capabilities, in both hardware implementations with drive controllers and in software RAID-0 and RAID-1 implementations. Late in 1992, Digital announced new RAID-0/1/3/5 arrays, which are also offered in OEM markets. In 1993, Digital announced StorageWorks, a modular family of storage subsystems and subsystem components. The family has been upgraded with larger drives and improved controllers several times since its initial introduction. Most of the announced subsystems operate in RAID-0/1/3/5 modes.

DIRECT CONNECTIONS
7668 Executive Drive
Eden Prairie, MN 55344

Founded in 1987, Direct Connections offers customized storage subsystems for the Apple Macintosh aftermarket. The firm offers a software based RAID-1/RAID-0 array, and also sells other customized hardware and software based array subsystems.

DIRECT CONNECT SYSTEMS
2260 NW Parkway, Suite O
Marietta, GA 30067

Founded in August, 1993, DCS is a storage subsystem integrator for DEC, Sun, NCR and other UNIX based equipment. Array products make use of sever-

al different arrays and array controllers from third parties, including Raidtec, CMD, Data General and TD Systems.

DISTRIBUTED PROCESSING TECHNOLOGY (DPT)
140 Candace Drive
Maitland, FL 32751

DPT has designed and sold board level controllers for the personal computer and network markets since 1977. An early producer of SCSI controllers, the firm pioneered in development of cache usage with controller boards. A SCSI host adapter chip set is also available. DPT's "disk mirroring module" attached to its ISA and EISA "SmartCache Plus" controller boards, provides RAID-1 capability. The more recent "SmartCache III", which began shipping in late 1993, provides RAID levels 0/1/5, plus an array manager software utility. As with previous designs, array functionality is created when additional modules are installed on the basic SCSI controller board. A new line of subsystems began shipping in late 1994.

The firm markets its controllers and arrays to OEMs and through distribution in the U.S. and Europe. About 30% of sales are to non-U.S. markets.

DIVERSE LOGISTICS, INC.
2862 McGaw Avenue
Irvine, CA 92714

A subsidiary of Dialog S.A., a Swiss company, DLI was founded in mid-1993. The company is a storage subsystems integrator selling to system integrators and system manufacturers. The "Windjammer" series of array products, based on the firm's own controller, provides RAID-0 and RAID-1 capability and attaches to SCSI host processors. First shipments were in early 1994. DLI also intends to market its controller on an OEM basis.

DYNATEK AUTOMATION SYSTEMS, INC.
200 Bluewater Road
Bedford, Nova Scotia B4B 1G9
Canada

DynaTek, a privately owned firm established in 1985, is a system integrator specializing in packaged SCSI-based storage systems operable with a broad variety of hardware platforms. In addition to disk drive arrays, DynaTek provides automated library systems and a variety of disk and tape drive subsystems. The firm markets primarily to VARs and other types of dealer/integrators on a worldwide basis.

DynaTek offers several array products ranging from RAID-5 configurations that fit within the standard 5.25" full height form factor to larger tower mounted

installations operating in RAID-0, 1, 3 and 5 modes. A variety of purchased controllers is used.

ECLIPSE TECHNOLOGIES
3827 Canyon Ridge DRive
San Jose, CA 95148

Founded in 1992 as an engineering consulting organization, the firm entered the LAN network adapter market and then evolved into an array supplier, selling through integrators into the UNIX server market. RAID levels 0/1/3/4/5 are offered. The firm has done particularly well in non-U.S. markets.

ECCS, INC.
1 Sheila Drive, Building 6A
Tinton Falls, NJ 07724

1994 total net sales: $42,738,000 Net income: ($6,790,000)

ECCS is a systems integrator and VAR specializing in UNIX-based systems and subsystems, including those of AT&T, H-P, IBM and Sun Microsystems. The company was founded in February, 1980, and after a period of rapid growth, went public in June of 1993. Array products include RAID-1 and RAID-1/3/5 arrays. The arrays can be operated in a combined RAID-0/1 mode which the company designates as RAID-10, in which data is striped across a set of SCSI controllers, which in turn control mirrored disks. ECCS is credited with popularizing the RAID-10 nomenclature, which has been endorsed by the RAID Advisory Board.

EMC CORPORATION
171 South Street
Hopkinton, MA 01748

1994 total net sales: $1,377,492,000 Net income: $250,668,000

Established in 1979, EMC has become a born-again growth company in the last few years, based on rapid growth since 1990 in the market for its Symmetrix family of cached disk storage systems offering mirrored disk capability for IBM and other mainframe computers, supplemented by the Harmonix subsystem family sold in the AS/400 market. In April, 1994, EMC announced the HX3SR RAID-0/1/5 version of the Harmonix and RAID-0/1/5 upgrades to existing HX3 series Harmonix subsystems. The company also sells tape drive add-on products and a variety of solid state disk and main memory upgrades for several systems. Aided by IBM's failure to provide disk drive array subsystems until late

1994 and Storage Technology's delays with its Iceberg program, EMC has become the leading supplier of high performance mirrored disk subsystems for the mainframe market. In early 1994, EMC acquired Array Technology's disk array product line and other selected assets from Tandem. In early 1995, EMC acquired the disk drive array operations of Sanyo Icon, which had been supplying important elements of EMC's Centriplex systems. Also in 1995, EMC announced its RAID-"S" feature for selected Symmetrix subsystem models, providing mainframe array disk redundancies similar to RAID-5, but without some of the performance limitations of RAID-5.

ENCORE COMPUTER CORPORATION
6901 West Sunrise Blvd.
Fort Lauderdale, FL 33313-4499

Encore Computer Corporation was founded in 1963 to design, manufacture, market and service open computing solutions with mainframe performance for complex real time on-line transaction processing applications. The Encore 90 family of computers combines parallel processing and real time computing facilities by implementing a hardware and software architecture and provides open systems and standards while delivering very high performance solutions.

The 90 Series of computers focus on a massively expandable systems configuration in order to solve complex computing problems. This configuration flexibility enables connection of multiple CPUs, I/O subsystems and intelligent communications controllers, providing the processing power formerly found only in the largest of mainframe type computer environments. Encore's fiber-optic memory channels maintain I/O bandwidths in excess of 53 megabytes/second per I/O channel.

Encore offers a RAID level 1 and 5 I/O subsystem which incorporates the Interphase Cougar 4220 SCSI-2 host bus adapter module in the high performance data I/O path. It has the capability of supporting host data transfer rates of 50 megabytes/second.

EXSYS STORAGE SYSTEMS
1290 Tully Road, Suite 703
San Jose, CA 95122

Exsys Storage Systems is a storage subsystems integrator serving primarily the DEC and RS/6000 systems market. The firm started up in 1987 as a supplier of protocol converters connecting to DEC system interfaces. Disk drive arrays were first shipped in early 1993, using purchased controllers. RAID levels 0/1/5 are supported.

FALCON SYSTEMS, INC.
1417 West North Market Boulevard
Sacramento, CA 95834

Falcon, founded in 1986, is a distributor and integrator of storage subsystems and UNIX based systems. The company has several sales and distribution locations. The firm customizes array configurations using a variety of purchased controllers and drives.

FORMATION, INC.
121 Whittendale Drive
Moorestown, NJ 08057

Since 1970, Formation has provided mass storage and network interconnect products to system integrators, system manufacturers, VARs and distributors. In network markets, Formation has become a specialist in air traffic control systems, tape drive and disk drive subsystems and controllers for IBM mainframes and midrange systems. Formation is offering a PCM version of the 9337 for IBM AS/400 systems and has also announced a RAID-3/5 system attachable to any SCSI host system for applications requiring high availability.

FWB INC.
1555 Adams Drive
Menlo Park, CA 94025

Rapidly growing FWB is a supplier of add-on storage subsystems and other products to the Macintosh market. The firm offers a variety of tape drives, rigid disk drives and optical disk drives. Disk drive array products include the RAID ToolKit, a software array, and the SledgeHammer series of array subsystems, which operate in either RAID-1 or RAID-0 mode. The SledgeHammer FT will also operate in RAID-5 mode, and includes redundant power supplies and fans.

The large size of the IBM-compatible array market has caught FWB's imagination, as has the rapidly developing video server market segment. FWB is expected to introduce products serving both areas in 1995.

GAIN SYSTEMS
6025-D Unity Drive
Norcross, GA 30071

Gain Systems is a system integrator producing personal computers, servers and complete disk drive array subsystems. The firm also sells subsystems less drives in a few cases. Gain arrays provide redundance in fans, power supplies and, optionally, controllers.

GENERAL MICROSYSTEMS
118th Avenue SE, Suite 100
Bellevue, WA 98005

General Microsystems is a technical and industrial systems VAR selling to end users and government organizations. Disk drive array products were built around the Ciprico controller and Seagate disk drives, but the company is in the middle of a product transition and had withdrawn its array products as of early 1995.

HEWLETT-PACKARD COMPANY
3000 Hanover Street
Palo Alto, CA 94303

1994 total net sales: $24,991,000,000 (FY ending 10/31/94) Net income: $1,599,000,000

Hewlett-Packard has an extensive manufacturing operation for disk drives at Boise, Idaho, established in 1977, which is also the firm's development and manufacturing facility for disk controllers. After a long history of large diameter disk drive production, H-P has successfully transitioned to 3.5" high capacity drives, used extensively with H-P computer systems, and sold in the OEM market. In 1989, H-P startled the industry by announcing 150,000 hour MTBF and a five year warranty for its 5.25" drives, an action which substantially improved the firm's visibility in the OEM market.

Since early 1992, H-P has offered a family of RAID-0/1/3/5 arrays for UNIX workstation and multiuser applications, supplemented in 1993 with an array program for personal computers, using Mylex controllers. In early 1995, H-P made a technology announcement of an improved array technology it dubbed AutoRAID. AutoRAID offers a simple user interface, self-configuration, an innovative approach to hot sparing, and automatic data migration between RAID levels depending upon the demand rate for particular files. Shipment of products incorporating AutoRAID will occur in the second half of 1995.

HIGH PERFORMANCE STORAGE, INC.
215 Commerce Way
Portsmouth, NH 03801

Founded in the late 1980s to sell storage products in the Data General market, HPS is expanding its reach to other UNIX based systems as well. The firm's disk drive arrays operate in RAID modes 0/1/3/5 as well as combined RAID-0 and RAID-1.

INFORMATION MANAGEMENT TECHNOLOGY
31 South Main Street
Newton, NH 03858

IMT integrates storage subsystems for the Wang market and for UNIX based host systems. The arrays make use of both 2.5" and 3.5" drives, making IMT one of the few firms to offer arrays based on 2.5" drives. RAID-1, RAID-3, and RAID-5 capabilities are provided.

INTEGRA TECHNOLOGIES, INC.
17532 Von Karman Avenue
Irvine, CA 92714

Integra, a supplier of disk drive array software, entered the array business in 1990 when it acquired Pacstor, Inc. Pacstor, founded in 1987, had moderate success in early market development for its RAID-5 software with customers primarily in the banking business. The firm provided disk drive array technology on a licensed basis to system vendors. IBM, Zenith Data Systems and others offered software based arrays licensed from Integra. The company entered into agreements with a number of companies, including Adaptec, allowing its software to be bundled with its partners' products.

In 1994, the company management changed and the firm was relocated to Southern California. As the result of slumping sales of standard software products and dropping licensing revenue, the company has attempted to license or sell its technology to other companies.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1994 total net sales: $64,052,000,000 Net income: $3,021,000,000

In July, 1990, IBM created the new Storage Systems Products Division, encompassing the previous General Products Division, which held responsibility for more than twenty years for disk and tape drives for mainframe applications, and Low End Disk Operations, established during the 1980's to coordinate IBM's worldwide development and manufacturing operations for disk drives used in personal computers and midrange systems. In early 1992, SSPD briefly became "AdStaR", one of IBM's new wholly owned subsidiary companies -- until new corporate management decided it should rejoin the family as IBM's Storage Systems Division. IBM manufactures 10.8", 5.25", 3.5" and 2.5" fixed disk drives at several factories in the United States, Europe and Asia.

During the last few years, IBM has established several disk drive array programs, using both internally developed and purchased technology. One of the most interesting arrays introduced by the industry to date is the IBM RAID-0/5

array developed at Rochester and sold as the 9337 for AS/400 applications and as the 3514 for PS/2 applications. Initial versions of this array overcame the usual RAID-5 write latency problems by utilizing a dedicated disk drive as a "write assist disk" -- in effect a write cache. Programs using externally developed array technology have included the Oasas RAID-0/1/5 software array licensed from Integra, the PS/2 file servers using Parallan and Mylex controllers, the 7051 RS/6000 RAID-0/1 using an Auspex controller, and the 9570 series of very high performance arrays using Maximum Strategy controllers. It is expected that IBM will undertake internal development of arrays for most of its own requirements during the next few years.

Of major importance to the industry is IBM's choice of array technology for use with mainframe computers. EMC has developed a rapidly growing business during the last four years based on its Symmetrix heavily cached 5.25" and 3.5" disk subsystems with mirrored disk capability, by displacing a large number of IBM 3390 drives. Storage Technology's Iceberg RAID-5 array with enhanced features was delayed until 1994, much to STC's financial embarrassment. In the meantime, early in 1993 IBM revealed plans to offer data compression capability for part of the mainframe product line, as a rear guard action. IBM's mainframe array introduction finally occurred in 1994, with the announcement of the RAID-5 subsystem bearing the reincarnated RAMAC brand name. Despite the limitation of using only 2 gigabyte drives and relying on a controller attachment restricting capacity to 180 gigabytes, IBM has enjoyed heavy early RAMAC sales. The industry expects future RAMAC models to use higher capacity drives and eliminate the controller's capacity limitation, probably in 1996.

INVINCIBLE TECHNOLOGIES CORPORATION
31 Hayward Street
Franklin, MA 02038

ITC, founded in April of 1993, integrates disk drive arrays for DEC, Data General and other UNIX based systems. The firm's Ultimate 1 series provides a mirrored array, while the Ultimate 5, a modified DG CLARiiON, provides a redundant controller array capability for DEC systems.

IPL SYSTEMS, INC.
124 Acton Street
Maynard, MA 01754

1994 total net sales: $29,949,000 Net income: ($15,046,000)

IPL's primary market focus is tape and disk drive subsystems, plus memory upgrades, sold into the IBM AS/400 market. Founded in 1973, IPL distributes AS/400 data storage products through large independent distributors in the U.S.

and Europe. IPL's 9336 RAID-0/1 using 5.25" drives and 9337 RAID-0/1 using 3.5" drives became the company's main thrust in the AS/400 market, since displaced by newer RAID-0/1/5 arrays using 1 and 2 gigabyte 3.5" drives aimed at the RS-6000 and open systems market.

JTS CORPORATION (Formerly Kalok)
1289 Anvilwood Avenue
Sunnyvale CA 94089

Kalok had been developing an array based upon a third party controller, but array related activity ceased when the company had to file for Chapter 11 bankruptcy in 1993. Reorganized and refinanced by disk drive industry veteran Jugi Tandon, the firm resumed operations as JTS in early 1994. JTS has restarted its array development program and is working with several firms in the U.S. and Asia in its development effort.

LA CIE (Subsidiary of Quantum Corporation)
8700 SW Creekside Place
Beaverton, OR 97008

La Cie is Quantum's direct sales marketing organization, offering a wide range of computer add-on or add-in products. Arrays are software based, with RAID levels 0/1/4/5 available. The disk drives are packaged in individual stackable modules.

LEGACY STORAGE SYSTEMS, INC.
43 Riviera Drive
Markham, Ontario L3R 5J6
Canada

Legacy Storage Systems is the name adopted in June, 1991, for the firm which resulted from the merger of two earlier Canadian companies. Although Legacy offers several tape and disk drive subsystems, it is now concentrating on development of its disk drive array product line. RAID-0/1/3/5/10 arrays, which also include tape drive options, are offered for a variety of PC, NetWare and UNIX network applications.

LIGHTHOUSE TECHNOLOGY
5933 Sea Lion Place
Carlsbad, CA 92008

Specializing in scientific, aerospace and medical systems markets, Lighthouse integrates array subsystems incorporating CMD controllers and a variety of disk drives. Most sales are to end users.

LOMAS DATA CORPORATION (Formerly Lomas Data Products)
420 Maple Street #2
Marlboro, MA 01752

A diversified small electronics design and manufacturing company founded in 1980, Lomas started making PC bus products in 1987. The firm's product line includes caching SCSI controllers with mirroring capability. Sales are mostly to system manufacturers, with a concentration in producers of voice mail systems. As the result of an outside investment providing more capital for expansion, Lomas Data has modified its corporate name slightly.

MACRO COMPUTER PRODUCTS, INC.
2523 Product Court
Rochester Hills, MI 48309

Founded in 1981, Macro Computer Products was originally a reseller of used equipment. Since its founding, it has developed its own microfiche to optical disk drive conversion software and has entered the leasing business. The firm is also an IBM reseller. In 1990, the Storage Peripherals Division was formed, and in 1991 MCPI's first array, based on the Storage Computer controller, was sold. While the company does most of its business in the Unisys mainframe add-on market, the array is also available for other SCSI interfaced platforms.

MARNER INTERNATIONAL, INC.
14524 61st St. Court North
Stillwater, MN 55082

Marner, established in March of 1991, is a subsidiary of the Swiss firm Fenner Elektronik AG, which also operates as Marner's international sales arm. The firm integrates systems based upon Sun, H-P, Digital and Silicon Graphics SPARC and UNIX platforms, with emphasis on Sun-based systems. The array products offer RAID-0/3/5 modes and employ purchased controllers, plus an internally developed high performance version.

MASPAR COMPUTER CORPORATION
749 North Mary Avenue
Sunnyvale, CA 94086

MasPar provides massively parallel processors capable of very high performance to support applications such as real time image processing, simulations, complex design tasks and fast access to large data bases. The company was founded in March, 1988, and is still privately held. MasPar does not make its

own arrays, but originally used Maximum Strategy RAID-3 arrays to provide its systems with fast I/O and a degree of fault tolerance. More recent products have operated in RAID 5 mode and used a different controller.

MAXCONCEPT, INC.
7964 Arjons Drive, Suite 1
San Diego, CA 92126

MaxConcept was founded in May, 1994 as a subsystem integrator serving the Apple Macintosh aftermarket. The firm markets mostly in the U.S. to customers with video and graphic applications. The company offers a software RAID-0/1/3/5 subsystem that uses the ATTO SCSI controller.

MAXIMUM STRATEGY, INC.
801 Buckeye Court
Milpitas, CA 95035

Founded in September, 1986, Maximum Strategy has succeeded in becoming a supplier of array subsystems to a number of major system manufacturers, including IBM, Cray Research and others. While the firm's first products, shipped in 1987 for use by Walt Disney animators, were RAID-0 configurations, most recent shipments have been of RAID-3 and RAID-5 arrays. In 1991, the firm announced an array attaching to the IBM RS/6000 system, and in 1992 began shipping a RAID-3 HIPPI interface array controller to IBM for use in the IBM 9570 disk array subsystem.

Maximum Strategy arrays emphasize performance. The Gen 4 array subsystem, first shipped in 1992, provided HIPPI host interfaces and an IPI-2 drive interface, as well as partitioning to allow simultaneous RAID-1/3/5 operation. The more recent Gen 5 series also can support ATM and FCS attachment, but has dispensed with the IPI interface in favor of SCSI-2. The market focus of the company is shifting to providing storage subsystems for very high performance UNIX based systems.

MEDIA INTEGRATION, INC.
3949 Research Park Court, Suite 190
Soquel, CA 95073

Media Integration is a storage subsystems integrator. Disk drive arrays are offered in tower, rack and server packages. The arrays operate in RAID modes 0, 1 and 5, using purchased controllers. A larger and more fault tolerant array, based upon a Digital Equipment controller and operating in RAID modes 0, 3, and 5, was added in early 1995.

MEGABYTE MEMORY AND PERIPHERALS
11772 Sorrento Valley Road
Suite 123
San Diego, CA 92121

Founded in 1990 as an add-on memory products company, MMP first shipped disk drive arrays in 1993. The company sells directly to end users, focusing on UNIX platforms. Third party controllers are used.

MEGA DRIVE SYSTEMS
489 S. Robertson Blvd.
Beverly Hills, CA 90211

Mega Drive Systems was founded in 1988 to provide high performance data storage solutions to fulfill users' requirements for the accurate and reliable processing of large amounts of information. Mega Drive's strategy has been to capitalize on its removable adaptation of Winchester hard drive technology by providing a family of highly reliable, small form factor rugged mass storage subsystems with high capacity and performance as well as security.

Mega Drive's MR RAID subsystems use an intelligent disk controller to interface on the SCSI bus as a single device. The hardware based architecture operates in a manner that is fully transparent to the host operating system. The various models of the MR and MK RAID series are available in desktop, deskside and rack mount configurations. The new Enterprise array, first shipped in early 1995, offers RAID levels 0, 1, 5, and 10 with either 3.5" or 5.25" drives. Also shipping in early 1995 was the MX-500, an upgrade of the MR series, expandable to over 2 terabytes capacity. Still available is the Mercury series of arrays, which uses software to provide RAID-1 or RAID-0 capability. Mega Drive Systems markets its removable data storage subsystems principally to VARs, systems integrators, OEMs and large end users.

MICRONET TECHNOLOGY
20 Mason Street
Irvine, CA 92718

MicroNet Technology was founded in 1989 to supply high performance disk storage subsystems to the Apple Mac market. In March of 1990 it introduced its first disk array RAID-1 product, the Raven 30, which was followed by the MICRO MIRROR, the RAPID ACCESS series and the Raven 40 by November, 1991. The RAPID ACCESS series designed for the PC-based NetWare LAN environment was replaced by the RAIDbank in late 1993.

Over 80% of the business for MicroNet comes from the Macintosh market with the remaining portion from the PC marketplace. MicroNet Technology sells its products through a series of resellers and dealers in the Apple market and through VARs with their PC DOS products. The firm's RAIDbank series of arrays

for PC compatible systems is reducing dependence on the Apple market, but support for the Macintosh remains the company focus.

MICROPOLIS CORPORATION
21123 Nordhoff Street
Chatsworth, CA 91311

1994 total net sales: $346,314,000 Net income: ($30,675,000)

Known as the originator of what were then considered high capacity 5.25" flexible disk drives, Micropolis started production of 8" Winchester disk drives in 1979 and subsequently became a factor in the 5.25" marketplace after the usual Winchester early production problems, with more than half of its current production in high-end 3.5" drives.

After an abortive disk drive array development project in the late 1980s, Micropolis entered the array market in 1991 with its RAIDION family of RAID subsystems. The initial products were software array based. Beginning with the Model 680, with 10 gigabytes of storage and either RAID Level 1 or 5 functionality, the product line has grown to a series of models which range up to 245 gigabytes in capacity. The current RAIDION array family is built around the Micropolis RM family of high performance 5.25" drives and the LM series of 3.5" drives. In early 1994, Micropolis announced the RAIDION VOT 101, an array subsystem fitted with Micropolis AV series drives and aimed at the video server market. Several video servers have been announced since.

In mid-1994, Micropolis began shipments of its Gandiva hardware-based array controller. It is used with the RAIDION LT, LTX and RTX series, and is also incorporated in Micropolis AV server series, which is aimed at the video server market.

MICROTECH INTERNATIONAL
158 Commerce Street
East Haven, CT 06512

Microtech is a distributor and integrator of products for the Apple Macintosh market. Mirroring software is bundled with a controller interfacing SCSI drives to achieve the array configuration.

MIRROR TECHNOLOGIES, INC.
5189 West 76th Street
Edina, MN 55439

Mirror Technologies was founded in 1985. The firm currently offers customized arrays and a few standard configurations for the Apple Macintosh. The original array products were software based, but the firm plans to add a hard-

ware based array in 1995. Mirror offers a wide variety of add-on products through DTP Direct, a catalog sales operation associated with the firm.

MORTON MANAGEMENT, INC.
12079 Tech Road
Silver Spring, MD 20904

Morton is a network and communications system integrator. Array products are typically rack mounted, and incorporate either array software or a Digi-Data controller. The arrays attach to PC compatible systems, and support RAID-5 (software versions) or RAID-0/1/5 (hardware controller). The arrays are available in 6 or 12 gigabyte capacities.

MOUNTAINGATE DATA SYSTEMS, INC. (Division of Lockheed Corporation)
9393 Gateway Drive
Reno, NV 89511

MountainGate was formed in 1992 as the result of Lockheed's complete acquisition of Cherokee Data. The company specializes in storage for ruggedized applications and applications where removability is desired, such as desktop publishing and data security.

In mid-1994, the firm announced that it would supply an array for its PassPort XL removable disk drive family (earlier acquired from Quantum), integrating a software array solution. RAID levels 0/1/3/5/10 are supported.

MTI TECHNOLOGY CORPORATION
4905 East La Palma Ave.
Anaheim, CA 92807

Micro Technology was founded in 1983 to design, manufacture, market and service storage subsystems for the DEC VMS, UNIX and network attached computing environments. Today the company's product line encompasses on-line high-capacity storage arrays, tape backup, and archival storage products as well as fault tolerant subsystems.

The company expanded into the fault tolerant storage arena with its acquisition of SF2, Inc., a Sunnyvale, California, company that pioneered and commercially delivered the first independent RAID-5 array to the DEC marketplace. As a result of this acquisition, the company now holds 24 patents pending or issued in fault tolerant RAID technology and networking. In late 1993, MTI acquired System Industries and is continuing to market the SI product line, including a RAID-3 subsystem for UNIX based systems. Micro Technology markets its

products worldwide and in addition to its sales offices, the company has 34 service centers in the domestic U.S. and 13 service centers overseas. To broaden its markets beyond the DEC base, in April, 1995, MTI announced it would acquire National Peripherals, which provides hardware and software solutions for the open UNIX systems market.

MYLEX CORPORATION
34551 Ardenwood Boulevard
Fremont, CA 94537

1994 total net sales: $62,513,000 Net income: $7,509,000

Mylex produces a variety of controller boards for graphics and storage devices as well as Ethernet adapters, system motherboards and disk drive array controllers and subsystems. The firm also produces its own multiprocessor server. While array activity in 1992 was nominal, Mylex succeeded in obtaining OEM contracts for array controllers from AST, Northgate and many others, and executed a spectacular ramp-up in 1993 to capture 29% of the network oriented array board market. Mylex remained the leading supplier of array controller boards in 1994, with 33.2% of the worldwide noncaptive market for board level arrays for network applications.

Mylex controllers attach to the host controller bus and can be used with many PC compatible systems. Mylex controllers provide RAID levels 0, 1 and 5, plus combined striping and mirroring which Mylex designates as "Mylex RAID", or Mylex RAID-6/7. Operating system support includes Novell NetWare 3.11 and SCO UNIX 3.2 V4. In the future, Mylex expects its array controllers will also operate with Windows NT, Solaris, UNIX SV R4 and others.

NATIONAL PERIPHERALS INC.
1111 Pasquinelli Drive, Suite 400
Westmont, IL 60559

NPI is a subsystem integrator and distributor of peripheral products. The firm procures array components and adds drives and software utilities and drivers. The more sophisticated array elements have been provided by Array Technology. In April, 1995, MTI Technology announced it would acquire National Peripherals to strengthen its distribution capabilities in the UNIX market.

NCL AMERICA COMPUTER PRODUCTS
1031 East Duane Avenue
Sunnyvale, CA 94086

Founded in 1984 as a U.S. subsidiary of a Japanese firm, NCL America became independent in 1993 when its parent went bankrupt. The firm specializes in storage controller boards which are marketed through resellers. By

bundling array software from third parties with its controllers, NCL America is able to offer RAID technology to its customers.

NETFRAME SYSTEMS, INC.
1545 Barber Lane
Milpitas, CA 95035

1994 total net sales: $89,135,000 Net income: $5,745,000

NetFRAME manufactures and sells specialized, high performance multiprocessor computers for use as network servers. Novell NetWare and OS/2 LAN Manager are currently supported, and operation under UNIX SVR4 and Windows NT is anticipated in the future. The company began operation in 1987 as Carlton G. Amdahl Associates, acquired its present name in 1988, and shipped its first systems in 1989. Olivetti is a major customer and distributes NetFRAME products worldwide.

NetFRAME provides a disk controller for its systems that is optimized for striping and mirroring, but relies upon the operating system to actually provide the array function. The storage subsystem architecture allows for redundant buses, redundant I/O processors, and redundant power and cooling. At present, NetFRAME has several fault tolerant systems in its product line that make use of disk arrays.

NETWORK APPLIANCE CORPORATION
295 North Bernardo Avenue
Mountain View, CA 94043

Founded in April, 1992, NAC designs, manufactures and sells high performance file servers. The systems include disk drive arrays operating in RAID-4 mode. The array controller is highly integrated into the main processor, which NAC believes allows the system to avoid the performance penalties associated with RAID-4 configurations, especially those run under UNIX, as the file handler for the system does not require UNIX services (and overhead) to operate.

NETWORK CONNECTION, INC.
1324 Union Hill Road
Alpharetta, GA 30201

Network Connection is a system integrator offering RAID-0/1/4/5 mode subsystems attached to its products. A variety of drives can be accommodated.

NEXSTOR
631 South Milpitas Boulevard
Milpitas, CA 95035

NexStor is a manufacturer of SCSI controllers that is starting to branch out into the disk drive array controller market. First production is expected in the second half of 1995.

NEW WORLD TECHNOLOGIES
200 Homer Avenue
Ashland, MA 01721

Founded in 1991, New World is a system integrator providing built to order systems to a U.S. customer base consisting almost exclusively of VARs and other resellers. The firm also provides follow-on service through arrangements with Wang Corporation. Systems provided by New World typically use Intel family processors and operate in NetWare and various UNIX environments. Because configurations are customized, a variety of array controllers and disk drives are used.

NONSTOP NETWORKS LIMITED
20 Waterside Street
New York, NY 10010

NonStop Networks offers a software solution providing RAID-1 functionality for PC compatible networks and workstations. The mirrored drives may be in one host system or scattered among several hosts on a network. However, the host systems must be running DOS.

NORTHGATE COMPUTER SYSTEMS, INC.
7075 Flying Cloud Drive
Eden Prairie, MN 55344

Founded in 1968, Northgate in recent years has been a manufacturer of IBM compatible personal computers, and during the past year has been impacted by the PC price wars, with reduced sales and heavy losses. In 1991, Northgate introduced the OmniArray, using a Ciprico controller. In late 1992 that product was replaced by the Northgate Disk Array, a RAID-0/1/5 subsystem based on Mylex products. However, array related activities dwindled as the company encountered financial difficulties.

OMNI TECHNOLOGY (Formerly Unbound, Inc.)
17951 Lyons Circle
Huntington Beach, CA 92647

The company was originally founded in 1984 as UNBOUND, Inc. to develop, manufacture and market DEC-compatible computer systems. In 1987, the company introduced its first tape and disk subsystems for the DEC marketplace. In 1988, the company expanded its market area with the introduction of removable and lockable drive subsystems for the workstation marketplace with offerings for Sun, DEC, Mac, PCs and other host platforms which incorporate the SCSI bus interface.

In 1991, the firm introduced a family of high performance SCSI RAIDSTOR-F5 disk array subsystems. This product family offers RAID-0, 3 and 5 level support with data storage ranging from 7.5 to 70 gigabytes, utilizing high performance 5.25" Winchester disk drives from various drive manufacturers. The company sells its products through a network of distributors and VARs as well as to the OEM market. The company was renamed in 1994 as part of its shift to open systems markets.

OPTIMA TECHNOLOGY
17526 Von Karman
Irvine, CA 92714

System integrator Optima Technology shipped its first products in 1994. The firm's products include software based RAID-0/1 arrays for Apple systems and hardware based RAID-0/1/5/10 arrays for both Apple and IBM PC compatible computers.

PACE TECHNOLOGIES
11251 Phillips Parkway Drive East
Jacksonville, FL 32256

PACE Technologies was founded in 1987 as a service and maintenance organization for the Jacksonville area. In mid-1991, the firm expanded its activities to include sales of computer and network systems. PACE currently resells a controller board supporting RAID-0, RAID-3, and RAID-5, plus a complete server developed in conjunction with Hauppage Computer Works. The array controller uses the Intel i960 RISC processor.

PACIFIC COMPUTER EXPANSIONS
23456 Madero Street, #210
Mission Viejo, CA 92691

Founded in April of 1993, PCE is a peripheral subsystem integrator now beginning to assume the role of a complete system integrator of UNIX based

platforms, including Sun and the IBM RS/6000. The firm offers a variety of third party software and hardware array solutions that are custom configured to meet customer desires.

PACIFIC MICRO DATA, INC.
3002 Dow Ave.
Tustin, CA 92680

Pacific Micro Data was founded in 1988 as a systems integrator to offer RAID 0, 1 and 5 solutions to the Novell, UNIX, DOS and OS/2 markets. Its first product, the MAST VI, is no longer marketed and has been replaced by the MAST VII and MAST VIII. Supporting standards and open systems are the cornerstones of Pacific Micro Data's price/performance strategy. The MAST product series combines nonproprietary SCSI-2 disk drives, tape drives, host adapters, and RAID technology (software and hardware) in its subsystems. The RAID subsystem monitors temperature and fan RPM by an audible alarm which can be disabled in the event of a subsystem failure. The enclosures are designed to contain 3.5" SCSI devices and support hot disk drive power-on replacement.

PARALLAN COMPUTER, INC.
1310 Villa Street
Mountain View, CA 94041

Parallan, founded in 1988 as a server developer and producer, established development relationships with both Microsoft and IBM early in its life. By 1990, the firm had introduced its first systems, providing server services to PC networks running DOS, Windows and OS/2. The server included an array operating in RAID-5 mode, and incorporated redundant processors, controllers and power supplies, providing a high degree of fault tolerance.

In 1992, IBM acquired a minority interest in Parallan and became Parallan's exclusive distributor for its servers, which were announced by IBM as the PS/2 Server 295 and the PS/2 Server 195. After IBM later discontinued use of the Parallan servers, Parallan discontinued its array products. In December, 1994, Parallan acquired Meridian Data, Inc., a supplier of CD-ROM based server and CD-ROM authoring systems and changed its name to Meridian Data, Inc. in April, 1995.

PARITY SYSTEMS
110 Knowles Drive
Los Gatos, CA 95030

Parity Systems is a subsystem integrator producing an array based upon a purchased array controller. RAID modes 0, 3 and 5 are provided, as is a RAID-3 only subsystem. The arrays attach to Sun, H-P, IBM and other UNIX based

systems, and are available in rack, desktop or tower configurations. Some models are equipped with dual AC power feeds and battery backup for the cache.

PC EXPANDERS, INC. (Formerly Vanguard Technologies)
590 Herndon Parkway, Suite 300
Herndon, VA 22070

PC Expanders is a system integrator providing fault tolerant file servers for local area networks. The servers include disk drive arrays offering RAID-0/1/4/5 capability, using a controller attached to the EISA bus. Redundant power supplies and fans are also provided.

PERCEPTIVE SOLUTIONS
2700 Flora Street
Dallas, TX 75201

Perceptive Solutions was founded in 1988 to develop, manufacture and market intelligent mass storage controllers, disk array subsystems, and related storage-enhancement products for microcomputers, workstations, and file servers. Both software and hardware based mirroring arrays that attach to PC compatible equipment are available. The company sells its products through several different channels. Domestic U.S. distribution includes a number of regional distributors and direct sales to VARs and systems integrators. Selected products are also sold through a number of direct marketers and retailers, such as CompUSA.

PERIPHERAL LAND, INC.
47421 Bayside Parkway
Fremont, CA 94538

PLI got its start in 1985 with the introduction of an early SCSI adapter which allowed SCSI disk drives to be used with the Macintosh without voiding the warranty. The firm's product line of add-on peripherals was subsequently expanded to include SyQuest removable cartridge drives, CD-ROMs, magneto-optical drives, floptical drives, fixed hard disk drives, DAT tape drives and a variety of SCSI host adapters. Starting in mid-1992, PLI offered SCSI adapters with RAID-0/1 capability for a variety of Macintosh models. The company encountered severe financial problems in 1994, followed by a sharp reduction in activities.

PERISOL TECHNOLOGY
1148 Sonora Court
Sunnyvale, CA 94086

Perisol is a storage subsystem integrator specializing in the open systems and UNIX markets. The firm uses CMD controllers in its array subsystems.

PHOENIX INTERNATIONAL
812 West Southern Avenue
Orange, CA 92665

The RAIDMASTER array, based upon CMD controllers, is available from subsystem integrator Phoenix International. It is offered in a rack mounted configuration.

POLYWELL COMPUTERS, INC.
1461 San Mateo Avenue, Suite 1
South San Francisco, CA 94080

Founded in 1987 as a manufacturer of PC clones, Polywell began offering a family of disk drive array subsystems in 1994. The arrays incorporate Mylex controllers.

PRECISION COMPUTERS, INC.
1111 SE Stephens
Portland, OR 97214

Precision Computers is a systems integrator offering complete subsystems for IBM compatible personal computers. The equipment is provided with Hewlett-Packard and Seagate disk drives, and Mylex controllers. The original array systems used an Intel 486 processor, but the system announced in 1994 uses the Pentium chip.

PROCOM TECHNOLOGY
2181 Dupont Drive
Irvine, CA 92715

Procom Technology was founded in 1986 to provide external 5.25" flexible disk drive products to the IBM PS/2 market. The company next expanded its product line into the Apple Mac market with a family of hard disk drive subsystems. Subsequent ventures led them into the removable media hard disk drive

arena with SyQuest drives, DAT tape subsystems and TEAC tape cassette subsystems. The company designs its own ISA, EISA and SCSI-2 host bus adapters for its market requirements. Procom markets worldwide through a network of VARs, VADs and other resellers.

In late 1992, Procom introduced its first RAID product, the "XCELERATOR". This RAID controller makes it possible for the host to configure the board to look like a standard SCSI-2 host bus adapter or it can be user defined to function as a RAID-0, RAID-1 or both simultaneously. In 1993, the company announced array subsystems attachable to any SCSI host. These arrays use third party controllers and provide RAID modes 0, 1, 3, and 5.

RAAC TECHNOLOGIES, INC.
219 North Milwaukee Street
Milwaukee, WI 53202

RAAC (pronounced race) was founded in 1991. The company integrates ruggedized fault tolerant systems and subsystems for industrial customers, with most of its output going to the telecommunications sector. In 1991, the firm introduced its first disk drive array subsystem and several related models have since been introduced. All models provide RAID-0/1/5 and incorporate the DPT controller.

RAID POWER
210 Carnegie Center, Suite 101
Princeton, NJ 08540

Formed in 1993, RAID Power is a system integrator focused upon the New York and Central Atlantic area. The firm markets to specific industry segments, notably financial institutions and major brokerages.

RAIDTEC CORPORATION
105 Hembree Park Drive
Roswell, GA 30201

Founded in 1991, Raidtec offers RAID-0/1/3/5 arrays for Novell NetWare, UNIX and other platforms. The company manufactures its products in Georgia and in Cork, Ireland. Most sales are to integrators, although sales to OEMs and distributors are increasing. Raidtec array products are SCSI-based controllers and subsystems using 3.5" drives that offer hot replacement of key components. The FlexArray MX is a SCSI interfaced mirroring controller supporting RAID-1 and combined RAID-0/1. The FlexArray IX and its associated RUAC IX controller provide RAID levels 0, 1 and a combined RAID-3/5 mode. The more recently announced RUAC II and RUAX FX have similar array capabilities.

RANGER PLUG 'N' GO
9128 Jordan Avenue
Chatsworth, CA 91311

Storage subsystems and system integration are the primary activities of Ranger Plug 'N' Go. The firm's PC compatible arrays include third party array software combined with internally and externally packaged disk drives. An Apple compatible model was introduced in 1995.

ROSE DATASYSTEMS
1580 Oakland Road, Suite C108
San Jose, CA 95131

Rose Datasystems was founded in 1993 as a subsystem integrator specializing in high availability storage configurations. Arrays are attached to the host system controller bus for EISA or PCI attached arrays, and SCSI attached arrays are also available. Rose Datasystems incorporates Infortrend controllers in its array subsystems.

R SQUARED
11211 East Arapahoe Road
Englewood, CO 80112

R Squared is a system integrator operating throughout the U.S., with a concentration on mass storage products for UNIX systems operated by major commercial and government users. Among R Squared's product offerings are high capacity disk drives, tape backup systems, and tape library systems. The firm added a RAID-3/5 array in 1993 utilizing a purchased controller. After a 1994 management buyout by key employees, which was partially financed by Fujitsu, the firm added DynaRAID arrays to the product line.

SEE FIRST TECHNOLOGY, INC.
18809 Cox Avenue, Suite 100
Saratoga, CA 95070

Founded in 1987, See First sells peripheral subsystems to resellers of DEC, Sun, Silicon Graphics and other UNIX based systems. The company's sales of array products, which are based upon purchased controllers, have largely been to European customers. The array subsystems are custom configured for the firm's customers.

SEEK SYSTEMS, INC.
11014 120th Avenue NE
Kirkland, WA 98033

Seek Systems, founded in 1986, is selling disk drive arrays and related products including array performance analyzers into Sun, IBM and other UNIX platform markets. The firm produces its own caching controller that is the basis for its most recent array products. Seek also offers arrays using purchased controllers.

SEQUENT COMPUTER SYSTEMS
15450 SW Koll Parkway
Beaverton, OR 97006

Sequent is a manufacturer of midrange systems used in larger networking applications, some of which were developed using technology provided by Tricord. The firm offers software based array technology providing RAID-1 and RAID-0 capability and in 1993 added RAID-3 and RAID-5 capabilities using a purchased array controller.

SEQUOIA SYSTEMS, INC.
400 Nickerson Road
Marlborough, MA 01752

1994 total net sales: $44,765,190 (FY ending 6/30/94) Net income: $8,566,555

Sequoia was founded in 1981 as a manufacturer of fault tolerant on-line transaction processing systems. The company's strategy has been to offer OLTP systems based as much as possible on industry standard hardware and software, consisting of multiple processors that share memory and are managed by a single operating system. Disk drives are mirrored, with newer systems using high capacity 3.5" drives. Although Sequoia established a series of development and marketing alliances with major computer companies, including Hewlett-Packard, Samsung and Toshiba, it experienced financial problems resulting in key management changes, resulting in a narrower marketing focus.

SERAPH, INC.
11008 Greenbrier Road
Minnetonka, MN 55305

Seraph is a subsystem integrator specializing in the Apple Macintosh market. The firm assembles its arrays using Seagate drives, BusLogic adapters and Trillium array software. At present, Seraph markets exclusively in the U.S. through dealers and VARs.

SILICON VALLEY COMPUTER
441 North Whisman Road
Mountain View, CA 94043

Silicon Valley Computer was founded in 1982. The firm manufactures PC motherboards, PC/AT compatible systems and IDE controllers, and distributes disk drives. In December, 1992, Silicon Valley announced an ISA bus to IDE disk controller with RAID-1 mirroring capability. A VESA host bus version was announced in late 1993. SCSI-2 and PCI attached arrays were introduced in late 1994.

SOLBOURNE COMPUTER, INC.
1900 Pike Road
Longmont, CO 80501

In 1986, Solbourne began operations as a manufacturer of SPARC workstations, and eventually emphasized SPARC multiprocessor servers for networks using Oracle financial applications. Solbourne provided optional mirrored disk capability with its BoSS disk subsystems, but in 1994 withdrew from hardware sales, concentrating only on software products.

SPIN PERIPHERALS (Division of Spirit Technologies)
734 Forest Street
Marlborough, MA 01752

Founded in 1991, Spin Peripherals is a direct retailer, selling many products to the Apple Macintosh market. The company is moving into higher end storage products. Array products are created by bundling Trillium software and ATTO controllers.

STORAGE COMPUTER CORPORATION
11 Riverside Street
Nashua, NH 03062

1994 total net sales: $11,983,000 Net income: $1,118,000

Storage Computer's array development activities started in 1984 as a project within Cab-Tek, Inc., a privately held company manufacturing computer printer accessories. Starting with what is now known as RAID-3, Storage Computer's program experimented with various array configurations, finally evolving into "RAID-7", an asynchronous subsystem with extensive cache which is designed to overcome performance limitations of other RAID implementations. The compa-

ny's subsystem uses either 3.5" or 5.25" drives and is designed with a high level of redundancy. The company was established as a separate entity in 1992, and array shipments started in mid-1992. In March, 1995, Storage Computer became a publicly traded company by completing a merger with Vermont Research, as the surviving company.

STORAGE CONCEPTS, INC.
2652 McGaw Avenue
Irvine, CA 92714

Storage Concepts was founded in May, 1984, to develop and market a series of high speed parallel disk subsystems. These products were developed to support real time image processing, super and near-supercomputer data storage and specialized government and military applications, as well as addressing the storage requirements for general purpose computer applications.

The fundamental design of the company's disk storage controllers is differentiated in the marketplace by its dual-bus architecture. Disk subsystems offered by the company have the traditional host interface to the CPU, but in addition they offer a proprietary bus, the Differential Fast Bus (DFB), a 16 bit data bus that can accommodate data throughput up to 25 megabytes/second. A second proprietary bus, the Enhanced Differential Fast Bus (EDFB), a 32 bit data bus, allows the user to read and write to the disk drive at speeds up to 50 megabytes/second. The company's family of disk array subsystems was first introduced in April, 1989, with the model Concept 51. Since that time the company has added several more models, the latest being the Concept 812 SW and Concept 910SW, the latter directed to the very high performance market, which offers up to 504 gigabytes of data storage. With its orientation to high performance, the company is emphasizing arrays for the video-on-demand market.

The company sells direct, supplemented with manufacturers' sales representatives. In 1991, the company opened a direct sales and support office in the U.K. for support of its European based business. In other parts of the world the company sells through local distributors and systems integrators.

STORAGE DIMENSIONS INC.
1656 McCarthy Boulevard
Milpitas, CA 93035

Storage Dimensions, founded in 1985, was purchased by Maxtor in 1987 and operated as a Maxtor subsidiary until late 1992, when the company was purchased from Maxtor by its managers and an investment group. The SDI product line includes storage subsystems containing disk drives, tape drives and optical drives for attachment to workstations, personal computers and file servers. They are available for a variety of host platforms, including Sun, IBM, and other UNIX based computers, and Novell based PC compatible systems.

SDI's disk drive arrays are available in RAID 0/1/5/10 configurations for PC compatible hosts with SCSI adapters. In 1993, the company expanded its product line to include subsystems ranging from software based arrays at the low end to a variety of configurations targeted to large local area network servers running under Novell NetWare. The higher end array products are supported by array management software utilities.

STORAGEPATH (Subsidiary of SWS Corporation)
6727 Heritage Business Court, Suite 700
Chattanooga, TN 37421

StoragePath is a storage subsystem integrator serving the midrange systems market. The firm offers attractively packaged equipment using CMD array controllers into domestic and European markets. Manufacturing is done in Newbury Park, California. SWS, the parent corporation, was founded in 1978 as a NASA subcontractor.

STORAGE SOLUTIONS, INC.
417 Shippan Avenue
Stamford, CT 06902

Storage Solutions, founded in 1989, is an independent supplier of disk drive and tape drive subsystems for various personal computer networks. The firm has been shipping arrays since 1992. Extensive use is made of Digi-Data controllers.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027

1994 total net sales: $1,624,959,000 Net income: $41,437,000

Storage Technology's "Iceberg" array for mainframe applications is easily the most famous disk drive array program so far, despite the fact that deliveries were embarrassingly late. After great success in the second half of the 1970's as the leader in plug compatible disk drives, STC's shipments dropped in 1982-1983, as IBM 3380 shipments started in earnest. STC's volume shipments of 3380 equivalent drives didn't start until early 1984, too late to save the company from failures in its other new business areas. The firm's management had launched expensive programs to build mainframe computers and optical disk drives -- and had acquired firms in other areas, with extensive bank borrowing. In October, 1984, the bankers wouldn't wait, and the company was thrown into Chapter 11. After a series of complex negotiations with creditors, the firm emerged from bankruptcy in mid-1987.

Orders for STC's innovative 1/2" tape cartridge library system provided several years of growth, and were instrumental in restoring STC's position in the storage products industry. However, shipments of drives equivalent to IBM's 3380K did not start until 1989, and the firm never regained its earlier share of the IBM disk drive plug compatible market, eventually stopping disk drive production. In 1990, the firm began discussing new products incorporating disk drive arrays to be sold into the PCM marketplace. In addition to Iceberg, the Alpine midrange array for the AS/400 market manufactured for Storage Technology by Array Technology was offered in late 1992, resulting in indifferent sales and a lawsuit with the manufacturer. The high-end Iceberg array project, which uses originally used 5.25" drives, and later 3.5" models, was to be available in the first half of 1992, but the schedule slipped and Iceberg didn't generate sales revenue until early 1994. STC has continued with an aggressive array development program, currently using Data General CLARiiON array technology in its Nordique array, and has indicated that major follow-up programs are soon to appear.

STORNET, INC.
1109 Saunders Court
West Chester, PA 19380

StorNet was founded in 1989 as a VAR/integrator of storage subsystems into the UNIX-based midrange systems market. The company now has nine sales locations. Arrays are offered in both custom and standard configurations, with the standard configurations based upon CMD controllers and 3.5" disk drives.

STRATUS COMPUTER, INC.
55 Fairbanks Boulevard
Marlboro, MA 01752

1994 total net sales: $576,556,000 (FY ending 1/1/95) Net income: $60,982,000

Stratus Computer was founded in 1980 to produce fault tolerant minicomputers, which are used primarily for on-line transaction processing, communications control, distributed computing, and other applications in which high system availability is essential. Stratus has progressed through multiple generations of systems, with the latest systems employing RISC processors. IBM's System/88 was produced by Stratus on a contract manufacturing basis, and the company also has OEM arrangements with Olivetti, Ericsson Telecom and NEC. The Stratus D600 and D700 Peripheral Subsystems utilize disk drive controllers which provide mirrored RAID-1 capability, using standard industry disk drives.

SUN MICROSYSTEMS, INC.
2550 Garcia Avenue
Mountain View, CA 94043

1994 total net sales: $4,689,892,000 (FY ending 6/30/94) Net Income: $195,824,000

Sun is a major producer of workstations and network servers based upon UNIX and Sun's own networking software. The firm was founded in 1982 and rapidly became a significant factor in workstation and server markets. The firm's SPARCstation and SPARCserver platforms are targets for many third party software providers. As an adjunct to its version of UNIX, Sun offers "Online: DiskSuite", a software-based file system that provides for very large file systems (up to one terabyte) to be created under UNIX and which also provides mirroring and striping. Sun licenses DiskSuite for both its desktop systems and its servers. In the first quarter of 1994, Sun announced a hardware based array operating with RAID levels 0, 1 and 5, as well as combined RAID-1/0 for attachment to its SPARCservers. An improved model was introduced in early 1995. Sun's arrays have been popular, and the company has obtained a significant share of the overall disk drive array market.

TANDEM COMPUTERS INC.
19333 Vallco Parkway
Cupertino, CA 95014

1994 total net sales: $2,108,035,000 (FY ending 9/30/94) Net income: $170,200,000

Since its start in 1974, Tandem has become the largest manufacturer of fault tolerant on-line transaction processing systems, and has expanded its product coverage to include fault tolerant UNIX software based systems and large network systems. In 1992, the company also introduced systems using RISC processors and for the first time offered data storage systems using large capacity 5.25" disk drives. Tandem's target customers are mainly large companies and government installations with mission critical applications requiring computer systems with high standards of availability.

In 1990, Tandem acquired Array Technology Corporation, which produced array subsystems, including the Storage Technology Alpine array marketed in the IBM AS/400 market. Tandem did not use Array Technology RAID subsystems with its own OLTP systems, and continues to employ the mirrored disk implementations which have been its storage mainstay for many years. In early 1994, most of the assets of Array Technology, which had been reduced to only a development facility, were sold to EMC. At least one array based upon EMC controllers will be added to the Tandem product line in 1995. This array will offer RAID levels 0, 1, 3, and 5.

The Tandem 4500 disk subsystem introduced in late 1991 utilizes up to six disk drive modules, each containing up to six disk drives, to provide up to 37.3 gigabytes in a single cabinet, and was supplemented in 1993 with the 4510 disk subsystem which doubles total capacity through the use of 2 gigabyte drives. The 4570, added in 1995, uses 4 gigabyte drives and supplies 32 gigabytes of capacity.

TANGENT COMPUTER, INC.
197 Airport Boulevard
Burlingame, CA 94010

Tangent is a system manufacturer that produces servers working under OS/2 and UNIX, and servers for Novell networks. Its product line includes a six drive array option operating in RAID-5 mode and several server models operating with RAID levels 0, 1, and 10.

TD SYSTEMS
24 Payton Street
Lowell, MA 01853

TD Systems manufactures and sells RAID-1 and dual path RAID-1 controllers to selected VARs and system integrators. The array works with SCSI hosts and drives. Multiple host computers are supported. The controllers are packaged in a standard 5.25" drive full height or half height form factor.

TEXAS MICROSYSTEMS, INC.
5959 Corporate Drive
Houston, TX 77036

Founded in 1981 as a systems integrator serving the oil industry, Texas Microsystems has retained its industrial customer orientation, providing fault tolerant systems for a variety of manufacturing and government organizations. The fault tolerant systems employ a RAID-1 configuration using purchased controllers with modified microcode. The firm sells extensively through manufacturers representatives. In 1995, Texas Microsystems became a wholly owned subsidiary of Sequoia Systems.

THINKING MACHINES CORPORATION
245 First Street
Cambridge, MA 02142

Thinking Machines was established in 1983 to design and manufacture parallel processing supercomputers. The company's pioneering "DataVault" disk drive array using a Hamming Code error correcting scheme became known as

RAID-2 when the U.C. Berkeley RAID nomenclature system was published in 1987. Unfortunately, RAID-2 was not as efficient in utilizing available disk drive resources as later array configurations, and the DataVault is no longer in production. It was superseded in 1992 by the CM-5 Scalable Disk Array, a RAID-3 array architecture originally with the theoretical ability to attach 3,072 3.5" drives, since scaled back to a more conservative 500 drive total.

TOTAL TEC SYSTEMS INC.
2 Gourmet Lane
Edison, NJ 08837

Total Tec is a distributor and integrator of storage products, networking products and complete systems, catering primarily to the DEC market but also to other UNIX platform markets. The firm's array products employ purchased controllers and operate in RAID-3 or RAID-5 mode.

TRANSOFT CORPORATION
31 Parker Way
Santa Barbara, CA 93101

Transoft was founded in 1986 as the result of a merger between two software companies, Mibek and Apolyonics. The company integrates software based array controllers with other mechanical and electrical subassemblies, shipping most of its output to VARs and OEMs serving the Macintosh market. The firm markets in the U.S., Europe and Asia, notably Taiwan.

TRICORD SYSTEMS, INC.
3750 Annapolis Lane
Plymouth, MN 55447

1994 total net sales: $81,121,000 Net income: $1,712,000

Tricord started in 1987 with venture capital funding to develop and manufacture network superservers for the enterprise computing market. Additional investment was received from Kubota, and Tricord has licensed Kubota Computer to manufacture and sell Tricord products in the Japanese domestic market. The PowerFrame server series is designed for field upgradability and includes duplexing for most components to achieve a high level of fault tolerance. In the past Tricord has resold Ciprico RAID-3 arrays, but in June, 1992, added its own RAID-0/1 capability for Tricord file servers, supplemented in April, 1993, with an optional RAID-0/1/4/5/10 array board. The servers were upgraded with third party controllers, custom configured for Tricord, in 1994 and 1995.

TRILLIUM RESEARCH, INC.
220 Locust Street
Hudson, WI 54106

In May of 1993, Trillium announced its RAID-0/1/4/5 Remus array software package, which is used by many system integrators with storage subsystems for the Apple Macintosh. The software package will operate with a number of widely available SCSI controllers, including ATTO, BusLogic, FWB, Seraph and others. An array configuration and status reporting utility is included.

ULTRASTOR CORPORATION
13766 Alton Parkway, Suite 144
Irvine, CA 92718

UltraStor Corporation was founded in 1989 to develop and market a family of "ULTRA" high performance disk controllers aimed at rapidly growing disk intensive systems such as multiuser, networking, CAD/graphics and desktop publishing. The company's family of disk controllers and adapters currently support the popular SCSI devices, IDE interface drives, as well as higher performance ESDI interface disk drives.

In October, 1991, the company introduced its first RAID product, the Model ULTRA 124F, an EISA/SCSI Array Controller for the OEM and systems integrator markets supporting RAID levels 0, 1, 4 and 5. In October, 1992, the company introduced the ULTRA 144F RAID level 0, 1, 4 and 5 disk array controller which can support many host computer platform (supermicros, minicomputers, PC's, etc.) which use SCSI host interfaces. UltraStor was initially successful with its array controllers, capturing many system integrators and some OEMs as customers. Despite its good start, UltraStor was unable to fund its growth and after acquisition discussions in 1993 with GigaTrend, filed for Chapter 11 bankruptcy. The company is now engaged in rebuilding its engineering team and updating its product line, and resumed shipments in 1994.

UNI SOLUTION, INC.
5005 Riverway, Suite 330
Houston, TX 77056

Uni Solution was founded in 1992 as a supplier of UNIX based systems. The firm began integrating disk drive arrays into its systems in 1993, and is currently emphasizing its storage integration activities. Most customers are in the U.S., and most of these are end users, including government organizations.

UNISON INFORMATION SYSTEMS
21 Walsh Way
Framingham, MA 01701

Founded in 1988, Unison's basic business is add-ons for Sun systems, including disk drive arrays and optical storage subsystems. The firm remarkets disk drive array subsystems from Fujitsu and others.

UNISYS CORPORATION
P.O. Box 500
Blue Bell, PA 19424

1994 total net sales: $7,399,700,000 Net income: $100,500,000

With roots deep in the history of the computer business, Unisys is a manufacturer of mainframes, minicomputers, and networking equipment. The existing company was formed from the merger of Burroughs and Sperry-Univac in 1986. With the decline of the mainframe market in recent years, Unisys has been focussing on networking, software and services. Financial services, airlines, travel and telecommunications are areas of Unisys market strength.

The company offers RAID-1 and RAID-0 arrays on its network and mainframe systems, many using Veritas array software. A hardware based array for network servers offers RAID levels 0, 1, 3, and 5. A subsystem with RAID-1 capability purchased from EMC is offered with some Unisys mainframe systems.

UNITROL DATA PROTECTION SYSTEMS INC.
1177 West Hastings Street, Suite 2108
Vancouver, British Columbia V6E 2K3 Canada

Unitrol offers a software implementation of a RAID-1 array. The software operates on any IBM compatible PC running DOS or Windows. The firm sells through dealers and VARs, but is gradually developing an OEM base as well. Unitrol's array can also operate with disk drives employing removable cartridges, allowing creation of instant backups as file contents change. It is also possible to logically partition the disks and mirror only selected partitions. The firm also offers IDE drive controllers configured to allow duplexing with mirroring software.

VERITAS SOFTWARE CORPORATION
1600 Plymouth Street
Mountain View, CA 94043

1994 total net sales: $15,121,000 Net income: $2,775,000

An offshoot of Tolerant Systems, a UNIX based systems manufacturer, Veritas was established in 1988. The company has developed storage management

software add-ons to the UNIX operating system, including a module permitting disks to operate in mirrored and striped modes. RAID-5 was added in 1995. At present, the Veritas modules operate with UNIX SVR4, SCO UNIX and Sun Solaris. The company has licensed the use of its technology to system manufacturers that include UNIX SVR4 with their systems. The SCO UNIX and Solaris versions are sold through distribution. Veritas modules appear on a large proportion of the UNIX SVR4 based systems currently marketed, but the firm is still trying to improve its presence in the SCO UNIX and the Sun Solaris-based markets. Veritas has had a long-standing joint development program with UNIX System Laboratories (recently acquired by Novell), and similar relationships with IBM relating to nonarray software products. The firm is also working on joint developments with a number of other firms, including Oracle and a number of array producers.

In recent months, Veritas has shifted its focus even further to storage management products, selling off its Vista division (that produced software quality tools) and acquiring Tidalwave Technologies, a producer of server automatic failover software. The firm began selling its products into the Sun reseller channel in October, 1994, and further development of distribution channels is anticipated. Veritas grew strongly during the first part of 1995.

WESTERN MICROTECHNOLOGY
12900 Saratoga Avenue
Saratoga, CA 95070

Founded in the 1970s as a semiconductor components distributor, Western Microtechnology entered the systems and subsystems markets in 1990, and is currently a distributor for several major suppliers of systems and peripheral devices. The company plans to offer its own integrated storage subsystem, including disk drive arrays, in 1995.

WINCHESTER SYSTEMS, INC.
400 West Cummings Park
Woburn, MA 01801

Winchester Systems has been marketing its add-on storage subsystems since 1981. Early products were mostly disk drive subsystems, but DAT tape subsystems have been a larger part of the company's business in recent years. The company's Flashdisk 2 RAID-1 subsystem has been offered since mid-1992, with up to 90 gigabytes capacity for DEC and most engineering workstation applications. Several additional RAID-0/1/3/5 subsystems for SCSI-2, EISA, ISA, and DSSI attachment were added in late 1993.

WYSE TECHNOLOGY
3471 North First Street
San Jose, CA 95134

Wyse Technology manufactures and markets personal computers and terminals. In 1993, at the Fall COMDEX show, the firm exhibited a server equipped with a DPT array controller. RAID-0 and RAID-1 are supported.

ZITEL CORPORATION
630 Alder Drive
Milpitas, CA 95035

1994 total net sales: $17,452,000 (FY ending 9/30/94) Net income: ($6,961,000)

Zitel, which began operation in 1979, is best known as a manufacturer of large solid state memory add-ons for Unisys mainframes and minicomputers, especially those used in on-line transaction processing. Zitel has also developed products for a number of OEM customers, including IBM. In 1991, the firm began selling a memory subsystem incorporating both solid state memory used as a large, fast cache and a high performance disk drive.

While Zitel does not market array products at present, it has done so in the past, beginning with a RAID-2 array sold to Ford Aerospace in 1988, and has undertaken custom array development projects for outside firms, including IBM. Zitel currently enjoys significant licensing revenue from IBM as a result of development activities during the gestation period of IBM's RAMAC mainframe array. The company remains interested in high performance arrays and may reenter the market in the future, probably in conjunction with a selected strategic partner.

ZZYXZ WORKSTATIONS AND PERIPHERALS
5893 Oberlin Drive
San Diego, CA 92121

ZZYXZ (Z-Zix, as it's pronounced) is a system integrator. The firm introduced an array based system in the second half of 1993. Array functionality is based upon a CMD controller. The ZRS-3000 series is packaged with 3.5" drives. The similar ZRS-5000 has 5.25" disk drives.

Asia/Pacific Rim Manufacturers

(All companies are in Japan unless otherwise noted.)

ABLY-TECH CORPORATION
16, Lane 209, Section 5, Chung-Hsin Road
San Chung, Taipei ,Taiwan
Republic of China

Ably-Tech displayed a mirroring disk controller with interfaces to the ISA bus and the VESA bus at the 1994 COMPUTEX show in Taipei. The firm is actively seeking distributors and OEMs for the card. The mirroring function is provided by a chip derived from technology developed by ITRI.

ACER CO.
347 Wu Lin Fung Chen Road
Lung Tan Hsiang
Taoyuan, Taiwan
Republic of China

1993 total net sales: $732,031,000 (FY ending 12/93) Net income: $40,629,000

Founded in 1981, Acer is known for its personal computers and related products. The firm is now one of Taiwan's largest companies. Acer's U.S. subsidiary, Acer America, is located in San Jose, at the facilities of Altos, which Acer acquired.

While Acer has had an internal development program focussed on RAID-0/1, its server class products equipped with an array option currently use controllers purchased from third parties that offer RAID levels 0, 1 and 5. All of Acer's array sales are for subsystems attached to Acer computers. The majority of Acer's array sales have been to customers outside the U.S., a pattern that is expected to continue.

ADVANCED TECHNOLOGY AND SYSTEMS CO., LTD.
1, Kirihara-cho
Fujisawa-shi, Kanagawa-ken 252

Marketing under the ADTX brand name, AT&S is a joint partnership with IBM participation. The firm is located at IBM's Fujisawa facility, marketing external rigid and optical disk drives, memory cards, and storage subsystems.

Hardware based array subsystems are offered with RAID levels 0, 1, and 5 available.

ARESYS INC.
11F, No. 101 Sung Chiang Road
Taipei, Taiwan
Republic of China

Founded in May of 1992, privately held Aresys is a manufacturer of controllers for PC compatible systems. The firm's array controller, introduced in 1993, provides for RAID-1 and RAID-0 operation. Aresys markets its products in Asia, Europe and the U.S.

AIWA CO., LTD.
2-11, Ikenohata 1-chome
Taito-ku, Tokyo 110

1994 total net sales: $2,059,637,000 (FY ending 3/94) Net income: $45,431,000

Best known for its entertainment products, Aiwa is an increasing presence in the data storage business as well, offering tape drives and libraries, fax modems, CD-ROM drives and other products.

Aiwa is the parent organization of Core International, and is responsible for sales of Core products through its various national sales organizations. The firm has also marketed a line of mirroring storage subsystems entirely under its own brand.

ATEN INTERNATIONAL CO., LTD.
12F, 101 Sung Chiang Road
Taipei, 10428
Taiwan

ATEN began producing add-on products for personal computers in 1980. In late 1993, ATEN began offering arrays with RAID-0/1/4/5 capability. Both ISA and EISA host interface boards are available.

DTC TECHNOLOGY CORPORATION
2F, 542-2 Chung Cheng Road
Hsin-Tien City
Taipei-Hsien
Taiwan

DTC has been producing a controller with RAID-1 and RAID-0 capability since 1992, and in late 1993 announced an EISA bus controller capable of providing RAID-0/1/4/5 capability. Both controllers support combined RAID-1 and RAID-0 operation as well.

EAST TN PRODUCTS CO., LTD.
17, Lane 118, Wu-Shin Street
Taipei, Taiwan
Republic of China

East TN displayed a VL bus to IDE mirroring array at COMPUTEX in mid-1994. The array is based upon ITRI technology, and is available with drivers for DOS, Novell, UNIX, and OS/2.

FUJITSU LTD.
6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100

1994 total net sales: $30,777,745,000 (FY ending 3/94) Net income: ($369,333,000)

Fujitsu derives about 70% of its sales from the computer industry and is known as the leading manufacturer of computers for the Japanese domestic market. Fujitsu is also a major exporter to the worldwide computer market. Since 1982, the company has been among the leaders in worldwide disk drive revenues, and skillfully managed a transition from older removable disk drives to a product line consisting mainly of fixed disk drives in all capacity ranges and in several disk diameters. Fujitsu is manufacturing some of its high performance drives at a major facility near Portland, Oregon, which is now in full operation. Some low end 3.5" drives are produced in Thailand. Intellistor, located in Longmont, Colorado, is a Fujitsu subsidiary which has developed small diameter disk drives and disk drive arrays. Fujitsu also has a 44% ownership position in Amdahl.

Since the second half of 1990, Fujitsu has been offering a RAID-3 array originally developed by Intellistor. All shipments of the array have so far been limited to Japan. In the first half of 1994, the firm began shipping RAID-3 arrays using Baydel controllers. Beginning in 1995, DynaRAID II will begin shipping, providing RAID levels 0, 1, 3, and 5. Both controllers and subsystems will be offered.

HITACHI DATA SYSTEMS
750 Central Expressway
Santa Clara, CA 95056

HDS introduced the 7600 disk storage subsystem for mainframe applications using unique Hitachi 6.5" disk drives, in June of 1993. The 7600 can utilize either 7693 2.8 gigabyte drives or 7699 10 gigabyte drives, and is capable of operating in RAID-1 mode. The model 7700, with first deliveries expected in the second half of 1995, operates in RAID-5 mode and can include up to 224 drives plus hot spares.

HITACHI, LTD.
4-6 Kanda-Surugadai
Chiyoda-ku, Tokyo 101

1994 total net sales: $72,551,029,000 (FY ending 3/94) Net income: $639,990,000

Hitachi remains Japan's largest manufacturer of electrical and electronic equipment and a major manufacturer of computer systems. The firm currently makes a wide range of Winchester technology fixed disk drives for both captive and noncaptive markets. In addition to significant OEM sales of smaller capacity fixed disk drives, Hitachi also sells IBM compatible mainframe storage subsystems through Hitachi Data Systems (formerly National Advanced Systems, before acquisition by Hitachi), and in 1983 started selling plug compatible drives for distribution in the European PCM market through BASF, and currently through Comparex.

Hitachi began shipping a RAID-3 array in late 1992, and added RAID-4 and RAID-5 capability in late 1993. The Hitachi arrays are SCSI interfaced and make use of Hitachi's own high capacity disk drives. The A6511 series, introduced in 1995, operates in RAID-3 and RAID-5 modes and can provide up to 138 gigabytes of storage for Hitachi's file servers.

INFOCOM DIGITAL SYSTEMS PVT., LTD.
B-285 Okhla Industrial Area
Phase 1, New Delhi 110 020
India

Infocom is a manufacturer of array controller boards. EISA and PCI interfaces to host systems are available, while drives are connected with SCSI-2 interface channels. RAID levels 0, 1, and 5 are provided.

INFORTREND, INC.
32-3 Dong Men Street
Baan Chyau, Taipei
Taiwan

Infortrend is a startup company working on an array controller offering RAID-0, RAID-1, RAID-3, and RAID-5. The controllers have PCI, EISA or SCSI-2 drive ports, and are intended for use on IBM PC compatible platforms. The firm is marketing the controllers on an OEM basis, and has achieved some success with system integrators in the U.S.

MIDORI ELECTRONICS CO., LTD.
559 Shimoasao, Asao-ku
Kawasaki, Kanagawa-ken

Midori is well known in Japan as a reseller of add-on and add-in components for small computers. Included in Midori's product line is a small array operating in RAID-1 or RAID-5 modes.

NEC CORPORATION
5-33-1, Shiba
Minato-ku, Tokyo 108

1994 total net sales: $35,095,951,000 (FY ending 3/94) Net income: $64,765,000

NEC has defined its product area as communications and computers, with computer products currently accounting for about 49% of the firm's total revenues. Current disk drive production involves fixed disk drives, from large to small configurations, for both captive and OEM markets. Fixed disk drives include 3.5", 2.5" and 1.8" disk diameters. NEC was the first of the major Japanese drive producers to produce small form factor rigid disk drives offshore, with the establishment of a factory in the Philippines. NEC has been shipping a SCSI controller board with mirroring capability in the personal computer market, and in 1992 announced a RAID-3 array for use with NEC supercomputers. A few small network servers incorporating disk drive arrays have also been introduced.

NIPPON TEXA CO., LTD.
824-1 Saedo Tsuzuki-ku
Yokohama 224

Nippon Texa is a subsystem integrator and reseller addressing the Japanese market. A variety of storage subsystems are offered for the Macintosh and PC compatible markets. Disk drive arrays capable of RAID-0, RAID-3, and RAID-5 operation have been shipped since early 1994. The company is emphasizing small arrays for single user systems and wishes to develop an international market for them.

NISSIN ELECTRIC CO., LTD.
47, Umezu-Takase-cho
Ukyo-ku, Kyoto 615

1994 total net sales: $1,061,392,000 (FY ending 3/94) Net income: $23,265,000

Nissin Electric is marketing several models of small disk drive arrays operating in RAID-3 or RAID-5 mode. The arrays have SCSI-2 interfaces to the

host and IDE drive interfaces. The first arrays were introduced in early 1994, and additional models became available in 1995.

SANYO ICON (Subsidiary of Sanyo Electric Co., Ltd.)
18301 Von Karman
Irvine, CA 92715

1994 total net sales: $16,603,941,000 (FY ending 11/94) Net income: $111,029,000

Sanyo Electric Co. is a multinational Japanese corporation, employing over 56,000 people in 100 different subsidiary companies in 27 countries. In North America, Sanyo Electric operates 27 of these subsidiaries and maintains 52 regional offices. The company's products include audio and video equipment, information systems and electronic devices, home appliances, batteries and industrial and commercial equipment.

Sanyo Icon became a Sanyo subsidiary in 1984. The company is part of the Information Systems Group, whose charter is to design, develop, manufacture and internationally market two separate product lines. The first is a line of high performance mass storage peripheral systems for local area networks, and the second is a line of high performance computer systems specifically designed for the PICK, UNIX and MS-DOS markets.

In October, 1992, Sanyo Icon introduced its LANser MRX (Multiple RAID eXtended) family of high performance disk array subsystems, complementing its LANser Intelligent Disk Subsystems products which were introduced in 1990 as Sanyo Icon's first offering for LAN markets. With the LANser MRX product, Sanyo Icon offered RAID-0, 1 or 5 capabilities in various physical packaging configurations. The LANser MRX line has fast internal bus structure (80 megabytes/second) and will support up to 12 file servers.

In early 1995, Sanyo Icon's disk drive array operations were acquired by EMC, to which the firm had been an OEM supplier of equipment used in EMC's Centriplex product line.

SUNIX CO., LTD.
76, Pao Kao Road
Hsin Tsin, Taipei, Taiwan
Republic of China

Sunix, established in 1986, is a manufacturer of controller cards. The product line includes a mirroring controller based upon ITRI tchnology. Up to 8 IDE drives can be attached.

SYMBIOS LOGIC (Subsidiary of Hyundai Electronics)
3718 North Rock Road
Wichita, Kansas 67226

Symbios Logic started as NCR's Peripheral Products Division. When NCR was purchased by AT&T, the organization then became a part of the AT&T Microelectronic Products Division, which was primarily concerned with specialized chips. In late 1994, Hyundai Electronics initiated the purchase of MPD from AT&T, and MPD became Symbios Logic, a wholly owned subsidiary of Hyundai Electronics.

Symbios Logic produces array controllers which it uses in its own arrays and also sells on an OEM basis to other array producers. In 1991, a specialized array chip set, produced by the Microelectronics Division, was introduced, which is used internally and also sold to OEMs. The chip set and controllers were upgraded in 1993 to use more powerful processors. A third series of upgraded array controllers using faster microprocessors is due in mid-1995.

AT&T also offered Disk Array Plus, software that provides array functionality without the need for specialized hardware. The software was generated by AT&T in its Naperville, Illinois, facility, and was retained by AT&T.

TEAC CORPORATION
3-7-3 Naka-cho
Musashino, Tokyo 180

1994 total net sales: $1,118,843,000 (FY ending 3/94) Net income: $72,049,000

TEAC is marketing in Japan an array with RAID-3 and RAID-5 capability, utilizing Allodyne controllers. The half inch high 3.5" disk drives produced by TEAC to the Kalok (now JTS) design are used, with up to five drives packaged in the form factor of a full height 5.25" disk drive. Marketing began in 1994.

TEKRAM TECHNOLOGY CO., LTD.
5, Lane 768, Pateh Road Section 4
Taipei, Taiwan
Republic of China

Tekram, founded in 1990, is a producer of controller cards. The firm's announced products include a mirroring disk controller displayed at COMPUTEX in 1994.

European Manufacturers

ADVANCED TELECOMMUNICATIONS MODULES LTD.
Mount Pleasant House
2, Mount Pleasant
Huntingdon Road
Cambridge CB3 0BL
United Kingdom

ATML was founded in 1993 as a spinoff from Olivetti's research laboratory in Cambridge, and has a minority investment by Olivetti. The firm's objective is to develop and market a wide variety of products for use with asynchronous transfer mode networks. The first array product offered is a high performance RAID-3 subsystem designed to interface directly to ATM networks.

ARCO ELECTRONICS INC. (Subsidiary of ARCO Electronic Control Ltd., Israel)
2750 North 29th Avenue, Suite 316
Hollywood, FL 33020

ARCO was founded in 1987 and is a supplier of LAN controllers and storage subsystems for personal computers. The firm is a subsidiary of ARCO Electronic Control, an Israeli company specializing in industrial electronics and timers. In late 1992, ARCO began shipping a RAID-1 array including a board with two mirrored 2.5" drives mounted on the board. The board, which has a Micro Channel interface, can also attach to two external drives, instead of drives mounted on the board. An ISA bus version was added in 1995.

ATON SYSTEMES
Batiment Euclide
9, Rue Olof Palme
94000 Creteil
France

ATON, founded in 1992, produces the AREKA brand array subsystems and array controllers. All sales are currently in Europe, through a network of distributors. The company's disk drive arrays operate in RAID modes 0, 1, 5 and combined RAID-1/0, with array controllers available with either an EISA or ISA bus host interface. SCSI-2 and PCI interfaced versions became available in 1994 and 1995, respectively.

BAYDEL LTD.
Brook Way
Leatherhead
Surrey KT22 7NA
United Kingdom

RAID-3 array controllers and subsystems are among the products of Baydel. Controllers are supplied on an OEM or PCM basis to firms in the U.S. and in Europe, while most complete subsystems are sold in Europe. Most European sales are through distributors in the U.K., Germany and Switzerland. The array attaches to a host SCSI port, and includes a cache ranging from 4 to 64 megabytes in capacity.

The firm was founded in 1972 by engineers from IBM's Hursley research establishment, and initially designed and fabricated peripheral equipment for the IBM and DEC systems market. Add-on products for the PC market became part of the product line in 1988. Controllers supporting mirroring and caching were first developed in 1979, and the first RAID-3 units were shipped in 1991.

COMPAREX INFORMATIONSSYSTEME GMBH
Subsidiary of BASF
Gottlieb-Daimler-Strasse 10
D-6800 Mannheim
Germany

Comparex became operational at the beginning of January, 1987, as a joint venture operation comprising the former BASF and Siemens PCM businesses, marketing systems and peripherals made by Fujitsu and Hitachi, with a concentration in recent years on Hitachi products. In late 1991, the owners announced BASF's assumption of complete ownership. In late 1992, Comparex and Hitachi Data Systems announced an agreement under which Comparex would control distribution of Hitachi mainframes and peripherals in Germany and Eastern Europe, and HDS would handle distribution in most of the rest of Europe and in the Middle East. Current disk drive activities involve PCM 3390 equivalent drives, including a subsystem with RAID-1 capability, produced by Hitachi. A new Hitachi PCM subsystem with RAID-5 capability is expected to be shipped in the second half of 1995.

DISK PACK
1 Cours de Billancourt
92130 Issy les Moulineaux
France

Disk Pack is a storage subsystems integrator offering externally mounted disk drives, docking bays, and disk drive arrays operating in RAID-0/3/5 modes. The firm employs Raidtec array controllers in its array subsystems.

EUROLOGIC SYSTEMS LIMITED
49 Bracken Road
Sandyford Industrial Estate
Dublin 18
Ireland

Eurologic is a system integrator producing storage subsystems with RAID-0/3/5 capability based upon a CMD controller. The subsystems are equipped with redundant power supplies and fans, and dual AC power feed is offered as an option. Host interfaces for SCSI-2 and the DEC DSSI and CI bus are available.

FUTURE COMPUTERS LTD.
14 Imperial Way
Croydon Airport Industrial Estate
Croydon, Surrey CR0 4RR
United Kingdom

Future Computers is a subsidiary of Baydel established to market array subsystems in the European market. The RAID-3 subsystems use the Baydel controller and are available in 3 drive or 5 drive configurations.

GROUPE BULL
121, avenue de Malakoff
75116 Paris
France

Groupe Bull is the parent organization of an intricate grouping of companies active in the computer industry. Included are Compagnie des Machines Bull, the successor to a long line of French computer organizations, and now the parent company for all Bull computer programs. Also included are the organizations previously known in the United States as Honeywell Information Systems and Zenith Data Systems.

Computer operations, except for personal computers, are the responsibility of Bull Systems Products, which early in 1993 announced deals with Data General to resell the DG CLARiiON RAID-0/1/3/5 array subsystems for UNIX applications and with EMC to resell the Symmetrix 4800 RAID-1 subsystems for mainframe applications. Zenith Data Systems had been reselling Integra RAID-5 software arrays for personal computer applications, but has switched to a hardware based design using Mylex controllers.

HI-DATA LIMITED
61 Reading Road, Unit 8
Pangbourne, Berkshire RG8 7HY
United Kingdom

Hi-Data manufactures and sells array controllers and subsystems capable of operating at RAID level 3 and in hybrid RAID-3/RAID-5 modes which Hi-Data calls RAID-53 and RAID-35. Redundant fans and power supplies are provided in the Hi-Data subsystems. A second array controller can be provided as an option to provide controller redundancy. Hot sparing and hot swapping are also supported. In a program to expand distribution beyond Europe, Hi-Data has opened a sales and support office in Woburn, MA, and has been promoting its presence in the market through participation in small exhibitions and other public relations activities.

ICL
Lovelace Road
Bracknell
Berkshire RG12 8SN
United Kingdom

ICL added disk drive arrays to its product line in 1993 with a software based array offering RAID-0 and RAID-1, plus a hardware based array with RAID modes 0, 1 and 5. In 1994, a more powerful array was added using a combined RAID-3 and RAID-5 mode of operation. Purchased controllers are used.

LION CABINETS LIMITED
Buslingthorpe Green
Meanwood Road
Leeds LS7 2HG
United Kingdom

Known for its cabinets and enclosures, Lion has produced small numbers of disk drive array subsystems attaching to UNIX-based platforms. U.S. operations were scaled back in early 1995.

MEMOREX TELEX CORPORATION (Subsidiary of Memorex Telex N.V.)
4343 S. 118th East Avenue
Tulsa, OK 74146

The pioneer magnetic media and plug compatible disk drive producer originally known as Memorex Corporation was acquired by Burroughs in late 1981, and Burroughs placed all disk drive development and manufacturing responsibility for the entire company in the Memorex organization. In late 1986, however,

Burroughs sold the disk drive sales and service operations of Memorex to a group of Memorex executives, retaining only the rigid disk development and manufacturing operations. Telex was acquired by Memorex in early 1988 and the firm adopted its new name.

Plug compatible disk drive subsystems now sold and serviced by Memorex Telex use various purchased drive mechanisms. Memorex, headquartered in Europe, includes PCM marketing operations, the Memorex Communications Division, and the flexible media operations. During the 1990's the firm has endured weak financial performance, and since 1991 has gone through two bankruptcies. In 1992 Memorex Telex introduced a RAID-1 subsystem in the AS/400 add-on market, using an array manufactured by Formation, and in 1994 announced a program to resell Data General CLARiiON array subsystems in the AS/400, RS/6000, Sun workstation and Novell network markets.

SOLID COMPUTER GMBH
Bruckmannring 32
D-8042 Oberschlessheim
Germany

Solid Computer is a system integrator and manufacturer offering SPARC workstation clones and a variety of controller cards for Sun and other systems. Also in the product line are solid state disk drives, optical disk drive subsystems, tape subsystems and servers. The firm has an array subsystem capable of operating at RAID levels 0, 1, 3, and 5, which began shipping in late 1992. Current designs incorporate the Data General CLARiiON array. While most sales have been in Europe, a U.S. subsidiary located in Norcross, GA, Solid Computer Corporation, is beginning to develop U.S. markets.

TELEDISK LTD.
Bnei-Brack
Israel

TeleDisk has developed a mirroring controller with SCSI host and drive ports for use with a wide variety of platforms and operating systems. The controller includes two SCSI output channels. A RAID-5 version is being developed. TeleDisk also integrates storage subsystems.

TWINCOM INTERNATIONAL
Slotlaan 15
4902 AD Oosterhout
The Netherlands

TwinCom is offering mirroring software for UNIX systems in Europe and in U.S. markets. The software can operate RAID-1 arrays locally or over a network.

Sales are made through distribution and on an OEM basis. A U.S. marketing and support office is located in Shreveport, LA.

TwinCom's product is derived from mirroring software developed 12 years ago for a Dutch pharmaceutical company. It was ported to UNIX in 1983, and first became generally available in 1986 as a system drive mirroring product. Support for multiple pairs became available in 1989 and for networks in 1992.

VORTEX COMPUTERSYSTEME GMBH
Falterstrasse 51-53
74223 Flein
Germany

Vortex was founded in 1985 and is privately held. The firm's product line consists of SCSI and disk array controllers. RAID levels 0, 1, 4, and 5 are provided via firmware installed in the controller. EISA and PCI bus array controllers, all made in Germany by Vortex, are available, and are resold by a network of system integrators and distributors.

WESTEK MARKETING LIMITED
Unit 1, Lancaster Park Estate
Bowerhill, Melksham
Wiltshire SN 12 6TT
United Kingdom

Westek is a system integrator, specializing in networking hardware. The firm's disk drive arrays are based upon purchased controllers.

XYRATEX (Havant International Ltd.)
P.O. Box 6, Langstone Road
Havant, Hampshire PO9 1SA
United Kingdom

Xyratex was created in December, 1994, as the result of a management buyout of IBM's Havant facilities, at that time a division of IBM. Xyratex, at that time a brand name, became the trading name of the new company. Products include disk drives, flexible circuits, storage subsystems, test systems and networking equipment, some produced under contract for a number of clients, including IBM. Xyratex also develops and sells specialized software products. Although "new", the company is of significant size, occupying about 600,000 square feet of space and employing about 2,000 people. The firm manufactured over two million small disk drives in 1994.

Xyratex announced its own line of disk drive array subsystems supporting RAID levels 0, 1, 3, and 5 at CeBIT in 1995. The initial products have conventional SCSI drive interfaces, but Xyratex has indicated future intentions to manufacture an SSA interfaced version as well.

ZENITH DATA SYSTEMS (Subsidiary of Groupe Bull)
2150 East Lake Cook Road
Buffalo Grove, IL 60089

Zenith entered the array market by remarketing a version of Integra's OASYS array software, beginning in 1992, on its EISA bus based servers. The company has dropped software solutions in favor of hardware implementations, and currently integrates the Mylex controller into its array subsystems.

1995 DISK/TREND REPORT

DISK/TREND ON DISK

Introduction

DISK/TREND ON DISK is a licensed set of floppy disks available for separate purchase that contain the statistical tables and specification tables from the annual DISK/TREND Reports. The disk files have been prepared in a format usable on IBM or IBM-compatible computers running under the MS-DOS or PC-DOS operating system. A system with a hard disk is highly recommended, but a system with two floppy disks can be used if necessary. All DISK/TREND ON DISK files contain data only -- manipulation of data is the user's responsibility. Because some of the files can be very large, system memory of 640K or more is recommended.

Two types of diskette files are supplied for each DISK/TREND disk drive report. The first type contains the statistical tables in ASCII format. File names are keyed to the table numbers in the report for easy identification. The second type contains the specification section in a Lotus 1-2-3 data base format. Multiple disks of each type are provided where the files are too numerous or too large to fit on a single floppy disk. The color of the label of the floppy disk is similar to the color used on the cover of the corresponding report for ease in identification.

Because the statistical tables are provided in ASCII format, they can be used with any spreadsheet program that can import ASCII text files. However, the specification tables have been prepared specifically in Lotus 1-2-3 format to allow them to be searchable using Lotus 1-2-3 data base commands. If you are using a spreadsheet program other than Lotus 1-2-3 that can translate Lotus WK1 formatted files to its own format, it may be able to import the specification tables without difficulty.

A file translation program, AutoImport, is available from DISK/TREND to assist in converting the data supplied to the formats of several popular spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to DISK/TREND subscribers who have purchased an original copy of DISK/TREND ON DISK but is provided only in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any

time. If you have not purchased DISK/TREND ON DISK, but would find AutoImport useful with other file translation tasks, it may be purchased independently from DISK/TREND or White Crane Systems, Inc.

IMPORTANT NOTE: Since July, 1994, White Crane has shipped version 3.13 or higher of AutoImport. Instructions in this section are written to work with these later versions. If you have an older version of AutoImport, refer to instructions in previous DISK/TREND reports. You must have AutoImport 3.13 or higher to use DISK/TREND ON DISK with these instructions.

The authors of this manual assume that you are familiar with personal computers, Lotus 1-2-3 or other spreadsheets, and MS-DOS, and do not cover their operation in this manual. This manual deals specifically with how to load and use the files supplied on the floppy disks.

Note: Please read the license on the following page.

DISK/TREND ON DISK

Information License

DISK/TREND supplies diskettes containing selected information from the 1995 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1995 DISK/TREND Report volume.

YOU MAY:

1. Install and use the information on a single computer system, provided that you or the organization by which you are employed has purchased at least one copy of the DISK/TREND report volume associated with the information.

2. Make backup copies of the information for your own use. Such backup copies may be used only on the computer on which the information is installed. You must reproduce the copyright notice on any copies.

3. Reproduce the information, but not the associated programs or documentation, contained in the Product for use within internal documents distributed within the organization by which you are employed.

YOU MAY NOT:

1. Install, or allow the use of, the information on more than a single computer system.

2. Transfer the information through or within a computer network.

3. Distribute the information or any portion thereof in any form outside the organization by which you are employed or modify the information for purposes of distribution.

4. Transfer this license to another party.

AUTOIMPORT

Use of AutoImport is subject to license terms and conditions of White Crane Systems, Inc.

Trademarks

IBM is a trademark of International Business Machines Corporation.
Lotus and Lotus 1-2-3 are trademarks of Lotus Development Corporation.
MS-DOS is a trademark of Microsoft Corporation.
AutoImport is a trademark of White Crane Systems, Inc.

1995 DISK/TREND REPORT

Getting started

The first thing you should do is to make working copies of the original DISK/TREND diskettes. Place the originals in a safe location and use only the working copies for day-to-day operations. This procedure will help to protect your data from inadvertent destruction or loss due to a malfunction of the computer or its operator. We also recommend that you place a write protect tab on the working copies (after you create them) for the same reason. Use the hard disk or another floppy disk copy for day-to-day manipulations of the files.

The statistical tables are provided in ASCII text format. This allows you to use any word processor to edit the file prior to importing it into Lotus 1-2-3. Appropriate editing removes any material you don't wish to work with and allows you to add figures or text to the data tables. You may also embed the data in internal documents or reports you are preparing for use within your company.

To convert the statistical tables to a spreadsheet you may use the AutoImport utility software, which is probably quicker and easier than the typical text file import and conversion procedure provided with spreadsheet programs. One copy of AutoImport is provided automatically at no extra charge to each DISK/TREND subscriber who has purchased an original copy of DISK/TREND ON DISK and is provided in the first year DISK/TREND ON DISK is purchased. Updates to AutoImport may be provided in following years at DISK/TREND's discretion. Extra copies of AutoImport may be purchased at any time.

DISK/TREND ON DISK is normally shipped on 1.44 megabyte 3.5" floppy disks, but is also available on 1.2 megabyte 5.25" disks if requested.

STATISTICAL TABLES

Loading and Installation

1. Place the floppy disk marked "Tables" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the Lotus 1-2-3 system disk in drive A. Use the DOS 'DIR' command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which Lotus 1-2-3 normally stores worksheet files. Using the DOS 'COPY' command, copy all the statistical table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?T*.*

   Several utility files should also be copied. The command is:

   COPY A:*.PRN (if you are using the Lotus 1-2-3 data parsing commands)
   COPY A:*.MSK (if you are using AutoImport)

   The utility files named FORMLIN?.PRN are specifically for usage with Lotus 1-2-3 data parsing if you prefer not to use AutoImport for file translation.

   Installing AutoImport V3.xx: If you have a hard disk, create a directory named AIMP (You could use other names if you prefer). Now place AutoImport disk 1 in drive A and type: COPY A:*.* and then ENTER. Follow any instructions appearing on the screen until installation is complete. To make AutoImport accessible from any directory, place C:\AIMP in your AUTOEXEC.BAT file's 'PATH' statement. See your MS-DOS instruction manual for information about this step.

   If you are using a floppy-only system, copy the AutoImport disks and use only the copies in following steps. In a floppy-only system, AutoImport disk 1 should be in drive A when AutoImport is in use for file translation.

3. If you are using AutoImport (highly recommended) for translation of files to spreadsheet format, do the translation at this point. See the following section on using AutoImport for details.

4. Now you are ready to start your spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the spreadsheet system disk in drive A. If you are using a rigid disk system, place a copy of the spreadsheet system disk in floppy drive A if required by the security provisions of your spreadsheet program. Now start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the appropriate file retrieval command to select a file. An example of a Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XTYY.WK1, where: X= Type of data

   R (Rigid disk drive data)
   O (Optical disk drive data)
   A (Disk drive array data)
   V (Removable drive data)

   YY= Table number, as shown in the appropriate report volume

   Examples:
   File RT10.WK1 is Rigid Disk Drive Report Table 10
   File OT1.WK1 is Optical Disk Drive Report Table 1
   File AT3.WK1 is Disk Drive Array Report Table 3
   File VT2.WK1 is Removable Drive Report Table 2

   The file selected will be loaded as a worksheet. If this is the first time the file has been loaded, you may want to create your own formulas linking the cells of the spreadsheet. See your spreadsheet reference manual for details on numerical manipulations and graphics.

If you don't use AutoImport

If you don't use AutoImport but still want to translate ASCII files to your spreadsheet format, you will have to use spreadsheet tools such as the Lotus 1-2-3 Data Parse commands. They allow the user to convert a table which has been imported in the form of a block of text to a form in which the individual numbers and labels can be manipulated as spreadsheet elements or used to prepare graphics. Let's take Lotus 1-2-3 as an example. Before proceeding, it would be useful to read the Lotus reference manual on this subject if you are not a regular user of the Data Parse commands.

The trickiest and most time-consuming part of using the Data Parse commands is setting up the format line. Several utility files have been provided on

the tables disk to make this process easier. These are used with various table formats encountered in the DISK/TREND Reports and correspond with the precomputed masks provided for use with AutoImport:

- o FORMLINA.PRN — Used with Tables 1 and 2, and the Revenue and Unit Shipment tables found in the product group sections of all DISK/TREND reports.
- o FORMLINB.PRN — Used with Tables 3 and 4.
- o FORMLINF.PRN — Used with Tables 5 through 12.
- o FORMLIND.PRN — Used with Application tables.
- o FORMLINE.PRN — Used with Drive Height, Drive Capacity and Track Density tables in Flexible Disk Drive Report.

There are no FORMLIN format files for disk diameter tables or market share tables, as these are variable in format. You will have to construct the format line directly, but after you have seen how it is done for the other tables, this should not be too big a job.

After you have used spreadsheet tools to translate a file, you will understand why we recommend AutoImport for this function.

Using AutoImport

Using AutoImport is a two-step process. Step one is creation of a translation mask for each format used in files to be converted. The typical DISK/TREND Report uses 5 to 7 standard mask designs (which have been precomputed and included on your Statistical Tables disk) plus additional masks that are dependent upon table content, as some table types have variable numbers of columns. You will have to create your own masks for such tables, but this can be done easily as shown below.

Step two is the translation process. Once the mask has been created, it can be used with any table matching the mask format. See the tables below which relate table types to specific masks.

MASK TABLE

Mask File Name	Rigid Report	Removable Report	Optical Report	Array Report
MASKA	<-------- Table 1--------->		Tables 1,2	Table 1
	<-------------- Product Group Revenue ------------------>			
	<-------------- Product Group Shipment ------------------>			
MASKB	<-------- Table 2 -------->		Tables 3,4	Table 2
MASKC	Tables 3,4,6,9, 10,11	Tables 3 to 6, 11,12,24,25	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			Table 21
MASKE	N/A	N/A	Write-Once/ Erasable Analysis	N/A
MASKH	Tables 7,8	Table 31	N/A	N/A
MASKI	<----- Product Group -----> Price/Megabyte		N/A	N/A

N/A = Not applicable to this report

* Variable format depending upon number of disk diameters in the product group.

TABLE NUMBER TO MASK CROSS-REFERENCE

Table Number	1994 Rigid Report	1994 Removable Report	1994 Optical Report	1995 Array Report
1	MASKA	MASKA	MASKA	MASKA
2	MASKB	MASKB	MASKA	MASKB
3	MASKC	MASKC	MASKB	MASKC
4	MASKC	MASKC	MASKB	MASKC
5	MASKC	MASKC	MASKC	MASKC
6	MASKC	MASKC	MASKC	MASKC
7	MASKH	--	MASKC	MASKC
8	MASKH	--	MASKC	--
9	MASKC	MASKA	MASKC	--
10	MASKC	MASKA	MASKC	MASKA
11	MASKC	MASKC	MASKC	MASKA
12	--	MASKC	MASKC	--
13	--	--	--	--
14	MASKA	MASKI	--	--
15	MASKA	--	--	--
16	--	MASKI	--	MASKA
17	--	--	MASKA	MASKA
18	MASKD	MASKI	MASKA	--
19	MASKI	--	--	--
20	--	MASKI	--	--
21	MASKA	--	MASKD	MASKD
22	MASKA	MASKA	--	--
23	--	MASKA	MASKA	MASKA
24	--	MASKC	MASKA	MASKA
25	MASKD	MASKC	--	--
26	MASKI	MASKA	--	--
27	--	MASKA	--	--
28	MASKA	MASKA	--	--
29	MASKA	MASKA	MASKE	MASKA
30	--	MASKA	MASKD	MASKA
31	--	MASKH	--	--
32	MASKD	MASKD	MASKA	--
33	MASKI	--	MASKA	--
34	--	MASKA	--	--
35	MASKA	MASKA	--	
36	MASKA	--	MASKD	
37	--	--	MASKA	
38	--	MASKI	MASKA	
39	MASKD	MASKD	MASKA	
40	MASKI	--	MASKA	
41	--	MASKA	--	
42	MASKA	MASKA	--	
43	MASKA	--	MASKE	
44	--	--	MASKA	
45	--	MASKD	MASKA	
46	MASKD	--	--	
47	MASKI	MASKA	--	

Cross-reference (continued)

Table Number	1994 Rigid Report	1994 Removable Report	1994 Optical Report	1995 Array Report
48	--	MASKA	MASKE	
49	MASKA	--	MASKA	
50	MASKA	--	MASKA	
51	--	MASKD	--	
52	--	--	--	
53	MASKD		MASKE	
54	MASKI			
55	--			
56	MASKA			
57	MASKA			
58	--			
59	--			
60	MASKD			
61	MASKI			
62	--			
63	MASKA			
64	MASKA			
65	--			
66	--			
67	MASKD			
68	MASKI			
69	--			
70	MASKA			
71	MASKA			
72	--			
73	--			
74	--			
75	MASKD			
76	MASKI			
77	--			

-- indicates that the format of this table is variable. Create a mask using AutoImport if a spreadsheet is needed.

Translation using precomputed masks

1. First, copy the files you wish to translate to the AIMP directory from the DISK/TREND ON DISK floppy disk. Go to the AIMP directory, insert the floppy disk in drive A and type the following commands:

   COPY A:?T*.*
   COPY A:*.MSK

   These commands copy the data files and mask files you need.

   If you are using a two floppy disk system, copy the files you want to translate to a second floppy disk along with the mask files. Make sure that no more than half of the floppy disk is filled, because you will need space for the converted files.

2. Now start AutoImport by typing AI, then the ENTER key. When the opening screen appears, select the "File" menu bar item using the mouse or just type /F. (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears (File Selection menu), use the arrow keys or the mouse to select the Mask name option, then select the name of the mask you want from the displayed list. If a standard mask is being used, see the mask table above to choose the mask file name to enter. If you used a mask previously, the system defaults to the last mask named.

4. Select Input file name option on the File Selection Menu.

   Enter the name of the file, <u>including the extension</u>, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: AT4.95A VT12.94V OT14.94O RT19.94R

5. Select the Output file option on the File Selection menu.

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (A, R, V, F, or O), T is just that, and nn is the DISK/TREND Report table number matching the file being translated. You should not enter the file name extension as the system adds it automatically for you.

   Examples: AT4 VT12 OT14 RT20

6. The default spreadsheet type to which translation is made is Lotus 1-2-3 version 2.x. If you wish to translate to a different spreadsheet format you may choose it by selecting Format from the File Selection menu and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Select "CONVERT" button using the mouse (or arrow keys and ENTER). If you are asked "Do you want to load input file *.* named in mask", answer "NO". You will see the file being translated scroll by as the translation proceeds.

8. If you want to do more translations, repeat from step 3.

9. When you are done translating, leave AutoImport by typing /Q or use the mouse to select "Quit" on the menu bar to return to the AutoImport main menu to leave AutoImport and return to DOS. It will save you some keystrokes if you copy your new spreadsheet files to your spreadsheet directory. If you are using a two floppy system, just remove the AutoImport disk from drive A and substitute your spreadsheet disk.

Mask Generation

1. Start AutoImport as above. When the opening screen appears, select "File" using the mouse or type /F.

2. Name the input file you will use as the template to create the mask. The file name will be of the form ?Tnn.yy?, where ? is the type of report (R, V, O, or A), nn is the table number and yy is the report year.

   Example: AT10.95A

   To name the file, select Input file from the File selection menu. Type the desired file name and press 'Enter'. The contents of the file will now appear on the screen.

3. Next define the header lines. These are lines that are translated to the spreadsheet as a single cell of text. Place the cursor at the top of the header area, normally at the left top of the report table. Now select "Lines" from the menu bar, then select "Header" from the pop-up window that opens. Using the down arrow key, expand the highlighted area until it extends to just above the first row of numerical data. Press 'ENTER'. If there are any footnotes at the bottom, the lines in which they appear can be treated the same way by locating the header at the left margin of the first footnote line, selecting "Lines" and "Headings" again, and extending the highlight area over the note and pressing 'ENTER'.

4. Next, locate the longest left margin label (excluding the header lines) in the table. Position the cursor so that it is at the left margin of the line containing the longest label. Select "Column" from the menu bar, then "Auto Define". This step actually creates the mask. Check to be sure all figures have been delineated properly. If not, see below.

   In a few cases, the automatic feature may be confused by a table layout and all values will not be picked for conversion. In these unusual cases, you may be able to get the overlooked values included by repeating this step on another line.

   Another unusual case can occur in which the right-hand part of a label is somehow included in a value occurring in the next column to the right. Deal with this rare case as follows:

   o Place cursor in left margin of offending line. Select "Column", then "Width & move". Select the column you wish to adjust with mouse (or arrows & ENTER), and then use arrow keys to move right column margin clear of the column of values. You can also shift the entire column by depressing the CONTROL key and using the appropriate arrow key (or drag with the mouse).

5. Save the mask in a mask file. Select "File", then "Mask", then the Save Mask button, or type /FMS (File:Mask:Save). Fill in the name of the mask file when asked.

   Example: MYMASK.MSK, or just MYMASK

6. Save the output file. Type /FO (File:Output). Now enter the file name.

   Example: AT10. You don't need to enter the file extender.

7. To make more masks, repeat from step 2. To quit the mask function, type /QY (quit).

Other AutoImport Functions

AutoImport can do much more than the functions described above, which are those concerned with a basic understanding of how to create spreadsheets from DISK/TREND ON DISK files. See the separate AutoImport manual provided for details of these other functions.

SPECIFICATION TABLES

Loading

1. Place the floppy disk marked "Specifications" in a floppy disk drive able to read your size disks. This is usually drive A, but if you are using a dual floppy only system, use drive B and put the spreadsheet system disk in drive A. Use the DOS "DIR" command to examine the file directory on the "Tables" disk. If there are any special instructions, they will be in a file named READ.ME. To see these instructions, at the DOS prompt type:

   TYPE A:READ.ME (Use the appropriate drive letter if not A)

   If you wish to print the instructions, turn on your printer and type:

   TYPE A:READ.ME>PRN

2. Do this step if you have a hard disk. Log into the hard disk directory in which your spreadsheet normally stores worksheet files. Using the DOS "COPY" command, copy all the specification table files to the hard disk. This can be done in one step using the copy command as follows:

   COPY A:?S*.*

3. Now you are ready to start Lotus 1-2-3 or other spreadsheet. If you are using a two floppy system, place the DISK/TREND disk in drive B and the Lotus spreadsheet system disk in drive A. If you are using a rigid disk system, place the spreadsheet system disk in floppy drive A. If your spreadsheet is not Lotus 1-2-3, you will have to translate the data from Lotus 1-2-3 to your format. Almost all spreadsheet packages of recent vintage are able to do this translation. After translation, if needed, start your spreadsheet as usual. After obtaining the blank spreadsheet image on the screen, use the spreadsheet File Retrieve command to select a file. The equivalent Lotus 1-2-3 command is:

   /FR<filename>

   The file names are in the format XSYZZ.WK1 or XSYZZ.WKS, depending upon which version of Lotus 1-2-3 you are using. X,Y, and Z are:

   X= O (Optical disk drive data)
   R (Rigid disk drive data)
   A (Disk drive array data)
   V (Removable data storage data)

   Y= Table number. Usually, there is only one table, but if the specification file is so large as to need multiple disks to hold it, there may be several.

ZZ= Year of report.

Example: AS195 Disk drive array specification table

Note that the specification tables load directly as a data base. You can use the data base functions of Lotus 1-2-3 to sort, count or otherwise manipulate the data for purposes of special analysis. Other spreadsheets may have similar capabilities.

Using the specification data base

Introduction: If you have not used the Lotus 1-2-3 /DATA QUERY commands, it will be helpful for you to review the sections of the Lotus 1-2-3 reference manual that pertain to their use before proceeding further.

The specification data base fits into a worksheet format of 25 to 30 columns, depending upon whether rigid, optical or floppy drives are involved, and a row count of up to 500 rows. Each row represents a specific record, and is equivalent to a single column in the Specifications section of the DISK/TREND report. Each column represents a specific specification parameter, and is equivalent to one row of the DISK/TREND report.

The data base has been set up for data extraction using Lotus 1-2-3 commands. The Input, Output and Criterion ranges have been predefined, but you, the user, will have to decide how you want the extracted data manipulated and place the appropriate Lotus functions, such as @COUNT, in the appropriate cells. Some rows between the bottom of the input range and the top of the output range have been left empty so that you can do this easily. When the data base is first loaded, you will see the top of the input range, showing the first column (manufacturer name) for the first several manufacturers. Use the arrow keys to find other manufacturers or specific product specifications. If you are not using Lotus 1-2-3, use the equivalent procedure for your spreadsheet.

Operating tips

Expanding the input or output ranges: The predefined output range is of a nominal size, and a search with broad parameters may result in overflowing the output range. In such a case, merely extend the output range (add more rows) using the Lotus 1-2-3 /DQEO command. Similarly, it is possible to extend the input range to add more products, but be sure you move the output range so that there is no overlap.

Memory overflow: If you should receive a memory overflow message while manipulating the specification data, it is usually because:

- o There are other "pop-up" programs resident in the memory of your computer. These should be removed.

- o You have selected too large an output range. Use a smaller output range or delete some of the columns that contain data not relevant to your analysis. If you delete data, be sure that if you save your spreadsheet you use a different file name, otherwise you will overwrite the original file with the modified spreadsheet.

- o If you receive a memory overflow message while loading the data base, the data base is too large for your computer's available memory. You probably will have to remove other resident programs and reload Lotus 1-2-3 and the data base. If your computer doesn't have 640K memory, you will probably get this message.

Saving time

The specification data base is large and takes significant time to recompute or perform other operations. If you are interested in drives that belong to only a few product groups, it will probably save you time in the long run if you extract only those groups you are interested in into a new worksheet and use that for the analysis. Use spreadsheet FILE EXTRACT and FILE COMBINE commands for this purpose.

Another way to save time is to use the SORT capabilities of your spreadsheet to organize the data the way you find it most useful. The most commonly done sorts are by manufacturer name and by DISK/TREND product group, but it would also be possible to sort by average seek time, price, and so on.

Make sure that when you save a worksheet using the FILE SAVE command

that you save it in a new file name. If you save it in the file name from which it was loaded, the original copy will be overwritten. If a file is overwritten unintentionally, it can take a long time to recreate.

If you are interested in only a subset of product groups, use the FILE EXTRACT and FILE COMBINE commands to move these records to another file and then use the second file for analysis. The smaller file will take less time to process.

Technical support

Just about all of your questions regarding the use of DISK/TREND ON DISK should be answered in this manual or in the Lotus 1-2-3 reference manual. However, if you need to contact us to resolve any points of confusion, report errors, or otherwise receive comfort:

Call us at: **415-961-6209**

Ask for Technical Support for DISK/TREND ON DISK

In order to make this process efficient, when you call--

1. Tell us what is on the diskette label.

2. Have your computer up and displaying the data or operation that is the subject of your call.

3. Have this manual and the Lotus 1-2-3 reference manual handy.

If you have questions about AutoImport as it is used with DISK/TREND ON DISK, contact DISK/TREND at the number above. Questions about other functions of AutoImport should be referred to White Crane Systems.

Apple Macintosh compatibility: While DISK/TREND ON DISK has been prepared for use on IBM PC compatible computers, users have reported that they are able to translate files into Macintosh format using Apple Computer software. The specific software reported used is Apple File Exchange.

Special data

The specification data base contains one category of information not present in the hard copy report. This is the country code field, representing the continental region in which the headquarters of the drive producer is located. A key is located at the top of the adjacent column to the right.

In order to make it easier to do sorting or extraction analysis on the data, the contents of certain fields have been modified and are not exactly the same as in the printed report tables. Some affected fields have been converted to purely numeric fields as described below. Where multiple values existed, the value representing the highest level of performance or capability has been retained.

Comments and asterisks in the affected fields have been eliminated. A '0' means that no data was available. Asterisks are retained in the comment field so that you will have an indication that one or more characteristics of the drive was referenced to a comment. Check the printed report table for details.

The affected fields are:

Group:	Numeric conversion: Now you can extract a range of groups.
Host_chans: (Number of host channels)	Numeric conversion: You can sort or extract on a value or range of values for number of host channels.

A country code field has been added in the last column of the data base.
The code explanation is:

1 = U.S. manufacturer
2 = Asian manufacturer
3 = European manufacturer
4 = South American or other manufacturer

Codes are based upon the location of the manufacturer's headquarters.

First ship date has been modified so that the last two characters will always represent the year of shipment. An entry of ??91 in the criterion field for the First Ship Date column will cause all products first shipped in 1991 to be extracted.