1994 DISK/TREND® REPORT

DISK
DRIVE
ARRAYS

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DISK DRIVE ARRAYS

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FOREWORD

We were gratified with the kind reception by the disk drive array industry to DISK/TREND's initial market study on the subject last year. This year we have again attempted 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.

Many observers have compared the ongoing stampede to enter the disk drive array industry with the rapid expansion of the number of manufacturers in the disk drive industry at the beginning of the last decade. There are similarities, but the number of participants in the array business is much larger. We identified 100 in last year's DISK/TREND Report on disk drive arrays, and the total for this year has increased to 154.

We are now in the 18th year of the DISK/TREND Report, a much longer period than most of the companies covered in the reports have been in business. We assume that the young disk drive array industry will go through the same turmoil that the disk drive producers have experienced -- and we can only hope that the best companies win!

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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INTRODUCTION

The second DISK/TREND Report on disk drive arrays. When we initiated our first annual market study on disk drive arrays one year ago, we established a method of organization and set of definitions which resemble those used for many years in the DISK/TREND Reports on disk drives, but with several additions. Concise definitions of market classes, product specifications and shipment data were used in gathering and organizing the statistics and text. But we made the assumption that disk drive array terms and applications will be new to many readers, so they have been explained in detail. Now that the second edition is being published, we've followed the same plan and have even added some new information.

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.

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.

What's an array cost? In each product section new tables have been added to display the average unit price, broken down by each of the market channels and by each of the types of arrays, for the five year span covered by the report. 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 revenues, which is important in interpreting DISK/TREND revenue statistics. 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.

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

Disk drive arrays generated $3.4 billion in worldwide revenues in 1993, and the total is forecasted to reach $13.0 billion in 1997, an average annual increase of 40.3%. 214,667 disk drive arrays of all types were shipped in 1993, with 1997 projected at 837,155 units, providing a 41.2% average annual increase.

Captive disk drive arrays, arrays sold by system manufacturers with their systems, have maintained a lead in total revenues which is expected to be continued through 1997. 1993's $2.1 billion in captive revenue is projected to grow to $7.4 in 1997, providing 57.2% of that year's total revenues. It should be noted, however, that 1997's total captive shipments will constitute only 41.5% of the year's total, due to the higher than average prices for captive arrays. All array revenues in the DISK/TREND Report are reported at the level of the first public sale by the originating manufacturer, whether originally sold as a complete subsystem, board assembly or software, and whether the sale occurs at the captive end user, PCM/Reseller, or OEM/Integrator levels.

Noncaptive sales of disk drive arrays are also expected to grow rapidly. PCM/Reseller array sales reached $1.2 billion in 1993 and are forecasted at $4.3 billion for 1997. OEM/Integrator sales, although smaller in revenue, are expected to maintain a faster growth rate, averaging 69.8% annual increases in the 1994-97 period, with total OEM/Integrator revenues reaching $1.2 billion in 1997.

Network/minicomputer/multiuser arrays will continue to provide higher total revenues than any other product group, growing from $2.5 billion in 1993 to a forecasted $7.6 billion in 1997. However, the group's share of total array revenues is slated to decline from 73.1% in 1993 to 58.1% in 1997, as revenues for mainframe arrays surge to new highs. With the expected entry of IBM into the mainframe array arena by the end of 1994, mainframe array total sales revenues are projected to reach $5.3 billion in 1997, 40.4% of the total for all types of arrays.

All array product types are expected to continue growing through 1997, but software arrays will decline to 11.4% of 1997's revenues. Subsystems and boards are expected to increase to 54.1% and 34.5% of the total, respectively.

TABLE 1

CONSOLIDATED WORLDWIDE REVENUES

DISK DRIVE ARRAYS

REVENUE SUMMARY

DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)

	1993 Revenues		Forecast 1994		Forecast 1995		Forecast 1996		Forecast 1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	993.8	2,050.5	1,340.9	2,625.1	2,643.0	4,712.2	3,740.7	6,493.8	4,184.4	7,338.8
PCM/Reseller	632.8	937.1	1,115.1	1,654.2	1,472.3	2,231.1	1,847.8	2,825.9	2,262.7	3,477.2
OEM/Integrator	116.6	165.2	191.1	297.7	353.3	552.0	540.2	818.3	767.7	1,118.9
TOTAL U.S. REVENUES	1,743.2	3,152.8	2,647.1	4,577.0	4,468.6	7,495.3	6,128.7	10,138.0	7,214.8	11,934.9
Non-U.S. Manufacturers										
Captive	--	35.6	--	43.6	3.3	68.5	5.6	88.6	8.8	104.4
PCM/Reseller	132.4	228.2	223.2	376.5	235.9	403.3	372.1	636.0	506.6	859.0
OEM/Integrator	9.3	18.8	24.6	47.5	39.4	72.9	53.3	91.7	70.5	113.4
TOTAL NON-U.S. REVENUES	141.7	282.6	247.8	467.6	278.6	544.7	431.0	816.3	585.9	1,076.8
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,884.9	3,435.4	2,894.9	5,044.6	4,747.2	8,040.0	6,559.7	10,954.3	7,800.7	13,011.7

Marketing channels

The young disk drive array industry has seen many enthusiastic missionary selling campaigns sponsored by the numerous independent manufacturers of controllers and other noncaptive data storage peripherals which have entered the disk drive array business, mostly aimed at the rapidly growing market for network file servers.

However, computer system manufacturers of all kinds have also developed arrays, and captive arrays have produced the majority of revenues to date. Internally developed arrays are being sold as captive products with their own systems 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. Captive arrays of all kinds held 60.7% of the 1993 worldwide revenue total. As noncaptive market penetration increases, the captive total is expected to decline to 57.2% by 1997.

Noncaptive array sales are dominated by the PCM/Reseller channel which starts and ends the five year span of this report with one third of all array revenues. More than half of the PCM/Reseller revenues are derived from mainframe arrays, which are low in unit shipments but very high in average price. Although PCM/Reseller sales of arrays for network file server applications has been slower than the participants desired, it is expected that the missionary selling will eventually pay off, with a six times increase in 1993's shipments of complete subsystems for network applications forecasted by 1997, to 118,880 units.

OEM/Integrator array sales are also starting from a low base level. However, the many network server programs which got under way last year using OEM subsystems and boards will increase overall OEM/Integrator revenues over the 1993 total by a factor of almost seven, boosting 1997's total to $1.2 billion.

Of the 154 array manufacturers identified in this report, 131 are headquartered in the United States and these manufacturers produced over 91% of worldwide array revenues. Despite the fact that the U.S. is less than 60% of the worldwide array market, the development and sales momentum already attained will enable U.S. companies to maintain their current market share through 1997.

TABLE 2

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
MARKET CLASS REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES BY MANUFACTURER TYPE	1993 Revenues		Forecast							
			1994		1995		1996		1997	
	$M	%	$M	%	$M	%	$M	%	$M	%
U.S. Manufacturers										
Captive	2,050.5	59.6%	2,625.1	52.0%	4,712.2	58.6%	6,493.8	59.3%	7,338.8	56.4%
	+131.3%		+28.0%		+79.5%		+37.8%		+13.0%	
PCM/Reseller	937.1	27.2%	1,654.2	32.7%	2,231.1	27.7%	2,825.9	25.7%	3,477.2	26.7%
	+102.3%		+76.5%		+34.9%		+26.7%		+23.0%	
OEM/Integrator	165.2	4.8%	297.7	5.9%	552.0	6.8%	818.3	7.5%	1,118.9	8.6%
	+92.8%		+80.2%		+85.4%		+83.1%		+36.7%	
Total U.S. Manufacturers	3,152.8	91.6%	4,577.0	90.6%	7,495.3	93.1%	10,138.0	92.5%	11,934.9	91.7%
	+119.6%		+45.2%		+63.8%		+35.3%		+17.7%	
Non-U.S. Manufacturers										
Captive	35.6	1.0%	43.6	.8%	68.5	.8%	88.6	.8%	104.4	.8%
	+41.8%		+22.5%		+57.1%		+29.3%		+17.8%	
PCM/Reseller	228.2	6.6%	376.5	7.4%	403.3	5.0%	636.0	5.8%	859.0	6.6%
	+976.4%		+65.0%		+7.1%		+57.7%		+35.1%	
OEM/Integrator	18.8	.8%	47.5	1.2%	72.9	1.1%	91.7	.9%	113.4	.9%
	+283.7%		+152.7%		+53.5%		+25.8%		+23.7%	
Total Non-U.S. Manufacturers	282.6	8.4%	467.6	9.4%	544.7	6.9%	816.3	7.5%	1,076.8	8.3%
	+452.0%		+65.5%		+16.5%		+49.9%		+31.9%	
Worldwide Recap										
Captive	2,086.1	60.7%	2,668.7	52.9%	4,780.7	59.5%	6,582.4	60.1%	7,443.2	57.2%
	+128.8%		+27.9%		+79.1%		+37.7%		+13.1%	
PCM/Reseller	1,165.3	33.9%	2,030.7	40.3%	2,634.4	32.8%	3,461.9	31.6%	4,336.2	33.3%
	+140.5%		+74.3%		+29.7%		+31.4%		+25.3%	
OEM/Integrator	184.0	5.4%	345.2	6.8%	624.9	7.7%	910.0	8.3%	1,232.3	9.5%
	+103.1%		+87.6%		+81.0%		+75.0%		+35.4%	
Total All Manufacturers	3,435.4	100.0%	5,044.6	100.0%	8,040.0	100.0%	10,954.3	100.0%	13,011.7	100.0%
	+131.0%		+46.8%		+59.4%		+36.2%		+18.8%	

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

Product groups

Overall array shipments and revenues are dominated by the networks/minicomputer/multiuser product group. The product group's $2.5 billion in 1993 revenues was 73.1% of the overall total, and the group's 1993 shipments of 194,041 arrays was 90.5% of the total for all arrays. 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 82% of the 1993 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 1997, their share of the group's total is expected to fall to 62.4%.

In 1993, noncaptive array unit shipments in the networks/minicomputer/-multiuser product group were less than the captive total, but by 1997 noncaptive arrays are projected to provide 66.4% of the product group's unit total. Leading this growth will be boards in the OEM/Integrator channel, with 225,215 units in 1997, and PCM/Reseller complete subsystems, with 118,800 arrays in the same year.

With only a few participants to date, mainframe system arrays produced 25.2% of the revenue for all product groups in 1993, and an insignificant 0.9% of all array unit shipments in 1993, but the market entry of additional significant suppliers will boost the expected 1997 mainframe share to 40.4% of the overall revenue total.

So far, EMC has 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. However, shipments of Storage Technology's overdue Iceberg are expected to start by this summer. And DISK/TREND shares the general industry assumption that IBM, the leading protagonist in the drama, will start shipments of a mainframe array in the autumn of 1994, with the remaining PCM vendors not far behind. All of this activity is expected to boost mainframe array revenues from 1993's $867.4 million to the projected $5.3 billion in 1997.

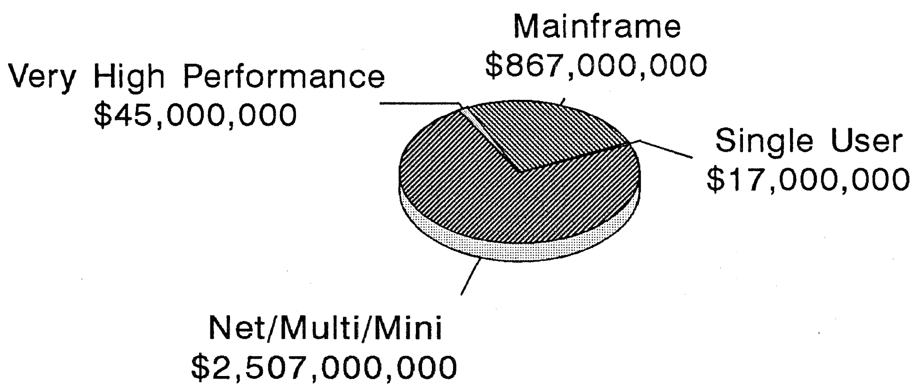
Although significant to the participating companies in each product group, neither single user arrays nor very high performance arrays are expected to produce more than 1% of the overall 1997 revenue total. The revenue totals in both groups will be modest -- but for different reasons in each product group.

Very high performance arrays, used by supercomputers, imaging systems and high-end workstations, are forecasted to generate revenues of $131.9 million in 1997. Most of the significant supercomputer manufacturers have recently added captive array subsystems to their product lines, so that the growth already 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 1997 are expected to be generated by OEM/Integrator shipments to massively parallel computer manufacturers, high-end workstation producers and specialized video/imaging system manufacturers.

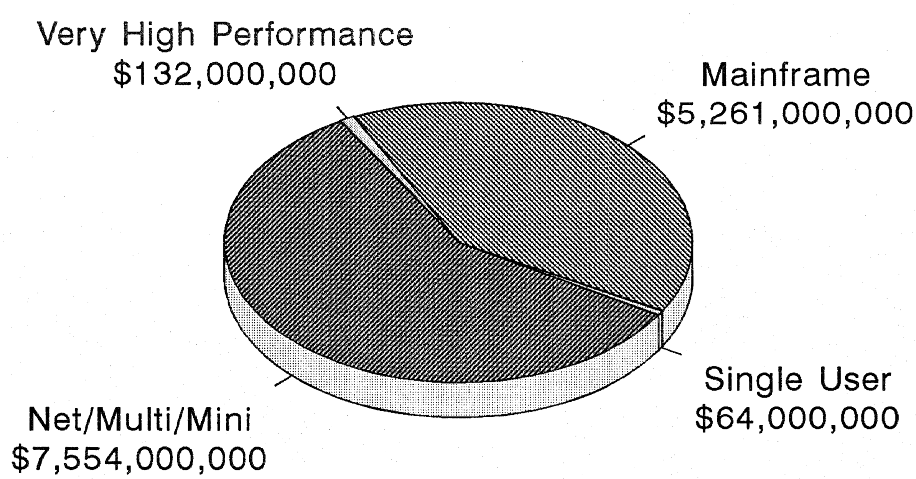
Single user arrays are expected to continue to provide only 0.5% of the overall total array revenue during the entire 1993-97 period, with a $64.4 million total for 1997, depressed by very low average unit prices. Usage will be broader than the revenue total suggests, however, with 1997 shipments of 55,420 single user arrays projected. Growth in this product group relies heavily on noncaptive add-on sales of low cost subsystems and boards, mostly RAID-1 mirrored disk arrays. 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 and have the funds available for highly reliable data storage.

Figure 1

CHANGING PRODUCT MIX
Worldwide Disk Drive Array Revenue



1993



1997

TABLE 3

CONSOLIDATED WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	------1993-----		----------Forecast----------							
ALL MANUFACTURERS	----Revenues---		------1994-----		------1995-----		------1996-----		------1997-----	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	16.7	.5%	27.1	.5%	41.7	.5%	55.8	.5%	64.4	.5%
	+496.4%		+62.3%		+53.9%		+33.8%		+15.4%	
NETWORKS/MINI/MULTIUSER	2,506.5	73.1%	3,346.9	66.3%	4,889.8	60.8%	6,157.0	56.2%	7,554.3	58.1%
	+107.8%		+33.5%		+46.1%		+25.9%		+22.7%	
MAINFRAMES	867.4	25.2%	1,629.3	32.3%	3,039.7	37.8%	4,640.2	42.4%	5,261.1	40.4%
	+233.9%		+87.8%		+86.6%		+52.7%		+13.4%	
VERY HIGH PERFORMANCE	44.8	1.2%	41.3	.8%	68.8	.9%	101.3	.9%	131.9	1.0%
	+150.3%		-7.8%		+66.6%		+47.2%		+30.2%	
Total Worldwide Revenue	3,435.4	100.0%	5,044.6	100.0%	8,040.0	100.0%	10,954.3	100.0%	13,011.7	100.0%
	+131.0%		+46.8%		+59.4%		+36.2%		+18.8%	

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

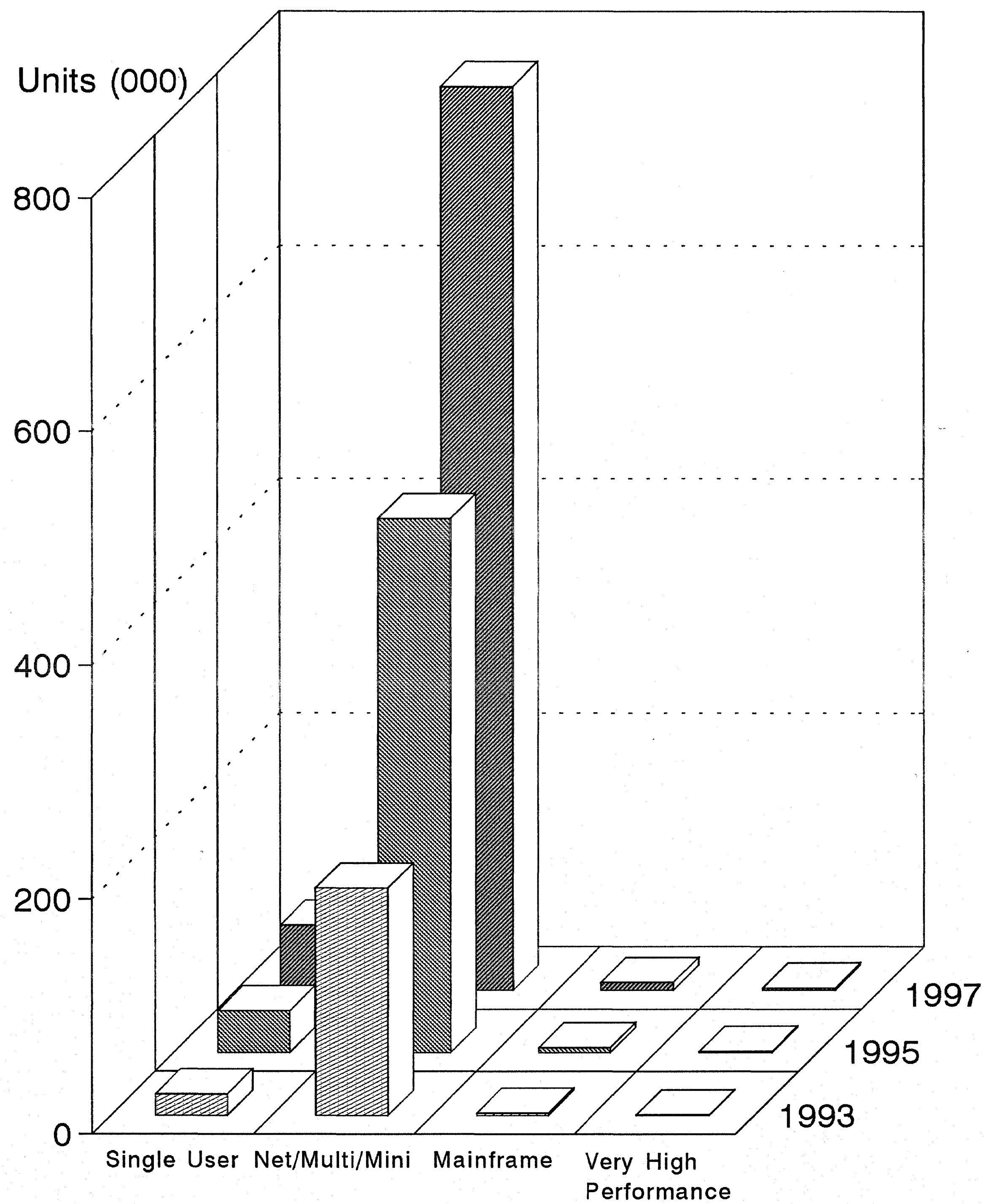


TABLE 4

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

UNIT SHIPMENTS	------1993-----		------------------------------Forecast----------------------------							
SINGLE UNITS	---Shipments---		------1994-----		------1995-----		------1996-----		------1997-----	
	Units	%	Units	%	Units	%	Units	%	Units	%
SINGLE USER SYSTEMS	18,095	8.4%	26,125	7.5%	35,735	7.2%	46,060	6.9%	55,420	6.6%
	+235.1%		+44.4%		+36.8%		+28.9%		+20.3%	
NETWORKS/MINI/MULTIUSER	194,041	90.5%	318,290	91.5%	456,230	91.8%	609,525	92.0%	773,340	92.5%
	+118.0%		+64.0%		+43.3%		+33.6%		+26.9%	
MAINFRAMES	2,025	.9%	3,035	.9%	4,250	.9%	5,875	.9%	6,615	.8%
	+62.3%		+49.9%		+40.0%		+38.2%		+12.6%	
VERY HIGH PERFORMANCE	506	.2%	796	.1%	1,085	.1%	1,455	.2%	1,780	.1%
	+91.7%		+57.3%		+36.3%		+34.1%		+22.3%	
Total Worldwide Shipments	214,667	100.0%	348,246	100.0%	497,300	100.0%	662,915	100.0%	837,155	100.0%
	+123.8%		+62.2%		+42.8%		+33.3%		+26.3%	
% U.S. Manufacturers	95.6%		91.1%		91.2%		91.3%		91.7%	

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

Array product mix

For the purposes of this report, shipment statistics are broken down 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.

Complete subsystems provided 52.7% of 1993 worldwide array unit shipments, and the share held by subsystems is expected to remain at about half of total array shipments through 1997. Complete subsystems constitute all of the mainframe array shipments and are expected to continue to provide more than 80% of array unit shipments for very high performance systems. Complete subsystems continue to constitute about half of the total array shipments for networks/minicomputer/multiuser systems. Growth is expected in subsystem penetration of single user computer markets, with their share increasing from 32.8% of 1993 array shipments for that product group to 58% in 1997.

Boards are an increasingly significant portion of the array industry. 1993's shipments of 58,204 boards is forecasted to grow to 288,955 boards in 1997, increasing the share of total array shipments held by boards from last year's 27.1% to 34.5% in 1997. Board shipments are increasing most rapidly in the networks/minicomputer/multiuser product group, where the 25.7% share of shipments held by boards in 1993 is forecasted to increase to 35.5% in 1997, culminating with 274,725 boards expected to be shipped that year. The largest factor driving board shipments in this product group is the broadening tendency to assemble arrays with purchased controllers by a variety of system manufacturers, integrators and distributors. On the other hand, board shipments for single user computer systems, once dominant in the product group due to early adoption by sophisticated computer users, is declining.

Although software array products can supply array functionality without requiring special hardware components, the overall software share of 1996 shipments is forecasted to drop from 20.2% of overall array shipments in 1993 to 11.4% in 1997. Shipments of software arrays are forecasted to decline in all DISK/TREND product groups, but the greatest penetration is expected to remain in single user system markets -- 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.

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. Mirrored disk arrays require 100% drive redundance, while the disk drive redundancy for RAID-5 is in the 20% range, so if all other elements are equal, 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-0/1 combinations	131
RAID-2	--
RAID-0/1/3 combinations	55
RAID-4	4
RAID-0/1/3/4/5 combinations	367

Figure 3

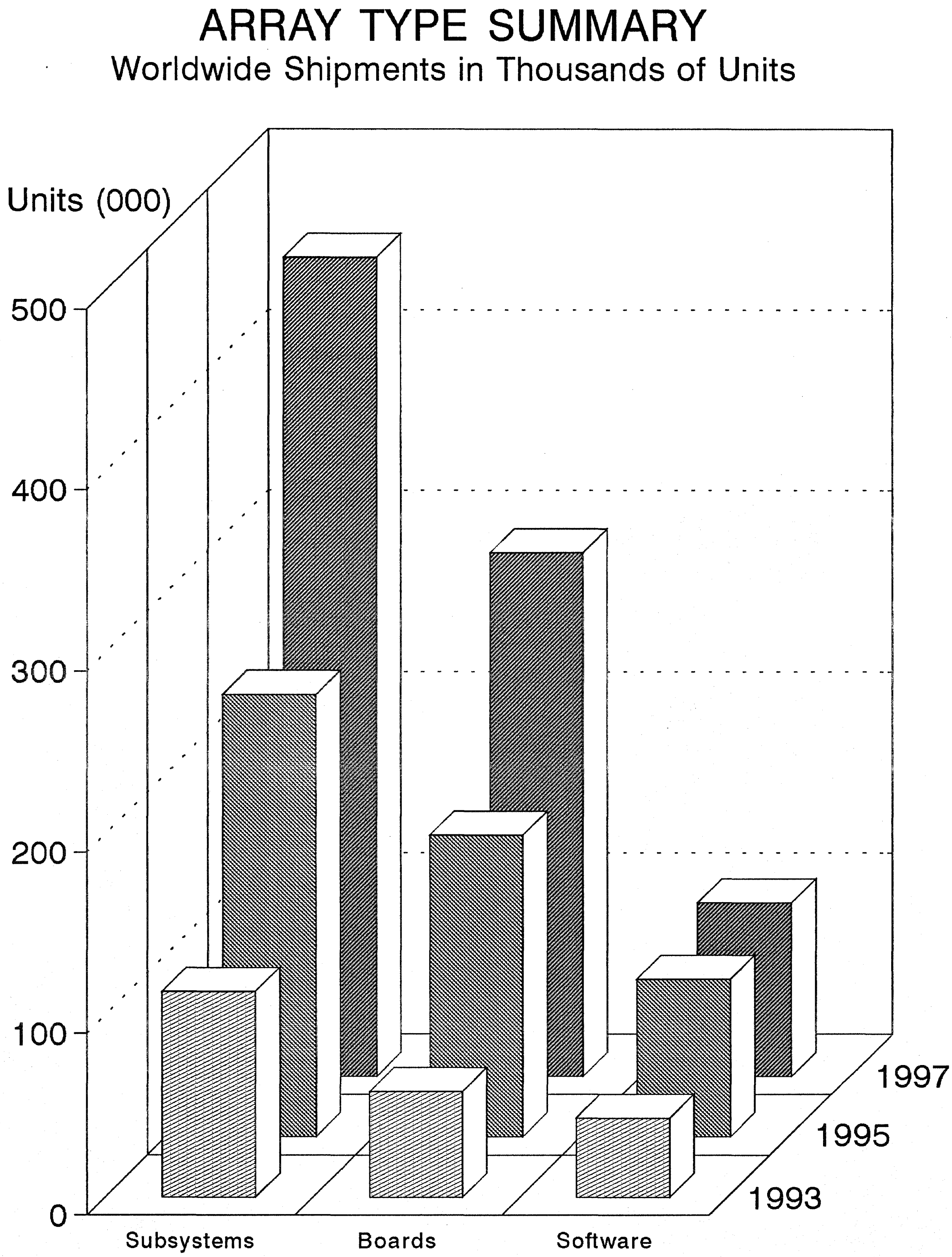

ARRAY TYPE SUMMARY
Worldwide Shipments in Thousands of Units
Units (000)
500
400
300
200
100
0
Subsystems
Boards
Software
1997
1995
1993

TABLE 5

CONSOLIDATED WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
SUMMARY BY ARRAY TYPE

UNIT SHIPMENTS	1993		Forecast							
SINGLE UNITS	Shipments		1994		1995		1996		1997	
	Units	%	Units	%	Units	%	Units	%	Units	%
SUBSYSTEMS	113,138	52.7%	164,721	47.3%	244,055	49.1%	343,190	51.8%	452,510	54.1%
	+115.8%		+45.6%		+48.2%		+40.6%		+31.9%	
BOARDS	58,204	27.1%	114,165	32.8%	166,520	33.5%	226,135	34.1%	288,955	34.5%
	+280.3%		+96.2%		+45.9%		+35.8%		+27.8%	
SOFTWARE	43,325	20.2%	69,360	19.9%	86,725	17.4%	93,590	14.1%	95,690	11.4%
	+53.6%		+60.1%		+25.0%		+7.9%		+2.2%	
Total Worldwide Shipments	214,667	100.0%	348,246	100.0%	497,300	100.0%	662,915	100.0%	837,155	100.0%
	+123.8%		+62.2%		+42.8%		+33.3%		+26.3%	

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

Noncaptive market

Aggressive growth in total noncaptive array shipments and revenues is expected to continue through 1997. Overall noncaptive array revenues jumped to $1.4 billion in 1993, and projected average annual revenue increases of 43.7% through 1997 will increase total noncaptive revenues to $5.6 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 two years. Noncaptive unit shipments are forecasted to increase from 104,670 in 1993 to 569,650 arrays in 1997.

In the DISK/TREND statistics for noncaptive array sales revenues, the PCM/Reseller channel has an insurmountable lead over OEM/Integrator sales, with a major assist from the expanding mainframe array market. Although the expected doubling of mainframe array unit shipments will produce a total of only 3,410 PCM/Reseller mainframe arrays in 1997, the very high average price per unit will produce 44.6% of noncaptive revenues of all array product groups, a total of $2.5 billion in 1997.

The other large contributor to PCM/Reseller leadership in noncaptive revenue totals will continue to be complete array subsystems in the networks/minicomputer/multiuser product group. Subsystems in that product group are forecasted to generate $1.7 billion in PCM/Reseller revenue in 1997, representing 118,880 array subsystems. OEM/Integrator sales growth will be helped by high unit sales of boards in the same product group, reaching 225,215 in 1997, but at much lower average prices.

The networks/minicomputer/multiuser product group's share of total noncaptive array revenues is forecasted to grow from 33.4% in 1993 to 51% in 1997, built on a diverse group of subsystem, board and software products from scores of manufacturers. By 1997, the networks/minicomputer/multiuser shipment total is expected to top 90% of all array shipments, at 513,485 units. The largest 1997 noncaptive product segment will be boards -- enabling a large number of system manufacturers, integrators and distributors to assemble their own arrays for various resale markets.

TABLE 6

NONCAPTIVE WORLDWIDE REVENUES
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

REVENUE SUMMARY

WORLDWIDE REVENUES	1993		Forecast							
ALL MANUFACTURERS	Revenues		1994		1995		1996		1997	
	$M	%	$M	%	$M	%	$M	%	$M	%
SINGLE USER SYSTEMS	16.7	1.2%	27.1	1.1%	36.2	1.1%	46.0	1.0%	53.7	1.0%
	+496.4%		+62.3%		+33.6%		+27.1%		+16.7%	
NETWORKS/MINI/MULTIUSER	449.4	33.4%	837.6	35.4%	1,411.7	43.4%	2,066.2	47.3%	2,842.3	51.0%
	+49.3%		+86.4%		+68.5%		+46.4%		+37.6%	
MAINFRAMES	867.4	64.3%	1,486.7	62.6%	1,769.1	54.3%	2,189.6	50.1%	2,575.5	46.3%
	+233.9%		+71.4%		+19.0%		+23.8%		+17.6%	
VERY HIGH PERFORMANCE	15.8	1.1%	24.5	.9%	42.3	1.2%	70.1	1.6%	97.0	1.7%
	+37.4%		+55.1%		+72.7%		+65.7%		+38.4%	
Total Worldwide Revenues	1,349.3	100.0%	2,375.9	100.0%	3,259.3	100.0%	4,371.9	100.0%	5,568.5	100.0%
	+134.6%		+76.1%		+37.2%		+34.1%		+27.4%	

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

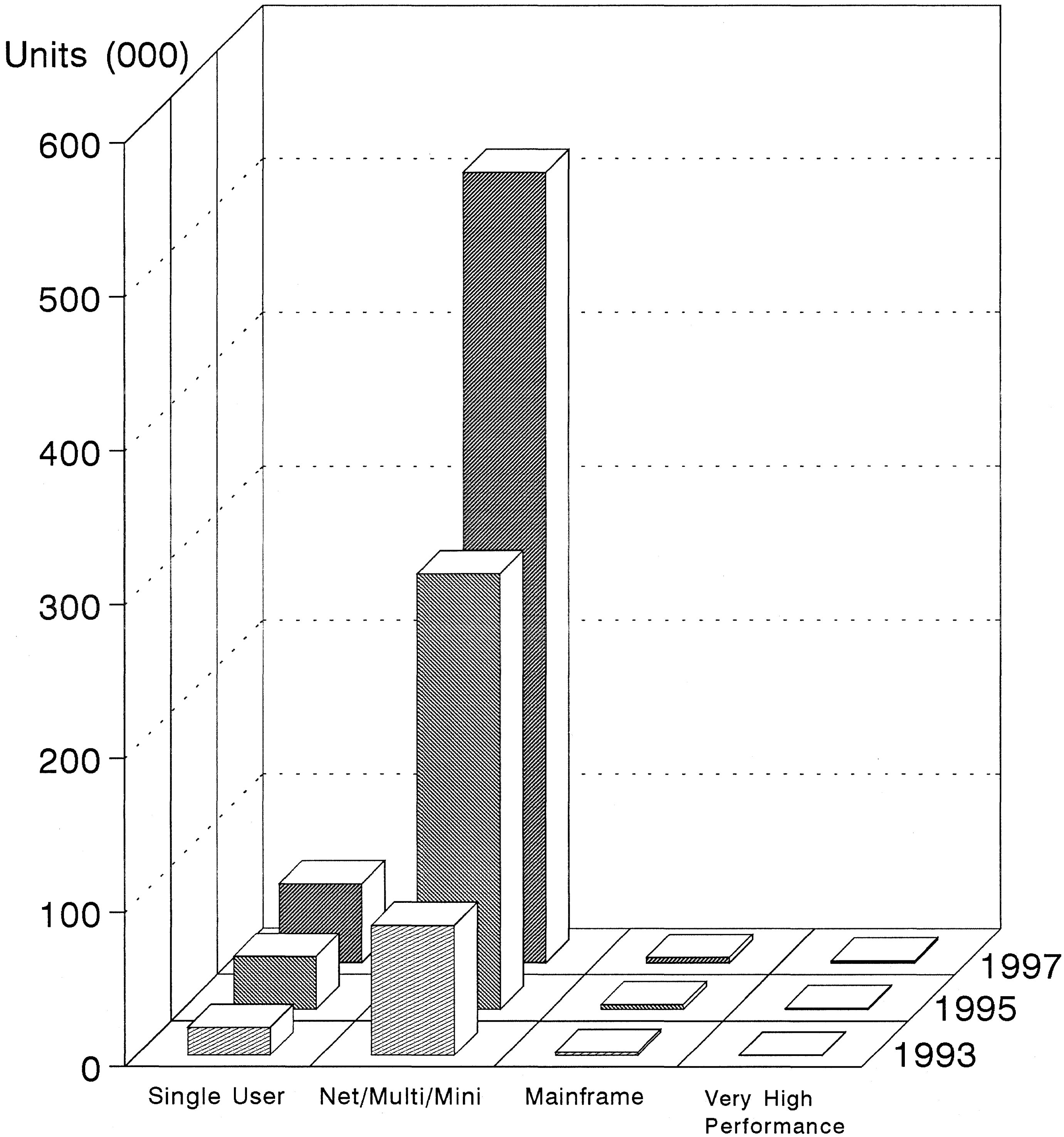


TABLE 7

NONCAPTIVE WORLDWIDE SHIPMENTS
DISK DRIVE ARRAYS
PRODUCT GROUP REVIEW

UNIT SHIPMENT SUMMARY

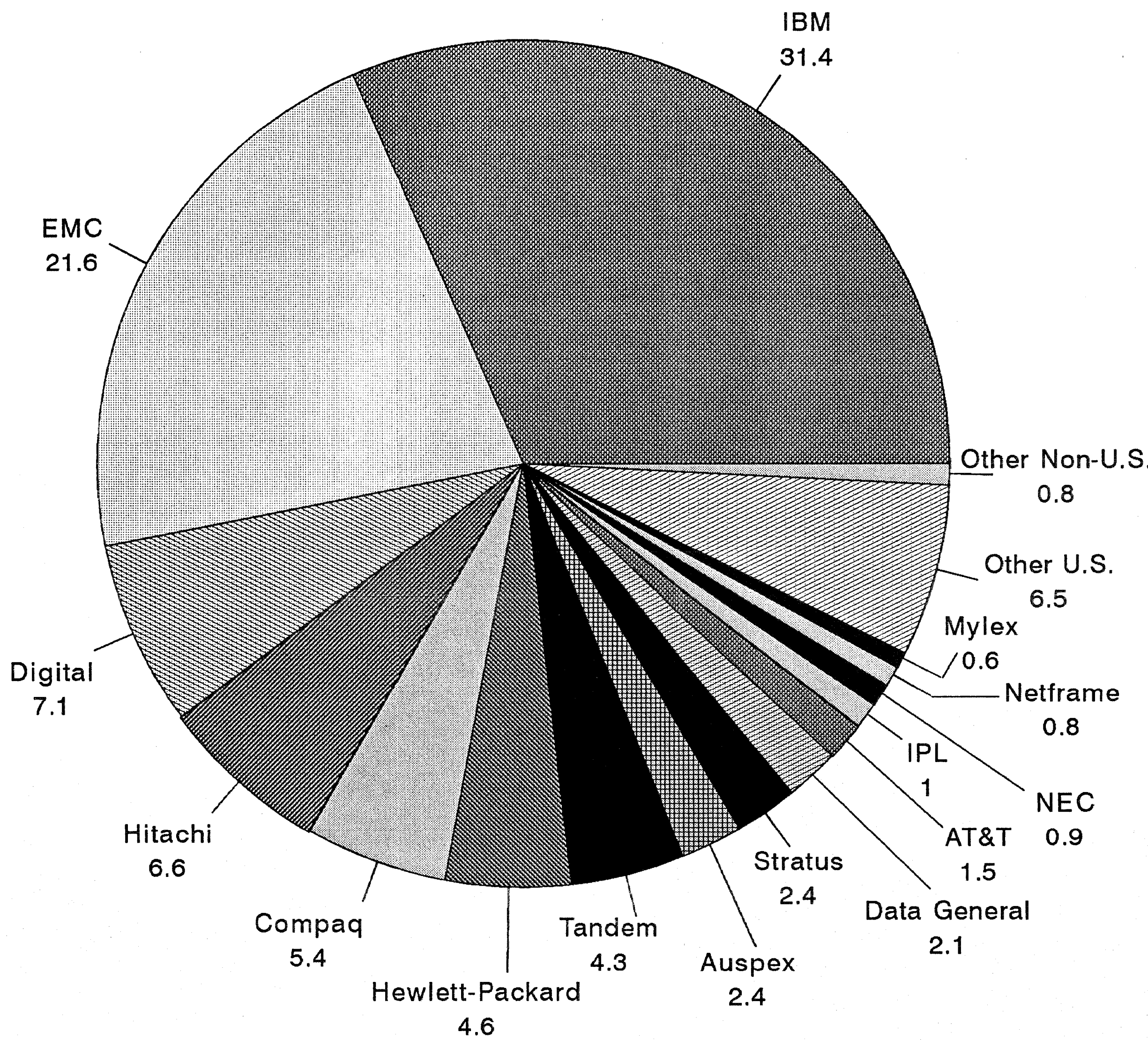
UNIT SHIPMENTS SINGLE UNITS	1993 Shipments Units	1993 Shipments %	Forecast 1994 Units	1994 %	1995 Units	1995 %	1996 Units	1996 %	1997 Units	1997 %
SINGLE USER SYSTEMS	18,095	17.3%	26,125	12.3%	33,935	10.6%	42,560	9.7%	51,120	9.0%
	+235.1%		+44.4%		+29.9%		+25.4%		+20.1%	
NETWORKS/MINI/MULTIUSER	84,239	80.6%	182,080	86.2%	282,630	88.3%	391,485	89.3%	513,485	90.2%
	+229.2%		+116.1%		+55.2%		+38.5%		+31.2%	
MAINFRAMES	2,025	1.9%	2,885	1.3%	2,990	.9%	3,290	.8%	3,635	.6%
	+62.3%		+42.5%		+3.6%		+10.0%		+10.5%	
VERY HIGH PERFORMANCE	311	.2%	540	.2%	805	.2%	1,125	.2%	1,410	.2%
	+45.3%		+73.6%		+49.1%		+39.8%		+25.3%	
Total Worldwide Shipments	104,670	100.0%	211,630	100.0%	320,360	100.0%	438,460	100.0%	569,650	100.0%
	+222.6%		+102.2%		+51.4%		+36.9%		+29.9%	
% U.S. Manufacturers	93.0%		86.7%		87.5%		87.9%		88.6%	

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

Figure 5

1993 ESTIMATED MARKET SHARES

Worldwide Percentage Revenues for all Disk Arrays



1993 Revenues: $3,453,000,000

TABLE 8

1993 ESTIMATED MARKET SHARES

WORLDWIDE REVENUES OF ALL DISK DRIVE ARRAYS
(Value of non-U.S. currencies estimated at average 1993 rates)

	CAPTIVE		PCM/RESELLER		OEM/INTEGRATOR		TOTAL INDUSTRY	
	$M	%	$M	%	$M	%	$M	%
U.S. MANUFACTURERS								
AT&T	40.6	1.9	--	--	9.7	5.3	50.3	1.5
Auspex Systems	--	--	77.2	6.6	4.0	2.2	81.2	2.4
Compaq Computer	184.8	8.9	--	--	--	--	184.8	5.4
Data General	66.9	3.2	--	--	6.7	3.6	73.6	2.1
Digital Equipment Corp.	246.3	11.8	--	--	--	--	246.3	7.1
EMC	--	--	652.2	56.0	91.4	49.7	743.6	21.6
Hewlett-Packard	145.0	7.0	15.2	1.3	--	--	160.2	4.6
IBM	1,078.6	51.7	--	--	--	--	1,078.6	31.4
IPL	--	--	32.8	2.8	--	--	32.8	1.0
Mylex	--	--	1.4	.1	18.6	10.1	20.0	.6
Netframe	--	--	16.1	1.4	10.6	5.8	26.7	.8
Stratus Computer	82.8	4.0	--	--	--	--	82.8	2.4
Tandem Computers	147.6	7.1	--	--	--	--	147.6	4.3
Other U.S.	57.9	2.8	142.2	12.2	24.2	13.2	224.3	6.5
U.S. Total	2,050.5	98.3	937.1	80.4	165.2	89.8	3,152.8	91.7
NON-U.S. MANUFACTURERS								
Hitachi	2.0	.1	221.5	19.0	1.8	1.0	225.3	6.6
NEC	30.0	1.4	--	--	--	--	30.0	.9
Other Non-U.S.	3.6	.2	6.7	.6	17.0	9.2	27.3	.8
Non-U.S. Total	35.6	1.7	228.2	19.6	18.8	10.2	282.6	8.3
WORLDWIDE TOTAL	2,086.1	100.0	1,165.3	100.0	184.0	100.0	3,435.4	100.0

Note: 1. Drives sold in the PCM/Reseller market by other than the original manufacturer are valued at PCM/Reseller prices above, to avoid distortion of total market value

2. The DISK/TREND estimates of revenue for each disk drive manufacturer include net sales of disk drives only and do not represent total revenues for individual companies

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			
U.S. Manufacturers (131)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
1776, Inc.	O,P		SW		
ADIC	P		SB		
ADS International	P		BD		
Allodyne	O,P		SB		
American Digital Systems	P		SB		
American Megatrends	O,P		BD		
ANDATACO	O,P		SB		
ASA Computers	P		SB		
AST Research	C,P		SB		
AT&T Global Information Sol.	C,O,P		BD,SB,SW		
ATTO Technology	O,P	BD,SW			
Auspex Systems	C,O		SB		
Aviv	P		SB		
Box Hill	C,P		SB		
BusLogic	O,P		BD,SW		
Cambex	P		SB		
Canary Communications	O		BD		
Ciprico	O,P		SB		SB
CLone Star Software	P		SW		
Clovis Manufacturing	P		SB		
CMD Technology	O	BD	BD		
CMS Enhancements	P		SB		
Compaq Computer	C		SB		
CompuAdd Computer	P		SB		
Concurrent Computer	C		SB		
Conley	O,P		SB,SW		
Conner Storage Systems	P		SB		
Consensys	O,P		BD,SW		
Control Data Systems	C		BD	SB	
Convex Computer	C				SB
Core International	O,P		SB		
Corel	O,P		SW		
Cray Research	C				SB
Data General	C,O		SB		
Data Storage Marketing	P		SB		
Datalink	P		SB		
Dataram	P		SB		
Dell Computer	C		SB		
Digi-Data	O		BD		
Digital Equipment Corporation	C,O		SB,SW		
Direct Connect Systems	P		SB		
Distributed Processing Tech.	O,P		BD		
Diverse Logistics	P		BD		
DynaTek Automation Systems	P		SB		
ECCS	O,P		SB		
EMC	P		SB	SB	
Encore Computer	C				SB
Exsys Storage Systems	P		SB		

U.S. Manufacturers (CONTINUED)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
Falcon Systems	P		SB		
Formation	O,P		SB		
FWB	P	SB	SB,SW		
Gain Systems	O,P		SB		
General Microsystems	P				SB
GigaTrend	P		SB		
Hammerman Associates	P		SB		
Hewlett-Packard	C,P		SB		
High Performance Storage	O,P		SB		
IBM	C,O,P		SB,SW		SB
Information Management Tech.	P		SB		
Integra Technologies	O		SW		
Invincible Technologies	P		SB		
IPL	P		SB		
Jaba System	P		SB		
Laura Technologies	O,P		BD		
Legacy Storage Systems	O,P		SB		
Lomas Data Products	O,P		BD		
Macro Computer Products	P			SB	
Marner International	O,P		SB		
MasPar Computer	C				SB
Maximum Strategy	O,P				SB
Media Integration	P		SB		
Megabyte Memory & Peripherals	P		SB		
Mega Drive Systems	O,P	SB	SB		
MicroAccess	P		SB		
Micronet Technology	O,P		SB		
Micropolis	P		SB		
Microtech International	P	SB			
Micro Technology	P		SB		
Morton Management	P		SB		
Mylex	O,P		BD,SB		
National Peripherals	P		SB		
NetFRAME	O,P		SB		
Network Appliance	P		BD,SB		
Network Connection	P		SB		
Nonstop Networks	P		SW		
PACE Technologies	O,P		SB		
Pacific Micro Data	O		SB		
Parity Systems	P		SB		
Peak Technologies	P		SB		
Perceptive Solutions	O,P		BD,SW		
Peripheral Land, Inc.	P	BD,SB			
Precision Computers	O,P		SB		
Procom Technology	O,P	BD,SB	SB		
Pro Engineering	O,P		SW		
R Squared	P		SB		
RAAC Technologies	P		SB		
RAID Power	P		SB		
Raidtec	O,P	SB	BD		
Ranger Technologies	P	SB			
See First Technology	P		SB		
Seek Systems	P		BD,SB		
Sequent Computer Systems	P		SB		
Sequoia Systems	C,O		SB		
Seraph	P	SB	SB		
Silicon Valley Computer	P	BD			
Storage Computer	O,P		SB		
Storage Concepts	O,P		SB		SB
Storage Dimensions	O,P		SB		

U.S. Manufacturers (CONTINUED)	Type	Single User Arrays	Networks/ Minicomputer/ Multiuser Arrays	Mainframe Arrays	Very High Performance Arrays
Storage Solutions	O,P		SB		
Storage Technology	P		SB	SB	
Stratus Computer	C		SB		
Sun Microsystems	C,P		SB,SW		
Tandem Computers	C		SB		
Tangent Computer	C,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		BD		
Unbound	O		BD,SB		
Unison Information Systems	P		SB		
Unisys	C		SB	SB	
Unitrol Data Protection Sys.	O,P	SW	SW		
Vanguard Technologies	P		SB		
Veritas Software	O,P		SW		
Winchester Systems	P		BD,SB		
Wyse Technology	P		SB		
ZZYXZ Workstations & Periph.	P		SB		
Asia/Pacific Rim Manufacturers (10)					
Acer	P		SB		
Aresys	O,P	BD	BD		
ATEN International	O,P		BD		
DTC Technology	O		BD		
Fujitsu	C,P		SB		SB
Hitachi	C,O,P		SB		
Hitachi Data Systems	P		SB	SB	
Infortrend	O		BD		
NEC	C		BD,SB		
Sanyo Icon	P		SB		
European Manufacturers (13)					
Arco Electronics	P	BD			
ATON Systemes	O,P	BD	BD,SB		
Baydel Ltd.	O,P		SB		
Disk Pack	P		SB		
Eurologic Systems	P		SB		
Future Computers	P		SB		
Hi-Data	O		BD,SB		
ICL	P		SB		
Lion Cabinets	O,P		BD		
Solid Computer	O,P		SB,SW		
TwinCom	O,P		SW		
Vortex Computersysteme	O,P		BD		
Zenith Data Systems	C		SW		

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, UNIX, etc.

Networks/Multiuser/Minicomputers: 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 software 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 revenue figures.

Market classification

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

Captive: Arrays manufactured internally or by a subsidiary of a computer manufacturer, 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 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 AT&T are noncaptive, except for arrays sold with systems made by the parent company or other subsidiaries.

* Shipments made by Micropolis or Storage Dimensions 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 Integra 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 sale of a complete subsystem.

* When BusLogic sells a copy of its Paragon 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 1994 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 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 disk drive 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:

* <u>RAID-0:</u> 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).

* <u>RAID-1 (Mirrored disk drives):</u> 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. Write performance may be somewhat slower, 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.

* <u>RAID-2:</u> 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.

* <u>RAID-3:</u> 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 extra drive provided for this purpose. 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.

* <u>RAID-4:</u> 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.

* <u>RAID-5:</u> 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.

* <u>RAID-6:</u> 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 proposal 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

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 CHECK LIST

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 coresident 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?

* 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?

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:

* If a high degree of fault tolerance is not initially needed, can it be economically added in the future?

* 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?

The most important cost of all may be the cost to the organization 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 lose data if further failures occur while the original failure remains unrepaired. Many 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 drive and start up an on-line spare (if available), and the ability to replace 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 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.

Some arrays make it easy to locate a failed drive, fan or power supply with indicator lights marking the defective element. 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.

Some other considerations:

* What kind of messages or alert signal 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?

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.

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:

* <u>Layered versus nonlayered arrays:</u> 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.

* <u>Host based versus controller based arrays:</u> 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 adaptor, 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 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. 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 offline 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 approaches 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. As 1.8" diameter drives achieve larger capacities, it is expected that arrays of 1.8" drives will be packaged in the form factor of a 3.5" drive.

The 5.25" package envelope is very attractive for arrays to be used with workstations or in servers for small work groups. Disk drives are expected to quadruple the capacity available in today's form factors by the end of 1996, which will make multigigabyte user capacity available in the 5.25" form factor.

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.

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.

Semiconductors: Specialized semiconductors for use in disk drive arrays have been available from AT&T since 1991, and other firms are also beginning to produce specialized chips for this purpose, including drive controllers, array management chips and specialized processors. Over the long haul, basic array controller chips may migrate to the motherboards of low end 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.

Cirrus Logic is among the semiconductor companies that have indicated plans to do an array chip set for the merchant market, joining AT&T as a specialized supplier to the array controller market. CMD, while not a semiconductor manufacturer, has designed a chip set which will be produced by a semiconductor manufacturer.

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 over 500 megabits per square inch density today are expected to offer a gigabit per square inch by 1996. The impact of this will be to make a gigabyte available in a single platter 3.5" drive or a double platter 2.5" drive. With the reduced parts count implied, the costs for a gigabyte of storage are expected to steadily decline.

The 3.5" disk drive in the one inch high form factor is expected to gradually become 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: Capacity expansion to four gigabytes per one inch high 3.5" drive within a few years is anticipated. 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 for high end drives have become common. Seagate, IBM and others are shipping 7,200 RPM drives. 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 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, 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.

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

Drive interfaces are almost all SCSI or SCSI-2, although a few arrays exist that connect to IDE or ESDI interfaces. SCSI-3 and serial SCSI are expected to become common drive interfaces as they enter the market because they support high 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 available in 1994.

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.

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 environments. 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.

Standards: There are a number of standards issues that impact the development of the disk drive array market. 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. The current target for the specification is the parallel SCSI-2 interface. 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.

* 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.

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 additional 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. 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: The logical algorithm used to recover data from an array when a drive has failed.

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

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 trade mark 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.

IPI: Intelligent Peripheral Interface. This is a high performance interface usually used in larger systems. Two variants are in current use: 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.

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 an 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.

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.

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.

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.

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.

ARRAYS: SINGLE USER SYSTEMS

ARRAYS: SINGLE USER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

FWB	Sledgehammer series
Mega Drive Systems	Mercury
Peripheral Land, Inc.	MiniArray, QuickArray
Procom Technology	480, 680
Raidtec	FlexArray MX
Ranger Technologies	Plug & Go
Seraph	Gemini SE

Board assembly (no drives)

ARCO Electronics	AC1079MC
Aresys	IDACO-1000
ATON Systemes	AREKA I-10S
ATTO Technology	Silicon Express
CMD Technology	SCEA/S
Peripheral Land, Inc.	QuickSCSI
Procom Technology	ISA SCSI Xelerator
Silicon Valley Computer	ADP 104, 111

Software arrays

ATTO Technology	Express Mirror
Trillium Research	Remus Ltd.

All disk drive arrays used primarily with single personal computers or workstations are included in this product group. Shipments in this product group started in 1990, with early software and board level array products.

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.

Although individual disk drive arrays offering RAID-3 or RAID-5 capability are included in each of the above subsystem, board and software product types, they remain the exception, and in some cases are intended for high-end workstations use for graphics and prepress applications. Most of the other products are designed for the very price-sensitive personal computer markets, and use disk mirroring.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1993	1994	1995	1996	1997
U.S. manufacturers	16.5	26.8	40.7	52.5	58.3
All manufacturers	16.7	27.1	41.7	55.8	64.4

Unit shipments of single user arrays increased 235.1% in 1993, reaching 18,095 individual arrays, with further growth to 26,125 forecasted for 1994. Due to the low average unit prices typical of this product group, 1993 worldwide revenues increased to only $16.7 million, with 1994 expected to climb to $27.1 million. The earliest disk drive array products specifically intended for single users appeared in 1990 and 1991, offering RAID-1 and RAID-0/1 for individual computer users who consider their work to be mission critical.

Shipments which have occurred so far in this product group have included a minority of complete disk drive array subsystems -- many more users have chosen the option of installing a controller board with mirroring capability. However, boards and board assemblies, which provided 70.6% of 1992 unit shipments, were down to 46.1% of 1993 shipments, and are forecasted to provide only 38% of 1994's shipments. Complete subsystems are expected to move up to 41.4% of 1994 unit shipments, with software arrays declining slightly to 20.6%.

The leader in 1993 noncaptive shipments was FWB with 29.8% of the worldwide total, all subsystems sold for Macintosh applications. Peripheral Land's combined total of 3,550 RAID-0/1 subsystems and boards for the Macintosh market earned the company a 19.6% share.

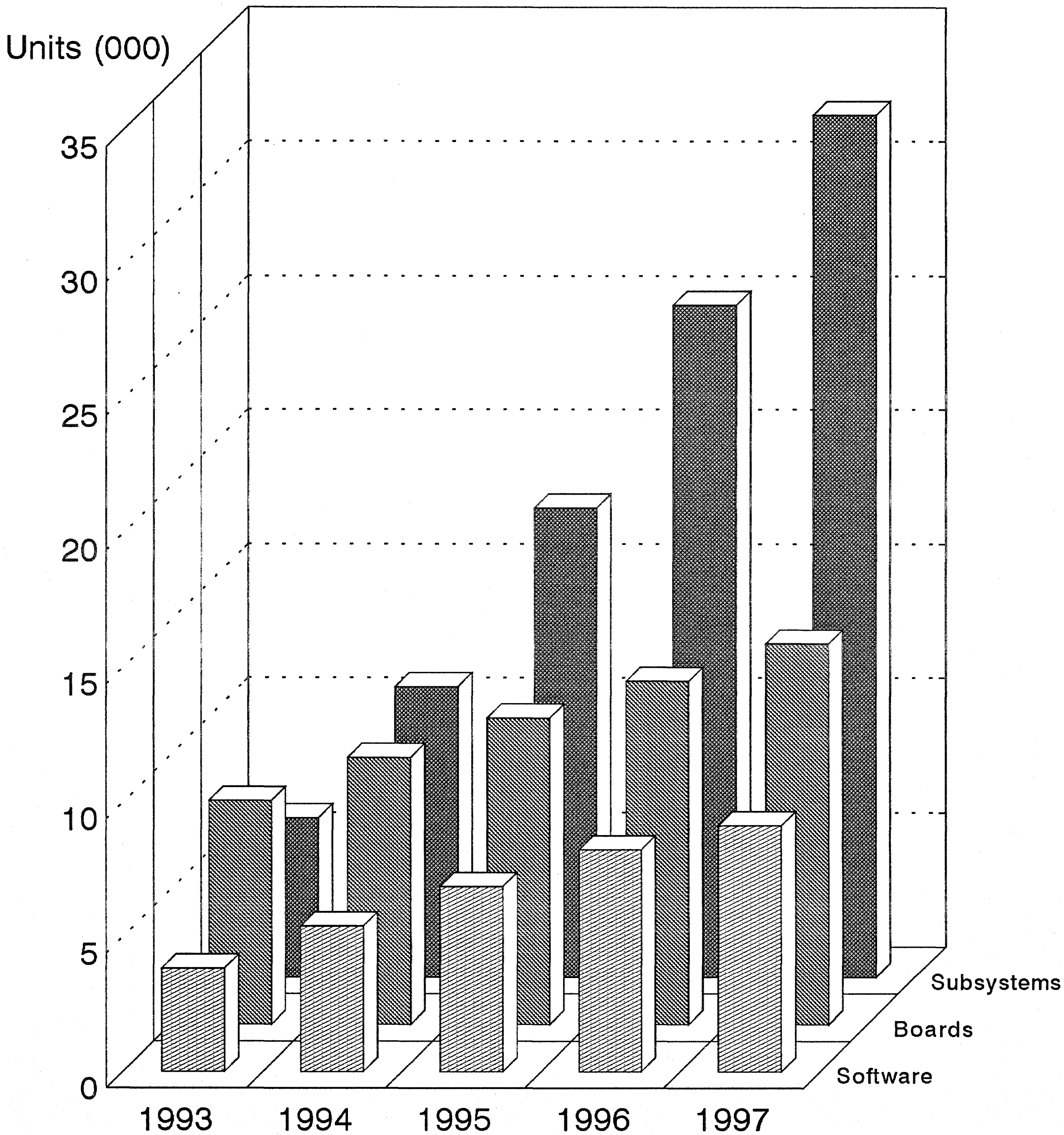
Marketing trends

Total revenues for arrays used with single user systems are expected to remain the smallest of the four DISK/TREND array product groups. The group's

Figure 6

Single User System Arrays

Worldwide Shipments by Array Type



low average unit prices will increase slightly due to the larger share expected for subsystems and the forecasted start of captive shipments, but not enough to boost the revenue total higher than 0.5% of the total for all four DISK/TREND array product groups. 1997 total revenues for single user arrays are forecasted at $64.4 million. Total unit shipments of single user arrays are forecasted to reach 55,420 units in 1997, an average increase for the 1995-97 period of 28.6% per year.

By 1997, complete subsystems are projected to provide 58% of all single user arrays, the result of an average annual growth of 44.4% during the 1995-97 period. Boards are expected to grow during the same period at an average of only 12.5%, dropping the 1997 share of all single user arrays down to 25.5%. 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 arrays, as 1.8" and 2.5" drives with higher capacities are packaged in very small array enclosures.

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 hold 90.5% of 1997 worldwide revenues. The PCM/Reseller channel is expected to remain dominant in sales of arrays for single user systems, and is forecasted to capture 79.9% of 1997 total unit shipments for all types of single user arrays.

Technical trends

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. 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.

A few manufacturers have taken advantage of the availability of 2.5" drives and one inch high 3.5" 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 newer 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 500 megabytes, and some 2.5" drives should soon exceed one gigabyte or more. 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.

1.8" drives with 130 megabytes capacity are now available, and 170 megabyte drives have been announced. These drives open additional packaging opportunities because they will be available in the PCMCIA Type III configuration, a plug-in card only 10.5 millimeters thick. These drives, which are expected to offer capacities of at least 500 megabytes within a few years, provide the opportunity to produce a disk drive array in the 3.5" disk drive form factor, probably with one inch height. The removable card-mounted drives will make it possible to upgrade drives when higher capacities become available and make replacement of failed drives easy.

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 to at least half of the unit shipments for the product group, due to convenience of installation and use, plus availability of new small arrays using 2.5" and 1.8" disk drives.

3. U.S. manufacturers will continue to dominate 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)

	1993 Revenues		Forecast 1994		Forecast 1995		Forecast 1996		Forecast 1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	4.1	5.5	7.1	9.8	7.4	10.7
PCM/Reseller	10.1	16.3	16.0	26.2	21.1	34.5	25.1	40.8	27.5	44.0
OEM/Integrator	.2	.2	.4	.6	.5	.7	1.4	1.9	2.8	3.6
TOTAL U.S. REVENUES	10.3	16.5	16.4	26.8	25.7	40.7	33.6	52.5	37.7	58.3
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	.2	.2	.2	.3	.6	.9	1.7	2.6	3.4	4.8
OEM/Integrator	--	--	--	--	--	.1	.4	.7	.7	1.3
TOTAL NON-U.S. REVENUES	.2	.2	.2	.3	.6	1.0	2.1	3.3	4.1	6.1
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	10.5	16.7	16.6	27.1	26.3	41.7	35.7	55.8	41.8	64.4

TABLE 11

SINGLE USER SYSTEMS

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	--	--	1,350	1,800	2,520	3,500	2,970	4,300
PCM/Reseller	10,694	16,105	14,800	22,800	18,710	28,755	22,140	33,960	24,910	38,090
OEM/Integrator	450	560	850	1,125	1,240	1,650	2,170	2,850	3,510	4,580
TOTAL U.S. SHIPMENTS	11,144	16,665	15,650	23,925	21,300	32,205	26,830	40,310	31,390	46,970
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	--	--	--	--	--
PCM/Reseller	1,000	1,300	1,500	2,000	2,220	3,000	3,255	4,530	4,450	6,210
OEM/Integrator	130	130	200	200	220	530	575	1,220	1,050	2,240
TOTAL NON-U.S. SHIPMENTS	1,130	1,430	1,700	2,200	2,440	3,530	3,830	5,750	5,500	8,450
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	12,274	18,095	17,350	26,125	23,740	35,735	30,660	46,060	36,890	55,420
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	16	23	33	49	57	85	88	131	125	186

TABLE 12

SINGLE USER SYSTEMS

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1993 Revenues			Forecast 1994			1995			1996			1997		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	--	--	--	--	--	--	5.5	--	--	9.8	--	--	10.7	--	--
PCM/Reseller	13.7	2.2	.4	23.2	2.5	.5	31.3	2.7	.5	37.6	2.6	.6	41.0	2.4	.6
OEM/Integrator	--	.1	.1	--	.3	.3	.1	.3	.3	1.3	.3	.3	2.8	.4	.4
TOTAL U.S. REVENUES	13.7	2.3	.5	23.2	2.8	.8	36.9	3.0	.8	48.7	2.9	.9	54.5	2.8	1.0
NON-U.S. MANUFACTURERS															
PCM/Reseller	--	--	.2	--	--	.3	.5	--	.4	2.2	--	.4	4.3	.1	.4
OEM/Integrator	--	--	--	--	--	--	--	.1	--	.4	.3	--	.7	.6	--
TOTAL NON-U.S. REVENUES	--	--	.2	--	--	.3	.5	.1	.4	2.6	.3	.4	5.0	.7	.4
WORLDWIDE RECAP															
Captive	--	--	--	--	--	--	5.5	--	--	9.8	--	--	10.7	--	--
	--	--	--	--	--	--	--	--	--	+78.2%	--	--	+9.2%	--	--
PCM/Reseller	13.7	2.2	.6	23.2	2.5	.8	31.8	2.7	.9	39.8	2.6	1.0	45.3	2.5	1.0
	+813.3%	+83.3%	+500.0%	+69.3%	+13.6%	+33.3%	+37.1%	+8.0%	+12.5%	+25.2%	-3.7%	+11.1%	+13.8%	-3.8%	--
OEM/Integrator	--	.1	.1	--	.3	.3	.1	.4	.3	1.7	.6	.3	3.5	1.0	.4
	--	--	--	--	+200.0%	+200.0%	--	+33.3%	--	--	+50.0%	--	+105.9%	+66.7%	+33.3%
Total Revenues	13.7	2.3	.7	23.2	2.8	1.1	37.4	3.1	1.2	51.3	3.2	1.3	59.5	3.5	1.4
	+813.3%	+91.7%	+600.0%	+69.3%	+21.7%	+57.1%	+61.2%	+10.7%	+9.1%	+37.2%	+3.2%	+8.3%	+16.0%	+9.4%	+7.7%
ANNUAL SHARE, BY TYPE	82.1%	13.8%	4.1%	85.7%	10.3%	4.0%	89.8%	7.4%	2.8%	92.0%	5.7%	2.3%	92.5%	5.4%	2.1%

TABLE 13

SINGLE USER SYSTEMS

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1993 Shipments			Forecast 1994			1995			1996			1997		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	--	--	--	--	--	--	1,800	--	--	3,500	--	--	4,300	--	--
PCM/Reseller	5,940	8,265	1,900	10,800	9,600	2,400	15,290	10,640	2,825	19,285	11,325	3,350	22,790	11,690	3,610
OEM/Integrator	--	60	500	--	325	800	120	380	1,150	900	550	1,400	2,150	760	1,670
TOTAL U.S. SHIPMENTS	5,940	8,325	2,400	10,800	9,925	3,200	17,210	11,020	3,975	23,685	11,875	4,750	29,240	12,450	5,280
NON-U.S. MANUFACTURERS															
PCM/Reseller	--	--	1,300	--	--	2,000	250	150	2,600	1,100	280	3,150	2,300	450	3,460
OEM/Integrator	--	--	130	--	--	200	--	230	300	260	600	360	570	1,250	420
TOTAL NON-U.S. SHIPMENTS	--	--	1,430	--	--	2,200	250	380	2,900	1,360	880	3,510	2,870	1,700	3,880
WORLDWIDE RECAP															
Captive	--	--	--	--	--	--	1,800	--	--	3,500	--	--	4,300	--	--
	--	--	--	--	--	--	--	--	--	+94.4%	--	--	+22.9%	--	--
PCM/Reseller	5,940	8,265	3,200	10,800	9,600	4,400	15,540	10,790	5,425	20,385	11,605	6,500	25,090	12,140	7,070
	+989.9%	+120.1%	+204.8%	+81.8%	+16.2%	+37.5%	+43.9%	+12.4%	+23.3%	+31.2%	+7.6%	+19.8%	+23.1%	+4.6%	+8.8%
OEM/Integrator	--	60	630	--	325	1,000	120	610	1,450	1,160	1,150	1,760	2,720	2,010	2,090
	--	+20.0%	--	--	+441.7%	+58.7%	--	+87.7%	+45.0%	+866.7%	+88.5%	+21.4%	+134.5%	+74.8%	+18.8%
Total Shipments	5,940	8,325	3,830	10,800	9,925	5,400	17,460	11,400	6,875	25,045	12,755	8,260	32,110	14,150	9,160
	+989.9%	+118.8%	+264.8%	+81.8%	+19.2%	+41.0%	+61.7%	+14.9%	+27.3%	+43.4%	+11.9%	+20.1%	+28.2%	+10.9%	+10.9%
ANNUAL SHARE, BY TYPE	32.8%	46.1%	21.1%	41.4%	38.0%	20.6%	49.0%	31.9%	19.1%	54.5%	27.7%	17.8%	58.0%	25.5%	16.5%

TABLE 14

SINGLE USER SYSTEMS

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1993	Forecast 1994	Forecast 1995	Forecast 1996	Forecast 1997
Captive					
Subsystems	--	--	3,000	2,800	2,500
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	--	--	3,000	2,800	2,500
PCM/Reseller					
Subsystems	2,307	2,148	2,050	1,951	1,803
Boards	273	265	249	229	209
Software	179	177	161	146	135
PCM/Reseller Average	950	1,069	1,115	1,127	1,100
OEM/Integrator					
Subsystems	--	--	1,500	1,377	1,279
Boards	1,100	900	734	579	481
Software	226	228	217	197	185
OEM/Integrator Average	302	392	432	641	708

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

	1993 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Drive Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
FWB	3,250	--	--	3,250	26.5	5,390	--	--	5,390	29.8
Peripheral Land Inc.	275	2,250	--	2,525	20.6	550	3,000	--	3,550	19.6
Silicon Valley Comp.	--	1,200	--	1,200	9.8	--	2,000	--	2,000	11.1
Arco Electronics	--	1,000	--	1,000	8.1	--	1,500	--	1,500	8.3
Unitrol Data Protect.	--	--	1,130	1,130	9.2	--	--	1,430	1,430	7.9
Other U.S.	--	1,369	1,800	3,169	25.8	--	1,825	2,400	4,225	23.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	3,525	5,819	2,930	12,274	100.0	5,940	8,325	3,830	18,095	100.0

ARRAYS: NETWORKS. MINICOMPUTERS. MULTIUSER SYSTEMS

1994 DISK/TREND REPORT

ARRAYS: NETWORKS/MINICOMPUTER/MULTIUSER SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Acer	Altos 7000
ADIC	SDS-RAID
Allodyne	A510, A1010
American Digital Systems	Masterdisk RAID
ANDATACO	Gigaraid GTS, GRS
ASA Computers	Clydesdale, Thoroughbred
AST Research	Manhattan, Premia-SE
ATON Systemes	AREKA VDS
AT&T Global Information Solutions	6298, 6299
Auspex Systems	NS 3XXX, NS 6XXX series
Aviv	Duet, Mustang
Baydel	DAR3, DAR5 series
Box Hill	RAID Box 530
Cambex	Array/6000 series
Ciprico	6700 series
Clovis Manufacturing	Multistor series
CMS Enhancements	Platinum ARRAY series
Compaq Computer	ProLiant, ProSignia series
CompuAdd	DriveArray
Concurrent Computer	D-251, SD-22
Conley	SR1, SR2
Conner Storage Systems	CR611 series, CR622
Core International	LAN Array, MicroArray
Data General	CLARiiON series
Datalink	RSG 200, RSP 500
Dataram	DTM900, DTM4000
Data Storage Management	Datastor RAID
Dell Computer	DSA
Digital Equipment	HSC65 series, StorageWorks series
Direct Connect Systems	Guardian RAID
Disk Pack	DP-RAID
DynaTek Automation Systems	RDR, IIR, XPRS series
ECCS	FFT series, Micro DFT
EMC	Harmonix series
Eurologic Systems	EL-RAID 300
Exsys Storage Systems	RFCS ISA series
Falcon Systems	FalconRAID
Formation	9937 series
Fujitsu	F7956, DynaRAID
Future Computers	RAIDER-5
FWB	Sledgehammer series
Gain Systems	Superserver
Gigatrend	MasstoRAID

Complete subsystems, with disk drives (continued)

Hammerman Associates	DATA-SAFE series
Hewlett-Packard	C2436HA, C3609A
Hi-Data	2000, 3000
High Performance Storage	Wildcat series
Hitachi	A-6511, HitRAID series
IBM	9337, 3514, 7135, 9570 series
ICL	PowerARRAY
Information Management Technologies	HiPerRaid5
IPL	7037, 7737 series
Invincible Technologies	Ultimate 1, 5
Jaba System	Alpha 150 NT
Legacy Storage Systems	HFD, SmartArray
Marner International	DSV100 series
Media Integration	SMARTstor
Megabyte Memory Products	MegaRAID
Mega Drive Systems	MR/5, MR/20, MK/245
Microaccess	San Francisco
Micronet Technology	Raven, RAIDbank
Micropolis	RAIDION, RAIDION LT series
Micro Technology	Failsafe series, Stingraid
Morton Management	GBR-RD series
Mylex	IDA S 2000, DA-1200-3
National Peripherals	5000 series
NEC	N1137 series
NetFRAME	NF250 FT, NF450 FT
Network Appliance	FAServer series
Network Connection	T.R.A.C Array
PACE Technologies	PACE RAID-5
Pacific Micro Data	MAST VII, MAST VIII
Parity Systems	6000 series
Peak Technologies	FA-7040, FA-7180
Precision Computers	486-XX
Procom Technology	2000, LFRAID series
RAAC Technologies	ESP1000
Raid Power	Ultraraid 55
R Squared	Ultima
Sanyo Icon	MRX-100, MRX-300, MRX-500FT
See First Technology	Array System
Seek Systems	S401
Sequent Computer Systems	Winserver 3000
Sequoia Systems	DS310, DS4003
Seraph	Gemini SE, AU-1
Solid Computer	WSR425, N20
Storage Computer	CLx, D3x, D5x, R3x, R5x
Storage Concepts	Concept 51, Concept 550
Storage Dimensions	LANStor-CDA, LAN6-FEP-RC
Storage Solutions	CM-02, CM-03, CM-04
Storage Technology	Alpine 9600
Stratus Computer	D600 (K121)
Sun Microsystems	SPARCstorage Model 100
Tandem Computers	4500, 4510

Complete subsystems, with disk drives (continued)

Tangent Computer	Raid5Server, Multiserver
Texas Microsystems	FTSA series
Total Tec Systems	Triad
Transoft	DataDock
Unbound	RAIDSTOR series, MacRAID
Unison Information Systems	RD5-1
Unisys	MasCab-2, UCR-6000
Vanguard Technologies	ARRAYSERVER
Winchester Systems	Flashdisk 2, FlashCluster
Wyse	7000 i
ZZYXZ Workstations & Peripherals	ZRS-3000

Board assembly (no drives)

ADS International	ADS/3000
American Megatrends	PCI RAID
Aresys	IDACO-2000
AT&T Global Information Solutions	ADP-93, 93 series
ATEN International	AI-700
ATON Systemes	AREKA E-10F
BusLogic	DA2788, DA4988
Canary Communications	IDA3500
CMD Technology	CRD-5000
Consensys	RAIDIX/IDE
Control Data Systems	47008
Digi-Data	Model Z, Z9000
Distributed Processing Technology	Smart Cache, DM 4000
Diverse Logistics	Windjammer series
DTC Technology	DTC 3199, 8200
Hi-Data	SC-510, SC-550
Infortrend	IS-1000
Laura Technologies	PowerCache SC
Lion	RD35, RD351
Lomas Data Products	LDP Cache IIP
Mylex	DAC-960 series
NEC	OP-450 series
Perceptive Solutions	dataSHADOW, quickRAID
Raidtec	FlexArray, Ruac IX
Seek Systems	Xcelerator
TD Systems	Omniserve 2, 3
Tricord Systems	Powerraid, ISS
UltraStor	124F, 144F
Unbound	RAIDSTOR
Vortex Computersysteme (ICP-Vortex)	GTD2000, GTD3000
Winchester Systems	Flashserver

Software arrays

1776, Inc.	76SC4A, 76SC34H
AT&T Global Information Solutions	Disk Array Plus
BusLogic	Chantal 4.5 NW

Software arrays (continued)

CLone Star Software	Reflect, Alter Ego
Conley	SoftRAID
Consensys	RAIDIX
Corel	Network Manager
Digital Equipment	HSD05, Volume Shadowing 6.0
FWB	RAID ToolKit
IBM	OASAS I V2.0, Disk Array/2
Integra Technologies	OASAS series
Nonstop Networks	No-Stop Network
Perceptive Solutions	quickSHADOW
Pro Engineering	EZRAID
Solid Computer	B5H, B5S
Storage Dimensions	RaidMaster
Sun Microsystems	Online: DiskSuite 1.0
TwinCom	Dual Mirror, Network Mirror
Unitrol Data Protection Systems	Immunity 2
Veritas Software	VxVM, VxMirror
Zenith Data Systems	OASYS I

This product group includes arrays intended primarily for use with networks, minicomputers and multiuser systems. While mirrored disk 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 controller manufacturers, network server manufacturers, software development firms, and startup companies founded for the sole purpose of producing 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 two 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 and independent server manufacturers, which assemble the completed array subsystem, plus sophisticated computer users with a do-it-yourself urge. Array software is also typically purchased 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

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1993	1994	1995	1996	1997
U.S. manufacturers	2,445.6	3,244.0	4,735.0	5,956.3	7,305.0
All manufacturers	2,506.5	3,346.9	4,889.8	6,157.0	7,554.3

Still in its early growth period, the networks/minicomputer/multiuser market for disk drive arrays increased from $1.2 billion in sales revenue in 1992 to $2.5 billion in 1993. More than 140 companies are now participating in this product group -- a conservative estimate, in that it is difficult to be certain of the total number of firms which sell array subsystems assembled with purchased controllers or software.

1993's 194,041 array worldwide unit shipments represented 118% growth for the product group, and 1994's estimated shipments of 318,290 arrays will provide a further increase of 64%, bringing the shipment total for network/minicomputer/multiuser arrays to 91.5% of the overall shipment total for all DISK/TREND array product groups. Complete subsystems held 54.1% of the 1993 total for the product group, but will drop to an estimated 47.3% of 1994 worldwide unit shipments, as OEM sales of boards and board assemblies undergo a current surge in shipments.

Captive array subsystems continue to dominate this product group, and will provide one third of the 1994 total worldwide shipments for the group and 71.2% of the revenues. The revenue total would have been even higher, except for a more rapid decline in average unit prices than previously expected. Strong shipments by Compaq Computer, Data General, IBM, Hewlett-Packard and Digital Equipment, and established mirrored disk programs by Tandem Computers and Stratus Computer have all contributed to the high captive array shipments. RAID-1 software products from Digital Equipment and Sun Microsystems have also contributed to the growing captive total for unit shipments, but more modestly to the captive revenue totals, due to lower average prices.

Although lower than previously expected, a major contribution to the product group's 1994 revenues will also be made by PCM/Reseller sales of complete subsystems, which are expected to provide 64% of the group's 1994 total worldwide noncaptive array revenues, representing 29,975 individual array subsystems. Most of the more than 35 companies active in this segment are providing arrays for use with personal computer and UNIX workstation file servers, but a few are active in the IBM AS/400 add-on market.

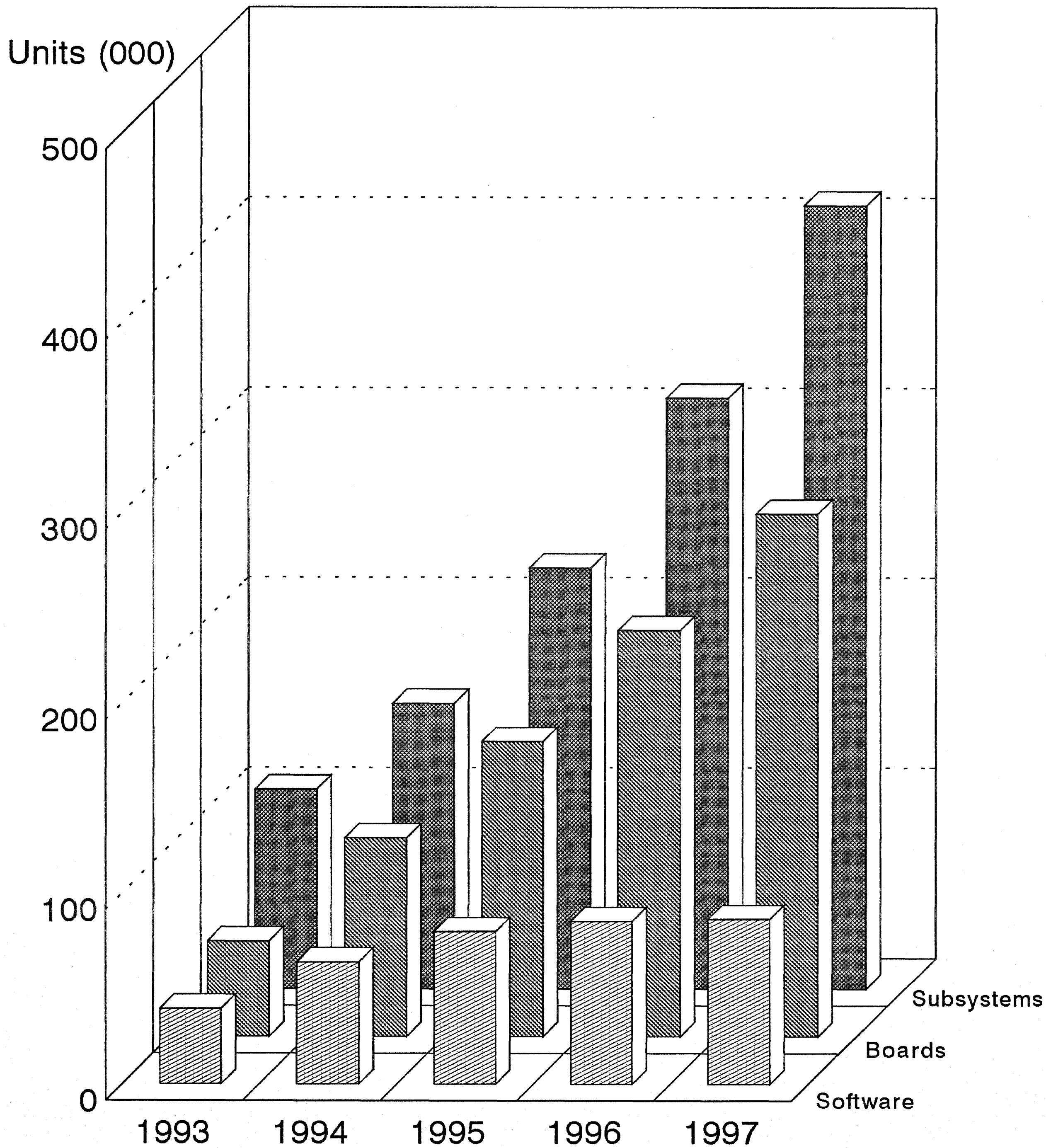
OEM/Integrator sales of boards and partial array assemblies to numerous systems manufacturers and network server manufacturers are now available from more than 17 manufacturers, several of which are currently enjoying rapidly increasing board shipments, as numerous new assemblers of complete subsystems enter the array business. OEM/Integrator worldwide board shipments grew 386.8% in 1993, with an increase of 122.3% forecasted for 1994, for a total of 83,550 boards.

Mylex expanded its lead in worldwide noncaptive unit shipments for the networks/minicomputer/multiuser group in 1993, with 29.0% of the total, mostly board assemblies. Integra Technologies was second with 6.6%, all software. AT&T held 6.2%, mostly boards, but also including subsystems and software (although it should be noted that AT&T's presence in the industry is larger than this figure would suggest due to the firm's sale of array chip sets, which are not counted as completed array products in this report). EMC was fourth with 5.5%, all subsystems sold in the IBM AS/400 market.

Figure 7

Networks/Minicomputer/Multiuser System Arrays

Worldwide Shipments by Array Type



Marketing trends

During the 1995-97 period, worldwide revenues for all types of network/mini-computer/multiuser arrays are forecasted to increase an average of 31.6% annually, with the 1997 revenue total expected to reach $7.6 billion. Unit shipments in 1997 are projected at 773,340, an average annual increase for the 1995-97 period of 34.6%. The average revenue increase will be slightly lower due to declining average unit prices.

The nature of the disk drive array business is expected to see several major changes during the next three years. Complete subsystems and board assemblies will increase their share of the industry total, at the expense of software products, as hardware array implementations continue to reduce costs. The software products' share of overall unit shipments is projected to decline from 20% in 1994 to 11.1% in 1997. Boards are expected to retain the surge in market share being experienced in 1994, climbing from 1994's 32.7% to 35.5% in 1997. The 1997 product mix will contain a much higher percentage of RAID-5 and other advanced array implementations than today, as the total disk storage required for individual networks continually increases.

Although noncaptive shipments and revenues are expected to grow at a faster rate than captive shipments and revenues in most product segments and sales channels, captive revenues for complete subsystems are still projected to provide 61.1% of the entire product group's revenues in 1997. Several of the U.S major system manufacturers undertook early subsystem development programs, which have remained vigorous product development activities. The expected result is forecasted 1997 shipments of 243,095 captive complete subsystems, generating $4.6 billion in revenue.

Subsystem sales through the PCM/Reseller channel are growing faster than captive sales, a trend expected to continue at least through 1997. PCM/Reseller subsystem sales are forecasted at 118,880 for 1997, generating $1.7 billion in worldwide revenue, boosted by intense competition among the numerous manufacturers and resellers, combined with continuing product improvements.

OEM/Integrator unit shipments of complete subsystems are expected to sustain the highest growth rate of all during the 1995-97 period, an average of 106.6% per year, culminating in 50,110 subsystems in 1997. OEM/Integrator shipments of boards and board assemblies will also maintain an excellent average growth rate during the 1995-97 period, at 39.3% per year, with 1997 sales projected at 225,215 boards. Due to differences in average unit price, however, subsystems are forecasted at $866 million in 1997 revenue, compared to $203 million for boards. OEM/Integrator growth for both product segments will be fueled by the demand for arrays from system manufacturers and network server manufacturers lacking the resources or time to develop their own arrays.

Although unit shipments of noncaptive software array products are expected to continue their growth through 1997, the rate of growth will be modest, and captive software arrays will decline. It is believed the typical end users will prefer to acquire and use complete array product offers, to avoid the nuisance and complexity of separately purchasing software, drives, cabinets, etc. Individual software packages will continue to be most interesting to users who already have computer systems using multiple disk drives.

Shipments of disk drive arrays for this product group are currently dominated by companies headquartered in the United States, which held 97.6% of 1993 worldwide revenues for all types of arrays. Although the number of non-U.S. participants is expected to increase from today's 21 companies (several with operations mostly in the U.S.), the revenue share for U.S. companies is not expected to decline significantly through 1997. 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 possibilities that disk drive array functions may be embedded in future operating systems or in chips mounted on system motherboards provide the major area of uncertainty for today's disk drive array manufacturers. 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 may be 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. The most pressing challenge, especially for manufacturers of RAID-5 arrays, will be to reduce price per megabyte, in comparison to other storage alternatives.

Much of the future growth for RAID-5 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 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 usually 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 and boards will achieve higher growth than software array products by providing users with the convenience of complete array subsystems and typically higher performance.

TABLE 16

NETWORKS/MINI/MULTIUSER

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993		Forecast							
	Revenues		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	976.1	2,023.6	1,231.5	2,467.8	1,768.0	3,426.1	2,138.3	4,030.4	2,509.9	4,645.6
PCM/Reseller	256.5	356.8	395.3	573.9	577.7	863.1	814.7	1,237.6	1,098.3	1,694.6
OEM/Integrator	50.2	65.2	126.5	202.3	281.6	445.8	449.0	688.3	658.2	964.8
TOTAL U.S. REVENUES	1,282.8	2,445.6	1,753.3	3,244.0	2,627.3	4,735.0	3,402.0	5,956.3	4,266.4	7,305.0
Non-U.S. Manufacturers										
Captive	--	33.5	--	41.5	3.3	52.0	5.6	60.4	8.8	66.4
PCM/Reseller	4.7	8.6	6.0	13.9	11.3	30.4	21.1	50.3	34.4	72.9
OEM/Integrator	9.3	18.8	24.6	47.5	39.2	72.4	52.3	90.0	68.5	110.0
TOTAL NON-U.S. REVENUES	14.0	60.9	30.6	102.9	53.8	154.8	79.0	200.7	111.7	249.3
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	1,296.8	2,506.5	1,783.9	3,346.9	2,681.1	4,889.8	3,481.0	6,157.0	4,378.1	7,554.3

TABLE 17

NETWORKS/MINI/MULTIUSER

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	56,241	107,661	68,595	133,545	88,540	170,270	114,100	214,210	138,445	255,645
PCM/Reseller	24,438	34,612	41,599	59,700	65,930	97,430	90,070	136,550	117,190	181,350
OEM/Integrator	39,196	44,393	83,110	97,590	122,980	149,720	166,570	208,445	216,600	276,825
TOTAL U.S. SHIPMENTS	119,875	186,666	193,304	290,835	277,450	417,420	370,740	559,205	472,235	713,820
Non-U.S. Manufacturers										
Captive	--	2,141	--	2,665	350	3,330	500	3,830	720	4,210
PCM/Reseller	1,673	3,331	2,700	7,285	4,285	11,680	6,210	16,420	8,290	20,360
OEM/Integrator	546	1,903	11,450	17,505	14,455	23,800	17,525	30,070	20,560	34,950
TOTAL NON-U.S. SHIPMENTS	2,219	7,375	14,150	27,455	19,090	38,810	24,235	50,320	29,570	59,520
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	122,094	194,041	207,454	318,290	296,540	456,230	394,975	609,525	501,805	773,340
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	169	283	376	601	673	1,057	1,068	1,667	1,570	2,440

TABLE 18

NETWORKS/MINI/MULTIUSER

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1993 Revenues			Forecast 1994			1995			1996			1997		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	1,907.0	5.4	111.2	2,339.7	1.2	126.9	3,334.3	1.3	90.5	3,937.8	1.3	91.3	4,553.1	1.3	91.2
PCM/Reseller	332.5	20.0	4.3	527.1	40.3	6.5	802.7	51.1	9.3	1,165.5	63.1	9.0	1,614.9	71.8	7.9
OEM/Integrator	26.4	37.1	1.7	122.2	77.4	2.7	324.7	116.7	4.4	531.4	153.0	3.9	770.3	191.2	3.3
TOTAL U.S. REVENUES	2,265.9	62.5	117.2	2,989.0	118.9	136.1	4,461.7	169.1	104.2	5,634.7	217.4	104.2	6,938.3	264.3	102.4
NON-U.S. MANUFACTURERS															
Captive	33.5	--	--	41.5	--	--	50.7	.3	1.0	58.5	.5	1.4	64.0	.6	1.8
PCM/Reseller	5.9	1.7	1.0	9.1	3.4	1.4	18.6	9.9	1.9	35.1	13.2	2.0	56.5	14.3	2.1
OEM/Integrator	14.2	4.6	--	34.8	10.6	2.1	59.5	11.0	1.9	77.6	10.6	1.8	96.0	12.3	1.7
TOTAL NON-U.S. REVENUES	53.6	6.3	1.0	85.4	14.0	3.5	128.8	21.2	4.8	171.2	24.3	5.2	216.5	27.2	5.6
WORLDWIDE RECAP															
Captive	1,940.5	5.4	111.2	2,381.2	1.2	126.9	3,385.0	1.6	91.5	3,996.3	1.8	92.7	4,617.1	1.9	93.0
	+142.7%	+671.4%	+5.6%	+22.7%	-77.8%	+14.1%	+42.2%	+33.3%	-27.9%	+18.1%	+12.5%	+1.3%	+15.5%	+5.6%	+.3%
PCM/Reseller	338.4	21.7	5.3	536.2	43.7	7.9	821.3	61.0	11.2	1,200.6	76.3	11.0	1,671.4	86.1	10.0
	+33.3%	+161.4%	+488.9%	+58.5%	+101.4%	+49.1%	+53.2%	+39.6%	+41.8%	+46.2%	+25.1%	-1.8%	+39.2%	+12.8%	-9.1%
OEM/Integrator	40.6	41.7	1.7	157.0	88.0	4.8	384.2	127.7	6.3	609.0	163.6	5.7	866.3	203.5	5.0
	+82.9%	+195.7%	+6.3%	+286.7%	+111.0%	+182.4%	+144.7%	+45.1%	+31.3%	+58.5%	+28.1%	-9.5%	+42.2%	+24.4%	-12.3%
Total Revenues	2,319.5	68.8	118.2	3,074.4	132.9	139.6	4,590.5	190.3	109.0	5,805.9	241.7	109.4	7,154.8	291.5	108.0
	+115.7%	+197.8%	+9.6%	+32.5%	+93.2%	+18.1%	+49.3%	+43.2%	-21.9%	+26.5%	+27.0%	+.4%	+23.2%	+20.6%	-1.3%
ANNUAL SHARE, BY TYPE	92.6%	2.7%	4.7%	92.0%	4.0%	4.0%	94.0%	3.9%	2.1%	94.4%	3.9%	1.7%	94.8%	3.9%	1.3%

TABLE 19

NETWORKS/MINI/MULTIUSER

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1993 Shipments			Forecast 1994			Forecast 1995			Forecast 1996			Forecast 1997		
	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software	Subsys.	Boards	Software
U.S. MANUFACTURERS															
Captive	82,161	1,900	23,600	111,295	550	21,700	151,560	610	18,100	196,890	720	16,600	239,635	810	15,200
PCM/Reseller	18,602	9,190	6,820	29,570	17,030	13,100	48,650	25,530	23,250	77,700	33,200	25,650	115,350	39,870	26,130
OEM/Integrator	1,348	35,870	7,175	5,810	79,820	11,960	15,460	116,680	17,580	27,970	161,125	19,350	45,310	212,415	19,100
TOTAL U.S. SHIPMENTS	102,111	46,960	37,595	146,675	97,400	46,760	215,670	142,820	58,930	302,560	195,045	61,600	400,295	253,095	60,430
NON-U.S. MANUFACTURERS															
Captive	2,141	--	--	2,665	--	--	2,980	150	200	3,250	300	280	3,460	420	330
PCM/Reseller	241	1,190	1,900	405	3,080	3,800	930	5,230	5,520	1,950	7,320	7,150	3,530	8,410	8,420
OEM/Integrator	193	1,710	--	375	3,730	13,400	1,700	6,900	15,200	3,100	10,670	16,300	4,800	12,800	17,350
TOTAL NON-U.S. SHIPMENTS	2,575	2,900	1,900	3,445	6,810	17,200	5,610	12,280	20,920	8,300	18,290	23,730	11,790	21,630	26,100
WORLDWIDE RECAP															
Captive	84,302	1,900	23,600	113,960	550	21,700	154,540	760	18,300	200,140	1,020	16,880	243,095	1,230	15,530
	+116.8%	+645.1%	-2.9%	+35.2%	-71.1%	-8.1%	+35.6%	+38.2%	-15.7%	+29.5%	+34.2%	-7.8%	+21.5%	+20.6%	-8.0%
PCM/Reseller	18,843	10,380	8,720	29,975	20,110	16,900	49,580	30,760	28,770	79,650	40,520	32,800	118,880	48,280	34,550
	+71.8%	+204.9%	+606.1%	+59.1%	+93.7%	+93.8%	+65.4%	+53.0%	+70.2%	+60.6%	+31.7%	+14.0%	+49.3%	+19.2%	+5.3%
OEM/Integrator	1,541	37,580	7,175	6,185	83,550	25,360	17,160	123,580	32,780	31,070	171,795	35,650	50,110	225,215	36,450
	+140.0%	+386.8%	+344.3%	+301.4%	+122.3%	+253.4%	+177.4%	+47.9%	+29.3%	+81.1%	+39.0%	+8.8%	+61.3%	+31.1%	+2.2%
Total Shipments	104,686	49,860	39,495	150,120	104,210	63,960	221,280	155,100	79,850	310,860	213,335	85,330	412,085	274,725	86,530
	+107.3%	+338.2%	+45.5%	+43.4%	+109.0%	+61.9%	+47.4%	+48.8%	+24.8%	+40.5%	+37.5%	+6.9%	+32.6%	+28.8%	+1.4%
ANNUAL SHARE, BY TYPE	54.1%	25.7%	20.2%	47.3%	32.7%	20.0%	48.6%	34.0%	17.4%	51.1%	35.0%	13.9%	53.4%	35.5%	11.1%

TABLE 20

NETWORKS/MINI/MULTIUSER

WORLDWIDE PRICE PER UNIT ($)

ARRAY TYPE	1993	Forecast 1994	1995	1996	1997
Captive					
Subsystems	23,018	20,894	21,903	19,967	18,992
Boards	2,800	2,200	1,980	1,765	1,545
Software	4,713	5,845	4,996	5,496	5,993
Captive Average	18,734	18,421	20,034	13,980	14,076
PCM/Reseller					
Subsystems	17,957	17,888	16,565	15,073	14,059
Boards	2,085	2,169	1,982	1,881	1,782
Software	604	469	388	336	287
PCM/Reseller Average	9,627	8,774	8,188	8,419	8,762
OEM/Integrator					
Subsystems	26,353	25,384	22,386	19,598	17,287
Boards	1,106	1,053	1,033	952	904
Software	237	191	189	158	136
OEM/Integrator Average	1,811	2,171	2,985	4,430	4,326

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

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1993 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Drive Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Mylex	50	22,000	--	22,050	33.5	50	24,400	--	24,450	29.0
Integra Technologies	--	--	5,600	5,600	8.5	--	--	5,600	5,600	6.6
AT&T	18	4,845	100	4,963	7.5	18	5,100	100	5,218	6.2
EMC	3,270	--	--	3,270	5.0	4,670	--	--	4,670	5.5
Ultrastor	--	1,665	--	1,665	2.5	--	2,880	--	2,880	3.4
Micropolis	1,960	--	--	1,960	3.0	2,800	--	--	2,800	3.3
Other U.S.	8,681	9,195	6,250	24,126	36.6	12,412	12,680	8,295	33,387	39.8
Other Non-U.S.	224	495	1,500	2,219	3.4	434	2,900	1,900	5,234	6.2
TOTAL	14,203	38,200	13,450	65,853	100.0	20,384	47,960	15,895	84,239	100.0

ARRAYS: MAINFRAME SYSTEMS

1994 DISK/TREND REPORT

ARRAYS: MAINFRAME SYSTEMS

Coverage

Examples of disk drive arrays in this group include:

Complete subsystems, with disk drives

Control Data Systems	5830
EMC	Symmetrix series
Hitachi Data Systems	7600
Macro Computer Products	Macro-RAID 7
Storage Technology	Iceberg, Nordique
Unisys	M9760, USR 3000

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, but array software sold as add-on products are recognized in the report. The earliest activity in the group was represented by the Control Data Systems shipments of its early RAID-3 disk drive array in 1989.

EMC's shipments of the firm's Symmetrix series of subsystems with RAID-1 mirrored disk capability for the IBM mainframe plug compatible market have been the dominant products in the group to date, supplemented in mid-1993 with Hitachi Data Systems' 7600 subsystem with RAID-1 capability. However, it is clear that Storage Technology's Iceberg was the winner in the first round of public relations campaigns for mainframe disk drive arrays -- which has been all the more embarrassing for STC with each announcement of further shipment delays. The current estimate for Iceberg's first commercial shipment is sometime in the second quarter of 1994.

The company not named in the above list of announced array products is IBM. Although IBM has introduced several arrays for personal computer and workstation networks, office minicomputers and very high performance applications, the company hasn't yet made its move in the mainframe array market. However, after several delays, IBM is expected to announce at least two disk drive arrays for mainframe applications by the Autumn of 1994, utilizing 4.3 gigabyte 3.5" drives from its new Starfire series.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1993	1994	1995	1996	1997
U.S. manufacturers	648.0	1,267.0	2,653.7	4,031.6	4,444.7
All manufacturers	867.4	1,629.3	3,039.7	4,640.2	5,261.1

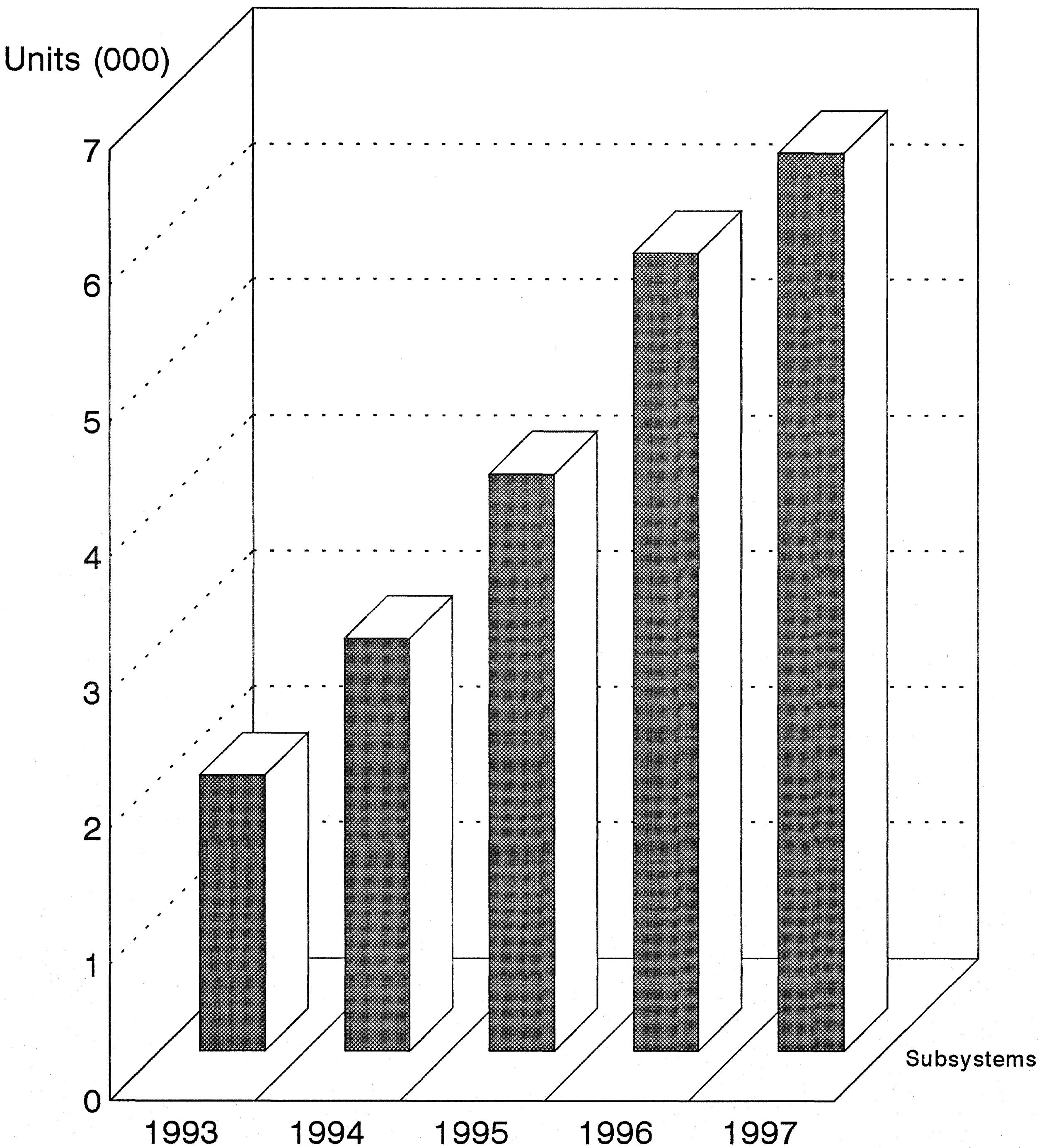
EMC's success with the Symmetrix subsystem providing RAID-1 mirrored disk capability is the principal reason for the substantial revenue levels achieved so far in this product group. Boosted by EMC's extremely strong performance in 1993, the worldwide overall revenue total for that year jumped 233.5%, to $867.4 million. It should be noted that 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, but are not necessarily continually operated as arrays.

2,025 array subsystems for mainframe applications were shipped in 1993, and a 1994 increase of 49.9% is forecasted, to 3,035 units. The 1993 revenue total was swollen by the high average unit price for PCM/Reseller subsystems in this product group, over $450,000 in 1993, climbing to an estimated $517,500 in 1994.

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.

The expectation of imminent availability of major new array products has overhung this product group for the last few years. Storage Technology's very well promoted and long delayed Iceberg array has finally reached a pre-reannouncement stage in which several subsystems are in use by customers, with an announcement of the commencement of revenue shipments expected soon. Since the Iceberg is expected to provide part of its operating cost-effectiveness with built-in data compression, IBM's system data compression may obviate part of the Iceberg's price per megabyte story. Nevertheless, the Iceberg is expected to retain enough sales appeal to provide an attractive market, especially with no comparable arrays yet in the market.

Figure 8
Mainframe System Arrays
Worldwide Shipments by Array Type



However, DISK/TREND shipment estimates also assume that IBM's long-expected mainframe arrays will be available in 1994. These arrays are expected to utilize IBM's existing 3990 and 9340 series of controllers, so the firm's customers will be able to migrate to the new disk arrays with a minimum of complications, even though this generation of IBM arrays might not be as cost-effective as a complete new design could have been. The projected $142.6 million in 1994 revenue for IBM's mainframe arrays is, of course, dependent on when IBM actually starts shipments. We're currently assuming late third quarter.

DISK/TREND estimates for 1993 noncaptive unit shipments indicate EMC held 69.1% of the worldwide total, followed by Hitachi Data Systems with 28.9%. Although most of the array subsystems in this group have been shipped in the plug compatible add-on market, an OEM market has also come into existence, and EMC has announced OEM contracts with both Unisys and Groupe Bull.

Marketing trends

IBM's entry into the mainframe array market will easily be the most significant development in this product group. If IBM starts shipments in the second half of 1994, as expected, the outlook for 1995 total revenue for the product group will be high. An 86.6% boost in 1995 revenue is forecasted, to over $3 billion, with the 1997 total projected at $5.3 billion.

By 1997, the overall average price will rise to over $795,000 per array unit, driven up by increased captive shipments at higher average prices and by the larger storage capacity of expected new high-end models. These price levels will make it possible to achieve the expected $5.3 billion in 1997 revenue with shipments of only 6,615 arrays, of which IBM is forecasted to ship 2,850.

Storage Technology's Iceberg was the first announced RAID-5 array subsystem intended for the mainframe market, and it is expected that some of the other arrays from independent peripherals suppliers for mainframe applications to be introduced during the next few years will also utilize RAID-5 implementations optimized to overcome the normal write latency problems associated with that type of array. Although the mirrored disk configurations which have dominated mainframe applications so far are probably not going to decline in shipments, much of the future growth will probably go to enhanced RAID-5 arrays, because of the outlook for lower price per megabyte.

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 eventual mainframe array product line. Which array type(s) will be offered? 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?

Until the answers to these questions and others are known, the long-term patterns for the development of disk drive array technology for mainframe applications are uncertain.

Forecasting assumptions

1. IBM will introduce arrays utilizing 3990 and 9340 controllers, with enhanced RAID-1/5 capability, for use with multiple mainframe models in third quarter, 1994.

2. Iceberg will start commercial shipments at modest levels in second quarter, 1994.

3. Non-U.S. manufacturers will initiate shipments in 1995 of enhanced RAID-5 array subsystems for captive mainframe applications and for IBM compatible PCM markets.

TABLE 22

MAINFRAMES

REVENUE SUMMARY

DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)

	1993 Revenues		Forecast 1994		Forecast 1995		Forecast 1996		Forecast 1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	99.8	142.6	854.9	1,256.6	1,576.3	2,425.1	1,646.1	2,650.5
PCM/Reseller	359.7	556.5	695.0	1,041.9	861.0	1,316.0	990.0	1,522.5	1,113.9	1,706.4
OEM/Integrator	59.4	91.5	53.7	82.5	51.8	81.1	54.6	84.0	56.6	87.8
TOTAL U.S. REVENUES	419.1	648.0	848.5	1,267.0	1,767.7	2,653.7	2,620.9	4,031.6	2,816.6	4,444.7
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	14.0	--	25.5	--	35.1
PCM/Reseller	127.5	219.4	217.0	362.3	224.0	372.0	349.3	583.1	468.8	781.3
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. REVENUES	127.5	219.4	217.0	362.3	224.0	386.0	349.3	608.6	468.8	816.4
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	546.6	867.4	1,065.5	1,629.3	1,991.7	3,039.7	2,970.2	4,640.2	3,285.4	5,261.1

TABLE 23

MAINFRAMES

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1993 Shipments		Forecast 1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	--	--	105	150	830	1,220	1,625	2,500	1,770	2,850
PCM/Reseller	721	1,129	1,104	1,678	1,230	1,880	1,320	2,030	1,410	2,160
OEM/Integrator	202	311	112	172	115	180	130	200	145	225
TOTAL U.S. SHIPMENTS	923	1,440	1,321	2,000	2,175	3,280	3,075	4,730	3,325	5,235
Non-U.S. Manufacturers										
Captive	--	--	--	--	--	40	--	85	--	130
PCM/Reseller	340	585	620	1,035	560	930	635	1,060	750	1,250
OEM/Integrator	--	--	--	--	--	--	--	--	--	--
TOTAL NON-U.S. SHIPMENTS	340	585	620	1,035	560	970	635	1,145	750	1,380
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	1,263	2,025	1,941	3,035	2,735	4,250	3,710	5,875	4,075	6,615
Cumulative Shipments (Units in thousands)										
WORLDWIDE TOTAL	2	3	4	6	6	10	10	16	14	23

TABLE 24

MAINFRAMES

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1993 Revenues Subsys.	Forecast --1994-- Subsys.	Forecast --1995-- Subsys.	Forecast --1996-- Subsys.	Forecast --1997-- Subsys.
U.S. MANUFACTURERS					
Captive	--	142.6	1,256.6	2,425.1	2,650.5
PCM/Reseller	556.5	1,041.9	1,316.0	1,522.5	1,706.4
OEM/Integrator	91.5	82.5	81.1	84.0	87.8
TOTAL U.S. REVENUES	648.0	1,267.0	2,653.7	4,031.6	4,444.7
NON-U.S. MANUFACTURERS					
Captive	--	--	14.0	25.5	35.1
PCM/Reseller	219.4	362.3	372.0	583.1	781.3
TOTAL NON-U.S. REVENUES	219.4	362.3	386.0	608.6	816.4
WORLDWIDE RECAP					
Captive	--	142.6	1,270.6	2,450.6	2,685.6
	--	--	+791.0%	+92.9%	+9.6%
PCM/Reseller	775.9	1,404.2	1,688.0	2,105.6	2,487.7
	+254.9%	+81.0%	+20.2%	+24.7%	+18.1%
OEM/Integrator	91.5	82.5	81.1	84.0	87.8
	+122.1%	-9.8%	-1.7%	+3.6%	+4.5%
Total Revenues	867.4	1,629.3	3,039.7	4,640.2	5,261.1
	+233.9%	+87.8%	+86.6%	+52.7%	+13.4%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 25

MAINFRAMES

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1993 Shipments Subsys.	Forecast --1994-- Subsys.	--1995-- Subsys.	--1996-- Subsys.	--1997-- Subsys.
U.S. MANUFACTURERS					
Captive	--	150	1,220	2,500	2,850
PCM/Reseller	1,129	1,678	1,880	2,030	2,160
OEM/Integrator	311	172	180	200	225
TOTAL U.S. SHIPMENTS	1,440	2,000	3,280	4,730	5,235
NON-U.S. MANUFACTURERS					
Captive	--	--	40	85	130
PCM/Reseller	585	1,035	930	1,060	1,250
TOTAL NON-U.S. SHIPMENTS	585	1,035	970	1,145	1,380
WORLDWIDE RECAP					
Captive	--	150	1,260	2,585	2,980
	--	--	+740.0%	+105.2%	+15.3%
PCM/Reseller	1,714	2,713	2,810	3,090	3,410
	+89.0%	+58.3%	+3.6%	+10.0%	+10.4%
OEM/Integrator	311	172	180	200	225
	-8.8%	-44.7%	+4.7%	+11.1%	+12.5%
Total Shipments	2,025	3,035	4,250	5,875	6,615
	+62.3%	+49.9%	+40.0%	+38.2%	+12.6%
ANNUAL SHARE, BY TYPE	100.0%	100.0%	100.0%	100.0%	100.0%

TABLE 26

MAINFRAMES

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1993	Forecast 1994	Forecast 1995	Forecast 1996	Forecast 1997
Captive					
Subsystems	--	950.0	1,008.4	947.9	901.2
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	--	950.0	1,008.4	947.9	901.2
PCM/Reseller					
Subsystems	452.6	517.5	600.7	681.3	729.5
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Reseller Average	452.6	517.5	600.7	681.3	729.5
OEM/Integrator					
Subsystems	294.0	479.4	450.0	420.0	390.0
Boards	--	--	--	--	--
Software	--	--	--	--	--
OEM/Integrator Average	294.0	479.4	450.0	420.0	390.0

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 27

MAINFRAMES

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1993 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Drive Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
EMC	909	--	--	909	72.0	1,399	--	--	1,399	69.1
Hitachi Data Systems	340	--	--	340	26.9	585	--	--	585	28.9
Other U.S.	14	--	--	14	1.1	41	--	--	41	2.0
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	1,263	--	--	1,263	100.0	2,025	--	--	2,025	100.0

ARRAYS: VERY HIGH PERFORMANCE SYSTEMS

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-007
Cray Research	DA-60, DA-62, ND-14
Encore Computer	Infinity
Fujitsu	K6490
General Microsystems	PD/A440
IBM	9570 series
MasPar Computer	DA-4116A, DA-4124A
Maximum Strategy	Gen 4SL, HIPPI-S2
Storage Concepts	Concept 151, Concept 71 FCS
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.

The majority of arrays in this product group are provided on a captive basis by supercomputer manufacturers, and the majority of those arrays are currently RAID-3 complete subsystems. However, four companies with arrays in this product group also offer RAID-5 configurations. 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 with the theoretical capability to attach 3,072 3.5" drives, for a total available capacity of 3.2 terabytes.

In addition to the arrays offered by supercomputer manufacturers, a few independent array manufacturers offer RAID-3 subsystems which are sold on an OEM basis to manufacturers of specialized very high performance systems and storage subsystems used in a variety of high-end technical workstation and imaging applications.

Market status

DISK/TREND estimate of total market size:

Worldwide sales ($M)	1993	1994	1995	1996	1997
U.S. manufacturers	42.7	39.2	65.9	97.6	126.9
All manufacturers	44.8	41.3	68.8	101.3	131.9

The current movement to lower cost 3.5" drives has caused a drop in projected 1994 revenues for U.S. captive subsystem arrays used with very high performance systems, holding down overall revenues for the product group. Captive array revenues dominated the 1993 worldwide revenue total for all market channels, which reached $44.8 million, up 150.3% over the previous year. However, 1994 total revenues are expected to be depressed by lower average prices for captive subsystems. 1994 revenues for the product group are estimated at $41.3 million, down 7.8%, despite an expected 57.3% increase in 1994 array unit shipments.

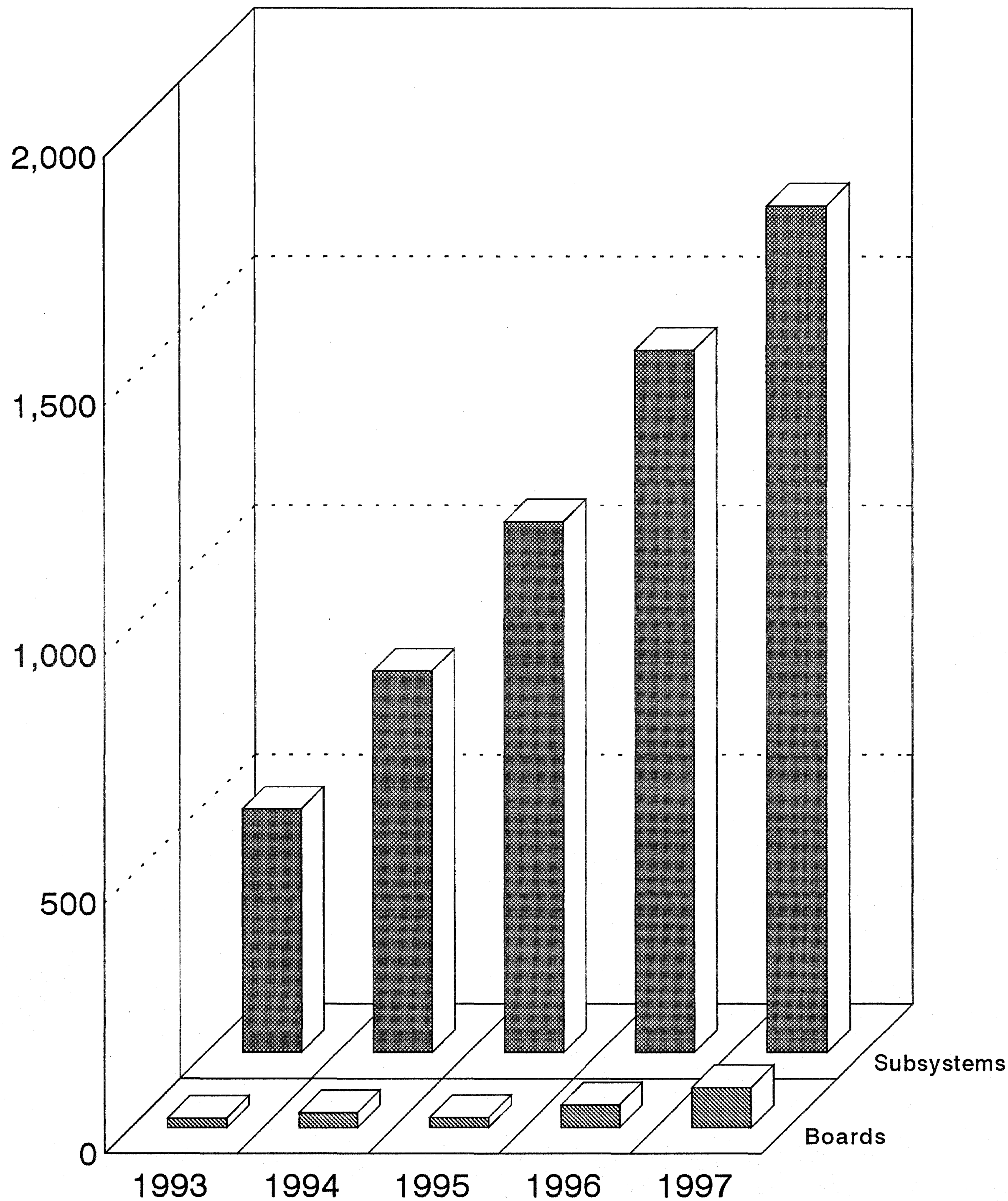
Although there are a few OEM shipments of board-level array controllers for use with very high performance systems, 97.7% of 1994 revenues, and 96.3% of 1994 shipments, are expected to be generated by complete array subsystems. Subsystem shipments in 1993 were boosted by new captive subsystems introduced by Cray Research, Thinking Machines and Encore Computer at the end of 1992. Despite the dip in 1994 total revenues caused by declining average unit prices of complete array subsystems, shipments continue to grow, from 487 array units in 1993 to an estimated 766 in 1994. Most of the arrays offered in this product group are RAID-3 types, reflecting the supercomputer market's requirement for very high data transfer rates, but some of the newer introductions also include RAID-5 models.

Ciprico's share of noncaptive unit shipments moved up to 48.2% of the worldwide total in 1993, composed entirely of subsystems, followed by Storage Concepts, with 32.5%.

Marketing trends

Total revenues for this product group are projected to grow during the 1995-97 period at an average annual increase of 48.7%, reaching $131.9 million in 1997, barely 1% of the overall revenues for all disk drive array product groups.

Figure 9
Very High Performance System Arrays
Worldwide Shipments by Array Type



Although supercomputers, the principal market for arrays in this product group, are expected to have only modest growth potential during the next few years, overall shipments are expected to more than double by 1997, to 1,780 units, as a higher share of supercomputer disk storage moves to array configurations and as specialized video and imaging servers realize shipment growth.

Complete subsystems are expected to continue their dominance of shipments in this product group. Captive subsystems, predominantly for use with supercomputers, are projected to resume a pattern of annual growth in the 1995-97 period, but unit shipments for the period are expected to increase at a modest 13.1% average annual rate.

Shipments of noncaptive subsystems have already established a faster growth rate than captive subsystems, driven by the OEM/Integrator market channel. OEM/Integrator shipment growth is being driven by demand from massively parallel computer manufacturers and specialized storage subsystem manufacturers, with continued increases expected. By 1997, it is projected that noncaptive shipments will provide 78.2% of the worldwide subsystem total. It is expected that OEM/Integrator shipments of board assemblies will continue to grow gradually, responding to continuing demand from specialized workstation and imaging markets, plus small supercomputer manufacturers.

Technical trends

Several leading supercomputer companies introduced high-end RAID-3 arrays in late 1992, driven by the need for storage subsystem architectures which 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. In fact, the Maximum Strategies RAID-0/1/3/5 Gen 4XL has a host transfer rate specified at 90 megabytes per second.

It is believed that most of the improvements in arrays used with very high performance systems through 1997 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 dominant 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 core application for arrays in this product group, supplemented by massively parallel computers and video/image servers.

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

TABLE 28

VERY HIGH PERFORMANCE

REVENUE SUMMARY

	DISK DRIVE ARRAY REVENUES, BY SHIPMENT DESTINATION ($M)									
	1993		Forecast							
	Revenues		1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	17.7	26.9	9.6	14.7	16.0	24.0	19.0	28.5	21.0	32.0
PCM/Reseller	6.5	7.5	8.8	12.2	12.5	17.5	18.0	25.0	23.0	32.2
OEM/Integrator	6.8	8.3	10.5	12.3	19.4	24.4	35.2	44.1	50.1	62.7
TOTAL U.S. REVENUES	31.0	42.7	28.9	39.2	47.9	65.9	72.2	97.6	94.1	126.9
Non-U.S. Manufacturers										
Captive	--	2.1	--	2.1	--	2.5	--	2.7	--	2.9
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	.2	.4	.6	1.0	1.3	2.1
TOTAL NON-U.S. REVENUES	--	2.1	--	2.1	.2	2.9	.6	3.7	1.3	5.0
Worldwide Recap										
TOTAL WORLDWIDE REVENUES	31.0	44.8	28.9	41.3	48.1	68.8	72.8	101.3	95.4	131.9

TABLE 29

VERY HIGH PERFORMANCE

UNIT SHIPMENT SUMMARY

	DISK DRIVE ARRAY UNIT SHIPMENTS, BY SHIPMENT DESTINATION									
	1993 Shipments		Forecast							
			1994		1995		1996		1997	
	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW	U.S.	WW
U.S. Manufacturers										
Captive	106	165	137	224	160	240	190	285	210	320
PCM/Reseller	50	68	60	90	75	105	90	125	100	140
OEM/Integrator	190	243	361	450	545	690	770	975	970	1,230
TOTAL U.S. SHIPMENTS	346	476	558	764	780	1,035	1,050	1,385	1,280	1,690
Non-U.S. Manufacturers										
Captive	--	30	--	32	--	40	--	45	--	50
PCM/Reseller	--	--	--	--	--	--	--	--	--	--
OEM/Integrator	--	--	--	--	5	10	15	25	25	40
TOTAL NON-U.S. SHIPMENTS	--	30	--	32	5	50	15	70	25	90
Worldwide Recap										
TOTAL WORLDWIDE SHIPMENTS	346	506	558	796	785	1,085	1,065	1,455	1,305	1,780
Cumulative Shipments (Single units)										
WORLDWIDE TOTAL	570	770	1,128	1,566	1,913	2,651	2,978	4,106	4,283	5,886

TABLE 30

VERY HIGH PERFORMANCE

WORLDWIDE REVENUES ($M)

BREAKDOWN BY ARRAY TYPE

	1993 Revenues		Forecast 1994		Forecast 1995		Forecast 1996		Forecast 1997	
	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards
U.S. MANUFACTURERS										
Captive	26.9	--	14.7	--	24.0	--	28.5	--	32.0	--
PCM/Reseller	7.5	--	12.2	--	17.5	--	25.0	--	32.2	--
OEM/Integrator	6.5	1.8	11.3	1.0	24.2	.2	43.7	.4	62.1	.6
TOTAL U.S. REVENUES	40.9	1.8	38.2	1.0	65.7	.2	97.2	.4	126.3	.6
NON-U.S. MANUFACTURERS										
Captive	2.1	--	2.1	--	2.5	--	2.7	--	2.9	--
OEM/Integrator	--	--	--	--	.4	--	1.0	--	2.1	--
TOTAL NON-U.S. REVENUES	2.1	--	2.1	--	2.9	--	3.7	--	5.0	--
WORLDWIDE RECAP										
Captive	29.0	--	16.8	--	26.5	--	31.2	--	34.9	--
	+353.1%	--	-42.1%	--	+57.7%	--	+17.7%	--	+11.9%	--
PCM/Reseller	7.5	--	12.2	--	17.5	--	25.0	--	32.2	--
	--	--	+62.7%	--	+43.4%	--	+42.9%	--	+28.8%	--
OEM/Integrator	6.5	1.8	11.3	1.0	24.6	.2	44.7	.4	64.2	.6
	+41.3%	-73.9%	+73.8%	-44.4%	+117.7%	-80.0%	+81.7%	+100.0%	+43.6%	+50.0%
Total Revenues	43.0	1.8	40.3	1.0	68.6	.2	100.9	.4	131.3	.6
	+290.9%	-73.9%	-6.3%	-44.4%	+70.2%	-80.0%	+47.1%	+100.0%	+30.1%	+50.0%
ANNUAL SHARE, BY TYPE	96.1%	3.9%	97.7%	2.3%	99.8%	.2%	99.7%	.3%	99.6%	.4%

TABLE 31

VERY HIGH PERFORMANCE

WORLDWIDE SHIPMENTS (UNITS)

BREAKDOWN BY ARRAY TYPE

	1993 Shipments		Forecast 1994		Forecast 1995		Forecast 1996		Forecast 1997	
	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards	Subsys.	Boards
U.S. MANUFACTURERS										
Captive	165	--	224	--	240	--	285	--	320	--
PCM/Reseller	68	--	90	--	105	--	125	--	140	--
OEM/Integrator	224	19	420	30	670	20	930	45	1,150	80
TOTAL U.S. SHIPMENTS	457	19	734	30	1,015	20	1,340	45	1,610	80
NON-U.S. MANUFACTURERS										
Captive	30	--	32	--	40	--	45	--	50	--
OEM/Integrator	--	--	--	--	10	--	25	--	40	--
TOTAL NON-U.S. SHIPMENTS	30	--	32	--	50	--	70	--	90	--
WORLDWIDE RECAP										
Captive	195	--	256	--	280	--	330	--	370	--
	+290.0%	--	+31.3%	--	+9.4%	--	+17.9%	--	+12.1%	--
PCM/Reseller	68	--	90	--	105	--	125	--	140	--
	--	--	+32.4%	--	+16.7%	--	+19.0%	--	+12.0%	--
OEM/Integrator	224	19	420	30	680	20	955	45	1,190	80
	+138.3%	-84.2%	+87.5%	+57.9%	+61.9%	-33.3%	+40.4%	+125.0%	+24.6%	+77.8%
Total Shipments	487	19	766	30	1,065	20	1,410	45	1,700	80
	+238.2%	-84.2%	+57.3%	+57.9%	+39.0%	-33.3%	+32.4%	+125.0%	+20.6%	+77.8%
ANNUAL SHARE, BY TYPE	96.3%	3.7%	96.3%	3.7%	98.3%	1.7%	97.0%	3.0%	95.6%	4.4%

TABLE 32

VERY HIGH PERFORMANCE

WORLDWIDE PRICE PER UNIT ($000)

ARRAY TYPE	1993	Forecast 1994	1995	1996	1997
Captive					
Subsystems	148.5	65.7	94.7	94.5	94.3
Boards	--	--	--	--	--
Software	--	--	--	--	--
Captive Average	148.5	65.7	94.7	94.5	94.3
PCM/Reseller					
Subsystems	110.0	135.5	166.5	199.8	229.7
Boards	--	--	--	--	--
Software	--	--	--	--	--
PCM/Reseller Average	110.0	135.5	166.5	199.8	229.7
OEM/Integrator					
Subsystems	28.9	26.8	35.9	46.8	53.8
Boards	93.0	35.3	10.0	8.0	7.0
Software	--	--	--	--	--
OEM/Integrator Average	33.9	27.4	35.1	45.0	50.9

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 33

VERY HIGH PERFORMANCE

MARKET SHARE SUMMARY
Worldwide Shipments of Noncaptive Disk Drive Arrays

	1993 Net Shipments									
	To United States Destinations					Worldwide				
	Units				%	Units				%
Drive Manufacturers	Subsys.	Boards	Softwre	Total		Subsys.	Boards	Softwre	Total	
Ciprico	120	--	--	120	50.0	150	--	--	150	48.2
Storage Concepts	60	--	--	60	25.0	101	--	--	101	32.5
Other U.S.	41	19	--	60	25.0	41	19	--	60	19.3
Other Non-U.S.	--	--	--	--	--	--	--	--	--	--
TOTAL	221	19	--	240	100.0	292	19	--	311	100.0

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. 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 mirrored 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.

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 so that the array will 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.

Also, if drive data rebuilding is done in the background, "background" or "back" is indicated. If rebuilding is done in foreground, preempting use of the array, then "foreground" 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.

1994 DISK/TREND product groups for disk drive arrays

Product groups for the 1994 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.	ACER	ACER
ARRAY MODEL	76SC34	76SC34H	76SC4A	Altos 7000	Altos 17000
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	Software	Software	Software	Subsystem	Subsystem
Host platform, software environment	ISA, EISA, MCA UNIX	ISA, EISA, MCA UNIX	ISA, EISA, MCA UNIX	Acer NetWare, XENIX, SCO UNIX	Acer NetWare, VINES, SCO UNIX
RAID level Configured by:	0/1* Host	0/1* Host	0/1* Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	NA Drive dependent	NA Drive dependent	NA Drive dependent	1/.5/1/1 10/5/8/8	1/5/1/1 20/10/16/16
Minimum drives per array	2	2	2	2/3	2/3
Maximum drives per array	28	24	24	8*	20
Concurrent host channels	1	1	2	1	1
Array interface to host	NA	NA	NA	EISA	EISA
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.192, 2.016	.192, 2.016	.192, 2.016	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes N/A N/A	Yes N/A N/A	Yes N/A N/A	No No No	No No No
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	500-1050	500-1050
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	3.5", 5.25"	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	10
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.7
Drive models	Various	Various	Various	Fujitsu, Seagate	Fujitsu, Seagate
ARRAY SIZE: Inches: H x W x D	N/A	N/A	N/A	23.2 x 7 x 23.2	24.6 x 14 x 16
POWER: Power backup	N/A	N/A	N/A	350 watts UPS optional	500 watts UPS optional
FIRST CUSTOMER SHIPMENT	1990	1993	1993	7/93	1991/1993*
COMMENTS	*Mirrored striping	Supports second host system in idle mode. *Mirrored striping.	Supports second host system concurr. active Auto backup switching. *Mirrored strip	Complete server *2 drives if 5.25"	Complete server up to 4 processors *With Pentium

MANUFACTURER	ADIC	ADS INTERNATIONAL	ADS INTERNATIONAL	ADS INTERNATIONAL	ALLODYNE
ARRAY MODEL	SDS-RAID	ADS/1000	ADS/3000	ADS/5000	A510-10
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	Board	Board	Board	Subsystem
Host platform, software environment	SCSI host Various	PC compatible UNIX, NetWare, OS/2	PC compatible UNIX, NetWare, OS/2	PC compatible UNIX, NetWare, OS/2	SCSI host Various
RAID level Configured by:	0/1/5 Host	0/1/4/5	0/3/5	0/3/5	3/5 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 1
Minimum drives per array	2	3	5	5	5
Maximum drives per array	6	21	35	28	5
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	EISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	IDE
Cache size (min, max: MB)	4	16	--	8, 32	256
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 No Yes	No No Yes	No No Yes	No Yes Option*
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	33 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1600-2100	Drive dependent	Drive dependent	Drive dependent	250
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 25.4 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	14
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	6.6
Drive models	Seagate	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D		4.75 x 13	3.25 x 5.75 x 8	3.25 x 5.75 x 8.12	5 x 5.75 x 8
POWER: Power backup	5 watts+drives None	230 watts None	300 watts None	300 watts None	45 watts Battery
FIRST CUSTOMER SHIPMENT	2Q94	1993	1993	1993	3Q93
COMMENTS	DPT or Buslogic controller with software array		Modified Digi-Data controller	CMD controller	*In external version

MANUFACTURER	ALLODYNE	ALLODYNE	ALLODYNE	ALLODYNE	AMERICAN DIGITAL SYSTEMS
ARRAY MODEL	A510-13	A510-20	A510-40	A1010-80	MASTERDISK RAID
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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	3/5 Port	3/5 Port	3/5 Port	3/5 Port	0/1/3/5 Port, Panel
Array capacity (Gbytes) MIN MAX	1.3 1.3	2 2	4 4	8 8	Drive dependent Drive dependent
Minimum drives per array	5	5	5	10	2
Maximum drives per array	5	5	5	10	28
Concurrent host channels	1	1	1	1	3
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2, DEC
Drive interface	IDE	IDE	IDE	IDE	SCSI-2
Cache size (min, max: MB)	256	256	256	256	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 Option*	No Yes Option*	No Yes Option*	No Yes Option*	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	340	540	1000	1000	Drive dependent
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 25.4 mm	Drive dependent
Average positioning time (msec)	13	10	8.5	8.5	Drive dependent
Average rotational delay (msec)	7.5	5.56	5.56	5.56	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	10 x 5.75 x 8	5.25 x 19 x 25
POWER: Power backup	45 watts Battery	45 watts Battery	45 watts Battery	85 watts Battery	26 watts+drives None
FIRST CUSTOMER SHIPMENT	3Q93	3Q93	1Q94	2Q94	3Q93
COMMENTS	*In external version	*In external version	*In external version	*In external version	

MANUFACTURER	AMERICAN MEGATRENDS	ANDATACO	ANDATACO	ARCO ELECTRONICS	ARESYS
ARRAY MODEL	PCI RAID	Gigaraid GRS	Gigaraid GTS	AC1079MC	IDACO-1000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Board	Board
Host platform, software environment	PC compatible NetWare, NT, Windows, OS/2	SCSI host UNIX, NT	SCSI host UNIX, NT	PC compatible DOS, OS/2, NetWare	PC compatible DOS, Windows, OS/2
RAID level Configured by:	0/1/3/5 Port	0/3/5 Host,Panel,Port	0/3/5 Host,Panel,Port	1 Preset	0/1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2.5 24	2.5 80	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	5	5	2	4
Maximum drives per array	75	9	28	2	4
Concurrent host channels	1	1, 3	1, 3	1	1
Array interface to host	PCI	SCSI-2	SCSI-2	Micro Channel	ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE	IDE
Cache size (min, max: MB)	128	8, 32	8, 32	--	.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)	-- -- --	Cold spare Yes Yes	Cold spare Yes Yes	No No No	NA NA NA
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	132 10/20	10/20 10/20	10/20 10/20	1.4 Drive dependent	3 4.5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	500-4000	500-4000	Drive dependent	Drive dependent
Nominal disk diameter, height	Drive dependent	3.5", 41.3	3.5", 41.3	2.5", 17.5 mm	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	Fujitsu, IBM, Seagate,Microp.	Fujitsu, IBM, Seagate,Microp.	Various	Various
ARRAY SIZE: Inches: H x W x D	4.2 x 12.283	8.8 x 16.2 x 16.75	29 x 10 x 22	3.5 x 11.5	.5 x 4.5 x 13.25
POWER: Power backup	None	300 watts UPS option	300 watts UPS option	6 watts+ drives None	NS NS
FIRST CUSTOMER SHIPMENT	4Q94	11/93	3/93	10/92	3/93
COMMENTS	Uses Intel 960 Preliminary specification	Modified CMD CRD5000 controller. Network attach module avail. 2Q94.	Modified CMD CRD5000 controller. Network attach module avail. 2Q94.	2 2.5" drives mount on card	

MANUFACTURER	ARESYS	ASA COMPUTERS	ASA COMPUTERS	AST RESEARCH	AST RESEARCH
ARRAY MODEL	IDACO-2000	Clydesdale	Thoroughbred	Manhattan P1	Manhattan P2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	PC compatible NetWare, NT, UNIX, OS/2	ASA UNIX, NetWare, DOS	EISA PC Various	Manhattan UNIX, NT, OS/2, NetWare	Manhattan UNIX, NT, OS/2, NetWare
RAID level Configured by:	0/1	0/1/5 Host	0/1/5 Host	0/1/5/6* Host	0/1/5/6* Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2.6/1.3/2.1 24/12/19.2	2.6/1.3/2.1 16/8/12.8	1/.5 8/4/6.4	2/1 16/8/12.8
Minimum drives per array	4	5	5	2	2
Maximum drives per array	4	12	8	16	16
Concurrent host channels	1	1	1	1	1
Array interface to host	ISA	EISA	EISA-2	EISA	EISA
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512, 16	4, 64	4, 64	4, 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)	NA NA NA	No Yes Yes	No Yes Yes	No No Option	No No Option
Spare drive (None/Auto/Manual)	Manual-backgrnd	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	3 4.5	33 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	525-2000	525-2000	500	1000
Nominal disk diameter, height	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
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	Seagate	H-P, Quantum, Seagate	H-P, Quantum, Seagate
ARRAY SIZE: Inches: H x W x D	.5 x 4.5 x 13.25	Varies	19 x 7.25 x 18	26 x 15 x 19	26 x 15 x 19
POWER: Power backup	NS NS	400 watts None	50 watts+drives None	625 watts None	625 watts None
FIRST CUSTOMER SHIPMENT	3/93	1993	2Q94	2/93	2/93
COMMENTS		Mylex controller Includes server	Mylex controller	Uses Mylex controller. *RAID 6=strip. and mirroring. P models have Pentium MPU	Uses Mylex controller. *RAID 6= strip. and mirroring. P models have Pentium MPU

MANUFACTURER	AST RESEARCH	AST RESEARCH	AST RESEARCH	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS
ARRAY MODEL	Manhattan P4	Premia-SE (Empire-3)	Premia-SE (Empire-5)	6298-2000	6298-3000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	PCM	PCM	Captive, OEM	Captive, OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Manhattan UNIX, NT, OS/2, NetWare	AST NetWare,NT,OS/2 UNIX, LAN Mgr.	AST NetWare,NT,OS/2 UNIX, LAN Mgr.	AT&T 3400, 3500 NT UNIX, NetWare	AT&T 3400, 3500 other UNIX
RAID level Configured by:	0/1/5/6* Host	0/1/5 Host	0/1/5 Host	0/1/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	4/2 32/16/25.6	 8	 16	5.2/2.6/4.2/4.2 21/12/16.8/16.8	5.2/2.6/4.2/4.2 21/12/16.8/16.8
Minimum drives per array	2	2	2	5	5
Maximum drives per array	16	8	16	20	20
Concurrent host channels	1	1	1	1	1
Array interface to host	EISA	EISA	EISA	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 64	--	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Option	No No No	No No No	Yes (option) Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2000	1000, 2000	1000	1050	1050
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	10.5	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	5.6	5.6
Drive models	H-P, Quantum, Seagate	H-P, Quantum, Seagate	H-P, Quantum, Seagate	Various	Various
ARRAY SIZE: Inches: H x W x D	26 x 15 x 19	26 x 15 x 19	26 x 15 x 19	29 x 12 x 28	29 x 12 x 28
POWER: Power backup	625 watts None	300 None	300 None	618 watts None	618 watts None
FIRST CUSTOMER SHIPMENT	2/94	11/93	11/93	1992	1992
COMMENTS	Uses Mylex controller. *RAID 6= strip. and mirroring. P models have Pentium MPU	Uses Mylex controller 3 SCSI channels	Uses Mylex controller 5 SCSI channels	ADP-92-02 controller 25 MHz 68020	ADP-93-08 controller Uses 40 MHz 68030 chip

MANUFACTURER	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS
ARRAY MODEL	6298-4000	6299	ADP-92-01	ADP-92-02	ADP-93-01
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, OEM	OEM, PCM	Captive,OEM,PCM	Captive,OEM,PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Host platform, software environment	AT&T 3400, 3500 other UNIX	AT&T 3400, 3500 UNIX, Solaris, AIX, NetWare	Various UNIX, OS/2, NetWare	Various UNIX, OS/2, NetWare	Various UNIX, OS/2, AIX NetWare
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	10.5/5/8.5/8.5 42/21/34/34	5.2/2.6/4.2/4.2 42/21/34/34	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	5	1/2/3/3	1/2/3/3	1/2/3/3
Maximum drives per array	20	20	35	35	35
Concurrent host channels	1	2	1	1	1
Array interface to host	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)	--	N/A	--	--	--
Cache function (Read, Write)	--	N/A	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes No No	Yes Supported Supported	Yes No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	10 5	20 5	20 10
DRIVES: Formatted capacity/drive(MB)	2100	1050, 2100	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	Drive dependent	Drive dependent
Average positioning time (msec)	9.7	9.7	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	29 x 12 x 28	13.94 x 18.97 x 30.13	5.1 x 14.4	9.8 x 13.7	5.1 x 14.4
POWER: Power backup	618 watts None	 None	15 watts None	15 watts None	30 watts None
FIRST CUSTOMER SHIPMENT	1993	4/94	1991	1992	1993
COMMENTS	ADP-93-08 controller Uses 40 MHz 68030 chip	ADP-93-02 controller Rack mountable. Uses 40 MHz 68030 chip	Uses 25 MHz 68020 chip	Uses 25 MHz 68020 chip	Uses 40 MHz 68030 chip Multiple SCSI initiator support

MANUFACTURER	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS	AT&T GLOBAL INFORMATION SOLUTIONS	ATEN INTERNATIONAL	ATEN INTERNATIONAL
ARRAY MODEL	ADP-93-02	ADP-93-04	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,OEM,PCM	OEM	Captive,OEM,PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Software	Board	Board
Host platform, software environment	Various UNIX, OS/2, AIX NetWare	Various UNIX, OS/2, AIX NetWare	AT&T 3xxx:UNIX AT&T Starserver	PC compatible Various	PC compatible Various
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/5 Host	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	1/2/3/3	1/2/3/3	N/A	3	3
Maximum drives per array	35	35	N/A	28	28
Concurrent host channels	1	1	1, 2	1	1
Array interface to host	SCSI-2	SCSI-2	N/A	ISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	Host dependent	4, 64	4, 64
Cache function (Read, Write)	--	--	Read	Read	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Supported Supported	Yes No No	N/A N/A N/A	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	Host dependent Drive dependent	4 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	9.75 x 8.5	5.1 x 14.4	N/A		
POWER: Power backup	30 watts None	30 watts None	N/A	 None	 None
FIRST CUSTOMER SHIPMENT	1992	1993	6/92	4Q93	4Q93
COMMENTS	Uses 40 MHz 68030 chip Multiple SCSI initiator support	Uses 40 MHz 68030 chip Multiple SCSI initiator support	Online tuning. Single volume. Can span multiple drives and adapters		

MANUFACTURER	ATON SYSTEMES	ATON SYSTEMES	ATON SYSTEMES	ATTO TECHNOLOGY	ATTO TECHNOLOGY
ARRAY MODEL	Areka I-10S	Areka E-10F	Areka VDS	Express Mirror	Express Stripe
DISK/TREND GROUP	Single User	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Software	Software
Host platform, software environment	PC: ISA DOS, Windows, Windows NT	PC: EISA, DOS, Windows, Windows NT	Various DOS, Windows, Windows NT	Macintosh	Macintosh
RAID level Configured by:	0/1/5/10 Host	0/1/5/10 Host	0/1/5/10 Preset	1 Preset	0 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	10 70	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	7	35	4	4
Concurrent host channels	1	1	1	1	1
Array interface to host	ISA	EISA	SCSI-2	SCSI	SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	0	0	0, 64	--	
Cache function (Read, Write)	--	--	Read	--	
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	No Yes Yes	Option No No	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Auto-background	None	None
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	6 5	33 10	10 10	10 Drive dependent	10 Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	N/A	N/A
POWER: Power backup	10 watts --	14 watts --	450 VA None	N/A	N/A
FIRST CUSTOMER SHIPMENT	1993	1993	1994	1/92	11/92
COMMENTS				Requires ATTO Silicon Express controller Can support 4 controllers	Requires ATTO Silicon Express controller Can support 4 controllers

MANUFACTURER	ATTO TECHNOLOGY	ATTO TECHNOLOGY	AUSPEX SYSTEMS	AUSPEX SYSTEMS	AVIV
ARRAY MODEL	Silicon Express 2	Silicon Express 4	NS 3XXX	NS 6XXX	Duet
DISK/TREND GROUP	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	Captive, OEM	Captive, OEM	PCM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	Macintosh	Macintosh	NFS (Sun)	NFS (Sun)	DEC Vax, Alpha, VMS,Ultrix,UNIX NetW., Wind. NT
RAID level Configured by:	0/1/3/4/5 Host	0/1/3/4/5 Host	0/1	0/1	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	2 30	2 180	4.2/2.1 16.81/8.5
Minimum drives per array	2	2	2	2	2
Maximum drives per array	4	4	10	60	8
Concurrent host channels	1	1	1	1, 3	1, 2
Array interface to host	NuBus	NuBus	VME	VME	SCSI-2, DSSI
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI	SCSI	SCSI-2
Cache size (min, max: MB)	--	--	16, 192*	16, 384*	--
Cache function (Read, Write)	--	--	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option No No	Option No No	No No No	No No Option	No Yes Yes
Spare drive (None/Auto/Manual)	None	None	None	None	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 20	30 2	40 5	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2000	3000	Drive dependent
Nominal disk diameter, height	Drive dependent	Drive dependent	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	11.5	11.5	8-10
Average rotational delay (msec)	Drive dependent	Drive dependent	5.5	5.5	4.7-5.6
Drive models	Various	Various	H-P C3010	Micropolis 1936	Various
ARRAY SIZE: Inches: H x W x D	N/A	N/A	42 x 21 x 32	76 x 24 x 39	5.25 x 19 x 26.5(rack)
POWER: Power backup	N/A	N/A	Cache battery*	Cache battery*	
FIRST CUSTOMER SHIPMENT	1/92	1/94	12/90	5/93	10/93
COMMENTS	Supports command tag queing, disc., asynch. I/O, scatter-gather	Supports command tag queing, disc., asynch. I/O, scatter-gather Req. array soft	*Optional nonvolatile memory battery backed 1 MB	*Optional nonvolatile memory, battery backed 1-3 MB	QBUS, BI, CI option avail. Pedestal and tabletop options

MANUFACTURER	AVIV	BAYDEL LTD.	BAYDEL LTD.	BOX HILL	BUSLOGIC
ARRAY MODEL	Mustang	DAR3-xxx	DAR5-xxx	RAID Box 530	Chantal 5.0 NW
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	Software
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 Novell 3.11, 3.12, 4.01
RAID level Configured by:	0/3/5 Port	3 Preset	3 Preset	0/3/5 Preset	0/1/5 Host
Array capacity (Gbytes) MIN MAX	4.2/3.4 8.4/5.6	Drive dependent Drive dependent	Drive dependent Drive dependent	4 12	Drive dependent Drive dependent
Minimum drives per array	5	2 + parity	2 + parity	3	2
Maximum drives per array	5	28 + 7 parity	28 + 7 parity	5	16
Concurrent host channels	1	1	1	1	4
Array interface to host	SCSI-2, DSSI	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-3
Cache size (min, max: MB)	32, 128	1, 64	1, 64	--, 32	N/A
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Write (option)	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option No Option	Option No Yes	Option Yes Yes	N/A N/A N/A
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	--	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10/20 5	10/20 5	10 10	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	2000-5000	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	5.25"	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	N/A
POWER: Power backup		250 watts Battery option	250 watts Battery option	450 watts None	N/A
FIRST CUSTOMER SHIPMENT	10/93	1992	1993	1991	1Q94
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		Includes smart drive reconstr. and performance monitor.

MANUFACTURER	BUSLOGIC	BUSLOGIC	BUSLOGIC	BUSLOGIC	BUSLOGIC
ARRAY MODEL	Chantal 4.5 NW Paragon 4.5	Chantal 4.5 UNX Paragon 4.0	DA2788	DA2988	DA4988
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	Software	Board	Board	Board
Host platform, software environment	PC compatible Novell 3.11, 3.12, 4.01	PC compatible SCO UNIX	PC compatible DOS, Windows, IX NetWare*	PC compatible DOS, Windows, IX NetWare*	PC compatible DOS, Windows, IX NetWare*
RAID level Configured by:	0/1/5 Host	0/1/5 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	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	16	16	14	14	28
Concurrent host channels	1, 4	1, 4	1	1	1
Array interface to host	SCSI, SCSI-2	SCSI, SCSI-2	EISA, EISA EBM	PCI	PCI
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	2, 64	2, 64	2, 64
Cache function (Read, Write)	N/A	N/A	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	N/A N/A N/A	N/A N/A N/A	-- -- --	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-backg,fore	Auto-backg,fore	Auto-backg,fore
ARRAY PERFORMANCE: Boot from array?	No	No	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent Drive dependent	33, 66 10	132 10	132 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	N/A	N/A			
POWER: Power backup	N/A	N/A	5 watts	5 watts	5 watts
FIRST CUSTOMER SHIPMENT	3Q93	3Q93	2Q94	2Q94	3Q94
COMMENTS	Includes smart drive reconstr. and performance monitor. Earliest vers. shipped in 1990	Includes smart drive reconstr. and performance monitor.	*Future support for Windows NT, OS/2, UNIX	*Future support for Windows NT, OS/2, UNIX	*Future support for Windows NT, OS/2, UNIX

MANUFACTURER	CAMBEX	CAMBEX	CAMBEX	CANARY COMMUNICATIONS	CIPRICO
ARRAY MODEL	ARRAY/6000-510	ARRAY/6000-910	ARRAY/6000	IDA3500	NA6700 SGX700
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	OEM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Subsystem
Host platform, software environment	RS/6000 UNIX/AIX HACMP/6000	RS/6000 UNIX/AIX HACMP/6000	RS/6000, AIX	NetWare, OS/2, UNIX, VINES	NetWare, SGI
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5	0/1/3/5 Host, Port	3 Preset
Array capacity (Gbytes) MIN MAX	5 31.5	16 189	8 96	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	10	5	2	5
Maximum drives per array	15	90	60	35	5
Concurrent host channels	2	2, 6	2	1, 2	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)	--	--	--	--	N/A
Cache function (Read, Write)	--	--	--	--	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Option Option Option	No No Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	--	--	--	--	
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	1000,1600,2100	1600, 2100	1600	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	Drive dependent
Average positioning time (msec)	10	10	10	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	5.6	Drive dependent	Drive dependent
Drive models	Various DEC	Various DEC	Various DEC	Various	Various
ARRAY SIZE: Inches: H x W x D	22.75 x 14 x 15.5	66 x 31 x 34	66 x 24 x 34		7 x 17 x 22
POWER: Power backup					200 watts --
FIRST CUSTOMER SHIPMENT	12/92	12/92	12/92	2Q94	1Q93
COMMENTS			Dual AC feed Supported under HACMP/6000		

MANUFACTURER	CIPRICO	CIPRICO	CIPRICO	CIPRICO	CIPRICO
ARRAY MODEL	NA6710 SGX710	NA6720	SGX720	AD6700 AS6700	AD6720
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Very High Perf.
MARKET	PCM	PCM	PCM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	NetWare, SGI	NetWare, SGI	NetWare, SGI	Various	Various
RAID level Configured by:	3 Preset	3 Preset	3 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2 8	2 8	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	9	5	5	5	5
Maximum drives per array	9	5	5	5	5
Concurrent host channels	1	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)	N/A	N/A	N/A	N/A	N/A
Cache function (Read, Write)	N/A	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	No No Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?					
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20 15	20 15
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	20 x 10 x 20	20 x 10 x 20	7 x 17 x 22	20 x 10 x 20
POWER: Power backup	300 watts --	200 watts --	300 watts	200 watts --	200 watts
FIRST CUSTOMER SHIPMENT	1Q93	4Q93	4Q93	1Q93	4Q93
COMMENTS					

MANUFACTURER	CIPRICO	CLONE STAR SOFTWARE	CLONE STAR SOFTWARE	CLOVIS MANUFACTURING	CLOVIS MANUFACTURING
ARRAY MODEL	A06710 AS6710	ALTER EGO	REFLECT	Multistor 1	Multistor 2-8 Multistor 2-11
DISK/TREND GROUP	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Software	Software	Subsystem	Subsystem
Host platform, software environment	Various	PC compatible MS-DOS	PC compatible MS-DOS, NetWare	Multistor VINES, NetWare, other	Multistor VINES, NetWare, other
RAID level Configured by:	3 Preset	1 Preset	1 Preset	1	1
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	9	2	2	2	2
Maximum drives per array	9	2	2	6	10
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	N/A	N/A	SCSI-2	SCSI-2
Drive interface	SCSI-2	N/A	N/A	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	--	--	4, 64	8, 64
Cache function (Read, Write)	N/A	--	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Yes	NA NA NA	NA NA NA		
Spare drive (None/Auto/Manual)	Manual-backgrnd	None	None	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?		Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 20	N/A N/A	N/A N/A	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm
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	N/A	N/A	Varies	Varies
POWER: Power backup	300 watts --	N/A N/A	N/A N/A	300 watts UPS optional	300 watts UPS optional
FIRST CUSTOMER SHIPMENT	1Q93	1989	1988		
COMMENTS				Requires array software	Requires array software

MANUFACTURER	CLOVIS MANUFACTURING	CMD TECHNOLOGY	CMD TECHNOLOGY	CMS ENHANCEMENTS	CMS ENHANCEMENTS
ARRAY MODEL	Multistor 3	SCEA/S	CRD-5000	1.0 Platinum ARRAY	2.0 Platinum ARRAY
DISK/TREND GROUP	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Board	Subsystem	Subsystem
Host platform, software environment	SCSI host VINES, NetWare, other	SCSI host NetWare, UNIX, DOS, Wind. NT*	SCSI host NetWare, UNIX, DOS, Wind. NT*	PC compatible NetWare	PC compatible NetWare
RAID level Configured by:	0/1/3/5	1 Panel	0/3/5 Host,Panel,Port	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	 1.5	 3
Minimum drives per array	3	2	5	3	3
Maximum drives per array	8	8	28	28	28
Concurrent host channels	1	1	1, 2, 3	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)	8, 64	--	8, 32	--	--
Cache function (Read, Write)	Read, Write	--	Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)		No No No	Yes No No	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto-background	Auto-background	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 Drive dependent	10, 20 Drive dependent	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	500	1000
Nominal disk diameter, height	3.5", 41.3 mm	Drive dependent	Drive dependent	5.25", 82.6 mm	5.25", 82.6 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	10	9.5
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	6.7	5.6
Drive models	Various	Various	Various	Quantum 525	DEC 3107
ARRAY SIZE: Inches: H x W x D	Varies	5.75 x 8.12	3.25 x 5.75 x 8.12		
POWER: Power backup	300 watts UPS optional	2 watts None	25 watts Cache battery	6 + drives None	6 + drives None
FIRST CUSTOMER SHIPMENT		2/93	4/93	1993	1993
COMMENTS		*Many software systems supported	*Many software systems supported	Uses purchased Array software	Uses purchased Array software

MANUFACTURER	CMS ENHANCEMENTS	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	4.2 Platinum ARRAY	486/50-2100A ProLiant 2000	486/50-2100A ProLiant 4000	486/50-4200A ProLiant 2000	486/50-4200A ProLiant 4000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	PC compatible NetWare	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:	0/1/5 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	 6.3	2.1 10.5/147*	2.1 10.5/147*	4.2 10.5/147*	4.2 10.5/147*
Minimum drives per array	3	2	2	2	2
Maximum drives per array	28	14	14	14	14
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	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**
Cache function (Read, Write)	--	Write	Write	Write	Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	With duplexing No No	With duplexing No No	With duplexing No No	With duplexing No No
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	No	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	33 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	2000	1050	1050	2100	2100
Nominal disk diameter, height	5.25", 82.6 mm	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"
Average positioning time (msec)	10	10.5	10.5	9.5	9.5
Average rotational delay (msec)	5.6	5.5	5.5	4.7	4.7
Drive models	DEC 3210	Fujitsu, H-P, Micropolis, IBM	Fujitsu, H-P, Micropolis, IBM	H-P, Seagate	H-P, Seagate
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
POWER: Power backup	6 + drives None	445 watts Cache battery	445 watts Cache battery	445 watts Cache battery	445 watts Cache battery
FIRST CUSTOMER SHIPMENT	1993	4Q93	4Q93	4Q93	4Q93
COMMENTS	Uses purchased Array software	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER
ARRAY MODEL	486DX2/66-2100A ProLiant 1000	486DX2/66-2100A ProSignia	5/60-2100 ProSignia	5/60-2100A ProLiant 1000	5/66-2100A 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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
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 10.5/117*	2.1 8.4/117.6*	2.1 8.4/117.6*	2.1 10.5/117*	2.1 10.5/147*
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
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 No	With duplexing No No	With duplexing No No	With duplexing No No	With duplexing No No
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	1050	1050	1050	1050	1050
Nominal disk diameter, height	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"
Average positioning time (msec)	10.5	10.5	10.5	10.5	10.5
Average rotational delay (msec)	5.5	5.5	5.5	5.5	5.5
Drive models	Fujitsu, H-P, Micropolis, IBM	Fujitsu, H-P Micropolis, IBM	Fujitsu, H-P Micropolis, IBM	Fujitsu, H-P, Micropolis, IBM	Fujitsu, H-P, Micropolis, IBM
ARRAY SIZE: Inches: H x W x D	25.8 x 8.75 x 22.4	21.93 x 8.96 x 17.25	21.93 x 8.96 x 17.25	25.8 x 8.75 x 22.4	25.8 x 8.75 x 22.4
POWER: Power backup	300 watts Cache battery	240 watts Cache battery	240 watts Cache battery	300 watts Cache battery	445 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q93	9/92	9/92	4Q93	4Q93
COMMENTS	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache

MANUFACTURER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPAQ COMPUTER	COMPUADD	CONCURRENT COMPUTER
ARRAY MODEL	5/66-2100A ProLiant 4000	5/66-4200A ProLiant 2000	5/66-4200A ProLiant 4000	DriveArray	D-251
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	PCM	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
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	SCSI host DOS, OS/2, UNIX Novell, other	Concurrent UNIX (RTU)
RAID level Configured by:	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host	0/1/5 Host	0/1
Array capacity (Gbytes) MIN MAX	2.1 10.5/147*	4.2 10.5/147*	4.2 10.5/147*	1/.5/2 8/4/8	2.8 45
Minimum drives per array	2	2	2	2	2
Maximum drives per array	14	14	14	5	32
Concurrent host channels	1	1	1	1	2, 8
Array interface to host	EISA	EISA	EISA	SCSI-2	VME
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	IPI-2
Cache size (min, max: MB)	4**	4**	4**	--	.5, .5
Cache function (Read, Write)	Write	Write	Write	--	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing No No	With duplexing No No	With duplexing No No	No Yes Yes	Yes No No
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Manual-backgrnd	Auto
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	33 10	10 10	20 7.5
DRIVES: Formatted capacity/drive(MB)	1050	2100	2100	500, 1000, 2000	1341
Nominal disk diameter, height	3.5", 1.625"	3.5", 1.625"	3.5", 1.625"	3.5", 41.3 mm	5.25"
Average positioning time (msec)	10.5	9.5	9.5	Drive dependent	11.5
Average rotational delay (msec)	5.5	4.7	4.7	Drive dependent	5.56
Drive models	Fujitsu, H-P, Micropolis, IBM	H-P, Seagate	H-P, Seagate	Various	Seagate ST81154K
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	15.5 x 15.5 x 15.5	5.25 x 19 x 25
POWER: Power backup	445 watts Cache battery	445 watts Cache battery	445 watts Cache battery	N/A None	20 watts+drives UPS
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	4Q93	5/93	11/92
COMMENTS	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	*With external ProLiant storage systems Cache added **Mirrored 2 MB cache	Raidtec controller	Supports concurrent mirroring, striping and dual porting

MANUFACTURER	CONCURRENT COMPUTER	CONLEY	CONLEY	CONLEY	CONNER STORAGE SYSTEMS
ARRAY MODEL	SD-22	SoftRAID	SR1	SR2	CR611DE
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	OEM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Software	Subsystem	Subsystem	Subsystem
Host platform, software environment	Concurrent UNIX (RTU)	Macintosh,Power PC, Quadra	Sun, Macintosh, SCSI hosts, UNIX, NetWare	Sun, Macintosh, SCSI hosts	SCSI host NetWare, DOS, NT, other
RAID level Configured by:	0/1	0/1/10	0/1/3/5 Host	0/1/3/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	1.7 27	Drive dependent Drive dependent	10 315	10 315	5 6
Minimum drives per array	2	2	3	3	6
Maximum drives per array	32	5	10	10	6
Concurrent host channels	2, 8	1	7	7	1
Array interface to host	VME	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	IPI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5, .5	--	1	1	--
Cache function (Read, Write)	Read	--	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	NA NA NA	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 6	Drive dependent Drive dependent	40 5	40 10	Host dependent 10/20
DRIVES: Formatted capacity/drive(MB)	850	Drive dependent	2000-9000	2000-9000	1000
Nominal disk diameter, height	8"	3.5", 5.25"	3.5" or 5.25"	3.5" or 5.25"	3.5", 41.3 mm
Average positioning time (msec)	15	Drive dependent	Drive dependent	Drive dependent	9.5
Average rotational delay (msec)	8.3	Drive dependent	Drive dependent	Drive dependent	5.55
Drive models	Seagate ST41800K	Various	Seagate	Seagate	Conner CFP-1060
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 25	N/A	28 x 9 x 22	28 x 9 x 22	12.5 x 7.5 x 12.5
POWER: Power backup	20 watts+drives UPS	N/A	250 watts None	250 watts None	85 watts None
FIRST CUSTOMER SHIPMENT	5/91	11/93	11/91	11/91	1/94
COMMENTS	Supports concurrent mirroring, striping and dual porting	Software array sold with Conley controller			Uses modified Buslogic RAID software

MANUFACTURER	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONNER STORAGE SYSTEMS	CONSENSYS	CONSENSYS
ARRAY MODEL	CR611DI	CR611DM	CR622DE	RAIDIX	RAIDIX/IDE
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	OEM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Software	Board
Host platform, software environment	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	SCSI host NetWare, DOS, NT, other	Various UNIX, SCO, Solaris, other	PC compatible UNIX, Solaris
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5*
Array capacity (Gbytes) MIN MAX	5 6	5 6	5 6	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	6	6	6	--	2
Maximum drives per array	6	6	6	--	8
Concurrent host channels	1	1	1	1	1
Array interface to host	PC AT	MCA	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE, SCSI	IDE
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	N/A N/A N/A	Option -- --
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent 10/20	Host dependent 10/20	33 10/20	Host dependent Drive dependent	33 Drive dependent
DRIVES: Formatted capacity/drive(MB)	1000	1000	1000	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	3.5", 41.3 mm
Average positioning time (msec)	9.5	9.5	9.5	Drive dependent	Drive dependent
Average rotational delay (msec)	5.55	5.55	5.55	Drive dependent	Drive dependent
Drive models	Conner CFP-1060	Conner CFP-1060	Conner CFP-1060	Various	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	--	4.25 x 13
POWER: Power backup	85 watts None	85 watts None	85 watts None	-- --	5 watts+ drives None
FIRST CUSTOMER SHIPMENT	1/94	1/94	2/94	1993	1993
COMMENTS	Uses modified Buslogic RAID software	Uses modified Buslogic RAID software	Mylex controller		*Combined RAID 0/1 available

MANUFACTURER	CONSENSYS	CONTROL DATA SYSTEMS	CONTROL DATA SYSTEMS	CONVEX COMPUTER	CONVEX COMPUTER
ARRAY MODEL	RAIDIX/SCSI	47008	5830	DAR-004	DAR-005
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Very High Perf.	Very High Perf.
MARKET	OEM	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Software	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	PC compatible	SGI, MIPS UNIX	SGI, MIPS,CYBER UNIX-NOX,VE-NOS	Convex C3 series	Convex C3 series
RAID level Configured by:	0/1/5*	0/3 Host	0/3 Host	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2.4 64	2.4 64	 34	 67
Minimum drives per array	2	2	2	12	24
Maximum drives per array	8	32	32	32	32
Concurrent host channels	1	2	4, 8	4	4
Array interface to host	EISA	VME	IPI-3	IPI-2	IPI-2
Drive interface	SCSI	IPI-2	IPI-2	IPI-2E	IPI-2E
Cache size (min, max: MB)	--	None	None	--	--
Cache function (Read, Write)	--	--	--	None	None
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option -- --	Yes No No	Yes No No	No No No	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-back,for	Manual-back,for	Auto	Auto
ARRAY PERFORMANCE: Boot from array?	Yes	No	No	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	25 7.5	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, height	Drive dependent	5.25"	5.25", 8"	5.25"	5.25"
Average positioning time (msec)	Drive dependent	11	11/18	11	11
Average rotational delay (msec)	Drive dependent	5.55	5.55/8.3	5.56	5.56
Drive models	Various	Seagate ST41201K,41800K	Seagte.ST81154K 41201K, 41800K	Seagate Elite III 2HP	Seagate Elite III 2HP
ARRAY SIZE: Inches: H x W x D	4.25 x 13	7 x 19	60 x 40 x 30	70 x 25.1 x 39.3	70 x 25.1 x 39.3
POWER: Power backup	2 watts+ drives None	85 watts(Board) None	2.8 KVA UPS	N/A	N/A
FIRST CUSTOMER SHIPMENT	1993	8/91	6/89	7/93	7/93
COMMENTS	*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	500/2	800/2	1300/2	LA-2000
DISK/TREND GROUP	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Convex C3 series	SCSI host Workstations, Networks	SCSI host, Workstations, Networks	Various PCs, Workstations, Networks	SCSI host NetWare, UNIX, OS/2, DOS
RAID level Configured by:	0/1/5 Host	3/5 Host	3/5 Host	3/5 Host	3/5 Port
Array capacity (Gbytes) MIN MAX	 89	.510 1.020	.842 1.68	1.35 2.7	2 2
Minimum drives per array	32	10	5	5	5
Maximum drives per array	32	10	10	5	5
Concurrent host channels	4	1	1	1	1
Array interface to host	IPI-2	SCSI	SCSI	SCSI	SCSI-2
Drive interface	IPI-2E	IDE	IDE	IDE	IDE
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) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No No No	No No No	No Yes Yes
Spare drive (None/Auto/Manual)	Auto	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	45 7.5-12	5 6	5 6	5 6	5 6
DRIVES: Formatted capacity/drive(MB)	2800	130	213	340	540
Nominal disk diameter, height	5.25"	2.5", 19 mm	2.5", 19 mm	2.5", 19 mm	3.5", 41.3 mm
Average positioning time (msec)	11	17	12	12	12
Average rotational delay (msec)	5.56	8.3	5.6	5.6	6.8
Drive models	Seagate Elite III 2HP	Various	Various	Various	Fujitsu
ARRAY SIZE: Inches: H x W x D	70 x 50.2 x 39.3	7.5 x 14 x 12	7.5 x 14 x 12	7.5 x 14 x 12	8.25 x 12.5 x 18
POWER: Power backup	N/A	 None	 None	 None	108 watts None
FIRST CUSTOMER SHIPMENT	7/93	8/92	1Q93	12/93	2/93
COMMENTS		500/2 is 2 MA-500 in external mount	800/2 is 2 MA-800 in external mount	1300/2 is 2 MA-1300 in external mount	

MANUFACTURER	CORE INTERNATIONAL	CORE INTERNATIONAL	CORE INTERNATIONAL	CORE INTERNATIONAL	CORE INTERNATIONAL
ARRAY MODEL	LA-4000	LA-8000 LAN ARRAY	LA-10000 LAN ARRAY	MA-500 MicroArray	MA-800 MicroArray
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
Host platform, software environment	NetWare, UNIX, OS/2, DOS	SCSI host NetWare, UNIX, OS/2, DOS	SCSI host NetWare, UNIX, OS/2, DOS	SCSI host Various	SCSI host Various
RAID level Configured by:	3/5 Host, Port	3/5 Host, Port	3/5 Host, Port	3/5 Host	3/5 Host
Array capacity (Gbytes) MIN MAX	4 4	8 10	10 10	.510	.842
Minimum drives per array	5	5	6	5	5
Maximum drives per array	5	6	6	5	5
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IDE	SCSI-2	SCSI-2	IDE	IDE
Cache size (min, max: MB)	2	2	2	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 Yes Yes	No Yes Yes	No Yes Yes	No No No	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 6	10 10	10 10	5 6	5 6
DRIVES: Formatted capacity/drive(MB)	1000	2000	2000	130	213
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	2.5", 19 mm	2.5", 19 mm
Average positioning time (msec)	10	9	9	17	12
Average rotational delay (msec)	5.6	5.6	5.6	8.3	8.3
Drive models	Micropolis	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8.25 x 12.5 x 18	8 x 13.7 x 18	8 x 13.7 x 18	3.25 x 5.75 x 8	3.25 x 5.75 x 8
POWER: Power backup	144 watts None	85 watts None	98 watts None	N/A None	N/A None
FIRST CUSTOMER SHIPMENT	2/93	12/93	1/94	8/92	1Q93
COMMENTS					

MANUFACTURER	CORE INTERNATIONAL	COREL	CRAY RESEARCH	CRAY RESEARCH	CRAY RESEARCH
ARRAY MODEL	MA-1300	Network Manager	DA-301	DA-60	DA-62
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	PCM	OEM, PCM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Software	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host Various	PC compatible NetWare 3.1X, NetWare 4.X	Cray Unicos	Cray Unicos	Cray Unicos
RAID level Configured by:	3/5 Host, Port	4/5 Host	3 Host	3 Host	3 Host
Array capacity (Gbytes) MIN MAX	1.35 1.35	Drive dependent Drive dependent	5.51 44.08	7.84 62.72	10.92 87.36
Minimum drives per array	5	3	5	5	5
Maximum drives per array	5	16	40	40	40
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	IPI-2	IPI-2	IPI-2
Drive interface	IDE	SCSI-2	IPI-2	IPI-2	IPI-2
Cache size (min, max: MB)	2	--	--	--	--
Cache function (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)	Manual-backgrnd	Man,Auto-backgr	Manual	Manual	Manual
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 6	10/20 10/20	32 8.2	80 20	32 8.1
DRIVES: Formatted capacity/drive(MB)	340	Drive dependent	1377	1960	2730
Nominal disk diameter, height	2.5", 19 mm	Drive dependent	3.5", 41.3 mm	8", 8.44"	8", 4.75"
Average positioning time (msec)	12	Drive dependent	11	12	12
Average rotational delay (msec)	5.6	Drive dependent	5.56	8.3	6.87
Drive models	Various	Various	IBM 0664 (2 head parallel)	Seagate Sabre 6 PTD 9 head	Seagate Sabre 7 PTD
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8	-- --		60.75 x 24 x 40.8	60.75 x 24 x 40.8
POWER: Power backup	65 watts None	-- --	167 watts/drive None	275 watts/drive None	167 watts/drive None
FIRST CUSTOMER SHIPMENT	4Q93	1Q94*	1/93	12/92	12/92
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-60 array groups	DCA-3 channel adapter controls up to 8 DA-62 array groups

MANUFACTURER	CRAY RESEARCH	CRAY RESEARCH	DATA GENERAL	DATA GENERAL	DATA GENERAL
ARRAY MODEL	ND-12	ND-14	1100 CLARiiON	1300 CLARiiON	2000/2200 CLARiiON
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Cray Unicos	Cray Unicos	Sun,AVi.,Unisys Eclip.,RS/6000, AS/400,OS/2,Net	Sun,AVi.,Unisys Eclips.,RS/6000 AS/400,OS/2,Net	Sun,AVi.,Unisys Eclips.,RS/6000 AS/400,OS/2,Net
RAID level Configured by:	1/5 Console	1/5 Console	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port	0/1/3/5/10 Host, Port
Array capacity (Gbytes) MIN MAX	27.4 232	54.8 232	3 20	5 20	5 40
Minimum drives per array	20	40	3	5	5
Maximum drives per array	160	160	10	10	20
Concurrent host channels	2	2	1, 2	1, 2	1, 2
Array interface to host	IPI-3 (HIPPI)	IPI-3 (HIPPI)	SCSI-2	SCSI-2	SCSI-2
Drive interface	IPI-2	IPI-2	SCSI	SCSI	SCSI-2
Cache size (min, max: MB)	20	20	8, 16 (option)	8, 16	8,16,32,64(opt)
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	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	No	No	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	67 5	67 5	20 10	20 10	20 20
DRIVES: Formatted capacity/drive(MB)	1700	1700	520, 1000, 2000	520, 1000, 2000	520, 1000, 2000
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	9.4 RD/11 WR	9.4 RD/11 WR	8.5-9.4	8.5-9.4	8.5-9.4
Average rotational delay (msec)	5.56	5.56	4.17-5.6	4.17-5.6	4.17-5.6
Drive models	IBM Allicat P15	IBM Allicat P15	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	62.25 x 29.5 x 38.5	62.25 x 29.5 x 38.5	24.8 x 10.5 x 30	24.8 x 10.5 x 30	24.8 x 14 x 30
POWER: Power backup	3.4 KVA None	3.4 KVA None	575 watts Battery	575 watts Battery	880 watts Battery
FIRST CUSTOMER SHIPMENT	11/93	11/93	1/94	3/94	6/92
COMMENTS	IBM 9570	IBM 9570	Concurrent RAID levels, mirrored cache	Concurrent RAID levels, mirrored cache	Concurrent RAID levels, mirrored cache

MANUFACTURER	DATA GENERAL	DATA STORAGE MANAGEMENT	DATALINK	DATALINK	DATALINK
ARRAY MODEL	2300 CLARiiON	Datastor RAID	RSD 500	RSG 200	RSG 300
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Sun,AVi.,Unisys Eclips.,RS/6000 AS/400,OS/2,Net	SCSI host Various	SCSI host UNIX, NFS, VAX station	SCSI host NetWare, SCO UNIX	SCSI host NetWare, DOS, Apple
RAID level Configured by:	0/1/3/5/10 Host, Port	0/3/5 Host	0/3/5 Panel, Port	0/1/5 Host	0/1/3 Panel
Array capacity (Gbytes) MIN MAX	5 40	Drive dependent Drive dependent	8 216	2 24	2 16
Minimum drives per array	5	5	5	2	2
Maximum drives per array	20	28	28	7	5
Concurrent host channels	1, 2	1, 3	1-3	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	Various	SCSI-2
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	8, 16, 32, 64	8, 32	4, 32	--	None
Cache function (Read, Write)	Read, Write	Write	Read, Write	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes No No	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Man,Auto-backgr	None	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	No	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 Drive dependent	10-20 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	520, 1000, 2000	Drive dependent	2000, 4000,9000	1000, 2000	1000, 2000,4000
Nominal disk diameter, height	3.5", 41.3 mm	Drive dependent	3.5", 5.25"	3.5", 25.4 mm	3.5", 25.4 mm
Average positioning time (msec)	8.5-9.4	Drive dependent	8-12	9-10	8-10
Average rotational delay (msec)	4.17-5.6	Drive dependent	4.2-5.5	5.5	4.2-5.5
Drive models	Various	Various	H-P, IBM, Seagate	H-P, IBM, Seagate	H-P, IBM, Seagate
ARRAY SIZE: Inches: H x W x D	24.8 x 14 x 30	Varies	40 x 21 x 27	15 x 15 x 15	15 x 15 x 15
POWER: Power backup	880 watts Battery	Cache battery	25 watts+drives UPS battery	UPS option	UPS option
FIRST CUSTOMER SHIPMENT	3/94	9/93	1994	2Q94	1/94
COMMENTS	Concurrent RAID levels, mirrored cache	CMD CRD-5000 controller	CMD controller	Uses Buslogic array software	Raidtec controller

MANUFACTURER	DATALINK	DATARAM	DATARAM	DATARAM	DELL COMPUTER
ARRAY MODEL	RSP 500	DTM900	DTM1000	DTM4000	DSA
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host UNIX, NFS, VAX station	Sun, DEC, H-P VMS, UNIX	DEC, Sun, H-P, VMS, UNIX	Sun, DEC, H-P VMS, UNIX	Dell Lanman 2.2,Dell UNIX, NetWare
RAID level Configured by:	0/3/5 Panel, Port	0/1 Port, Panel	0/3/5 Port, Panel	0/3/5 Port, Panel	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	4 24	2/1 24/12	3/2/2	 112	4 14
Minimum drives per array	5	2	3	3	4
Maximum drives per array	14	6	7	21	14
Concurrent host channels	1-3	1, 2	1	1, 2	1, 2
Array interface to host	SCSI-2	SCSI, DSSI	SCSI, DSSI	SCSI, DSSI, CI	Proprietary
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 32	--	8, 16, 32	8, 16, 32	1
Cache function (Read, Write)	Read, Write	--	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Option Yes No	No Yes Yes	Option Yes Yes	Yes No No
Spare drive (None/Auto/Manual)	Auto-background	Manual-backgrnd	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10-20 10	10 10	10 10	10 10	16 10
DRIVES: Formatted capacity/drive(MB)	2000, 4000,9000	1000, 2000	1000, 2000,4000	1000, 2000,4000	1050
Nominal disk diameter, height	3.5", 5.25"	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	8-12	11/9.5/9.5	11/9.5/9.5	11/9.5/9.5	9.5
Average rotational delay (msec)	4.2-5.5	5.56	5.56	5.6	5.56
Drive models	H-P, IBM, Seagate	Seagate	Seagate	Seagate	DEC 3105
ARRAY SIZE: Inches: H x W x D	21 x 7 x 21	5.22 x 17.65 x 22.5	5.22 x 17.65 x 22.5	5.22 x 17.65 x 22.5	24 x 7.5 x 22.3
POWER: Power backup	25 watts+drives Cache battery	-- --	-- Cache battery	-- Cache battery	Host dependent None
FIRST CUSTOMER SHIPMENT	11/93	1994	4Q93	1994	3/93
COMMENTS	CMD controller	TD Systems controller	StorageWorks compatible disk canisters CMD controller	StorageWorks compatible disk canisters CMD controller	ISA bus, RAID 1/0 version shipped 11/92

MANUFACTURER	DIGI-DATA	DIGI-DATA	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	Model Z	Model Z9000	DECraid+	HSC65 SDI	HSC65 SDI/SCSI
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI-2 host Various	SCSI-2 host Various	VAX, Alpha, VMS	VAX, Alpha, VMS ULTRIX	VAX, Alpha, VMS
RAID level Configured by:	0/3/5 Port	0/3/5 Port	0/1/0+1 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	2 96	1 40	1 40/21
Minimum drives per array	5	5	5	1	1
Maximum drives per array	35	35	48	20	20/20
Concurrent host channels	1	1	1	1, 3	1, 3
Array interface to host	SCSI-2	SCSI-2	CI	CI	CI
Drive interface	SCSI-2	SCSI-2	SDI	SDI	SDI, SCSI-2
Cache size (min, max: MB)	--	To 128	--, 128	64, 64	64, 64
Cache function (Read, Write)	Read, Write	Read, Write	Read	Read	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	Yes -- Yes	Yes No No	Yes No No
Spare drive (None/Auto/Manual)	Auto-backgrnd*	Auto-background	Auto	Auto (option)	Auto (option)
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	--	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	4 4	4 2.8	4 2.8, 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000, 2000	1000, 2000	1000, 2000
Nominal disk diameter, height	Drive dependent	Drive dependent	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm
Average positioning time (msec)	Drive dependent	Drive dependent	12.5-12.9	12.5	12.5
Average rotational delay (msec)	Drive dependent	Drive dependent	8.3	8.3	8.3
Drive models	Various	Various	RA72, RA73	RA72, RA73	RA72, RA73
ARRAY SIZE: Inches: H x W x D	3.25 x 5.75 x 8**	3.25 x 5.75 x 8*	81 x 22 x 38	41.7 x 21.3 x 35	41.7 x 21.3 x 35
POWER: Power backup	26 watts+drives None	26 watts+drives None	1470 watts --	785 watts None	785 watts None
FIRST CUSTOMER SHIPMENT	4/92	3/94	6/92	9/92	3/93
COMMENTS	*Starting in 1994 **Without drives	*Without drives	Software-based subsystem		

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSC95 SDI	HSC95 SDI/SCSI	HSD05	HSJ30 StorageWorks	HSJ40 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	Subsystem	Subsystem	Software	Subsystem	Subsystem
Host platform, software environment	VAX, Alpha, VMS ULTRIX	VAX, Alpha, VMS ULTRIX	VAX, Alpha, VMS	VAX, Alpha, VMS OSF	VAX, Alpha, VMS OSF
RAID level Configured by:	0/1 Host	0/1 Host	0/1	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	1 96	1 40/27.3	2.1 12.6	4.2 37.8	4.2 75.6
Minimum drives per array	1	1	2	2	2
Maximum drives per array	48	20/26	6	18	36
Concurrent host channels	1, 8	1, 8	1	1, 8	1, 8
Array interface to host	CI	CI	DSSI	CI	CI
Drive interface	SDI	SDI, SCSI-2	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 64	64, 64	--	0, 32	16, 32
Cache function (Read, Write)	Read	Read	--	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No No	Yes No No	-- -- --	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto (option)	Auto (option)	--		
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	4 2.8	4 2.8, 10	3	4-6 Drive dependent	4-6 Drive dependent
DRIVES: Formatted capacity/drive(MB)	1000, 2000	1000, 2000	1050,2100,3600	1050,2100,3600	1050,2100,3600
Nominal disk diameter, height	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 5.25"	3.5", 5.25"	3.5", 5.25"
Average positioning time (msec)	12.5	12.5	9.5-12	9.5-12	9.5-12
Average rotational delay (msec)	8.3	8.3	5.6	5.6	5.6
Drive models	RA72, RA73	RA72, RA73	RZ26, RZ28, RZ74	RZ26, RZ28 RZ74	RZ26, RZ28, RZ74
ARRAY SIZE: Inches: H x W x D	41.7 x 21.3 x 35	41.7 x 21.3 x 35	--	Various configurations	Various configurations
POWER: Power backup	785 watts None	785 watts None	-- --	1300-3140 watts	1300-3140 watts
FIRST CUSTOMER SHIPMENT	9/92	3/93	1/94	1Q94	3Q93
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION
ARRAY MODEL	HSJ42 StorageWorks	HSJ44 StorageWorks	QL-OMHA*-AA QL-OMGAA-3B StorageWorks	RAID Array 110 StorageWorks	RM HSC95 SDI/SCSI
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	Software	Subsystem	Subsystem
Host platform, software environment	VAX, Alpha, VMS OSF	VAX, Alpha, VMS OSF	Open VMX VAX	Digital, Sun, PC servers, VMS NetWare, UNIX	VAX, Alpha, VMS
RAID level Configured by:	0/1/3/5	0/1/3/5	5 Host	0/1/5 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	4.2 151.2	4.2 226.8	-- --	5.25 35.175	1 40/29.4
Minimum drives per array	2	2	--	5	1
Maximum drives per array	36/72	72/144	7 + parity	35	20/28
Concurrent host channels	1, 8	1, 8	--	1	1, 8
Array interface to host	CI	CI	Varies	SCSI	Digital prop.
Drive interface	SCSI-2	SCSI-2	Varies	SCSI-2	SDI, SCSI-2
Cache size (min, max: MB)	32, 64	64, 128	--		64, 64
Cache function (Read, Write)	Read, Write	Read, Write	--		Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	-- -- --	Option Yes Yes	Yes No Yes
Spare drive (None/Auto/Manual)			--	Auto (option)	Auto (option)
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	--		Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	4-6 Drive dependent	4-6 Drive dependent	Drive dependent Drive dependent		4 2.8, 10
DRIVES: Formatted capacity/drive(MB)	1050,2100,3600	1050,2100,3600	Drive dependent	1050, 2100	1000, 2000
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	Drive dependent	3.5", 41.3 mm	5.25", 82.6 mm
Average positioning time (msec)	9.5-12	9.5-12	Drive dependent	9.5	12.5
Average rotational delay (msec)	5.6	5.6	Drive dependent	5.6	8.3
Drive models	RZ26, RZ28, RZ74	RZ26, RZ28, RZ74	Various	RZ26, RZ28	RA72, RA73
ARRAY SIZE: Inches: H x W x D	Various configurations	Various configurations	--	24 x 14 x 15	67 x 31 x 34.5
POWER: Power backup	1300-3140 watts	1300-3140 watts	-- --	131 watts Battery option	785 watts Battery
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	12/93	5/93	3/93
COMMENTS					

MANUFACTURER	DIGITAL EQUIPMENT CORPORATION	DIGITAL EQUIPMENT CORPORATION	DIRECT CONNECT SYSTEMS	DIRECT CONNECT SYSTEMS	DIRECT CONNECT SYSTEMS
ARRAY MODEL	RM HSC95 SCSI	Volume Shadowing, Version 6.0	Guardian Array	Guardian Duplex	Guardian RAID
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive, OEM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Software	Subsystem	Subsystem	Subsystem
Host platform, software environment	VAX, Alpha, VMS	VAX, Alpha	DEC, Sun, AT&T UNIX, OS/2, NetWare	DEC, Sun, AT&T UNIX, OS/2, NetWare	DEC, Sun, AT&T UNIX, OS/2, NetWare
RAID level Configured by:	0/1 Host	1	3	1	0/3/5
Array capacity (Gbytes) MIN MAX	1.05 58.8	-- 464	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	1	1	3	2	3
Maximum drives per array	56	130 x 3	6	12	28
Concurrent host channels	1, 8	1, 130	1	1, 2	1, 3
Array interface to host	Digital prop.	DSSI, SCSI, CI	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	DSSI, SCSI, CI	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 64	DSSI, SCSI, CI	--	--	32
Cache function (Read, Write)	Read	--	--	--	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes No Yes	-- -- --	No Yes Yes	Yes Yes Yes	No* Yes Yes
Spare drive (None/Auto/Manual)	Auto (option)	--	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	4 10	Drive dependent Drive dependent	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1050, 2100	Drive dependent	1600-2000	1600-2000	1600-2000
Nominal disk diameter, height	5.25", 41.3 mm	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	9.5	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	RZ26	Various	Digital 3160 Seagate Barrac.	Digital 3160 Seagate Barrac.	Digital 3160 Seagate Barrac.
ARRAY SIZE: Inches: H x W x D	67 x 31 x 34.5	--	22.25 x 7.5 x 23	22.25 x 7.5 x 23	22.25 x 7.5 x 23
POWER: Power backup	785 watts Battery	-- --	170 watts None	170 watts None	170 watts None
FIRST CUSTOMER SHIPMENT	3/93	1990	10/93	10/93	9/93
COMMENTS			Raidtec controller Rack mount option avail.	TD Systems controller Rack mount option avail.	CMD CRD5000 *Future option Rack mount option avail.

MANUFACTURER	DIRECT CONNECT SYSTEMS	DISK PACK	DISTRIBUTED PROCESSING TECHNOLOGY	DISTRIBUTED PROCESSING TECHNOLOGY	DIVERSE LOGISTICS
ARRAY MODEL	Guardian Bulk Server	DP-RAID	DM 4000 Disk Array Module	Smart Cache Plus Mirroring Option	Windjammer
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
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Host platform, software environment	DEC, Sun, AT&T UNIX, OS/2, NetWare	SCSI host Various	PC compatible NetWare, VINES, LAN Mgr., UNIX	PC compatible NetWare, VINES, LAN Mgr., UNIX	SCSI host NetWare, UNIX
RAID level Configured by:	0/1	0/3/5 Port	0/1/5 Host	1 Preset	0/1 Panel, Port
Array capacity (Gbytes) MIN MAX	27 63	.950 10	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	5	2	2	2
Maximum drives per array	7	5	6	6	14
Concurrent host channels	1, 2	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	ISA, EISA	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	1, 64	.512, 16	4, 64
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No -- Yes	No No No	No No No	No No No
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Manual-backgrnd	Auto-background	None	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 20	10/33 10	Drive dependent Drive dependent	20 10
DRIVES: Formatted capacity/drive(MB)	9100	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	5.25"	3.5", 25.4 mm	Drive dependent	Drive dependent	3.5", 41.3 mm
Average positioning time (msec)	11	12	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Drive models	Seagate Elite 9	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 7.5 x 23	21.5 x 7.8 x 19	4.75 x 13	4.75 x 13	1.625 x 5 x 8
POWER: Power backup	300 watts None	100 watts UPS	10 watts+drives None	5 watts+ drives None	8 watts+ drives None
FIRST CUSTOMER SHIPMENT	3/94	1993	3Q93	2/92	1/94
COMMENTS	CMD SCEA controller Rack mount option avail.	Digi-Data controller	Smart Cache III SCSI Controller option. CM4000 cache module is prerequisite.		

MANUFACTURER	DIVERSE LOGISTICS	DIVERSE LOGISTICS	DIVERSE LOGISTICS	DTC TECHNOLOGY	DTC TECHNOLOGY
ARRAY MODEL	Windjammer 400	Windjammer 800	Windjammer 1400	DTC 3199	DTC 8200
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	Board	Board	Board	Board	Board
Host platform, software environment	SCSI host NetWare, UNIX	SCSI host NetWare, UNIX	SCSI host NetWare, UNIX	Various NetWare, OS/2, UNIX	Various NetWare, OS/2, UNIX
RAID level Configured by:	0/1 Panel, Port	0/1 Panel, Port	0/1 Panel, Port	0/1/4/5/10 RS-232C	0/1/10
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	4	8	14	21	7
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	EISA	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 64	4, 16	.256, -
Cache function (Read, Write)	Read	Read	Read	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes (option) Yes Yes	Option Yes Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	--	--
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	10 Drive dependent	10 Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	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 7 x 12	1 x 5 x 7.2	1 x 4 x 5.5
POWER: Power backup	8 watts+ drives None	8 watts+ drives None	8 watts+ drives None		
FIRST CUSTOMER SHIPMENT	1/94	1/94	1/94	11/93	8/82
COMMENTS					

MANUFACTURER	DTC TECHNOLOGY	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS
ARRAY MODEL	DTC 8210	IIR 1.0QI	IIR 2.0QI	IIR 500QI	RDR 2.0
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Various NetWare, OS/2, UNIX	PC compatible NetWare, SCO UNIX	PC compatible NetWare, SCO UNIX	PC compatible NetWare, SCO UNIX	RS/6000 NetWare, OS/2
RAID level Configured by:	0/1/4/5 RS232	0/5	0/5	0/1/4/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2.1/1.05	4.2/2.1	.6/.3/.4/.4 .6/.3/.4/.4	1.5/.8/1/1 2.6/1.3/2.1/2.1
Minimum drives per array	2	3	3	3	3
Maximum drives per array	7	3	3	3	5
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	EISA	EISA	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, 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 No No	No No No	No No No	No Per drive Per drive
Spare drive (None/Auto/Manual)	Auto-background	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	--	Yes	Yes	Yes	Host dependent
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 Drive dependent	10 10	10 20	10 10	10 5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	525	1050	200	520
Nominal disk diameter, height	Drive dependent	3.5", 25.4 mm	3.5", 41.3 mm	3.5", 25.4 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	10	8.6 RD/10.1 WR	16	12
Average rotational delay (msec)	Drive dependent	6.7	5.6	7	6.8
Drive models	Various	Quantum 525S LPS	IBM 0662-S12	Quantum 240S LPS	Fujitsu M2624
ARRAY SIZE: Inches: H x W x D	1.6 x 5.7 x 8.4	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: Power backup		60 watts None	60 watts None	60 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	4/94	1993	1993	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	XPRS 2.0F	XPRS 4.0F
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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	RS/6000 NetWare, OS/2	SCSI host NetWare, OS/2, AIX	SCSI host NetWare, OS/2, AIX	SCSI host Various	SCSI host OS/2, 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	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	3/1.5/2/2 5/2.5/4/4	2/1/2.4/2.4 5/2.5/4/4	4/2/4.8/4.8 10/5/8/8	3.6/1.8/2.4/2.4 12/6/9.6/9.6	4.8 9.6
Minimum drives per array	3	3	3	2	2
Maximum drives per array	5	5	5	5	5
Concurrent host 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-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Host dependent	Host dependent	Host dependent	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1000	1000	2000	520	1206
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 25.4 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	10	8.6 RD/10.1 WR	9.2 RD/10.7 WR	12	10
Average rotational delay (msec)	5.6	5.6	5.6	6.8	5.6
Drive models	Fujitsu M2694	IBM 0662-S12	IBM 0664-MIH	Fujitsu M2624	Fujitsu M2694 ESA
ARRAY SIZE: Inches: H x W x D	19 x 12 x 20.25	19 x 12 x 20.25	19 x 12 x 20.25	19 x 12 x 20.25	19 x 12 x 20.25
POWER: Power backup	250 watts None	250 watts None	250 watts None	500 watts None	500 watts None
FIRST CUSTOMER SHIPMENT	2Q92	1Q93	1Q93	1/94	1/94
COMMENTS	AT&T ADP-92-01 controller	AT&T ADP-92-01 controller	AT&T ADP-92-01 controller	Digi-Data controller	Digi-Data controller

MANUFACTURER	DYNATEK AUTOMATION SYSTEMS	DYNATEK AUTOMATION SYSTEMS	ECCS	ECCS	ECCS
ARRAY MODEL	XPRS 4.0I	XPRS 8.0I	DFT-1	FFT-1	FFT-1035
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	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host OS/2, UNIX, other	SCSI host OS/2, UNIX, other	SCSI host, H-P UNIX, NetWare, Solaris	SCSI host UNIX, NetWare, VINES	SCSI host UNIX, NetWare Solaris
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	1 Preset	1/10 Preset	0/1/10/3/5 Preset
Array capacity (Gbytes) MIN MAX	5 10	8.2 16.4	Drive dependent Drive dependent	2.1-6.3	10.5-4.2
Minimum drives per array	2	2	2	2	5
Maximum drives per array	5	5	8	6	20
Concurrent host channels	1	1	1	1, 2	1, 2
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
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 No No	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 5	10 5	10 5
DRIVES: Formatted capacity/drive(MB)	1259	2014	200-860	2100	2100
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 41.3 mm	3.5", 5.25"	3.5"	3.5"
Average positioning time (msec)	8.5 RD/10.1 WR	9.2 RD/10.7 WR	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	Drive dependent	Drive dependent	Drive dependent
Drive models	IBM 0662-S12	IBM 0664-MIH	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	19 x 12 x 20.25	19 x 12 x 22	10.56 x 7.50 x 11.8	8.75 x 19 x 22	29 x 13 x 30
POWER: Power backup	500 watts None	500 watts None	150 watts None	250 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	1/94	1/94	10/92	3/93	7/92
COMMENTS	Digi-Data controller	Digi-Data controller	ECCS controller	ECCS controller	AT&T controller

MANUFACTURER	ECCS	ECCS	EMC	EMC	EMC
ARRAY MODEL	Micro DFT-1E	Micro DFT-1	HX3 Harmonix	HX3C Harmonix	HX3HA Harmonix
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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	AT&T, H-P, Sun, RS/6000 NetWare	SCSI host UNIX, NetWare, VINES	AS/400	AS/400	AS/400
RAID level Configured by:	1/10 Preset	1/10 Preset	0/1	0/1	0/1
Array capacity (Gbytes) MIN MAX	.5 2.1	.5 2.1	1.7 6.8	3.4 6.8	3.4 6.8
Minimum drives per array	2	2	2	4	2
Maximum drives per array	2	2	8	8	8
Concurrent host channels	1, 2	1, 2	1	1	1
Array interface to host	SCSI-2	SCSI-2	IPI-3	IPI-3	IPI-3
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	None	None	16, 512	4, 512	4, 512
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 N/A N/A	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes			
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 5	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	500, 1000, 2100	500-2100	857	1714	1750
Nominal disk diameter, height	3.5"	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	10.5	10.5	10.5
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	5.56	5.56
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	5.75 x 9.25 x 13.08	3.25 x 5.75 x 8	5.25 x 17.5 x 28	5.25 x 17.5 x 28	5.25 x 17.5 x 28
POWER: Power backup	25 watts None	25 watts None	.26 KVA None	.26 KVA None	.26 KVA None
FIRST CUSTOMER SHIPMENT	2/94	6/93	12/92	6/93	6/93
COMMENTS	ECCS controller	ECCS controller	Remote diagnostics	Remote diagnostics	Remote diagnostics

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	HX3SC-2 Harmonix	HX3SC-4 Harmonix	HX5 Harmonix	4204 Symmetrix	4204-2S Symmetrix
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	AS/400	AS/400	AS/400	IBM mainframes	IBM mainframes
RAID level Configured by:	0/1	0/1	0/1	1 Preset	0/1
Array capacity (Gbytes) MIN MAX	1.94 6.79	7.87 13.77	3.4 6.8	4 8	 7.56
Minimum drives per array	2	4	2	4	4
Maximum drives per array	8	8	5	4	4
Concurrent host channels	1	1	1	4	4
Array interface to host	SCSI-2	SCSI-2	IPI-3	BMX	BMX
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI	SCSI
Cache size (min, max: MB)	4	4	4, 128	64, 1500	128, 1280
Cache function (Read, Write)	Read	Read	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	Yes Yes No	Yes Yes No
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto	Auto
ARRAY PERFORMANCE: Boot from array?					
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	3.0/4.5 Drive dependent	3.0/4.5 Drive dependent
DRIVES: Formatted capacity/drive(MB)	970	1980	1714	1000	1890
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm
Average positioning time (msec)	10.5	10.5	11.5	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56	5.56	5.56	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	6.75 x 17.5 x 28	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	.35 KVA None	Varies Battery	Varies Battery
FIRST CUSTOMER SHIPMENT	8/93	8/93	4/92	8/90	9/93
COMMENTS	Remote diagnostics	Remote diagnostics	Remote diagnostics	Remote diagnostics	Remote diagnostics

MANUFACTURER	EMC	EMC	EMC	EMC	EMC
ARRAY MODEL	4206-2S Symmetrix	4208-2S Symmetrix	4424 Symmetrix	4800 Symmetrix	5500 Symmetrix
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Mainframe	Mainframe
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	IBM mainframes	IBM mainframes	IBM mainframes	IBM mainframes	IBM mainframes All OS
RAID level Configured by:	0/1	0/1	1 Preset	1 Preset	1 Preset
Array capacity (Gbytes) MIN MAX	 11.34	 15.12	8 48	10 90	90 360
Minimum drives per array	6	8	8	8	48
Maximum drives per array	6	8	24	32	128
Concurrent host channels	4	4	8	8	32
Array interface to host	BMX	BMX	BMX	BMX/ESCON	BMX/ESCON
Drive interface	SCSI	SCSI	SCSI	SCSI	SCSI-2
Cache size (min, max: MB)	196, 1280	256, 1280	256	256, 3072	1024, 4096
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 No	Yes Yes No	Yes Yes No	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Auto-background
ARRAY PERFORMANCE: Boot from array?					
Transfer rate: host (MB/Sec) drive (MB/Sec)	3.0/4.5 Drive dependent	3.0/4.5 Drive dependent	3.0/4.5 Drive dependent	3.0/4.5 Drive dependent	3.0/4.5 Drive dependent
DRIVES: Formatted capacity/drive(MB)	1890	1890	1000, 1260	1260,1890,2830	1890, 2830
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm
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	31.4 x 11.56 x 33.31	31.4 x 11.56 x 33.31	67.9 x 24.1 x 33	67.9 x 24.1 x 33	74.9 x 68.7 x 36.4
POWER: Power backup	Varies Battery	Varies Battery	Varies Battery	Varies Battery	1.34-6.60 KVA Battery
FIRST CUSTOMER SHIPMENT	9/93	9/93	8/90	1Q92	1Q93
COMMENTS	Remote diagnostics	Remote diagnostics	Remote diagnostics	Remote diagnostics	Remote diagnostics UPS included. Version for Unisys avail.

MANUFACTURER	ENCORE COMPUTER	EUROLOGIC SYSTEMS LIMITED	EXSYS STORAGE SYSTEMS	EXSYS STORAGE SYSTEMS	FALCON SYSTEMS
ARRAY MODEL	Infinity	EL-RAID 300	RFCS-ISA-3105	RFCS-ISA-4340	FalconRAID(C)
DISK/TREND GROUP	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Encore, IBM UMAX-5	SCSI host UNIX, NetWare, other	DEC	DEC	RS6000, H-P, DEC, SGI, Sun UNIX, AIX
RAID level Configured by:	3/5 Host	0/3/5 Panel, Port	0/1/5 Host	0/1/5 Host	0/3/5 Host,Panel,Port
Array capacity (Gbytes) MIN MAX	6 32	Drive dependent Drive dependent	4 14	4 14	Drive dependent Drive dependent
Minimum drives per array	6	7	4 + parity	4 + parity	4
Maximum drives per array	16	28	4 + parity	4 + parity	28
Concurrent host channels	1, 15	1, 2, 3	1	1	1, 3
Array interface to host	VME-proprietary	SCSI-2*	DSSI	DSSI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64, 572	4, 32	Option	Option	8, 32
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Man,Auto-backgr	Manual-back,for	Manual-back,for	Auto,Man-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes*
Transfer rate: host (MB/Sec) drive (MB/Sec)	50 10	10 10	4 10	4 10	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	1050, 1986	Drive dependent	1050	2100	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	3.5", 5.25"
Average positioning time (msec)	Drive dependent	Drive dependent	10	11	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	5.6	Drive dependent
Drive models	Various	Various	DEC DSP3107L	DEC DSP3210	Various
ARRAY SIZE: Inches: H x W x D	5.25 x 19 x 15	40.9 x 23 x 26	10 x 21 x 24	10 x 21 x 24	48 x 12 x 30
POWER: Power backup	N/A Internal UPS	600 watts Cache battery	355 watts None	355 watts None	200 watts None
FIRST CUSTOMER SHIPMENT	5/93	1993	1Q93	1Q93	8/93
COMMENTS	Interphase 4220 controller	CMD controller Optional dual AC *Optional DSSI, CI	Digi-Data or CMD controller	Digi-Data or CMD controller	CMD controller. *Host dependent 25 mm h. drives avail. 1Q94. Many custom configurations.

MANUFACTURER	FALCON SYSTEMS	FORMATION	FORMATION	FORMATION	FORMATION
ARRAY MODEL	FalconRAID(D)	9937-120	9937-140	9937-225	9937-240
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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	RS6000, H-P, DEC, SGI, Sun UNIX, AIX	IBM AS/400	IBM AS/400	IBM AS/400	IBM AS/400
RAID level Configured by:	0/3/5 Port	5 Preset	5 Preset	5 Panel	5 Panel
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	2.9 5.8	5.9 11.8	2.9 6.69	5.9 13.77
Minimum drives per array	3	4	4	4	4
Maximum drives per array	5	7	7	8 + spare	8 + spare
Concurrent host channels	1	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)	--	4, 64	4, 64	4, 64	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	No Yes Yes	No Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto,Man-backgr	Option-backgrnd	Option-backgrnd	Option-backgrnd	Option-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes*				
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10 10	10 10	10/20 10	10/20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000	2000	1000	2000
Nominal disk diameter, height	3.5", 5.25"	3.5"	3.5"	3.5"	3.5"
Average positioning time (msec)	Drive dependent	8.8	9.5	8.8	9.5
Average rotational delay (msec)	Drive dependent	5.56	4.69	5.56	4.69
Drive models	Various				
ARRAY SIZE: Inches: H x W x D	48 x 12 x 30	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	200 watts None	250 watts	250 watts	250 watts	250 watts
FIRST CUSTOMER SHIPMENT	2/93	3/94	3/94	3/94	3/94
COMMENTS	Digi-Data contr *Host dependent 25 mm h. drives avail. 1Q94. Many custom configurations.	PCM IBM 9337	PCM IBM 9337	PCM IBM 9337 Up to 1 MB write cache	PCM IBM 9337 Up to 1 MB write cache

MANUFACTURER	FUJITSU	FUJITSU	FUJITSU	FUJITSU	FUTURE COMPUTERS
ARRAY MODEL	DynaRAID	F7956B1 Willow	F7956C1 Cottonwood	F6490A/B D1A	RAIDER-5
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Net/Mini/Multi
MARKET	PCM	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Any SCSI host UNIX, NetWare, DOS, Windows	Workstations UNIX	Workstations UNIX	VP2000 UNIX, proprietary	SCSI host Various
RAID level Configured by:	3 Port	3 Preset	3 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	4 73.5	2.0 4.1	2.0 8.2	15 120	
Minimum drives per array	5	6	11	10	5
Maximum drives per array	35	12	22	80	5
Concurrent host channels	2	2	2	2, 4, 8	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	IBM, prop.	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	IPI-2	SCSI-2
Cache size (min, max: MB)	4, 64	--	--	--	16, 64
Cache function (Read, Write)	Read, Write	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option-manual Yes Yes	No No No	No No No	Yes Yes Yes	No -- Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto	Auto	Auto	None
ARRAY PERFORMANCE: Boot from array?	Yes	No	No	No	
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 or 20 10	10 3	10 3	36 4.5	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	500	500	1890	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	8", 5.25"	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	12	12	12	Drive dependent
Average rotational delay (msec)	Drive dependent	6.8	6.8	6.9	Drive dependent
Drive models	Varies	M2628SC Picobird-4	M2628SC Picobird-4	M2671PA Swallow-7	Various
ARRAY SIZE: Inches: H x W x D	6.4 x 19 x 27	28 x 10 x 30	21 x 22 x 24	66 x 22 x 32	
POWER: Power backup	140 watts Battery	620 watts --	860 watts --	2.2 KVA --	
FIRST CUSTOMER SHIPMENT	1Q94	1Q93	2Q92	3Q90	
COMMENTS	Synchronized spindles				Baydel controller

MANUFACTURER	FWB	FWB	FWB	FWB	FWB
ARRAY MODEL	1060FMF Sledgehammer	2000FMF Sledgehammer	4000FT Sledgehammer	4100FMF Sledgehammer	4200FMF 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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac
RAID level Configured by:	0/1 Host	0/1 Host	0/1/5 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	1.06/.53	2/1	2/1/-- 5/2.5/4	4.1/2.05	4.2/2.1
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	5	2	2
Concurrent host channels	1	1		1	1
Array interface to host	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	2	5	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 No No	No Yes Yes	No No No	No No No
Spare drive (None/Auto/Manual)	None	None	Auto-background	None	None
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	10/20 10/20	10/20 10/20	10/20 10/20
DRIVES: Formatted capacity/drive(MB)	530	1000	1000	2050	2100
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 25.4 mm	3.5"	3.5"
Average positioning time (msec)	4.75	4.75	2	4.25	4.75
Average rotational delay (msec)	5.56	5.56	5.56	4.17	5.56
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75	7 x 19 x 21	4.5 x 9.5 x 9.75	4.5 x 9.5 x 9.75
POWER: Power backup	18 watts None	20 watts None	150 watts None	30 watts None	28 watts None
FIRST CUSTOMER SHIPMENT	1993	1992	1994	1993	1992
COMMENTS			Purchased controller		

MANUFACTURER	FWB	FWB	FWB	FWB	FWB
ARRAY MODEL	8000FMF Sledgehammer	8000FT Sledgehammer	16000FT Sledgehammer	RAID ToolKit	RAID ToolKit AUX
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	Software
Host platform, software environment	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac	Macintosh, Quadra, Power Mac
RAID level Configured by:	0/1 Host	0/1/5 Host	0/1/5 Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	8/4	4/2/-- 10/5/8	8/4/-- 20/10/16	Drive dependent	Drive dependent
Minimum drives per array	2	2	2	2	4
Maximum drives per array	2	5	5	2	2
Concurrent host channels	1			1	1
Array interface to host	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, NuBus	SCSI, PDS
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	5	5	Drive dependent	Drive dependent
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Drive dependent	Drive dependent
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-background	Auto-background	None	None
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/20 10/20	10/20 10/20	10/20 10/20	Drive dependent Drive dependent	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	4000	2000	4000	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	Drive dependent
Average positioning time (msec)	4.25	2	2	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	4.5 x 9.5 x 9.75	7 x 19 x 21	7 x 19 x 21	--	--
POWER: Power backup	32 watts None	150 watts None	150 watts None	-- None	-- None
FIRST CUSTOMER SHIPMENT	1994	1994	1994	1993	12/93
COMMENTS		Purchased controller	Purchased controller	Operates with FWB controllers	Operates with FWB controllers

MANUFACTURER	GAIN SYSTEMS	GENERAL MICROSYSTEMS	GIGATREND	HAMMERMAN ASSOCIATES	HAMMERMAN ASSOCIATES
ARRAY MODEL	Superserver	PD/A440	MasstoRaid	DATA-SAFE A	DATA-SAFE B
DISK/TREND GROUP	Net/Mini/Multi	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	IBM compatible NetWare, UNIX	Sun, Concurrent UNIX	SCSI host Various	PC compatible NetWare, DOS, UNIX	PC compatible NetWare, DOS, UNIX
RAID level Configured by:	0/1/5	3 Preset	0/1/5	0/1/3/5 Port	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	8.4 23.2	2 14.7/6.3/12.6	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	9	7	5	5
Maximum drives per array	20	9	21	5	5
Concurrent host channels	1	1	1	1	1
Array interface to host	EISA, SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	64	N/A	4, 64	8	--
Cache function (Read, Write)	Read, Write	N/A	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Yes	No No Option	No Yes Yes-per drive	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	No	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10/33 5/10	20 20	10 10	10 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1050-2900	Drive dependent	500-1200	500-1200
Nominal disk diameter, height	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
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 Barracuda,other	Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	32 x 22 x 10	7 x 17 x 22	20 x 12 x 14.5		
POWER: Power backup	750 watts None	650 watts None	325 watts None	None	None
FIRST CUSTOMER SHIPMENT	1993	1994	1993	1992	1992
COMMENTS	Mylex or Buslogic controller	Ciprico controller		Digi-Data controller	UltraStor controller

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD
ARRAY MODEL	C2258HA C2259HA	C2436HA C2436HZ	C2437HA C2437HZ	C2439HA C2439HZ	C2440HA C2440HZ
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
Host platform, software environment	H-P 3000	H-P-9000/800 H-P-9000/700 H-P-UX	H-P-9000/800 H-P-9000/700 H-P-UX	H-P-9000/800 H-P-9000/700 H-P-UX	H-P-9000/800 H-P-9000/700 H-P-UX
RAID level Configured by:	3	0/3/5 Preset	0/3/5 Preset	0/3/5 Preset	0/3/5 Preset
Array capacity (Gbytes) MIN MAX	4 8	3/2/2 21/14/14	6/4/4 42/28/28	5/4/4 35/28/28	10/8/8 70/56/56
Minimum drives per array	3	3	5	3	5
Maximum drives per array	5	5	5	5	5
Concurrent host channels	1	1	1	1	1
Array interface to host	HP-FL	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	.5, 1	.5, 1	.5, 1	.5, 1
Cache function (Read, Write)	Read	Read, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes No	No Yes No	No Yes No	No Yes No	No Yes No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?		Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 4.2	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	2003	1052	1052	2003	2003
Nominal disk diameter, height	5.25"	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm
Average positioning time (msec)	11.5	10.5	10.5	11.5	11.5
Average rotational delay (msec)	5.5	5.6	5.6	5.6	5.6
Drive models	H-P	H-P	H-P	H-P	H-P
ARRAY SIZE: Inches: H x W x D	10.5 x 16.7 x 26.1	10.1 x 18.2 x 26.5	10.5 x 16.7 x 21.6	10.5 x 16.7 x 21.6	10.5 x 16.7 x 21.6
POWER: Power backup	200 watts None	135** None	135** None	245** None	245** None
FIRST CUSTOMER SHIPMENT	2Q93	9/93	9/93	9/93	9/93
COMMENTS		*Fast, wide differential **Minimum configuration	*Fast, wide differential **Minimum configuration	*Fast, wide differential **Minimum configuration	*Fast, wide differential **Minimum configuration

MANUFACTURER	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HEWLETT-PACKARD	HI-DATA
ARRAY MODEL	C3609A-C3317A	C3609A-C3318A	C3609A-C3321A	NetServer LM	2000
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	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
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 NetWare, VINES, OS/2,DOS,SCO,NT	SCSI host
RAID level Configured by:	0/1/5/6 Host	0/1/5/6 Host	0/1/5/6 Host	0/1/5/6 Host	3/"35"/"53"
Array capacity (Gbytes) MIN MAX	3 10	6 20	10 20	2 8	Drive dependent Drive dependent
Minimum drives per array	3	3	5	2	5
Maximum drives per array	10	10	10	5	75
Concurrent host channels	1	1	1	8	1, 2
Array interface to host	EISA	EISA	EISA	EISA	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	4	4	4	.128, 4	5
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	Option Yes Option
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Manual-backgrnd	Auto-backgrnd*
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 3.1	10 3.7	10 5.1	33 10	20 10
DRIVES: Formatted capacity/drive(MB)	1000	2000	2000	510, 1050, 2000	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	10.7	10.7	8.9	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56	5.56	4.69	5.6	Drive dependent
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	19.3 x 13.7 x 18.1	7 x 19 x 17.7**
POWER: Power backup	24 watts None	24 watts None	24 watts None	654 watts None	25 watts+drives None
FIRST CUSTOMER SHIPMENT	1Q94	1Q94	1Q94	6/94	1992
COMMENTS					*Option **Controller module Rack mount package

MANUFACTURER	HI-DATA	HI-DATA	HI-DATA	HI-DATA	HIGH PERFORMANCE STORAGE
ARRAY MODEL	3000	SC-510	SC-520	SC-550	Wildcat II Tabletop
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Board	Board	Subsystem
Host platform, software environment	SCSI host	Various Various	Various Various	Various Various	SCSI host
RAID level Configured by:	3/"35"/"53"	3/"53"* Host	3/"53"* Host	3/"53"* Host	0/1/3/5* Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 10
Minimum drives per array	5	5	5	5	2
Maximum drives per array	75	35	75	75	5
Concurrent host channels	1, 2	1	1, 2	1, 2	1
Array interface to host	SCSI, SCSI-2	SCSI-2	SCSI-2	Fibre	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	5	2.5	5	10	N/A
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Yes Option	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto-backgrnd*	Auto-foreground	Auto-foreground	Auto-foreground	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 5	20 10	50 20	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	525-2100
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	Drive dependent	3.5", 41.3 mm
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	3.8 x 25.4 x 17.1**	Array size dependent	Array size dependent	Array size dependent	18 x 9.5 x 17
POWER: Power backup	25 watts+drives None	25 watts+drives Dual AC	25 watts+drives Dual AC	25 watts+drives Dual AC	0.2 KVA None
FIRST CUSTOMER SHIPMENT	1992	1990	3/92	3/93	2Q93
COMMENTS	*Option **Controller module Tabletop package	Tabletop or rack mount available. *RAID 53 is combined RAID 5 and RAID 3	Tabletop or rack mount available. *RAID 53 is combined RAID 5 and RAID 3	Tabletop or rack mount available. *RAID 53 is combined RAID 5 and RAID 3	*Also combined RAID 1/RAID 0

MANUFACTURER	HIGH PERFORMANCE STORAGE	HIGH PERFORMANCE STORAGE	HITACHI	HITACHI	HITACHI
ARRAY MODEL	Wildcat II Deskside	Wildcat III Deskside	A-6511-17	A-6511-34	DF-100-2 DF-100-4
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	OEM, PCM	Captive	Captive	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host	SCSI host	Hitachi	Hitachi	SCSI host Various
RAID level Configured by:	0/1/3/5* Port	0/1/3/5*	3/4/5 Port	3/4/5 Port	3/4/5 Port
Array capacity (Gbytes) MIN MAX	1 21	2 42	17.2	34.4	2.2 8.6
Minimum drives per array	5	5	8	16	5
Maximum drives per array	12	12	8	16	20
Concurrent host channels	1	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)	N/A	16,256 (option)	--	--	--
Cache function (Read, Write)	N/A	Read, Write	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-back,for
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 10	4.8 10	4.8 10	10-20 4.87
DRIVES: Formatted capacity/drive(MB)	525-2100	1000-4200	2870	2870	540
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	12.8	12.8	11.8
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	5.6	6.7
Drive models	Various	Various	DK517C-37	DK517C-37	DK315C-14
ARRAY SIZE: Inches: H x W x D	29 x 14 x 30	29 x 14 x 30	27.6 x 22.4 x 31.5	27.6 x 22.4 x 31.5	23.6 x 9.8 x 23.6
POWER: Power backup	0.4 KVA None	0.4 KVA Battery	1.7 KVA None	1.3 KVA None	.660 KVA None
FIRST CUSTOMER SHIPMENT	2Q93	2Q94	1993	1993	8/93
COMMENTS	*Also combined RAID 1/RAID 0	*Also combined RAID 1/RAID 0	Sold only in Japan	Sold only in Japan	Sold only in Japan

MANUFACTURER	HITACHI	HITACHI	HITACHI	HITACHI	HITACHI
ARRAY MODEL	HitRAID-11 DF100-11	HitRAID-12 DF100-12	HitRAID-17 DF100-17	HitRAID-34 DF100-34	HitRAID-5 DF100-5
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
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	3/4/5 Port	3/4/5 Port	3/4/5 Port	3/4/5 Port	3/4/5 Port
Array capacity (Gbytes) MIN MAX	11.2 11.2	11.4 11.4	17.2 17.2	34.4 68.8	5.6 5.6
Minimum drives per array	10	5	8	16	5
Maximum drives per array	20	10	32	32	20
Concurrent host channels	1	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)	--	--	--	--	--
Cache function (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 No No
Spare drive (None/Auto/Manual)	Manual-back,for	Manual-back,for	Manual-back,for	Manual-back,for	Manual-back,for
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10-20 4.87	10-20 4.87	10-20 4.87	10-20 4.87	10-20 4.87
DRIVES: Formatted capacity/drive(MB)	1400	2870	2870	2870	1400
Nominal disk diameter, height	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm
Average positioning time (msec)	11.8	12.8	12.8	12.8	11.8
Average rotational delay (msec)	6.7	5.6	5.6	5.6	6.7
Drive models	DK315C-14	DK517C-37	DK517C-37	DK517C-37	DK315C-14
ARRAY SIZE: Inches: H x W x D	23.6 x 9.8 x 23.6	23.6 x 9.8 x 23.6	27.6 x 22.4 x 31.5	27.6 x 22.4 x 31.5	23.6 x 9.8 x 23.6
POWER: Power backup	.660 KVA None	.660 KVA None	.990 KVA None	1.430 KVA None	.660 KVA None
FIRST CUSTOMER SHIPMENT	4Q93	4Q93	4Q93	4Q93	4Q93
COMMENTS		*DC-DC converter per drive	*DC-DC converter per drive	*DC-DC converter per drive	

MANUFACTURER	HITACHI DATA SYSTEMS	IBM	IBM	IBM	IBM
ARRAY MODEL	7600 Disk Storage Subsystem	3514-001 3514-101	3514-004 3514-104	3514-008 3514-108	7051-840 Power Network Dataserver
DISK/TREND GROUP	Mainframe	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	Captive	Captive,OEM,PCM	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	HDS/IBM mainframe	PS/2, RS/6000 NetWare, OS/2	PS/2, RS/6000 NetWare, OS/2	PS/2, RS/6000 NetWare, OS/2	RS/6000 AIX, NFS
RAID level Configured by:	1 Host	5 Preset	5 Preset	5 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	11.35 (7693) 272.4 (7699)	.769 2.79	1.97 6.9	3.935 13.774	10/5 48/24
Minimum drives per array	4	3	3	3	10
Maximum drives per array	32	8	8	8	40
Concurrent host channels	4/8	1	1	1	1, 3
Array interface to host	IBM	SCSI-2	SCSI-2	SCSI-2	Proprietary
Drive interface	Proprietary	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	128, 1024	4 RD/1 WR	4 RD/1 WR	4 RD/1 WR	16, 384
Cache function (Read, Write)	R,W,Fast Write	Read, Write	Read, Write	Read, Write	Read, Option.W
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No No Yes	No No Yes	No No Yes	No Yes Yes
Spare drive (None/Auto/Manual)	None	Manual	Manual	Manual-backgrnd	Option
ARRAY PERFORMANCE: Boot from array?	--	RS/6000 only	RS/6000 only	RS/6000 only	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5/6/10/17 4200/3900	10 2	10 10	10 10	55 10
DRIVES: Formatted capacity/drive(MB)	2838, 10017	398	986	1967	2000, 2400
Nominal disk diameter, height	6.5"	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5" (2/module)
Average positioning time (msec)	13.5/16.5	11.5	9.4 RD/11.4 WR	9.4 RD/11.4 WR	11, 9.8
Average rotational delay (msec)	7.1/15.2	6.95	6.95	5.6	6.95
Drive models	7693 (2838 MB) 7699 (10017 MB)	Turbo	Corsair-2E	Allicat	Corsair-1 Corsair-2
ARRAY SIZE: Inches: H x W x D	70.5 x 36.4 x 31.5	24 x 13.5 x 31.5	24 x 13.5 x 31.5	24 x 13.5 x 31.5	76.8 x 24 x 38.8
POWER: Power backup	 Dual AC	.660 KVA None	.660 KVA None	.37 KVA None	1.82 KVA None
FIRST CUSTOMER SHIPMENT	6/93	11/92	11/92	4/93	3/93
COMMENTS		PS/2 RS/6000 support starting 4/94. -101 is rack mount version.	PS/2 RS/6000 support starting 4/94. -104 is rack mount version.	PS/2 RS/6000 support starting 4/94. -108 is rack mount version.	RS/6000 server incorporates RS/6000 340R Auspex controller

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	7051-800 Power Network Dataserver	7135-010 7135-110 MultiRAID**	9336-020	9337-110	9337-115
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
Host platform, software environment	RS/6000 AIX, NFS	RS/6000 AIX 6000 Other SCSI**	AS/400	AS/400 9405	AS/400 9406
RAID level Configured by:	0/1 Host	0/1/3/5 Host	0/1 Preset	5	5
Array capacity (Gbytes) MIN MAX	10/5 96/48	4/2/8/8* 60/30/48/48	3.4	1.620 3.250	1.62 3.25
Minimum drives per array	10	2	2	4	4
Maximum drives per array	80	30	4	7	7
Concurrent host channels	1, 3	1, 2	1	1	1
Array interface to host	Proprietary	SCSI-2	IPI-3	IBM 6500 IOP	IBM 6500 IOP
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	Variable*	2	2
Cache function (Read, Write)	Read	--	Read	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	Yes (option) Yes Yes	No No Yes	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Option	Manual-backgrnd	None	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	55 10	20 10	 10	10 5	10 5
DRIVES: Formatted capacity/drive(MB)	2000, 4000	1300, 2000	1000	542	542
Nominal disk diameter, height	3.5" (2/module)	3.5", 41.3 mm	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 25.4 mm
Average positioning time (msec)	11, 9.8	7.8/9.5	8.9	6.7	6.7
Average rotational delay (msec)	6.95, 5.6	5.56	5.6	5.6	5.6
Drive models	Corsair-1, Allicat-S20	Allicat	Spitfire	Spitfire	Spitfire
ARRAY SIZE: Inches: H x W x D	76.8 x 24 x 38.8	10.5 x 17.4 x 26.2		8.75 x 19 x 28.2	8.75 x 19 x 28.2
POWER: Power backup	2.4 KVA None	660 watts None	-- None	.660 KVA None	.660 KVA None
FIRST CUSTOMER SHIPMENT	3/93	3Q93	9/90	4Q92	9/93
COMMENTS	Expansion unit for 7051-840	For RS/6000 *With 2 GB drives	Array software required *Unused buffer space usable as cache	AS/400 Read ahead cache	AS/400 Read ahead cache

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9337-120	9337-125	9337-140	9337-210	9337-215
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
Host platform, software environment	AS/400 9405	AS/400 9406	AS/400 9406	AS/400 9406	AS/400 9406
RAID level Configured by:	5	5	5	5	5
Array capacity (Gbytes) MIN MAX	2.910 5.820	2.91 5.82	5.901 11.802	1.62 3.79	1.62 3.79
Minimum drives per array	4	4	4	4	4
Maximum drives per array	7	7	7	8	8
Concurrent host channels	1	1	1	1	1
Array interface to host	IBM 6500 IOP	IBM 6500 IOP	IBM 6500 IOP	IBM 6501 IOP	IBM 6501 IOP
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	2	2	2	2+1 MB NV Write	2+1 MB NV Write
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 Yes	No No Yes	No No Yes	No No Yes	No No Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 5	10 5	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	1000	970	1967	542	542
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 41.3 mm	3.5", 25.4 mm	3.5", 25.4 mm
Average positioning time (msec)	8.9	8.9	9.2 RD/10.7 WR	6.7	6.7
Average rotational delay (msec)	5.6	5.6	5.6	5.6	5.6
Drive models	Spitfire	Spitfire	Allicat	Spitfire	Spitfire
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: Power backup	.660 KVA None	.660 KVA None	.660 KVA None	.660 KVA None	.660 KVA None
FIRST CUSTOMER SHIPMENT	4Q92	9/93	1993	11/93	11/93
COMMENTS	AS/400 Read ahead cache	AS/400 Read ahead cache	AS/400 Read ahead cache	AS/400 Read ahead cache	AS/400 Read ahead cache

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9337-220	9337-225	9337-240	Disk Array/2	Oasas I V2.0
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
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Software	Software
Host platform, software environment	AS/400 9406	AS/400 9406	AS/400 9406	PS/2 195, PS/2 295	PS/2 OS/2 2.0
RAID level Configured by:	5	5	5	5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	2.91 6.79	2.91 6.79	5.90 13.76	Host dependent Host dependent	Drive dependent Drive dependent
Minimum drives per array	4	4	4	2	3
Maximum drives per array	8	8	8	16	8
Concurrent host channels	1	1	1	1	--
Array interface to host	IBM 6501 IOP	IBM 6501 IOP	IBM 6501 IOP		SCSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	2+1 MB NV Write	2+1 MB NV Write	2+1 MB NV Write	--	--
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 Yes	No No Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	--
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	Host dependent Drive dependent	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	1000	970	1967	Drive dependent	100-1000
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 41.3 mm	Drive dependent	3.5"
Average positioning time (msec)	8.9	8.9	9.2 RD/10.7 WR	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	5.6	Drive dependent	Drive dependent
Drive models	Spitfire	Spitfire	Allicat	Various	Various
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	--	--
POWER: Power backup	.660 KVA None	.660 KVA None	.660 KVA None	-- None	--
FIRST CUSTOMER SHIPMENT	11/93	11/93	11/93		2/93
COMMENTS	AS/400 Read ahead cache	AS/400 Read ahead cache	AS/400 Read ahead cache		PS/2 Integra software

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	PS/2 195	PS/2 95-466	PS/2 95-560	PS/2 95-566	PS/2 Server 295
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	PCM	PCM	PCM	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	PS/2 195 OS/2, NetWare, NT	PS/2 Server 95 DOS, OS/2, NT	PS/2 Server 95 DOS, OS/2, NT	PS/2 Server 95 DOS, OS/2, NT	PS/2 Server 295 OS/2, NetWare
RAID level Configured by:	5 Host	5 Host	5 Host	5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	 28	Drive dependent Drive dependent	1.08 2.16	2 4	.8/.4/.6 16/8/12.8
Minimum drives per array	2	3	3	3	2
Maximum drives per array	16	5	5	5	16
Concurrent host channels	1	1	1	1	1, 4
Array interface to host	MCA	SCSI-2	SCSI-2	SCSI-2	Parallan
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	4	4	4	--
Cache function (Read, Write)	--	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No Option			No No Yes	Yes No Option
Spare drive (None/Auto/Manual)	Auto-background	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	40 10	10 10	10 10	10 10	10 2, 5
DRIVES: Formatted capacity/drive(MB)	400, 1000	540, 1000	540	1000	400, 1000
Nominal disk diameter, height	3.5"	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 25.4 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	6.7	8.9	11.5, 9.4
Average rotational delay (msec)	Drive dependent	Drive dependent	5.6	5.6	6.95, 6.95
Drive models	Spitfire, Turbo	Spitfire	Spitfire	Spitfire	Turbo, Corsair-1
ARRAY SIZE: Inches: H x W x D					26.9 x 23 x 13.3
POWER: Power backup	None	None	None	None	None
FIRST CUSTOMER SHIPMENT	1993	4Q93	4Q93	4Q93	10/92
COMMENTS	Parallan controller	Mylex controller	Mylex controller	Mylex controller	PS/2 Can span mult. SCSI channels. Support external UPS. Parallan contr.

MANUFACTURER	IBM	IBM	IBM	IBM	IBM
ARRAY MODEL	9570-020	9570-040	9570-120	9570-140	9570-1xx (5.25)
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
Host platform, software environment	ES/9000,ES/3090 RS/6000	ES/9000,ES/3090 RS/6000	ES/9000,ES/3090 RS/6000	ES/9000,ES/3090 RS/6000	RS/6000,ES/9000 MVS (ES/9000), AIX
RAID level Configured by:	0/1/3/5 Port, Host	0/1/3/5 Port, Host	0/1/3/5 Port, Host	0/1/3/5 Port, Host	3 Port, Host
Array capacity (Gbytes) MIN MAX	12.9 25.8	29 58.1	12.9 25.8	29 58.1	10.5 168
Minimum drives per array	10	20	10	20	5 (4 + parity)
Maximum drives per array	20	40	20	40	160
Concurrent host channels	--	--	1	1	1
Array interface to host	HIPPI (IPI-3)	HIPPI (IPI-3)	HIPPI (IPI-3)	HIPPI (IPI-3)	HIPPI (IPI-3)
Drive interface	IPI-2	IPI-2	IPI-2	IPI-2	IPI-2
Cache size (min, max: MB)	10, 20	10, 20	10, 20	10, 20	10, 20
Cache function (Read, Write)	Read	Read	Read	Read	Read
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-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	--	--	Yes	--	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	-- --	-- --	30 --	60 --	27.5-55 4.4
DRIVES: Formatted capacity/drive(MB)	1700	1700	1700	1700	1500
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	5.25"
Average positioning time (msec)	9.4 RD/11.4 WR	9.4 RD/11.4 WR	9.4 RD/11.4 WR	9.4 RD/11.4 WR	12
Average rotational delay (msec)	5.6	5.6	5.6	5.6	5.58
Drive models	Allicat P10	Allicat P10	Allicat P10	Allicat P10	9345
ARRAY SIZE: Inches: H x W x D	62 x 29.5 x 38.5	62 x 29.5 x 38.5	62 x 29.5 x 38.5	62 x 29.5 x 38.5	29.5 x 38.5 x 62
POWER: Power backup	.85 KVA	1.4 KVA	1.75 KVA	2.95 KVA	3.4 KVA None
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	2Q93	2Q93	11/91
COMMENTS	Maximum Strategy controller Expansion rack	Maximum Strategy controller Expansion unit	Maximum Strategy controller	Maximum Strategy controller	Maximum Strategy controller

MANUFACTURER	IBM	IBM	IBM	IBM	ICL
ARRAY MODEL	9570-220	9570-240	9570-2xx (3.5)	9570-2xx (5.25)	DiskMANAGER
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Net/Mini/Multi
MARKET	Captive	Captive	Captive	Captive	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	ES/9000,ES/3090 RS/6000	ES/9000,ES/3090 RS/6000	RS/6000,ES/9000 MVS (ES/9000), AIX	RS/6000,ES/9000 MVS (ES/9000), AIX	ICL UNIX SVR4.2
RAID level Configured by:	0/1/3/5 Port, Host	0/1/3/5 Port, Host	0/1/3/5 Port, Host	3 Port, Host	0/1
Array capacity (Gbytes) MIN MAX	12.9 25.8	29 58.1	13.5 220	10.5 168	Drive dependent Drive dependent
Minimum drives per array	10	20	10	5 (4 + parity)	2
Maximum drives per array	20	40	160	160	112
Concurrent host channels	2	2	1	2	1
Array interface to host	HIPPI (IPI-3)	HIPPI (IPI-3)	HIPPI (IPI-3)	HIPPI (IPI-3)	SCSI-2
Drive interface	IPI-2	IPI-2	IPI-2	IPI-2	SCSI-2
Cache size (min, max: MB)	10, 20	10, 20	10, 20	10, 20	--
Cache function (Read, Write)	Read	Read	Read	Read	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	--	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	30 --	60 --	27.5-55 5	27.5-55 4.4	10 10
DRIVES: Formatted capacity/drive(MB)	1700	1700	1700	1500	525-1000
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	5.25"	3.5", 41.3 mm
Average positioning time (msec)	9.4 RD/11.4 WR	9.4 RD/11.4 WR	9.4 RD/11 WR	12	8-11
Average rotational delay (msec)	5.6	5.6	5.6	5.58	5.56
Drive models	Allicat P10	Allicat P10	Allicat P10	9345	Various
ARRAY SIZE: Inches: H x W x D	62 x 29.5 x 38.5	62 x 29.5 x 38.5	29.5 x 38.5 x 62	29.5 x 38.5 x 62	
POWER: Power backup	1.75 KVA	2.95 KVA	2.95-1.4 KVA None	3.4 KVA None	 None
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	3/93	11/91	1993
COMMENTS	Maximum Strategy controller	Maximum Strategy controller	Maximum Strategy controller	Maximum Strategy controller	Software array

MANUFACTURER	ICL	ICL	INFORMATION MANAGEMENT TECHNOLOGIES	INFORMATION MANAGEMENT TECHNOLOGIES	INFORTREND
ARRAY MODEL	PowerARRAY	PowerARRAY PLUS	HiPerRaid5	HiPerRaid5 EX	IS-1000
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	Subsystem	Subsystem	Subsystem	Subsystem	Board
Host platform, software environment	ICL SCO UNIX, OS/2, NetWare	ICL UNIX NetWare	Wang VS	SCSI host Various UNIX	PC compatible DOS, OS/2, NetWare, NT
RAID level Configured by:	0/1/5	"53"	1/3/5 Host	1/3/5 Host	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	.25 1.4	.25 4	Drive dependent Drive dependent
Minimum drives per array	2	15	5	5	2
Maximum drives per array	14	30	9	9	21
Concurrent host channels	1	2	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	8	4	--	--	4, 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	Yes Yes Yes	No No Yes	No Yes Yes	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	33 10
DRIVES: Formatted capacity/drive(MB)	525-1000	1000-2000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	2.5"	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	8-11	8-11	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56	5.56	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Conner, DEC, Micropolis	Various
ARRAY SIZE: Inches: H x W x D		37 x 18 x 37	3.25 x 5 x 8	3.25 x 5 x 8	.625 x 5 x 13.375
POWER: Power backup	 UPS option	 UPS option	-- None	-- None	20 watts None
FIRST CUSTOMER SHIPMENT	1993	2Q94	1994	10/93	1993
COMMENTS			Allodyne controller Preliminary specification	Digi-Data controller	

MANUFACTURER	INTEGRA TECHNOLOGIES	INTEGRA TECHNOLOGIES	INTEGRA TECHNOLOGIES	INTEGRA TECHNOLOGIES	INVINCIBLE TECHNOLOGIES
ARRAY MODEL	OASAS 1	OASAS 1 V2	OASAS 1 V3	OASAS 1 V4	Ultimate 1
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type	Software	Software	Software	Software	Subsystem
Host platform, software environment	PC compatible SCO UNIX	PC compatible OS/2	PC compatible NetWare 3.11/3.12	PC compatible NetWare 3.11/3.12/4.X	Sun, H-P, DEC, RS/6000
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	1 Preset
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 12
Minimum drives per array	2	2	2	2	2
Maximum drives per array	56	56	56	56	12
Concurrent host channels	1	1	1	1	1,2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2, DSSI
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	--	--	*
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	-- -- --	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto-backgrnd.*	Auto-backgrnd.*	Auto-backgrnd.*	Auto-backgrnd.*	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	1000, 2000
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	Drive dependent	3.5", 41.3 mm
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, DEC
ARRAY SIZE: Inches: H x W x D	-- --	-- --	-- --	-- --	10 x 19 x 27
POWER: Power backup					400 watts None
FIRST CUSTOMER SHIPMENT	9/92	11/92	6/92	11/93	6/93
COMMENTS	*Pools spare drives between multiple software arrays	*Pools spare drives between multiple software arrays	*Pools spare drives between multiple software arrays	*Pools spare drives between multiple software arrays	Rack mount Tower avail. *Cache avail. in 1H 1994.

MANUFACTURER	INVINCIBLE TECHNOLOGIES	IPL	IPL	IPL	IPL
ARRAY MODEL	Ultimate 5	7037-20	7037-40	7737-20	7737-40
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
Host platform, software environment	DEC	AS/400	AS/400	AS/400	AS/400
RAID level Configured by:	0/1/3/5 Host, Panel	0/5	0/5	0/5	0/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	1.940 7.760	2 15.7	1.940 7.760	7.8 15.7
Minimum drives per array	5	2	2	2	2
Maximum drives per array	20	8	8	8	8
Concurrent host channels	1,2	1	1	1	1
Array interface to host	SCSI-2, DSSI	SCSI	IBM 6500/6501	IBM 6500/6501	SCSI
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, Write	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	No No Yes	No No Yes	No No No	No No No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto	Auto-background	Auto	Auto
ARRAY PERFORMANCE: Boot from array?	No	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	970	1967	970	1967
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	9.8	9.7	9.8	9.7
Average rotational delay (msec)	Drive dependent	6.95	5.5	6.95	5.5
Drive models	Various	IBM, H-P	DEC	IBM, H-P	DEC
ARRAY SIZE: Inches: H x W x D	25 x 14 x 27.5	6.6 x 19 x 28.3	6.6 x 19 x 28.3	5 x 19 x 26.5	5 x 19 x 26.5
POWER: Power backup	590 watts None	.24 KVA	.24 KVA	.20 KVA	.20 KVA
FIRST CUSTOMER SHIPMENT	1994	4/93	12/93	4/93	12/93
COMMENTS	DG CLARiiON modified to use redundant controllers in DEC interface	Compatible with IBM 9337	Compatible with IBM 9337	Compatible with IBM 9337	Compatible with IBM 9336

MANUFACTURER	JABA SYSTEM	LAURA TECHNOLOGIES	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS
ARRAY MODEL	Alpha 150NT	PowerCache SC	SL	XE	HFD
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	Subsystem	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	Alpha 150NT Windows NT, Open VMS, OSE/1	PC compatible UNIX, DOS, OS/2 NetWare	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX
RAID level Configured by:	0/1/5	1 Host	0/1/3/5	0/1/3/5	0/1/3/5
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	.5 14.7	.5 23.1	.5 14.7
Minimum drives per array	5	2	2	2	2
Maximum drives per array	5	6	8	12	8
Concurrent host channels	1	1	4	4	4
Array interface to host	SCSI-2	ISA	ISA, EISA, MCA	ISA, EISA, MCA	ISA, EISA, MCA
Drive interface	SCSI-2	SCSI	SCSI,SCSI-2	SCSI,SCSI-2	SCSI,SCSI-2
Cache size (min, max: MB)	--	.512, 16	0, 64	0, 64	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	Duplexing No No	Yes (option) Yes Yes (option)	Yes (option) Yes Yes (option)	Yes (option) Yes Yes (option)
Spare drive (None/Auto/Manual)	Manual-backgrnd	None	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes			
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	1 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	500-2100	500-2100	500-2100
Nominal disk diameter, height	3.5", 41.3 mm	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	25.75 x 9.5 x 19	--	17.5 x 7.75 x 18.5	27.5 x 9 x 21.75	17.5 x 7.75 x 18.5
POWER: Power backup	250 watts None	-- --	250-750 watts	250-750 watts	250-750 watts
FIRST CUSTOMER SHIPMENT	1993	2Q93	6/92	1991	1991
COMMENTS	Consensys controller	*User configurable cache	Optical & tape drive options. Software-based subsystem. RAID-5 optional	Optical & tape drive options. Software-based subsystem. RAID-5 optional	Optical & tape drive options. Software-based subsystem. RAID-5 optional

MANUFACTURER	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS	LEGACY STORAGE SYSTEMS	LION	LION
ARRAY MODEL	HFD/XE	SmartArray	Smart Array/XE	RD35	RD351
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	Board	Board
Host platform, software environment	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX	Misc. networks NetWare, NT, OS/2, UNIX	Various	Various
RAID level Configured by:	0/1/3/5	0/1/3/5	0/1/3/5	0/3/5 Port	0/3/5 Port
Array capacity (Gbytes) MIN MAX	.5 23.1	.5 16.8	.5 16.8	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	12	9	13	21	6
Concurrent host channels	4	1, 4	1, 6	1	1
Array interface to host	ISA, EISA, MCA	EISA, ISA, MCA	EISA, ISA, MCA	SCSI-2	SCSI-2
Drive interface	SCSI,SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 64	0, 64	0, 64	4, 128	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 (option) Yes Yes (option)	Yes (option) Yes Yes (option)	Yes (option) Yes Yes (option)	No Yes-per drive Yes-per drive	No Yes* Yes*
Spare drive (None/Auto/Manual)	Auto-background	Auto-option	Auto-option	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?		Option	Option	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	33 10	33 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	500-2100	.5-2.1	.5-2.1	Drive dependent	Drive dependent
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm
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	27.5 x 9 x 21.75	21.4 x 8.4 x 20.6	27.5 x 8.4 x 20.6	15 x 18 x 20	9.4 x 17 x 2 x 17.8
POWER: Power backup	250-750 watts	250-750 watts	250-750 watts	120watts+drives None	120watts+drives None
FIRST CUSTOMER SHIPMENT	1991	8/93	12/93	1Q93	1Q94
COMMENTS	Optical & tape drive options. Software-based subsystem. RAID-5 optional	Optical & tape drive options. Software-based subsystem. RAID-3/5 option	RAID-3/5 optional	With modified Digi-Data controller	Digi-Data controller *Cannot be hot swapped

MANUFACTURER	LOMAS DATA PRODUCTS	LOMAS DATA PRODUCTS	MACRO COMPUTER PRODUCTS	MARNER INTERNATIONAL	MARNER INTERNATIONAL
ARRAY MODEL	LDP CACHE IIP	LDP CACHE IV	Macro-RAID 7	DSV100	DSV101
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Mainframe	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	PCM	PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	ISA, EISA NetWare, UNIX, DOS, OS/2	PC compatible NetWare, UNIX, DOS, OS/2	Unisys A, V Other SCSI UNIX	Sun Solaris 2.X	Sun Solaris 2.X
RAID level Configured by:	0/1	1 Preset	"7" Preset	0/3/5 Host	0/3/5 Host
Array capacity (Gbytes) MIN MAX	.1 16	Drive dependent Drive dependent	Drive dependent Drive dependent	4.8 8.4	7.2 12.6
Minimum drives per array	2	2	3	4 + parity	6 + parity
Maximum drives per array	4	2	48	4 + parity	6 + parity
Concurrent host channels	1	1	1, 12	1	1
Array interface to host	ISA	ISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 16	2, 16	4, 256	--	32
Cache function (Read, Write)	Read, Write	Read, Write	Read,Write(opt)	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No -- --	No -- --	Option Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-foregrnd	Manual-foregrnd	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent 5	6 5	10/20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	1000-2000	Drive dependent	Drive dependent
Nominal disk diameter, height	Drive dependent	Drive dependent	3.5", 5.25"	3.5", 41.3 mm	3.5", 41.3 mm
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	Quantum PD1225S Seagat.ST12400N	Quantum PD1225S Seagat.ST12400N
ARRAY SIZE: Inches: H x W x D	4.7 x 13.4	4.7 x 13.4	Varies with configuration	24 x 20 x 22	24 x 20 x 22
POWER: Power backup	8 watts None	9 watts None	1.3 KVA None	400 watts None	1100 watts None
FIRST CUSTOMER SHIPMENT	1989	4Q93	3Q91	2Q93	2Q93
COMMENTS			Storage Computer controller. Nonvolatile memory option available 2Q	Server compatible with SPARCstation 10	Server compatible with SPARCstation 10

MANUFACTURER	MARNER INTERNATIONAL	MARNER INTERNATIONAL	MARNER INTERNATIONAL	MARNER INTERNATIONAL	MARNER INTERNATIONAL
ARRAY MODEL	DSV102	DSV201	DSV202	DSV50	DSV52
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
Host platform, software environment	Sun Solaris 2.X	Marner Sun, UNIX, NetWare,Solaris	Marner Sun, UNIX, NetWare,Solaris	Marner Sun, UNIX, NetWare,Solaris	Marner Sun, UNIX, NetWare,Solaris
RAID level Configured by:	0/3/5 Host	0/3/5 Panel, Port	0/3/5 Panel, Port	0/3/5 Panel, Port	0/3/5 Panel, Port
Array capacity (Gbytes) MIN MAX	14.4 25.2	7.2 25.2	28.8 50.4	4.8 8.4	7.2 12.6
Minimum drives per array	12 + 2 parity	6 + parity	12 + 2 parity	4 + parity	6 + parity
Maximum drives per array	12 + 2 parity	12 + parity	24 + 2 parity	4 + parity	6 + parity
Concurrent host channels	2	1 (3 max.)	2 (6 max.)	1 (3 max.)	1 (3 max.)
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)	64	32	32	8, 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 Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	No	No	No	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 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, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
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 PD1225S Seagat.ST12400N	Seagate ST12400N, oth.	Seagate ST12400N, oth.	Seagate ST12400N, oth.	Seagate ST12400N, oth.
ARRAY SIZE: Inches: H x W x D	24 x 20 x 22	28 x 17x 21	28 x 17x 21	20 x 7 x 20	20 x 7 x 20
POWER: Power backup	1100 watts None	1000 watts None	1000 watts None	300 watts None	300 watts None
FIRST CUSTOMER SHIPMENT	2Q93	3Q93	3Q93	2Q93	2Q93
COMMENTS	Server compatible with SPARCstation 10				

MANUFACTURER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER	MASPAR COMPUTER
ARRAY MODEL	DA-4004A	DA-4008A	DA-4016A	DA-4108A	DA-4116A
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
Host platform, software environment	Maspar UNIX	Maspar UNIX	Maspar UNIX	Maspar UNIX	Maspar UNIX
RAID level Configured by:	3 Preset	3 Preset	3 Preset	3 Preset	3 Preset
Array capacity (Gbytes) MIN MAX	5.5 5.5	 11	 22	11 11	22 22
Minimum drives per array	4 + parity	8 + parity	16 + parity	8 + parity	16 + 2 parity
Maximum drives per array	4 + parity	8 + parity	16 + parity	8 + parity	16 + 2 parity
Concurrent host channels	1	1	1	1	1
Array interface to host	VME	VME	VME	Proprietary	Proprietary
Drive interface	ESDI	ESDI	ESDI	ESDI	ESDI
Cache size (min, max: MB)	2	4	4	4	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	No No No
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	No	No	No	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 9.8	16 18	16 18	16 18	16 18
DRIVES: Formatted capacity/drive(MB)	1321	1321	1321	1321	1321
Nominal disk diameter, height	5.25"	5.25"	5.25"	5.25"	5.25"
Average positioning time (msec)	14	14	14	14	14
Average rotational delay (msec)	8.3	8.3	8.3	8.3	8.3
Drive models	Hitachi DK516-15	Hitachi DK516-15	Hitachi DK516-15	Hitachi DK516-15	Hitachi DK516-15
ARRAY SIZE: Inches: H x W x D	57.75 x 23 x 32.5	57.75 x 23 x 32.5	57.75 x 23 x 32.5	57.75 x 23 x 32.5	57.75 x 23 x 32.5
POWER: Power backup	2000 watts None	2000 watts None	4000 watts None	2000 watts None	4000 watts None
FIRST CUSTOMER SHIPMENT	12/90	1992	1992	12/90	12/90
COMMENTS	Optional hot standby disk			Optional hot standby disk	Optional hot standby disk

MANUFACTURER	MASPAR COMPUTER	MASPAR COMPUTER	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY
ARRAY MODEL	DA-4124A	DA-4216A	Gen 4L	Gen 4XL	HIPPI-S2
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	Captive	Captive	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Maspar UNIX	Maspar UNIX	IPI-3 compatible	IPI-3 compatible	Various
RAID level Configured by:	3 Preset	3 Preset	0/1/3/5 Host	0/1/3/5 Config. by host	3 Preset
Array capacity (Gbytes) MIN MAX	33 33	22 22	9.5 29.8	12 59	43 345
Minimum drives per array	24 + 3 parity	16 + 2 parity	8	10	40
Maximum drives per array	24 + 3 parity	16 + 2 parity	16	40	320
Concurrent host channels	1	2	1	2	1, 2
Array interface to host	Proprietary	Proprietary	HIPPI	HIPPI	HIPPI
Drive interface	ESDI	ESDI	IPI-2	IPI-2	ESDI
Cache size (min, max: MB)	4	8	N/A	N/A	N/A
Cache function (Read, Write)	Read, Write	Read, Write	N/A	N/A	N/A
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-background	Auto-background	Auto-background	Auto-background	Auto
ARRAY PERFORMANCE: Boot from array?	No	No	No	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	16 18	32 36	55 4 or 8	90 5.52	72-144 2.75
DRIVES: Formatted capacity/drive(MB)	1321	1321	1000	1520	1350
Nominal disk diameter, height	5.25"	5.25"	3.5", 41.3 mm	5.25", 82.6 mm	5.25", 82.6 mm
Average positioning time (msec)	14	14	11	11	14
Average rotational delay (msec)	8.3	8.3	5.5	5.5	8.3
Drive models	Hitachi DK516-15	Hitachi DK516-15	IBM P16 IBM P17	Seagate Elite ST41800K	Hitachi DK-516
ARRAY SIZE: Inches: H x W x D	57.75 x 23 x 32.5	57.75 x 23 x 32.5	24.5 x 19 x 27	75 x 25 x 41	78 x 42.5 x 38
POWER: Power backup	4000 watts None	4000 watts None	900 watts	3000 watts	3600 watts
FIRST CUSTOMER SHIPMENT	12/90	12/90	1/94	9/92	4/91
COMMENTS	Optional hot standby disk	2 optional hot standby disks			

MANUFACTURER	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MAXIMUM STRATEGY	MEDIA INTEGRATION
ARRAY MODEL	MCP-10	MCR-40	S2P	S2R	SMARTstor Rack
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Very High Perf.	Very High Perf.	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	IBM RS/6000 AIX	IBM RS/6000 AIX	Various	Various	SCSI host Various
RAID level Configured by:	3 Preset	3 Preset	3 Preset	3 Preset	0/1/5 Host
Array capacity (Gbytes) MIN MAX	10.8 10.8	10.8 43.2	5.5* 10.8*	5.5* 43.2*	1 12
Minimum drives per array	10	10	10	10	2/2/3
Maximum drives per array	10	40	10	40	7
Concurrent host channels	1, 2	1 to 4	1, 2	1 to 4	1
Array interface to host	Micro Channel	Micro Channel	VME-2E	VME-2E	SCSI-2
Drive interface	ESDI	ESDI	ESDI	ESDI	SCSI-2
Cache size (min, max: MB)	N/A	N/A	N/A	N/A	4, 16, 64
Cache function (Read, Write)	N/A	N/A	N/A	N/A	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 Yes Yes
Spare drive (None/Auto/Manual)	Auto	Auto	Auto	Auto	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	No	No	No	No	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	18 2.75	18 2.75	18* 2.75	18* 2.75	10 10
DRIVES: Formatted capacity/drive(MB)	1350	1350	1350	1350	1000, 1600,2100
Nominal disk diameter, height	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5",25.4/41.3m
Average positioning time (msec)	14	14	14	14	Drive dependent
Average rotational delay (msec)	8.3	8.3	8.3	8.3	Drive dependent
Drive models	Hitachi DK-516	Hitachi DK-516	Hitachi DK-516	Hitachi DK-516	DEC, H-P, Seagate
ARRAY SIZE: Inches: H x W x D	14 x 19 x 33	70 x 25 x 41	14 x 19 x 33	70 x 25 x 41	22.5 x 19 x 18
POWER: Power backup	700 watts	2000 watts	700 watts	2000 watts	250 watts Option
FIRST CUSTOMER SHIPMENT	7/91	7/91	8/90	11/90	3Q93
COMMENTS			*Depends upon disk drive used	*Depends upon disk drive used	Mylex controller

MANUFACTURER	MEDIA INTEGRATION	MEDIA INTEGRATION	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS
ARRAY MODEL	SMARTstor Tower	SMARTstor Server	Mercury BE-2V Mirror	MK/5	MK/245
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, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/5 Host	0/1/5 Host	1 Preset	0/1/3/5 Panel	0/1/3/5 Panel
Array capacity (Gbytes) MIN MAX	1.5 12	2 24	.5 12	2 10	10.9 980
Minimum drives per array	2/2/3	2/2/3	2	2	21
Maximum drives per array	7	14	6	5	245
Concurrent host channels	1	1	1, 2	1	1, 2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	4, 16, 64	4, 16, 64	--	0, 256	0, 256
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 No Yes	No Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10/20	10 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	1000, 1600,2100	1000, 1600,2100	Drive dependent	1050-2114	Drive dependent
Nominal disk diameter, height	3.5",25.4/41.3m	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 22-14.3mm
Average positioning time (msec)	Drive dependent	Drive dependent	9-15	10-9	9, 15
Average rotational delay (msec)	Drive dependent	Drive dependent	4.3-6.9	5.6	4.3, 6.9
Drive models	DEC, H-P, Seagate	DEC, H-P, Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 19 x 18	25.5 x 24 x 17	7 x 8 x 10*	7 x 16 x 20	78 x 57 x 20
POWER: Power backup	250 watts Option	450 watts None	60-200 watts* None	200 watts None	3500 watts Cache battery
FIRST CUSTOMER SHIPMENT	3Q93	3Q93	3Q93	4Q93	2Q93
COMMENTS	Mylex controller	Mylex controller	Software based array *Varies with number of drives	Modified purchased contoller Rack mount	Modified purchased controller Rack mount

MANUFACTURER	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS
ARRAY MODEL	MR/5	MK/10	MR/10	MK/20	MR/20
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
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various	SCSI host Various
RAID level Configured by:	0/1/3/5 Panel	0/1/3/5 Panel	0/1/3/5 Panel	0/1/3/5 Panel	0/1/3/5 Panel
Array capacity (Gbytes) MIN MAX	2 10	2 20	2 20	1.6 80	1.6 40
Minimum drives per array	2	3	3	3	3
Maximum drives per array	5	10	10	20	20
Concurrent host channels	1	1, 2	1, 2	1, 2	1, 2
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)	0, 256	0, 256	0, 256	0, 256	0, 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)	No Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20 10	20 10
DRIVES: Formatted capacity/drive(MB)	1050-2114	1050-2114	1050-2114	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 22-14.3mm
Average positioning time (msec)	10-9	9-15	9-15	9-15	9-15
Average rotational delay (msec)	5.6	4.3-6.9	4.3-6.9	4.3-6.9	4.3-6.9
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8 x 8 x 20	14 x 18 x 20	8 x 16 x 20	28 x 16 x 20	16 x 16 x 20
POWER: Power backup	200 watts None	200 watts None	200 watts None	350 watts Cache battery	350 watts Cache battery
FIRST CUSTOMER SHIPMENT	4Q92	2Q94	4Q92	2Q94	1Q93
COMMENTS	Modified purchased controller	Modified purchased controller Rack mount	Modified purchased controller	Modified purchased controller Rack mount	Modified purchased controller

MANUFACTURER	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGA DRIVE SYSTEMS	MEGABYTE MEMORY PRODUCTS	MEGABYTE MEMORY PRODUCTS
ARRAY MODEL	MK/35	MK/70	MK/140	MegaRAID	MegaRAID-1
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
Host platform, software environment	SCSI host Various	SCSI host Various	SCSI host Various	Sun, H-P, DEC, SGI UNIX	Sun, H-P, DEC, SGI UNIX
RAID level Configured by:	0/1/3/5 Panel	0/1/3/5 Panel	0/1/3/5 Panel	0/3/5 Panel, Port	1 Preset
Array capacity (Gbytes) MIN MAX	1.6 140	3.1 280	6.2 560	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	3	6	12	2	2
Maximum drives per array	35	70	140	27	8
Concurrent host channels	1, 2	1, 2	1, 2	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	0, 256	0, 256	0, 256	16, 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)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 22-14.3mm	3.5", 22-14.3mm	3.5", 22-14.3mm	Drive dependent	Drive dependent
Average positioning time (msec)	9-15	9-15	9-15	Drive dependent	Drive dependent
Average rotational delay (msec)	4.3-6.9	4.3-6.9	4.3-6.9	Drive dependent	Drive dependent
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	49 x 16 x 20	49 x 32 x 20	49 x 64 x 20	18.25 x 8.75 x 16.75	18.25 x 8.75 x 16.75
POWER: Power backup	500 watts Cache battery	1000 watts Cache battery	2000 watts Cache battery	120 watts* None	120 watts* None
FIRST CUSTOMER SHIPMENT	2Q94	2Q93	2Q93	5/93	1/93
COMMENTS	Modified purchased controller Rack mount	Modified purchased controller Rack mount	Modified purchased controller Rack mount	CMD controller *5 drive version	CMD controller *6 drive version

MANUFACTURER	MICRO TECHNOLOGY	MICRO TECHNOLOGY	MICRO TECHNOLOGY	MICRO TECHNOLOGY	MICRO TECHNOLOGY
ARRAY MODEL	FailSafe 26	FailSafe 44	FailSafe 88	Raiders Edge	Stingraid
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
Host platform, software environment	VAX-CI cluster VMS	VAX-CI cluster VMS	VAX-CI cluster VMS	VAX, DEC, Sun, IBM RS/6000, SGF, UNIX, oth.	VAX-CI cluster VMS
RAID level Configured by:	5+* Preset	5+* Preset	5+* Preset	3	0/1/3/5
Array capacity (Gbytes) MIN MAX	22 26	38 44	86 90	4.1/7.4 10	6/3/4.8/4.8 11/5/8.4/8.4
Minimum drives per array	13 (2 arrays)	13 (2 arrays)	13 (2 arrays)	5 (4+1)	5
Maximum drives per array	13 (2 arrays)	13 (2 arrays)	13 (2 arrays)	5 (4+1)	5
Concurrent host channels	2 (dual ports)	2 (dual ports)	2 (dual ports)	1, 2	2
Array interface to host	DEC CI Bus	DEC CI Bus	DEC CI Bus	CI, DSSI,SCSI-2	DEC CI Bus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	N/A	16, 64	N/A
Cache function (Read, Write)	N/A	N/A	N/A	Read, Write	N/A
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	Yes Yes Yes	Yes Yes Yes	Option No Yes	No No Yes
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 4.8	10 10	10 10	10 5	10 10
DRIVES: Formatted capacity/drive(MB)	1050	1900	2100	1200-3557	1200, 2100
Nominal disk diameter, height	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm	3.5", 5.25"	3.5", 41.3 mm
Average positioning time (msec)	15	12.9	8	Drive dependent	Drive dependent
Average rotational delay (msec)	8.3	8.3	4.2	Drive dependent	Drive dependent
Drive models	Seagate Wren 7	Seagate Wren 9	Seagate Barracuda	IBM 0663-E15 Seagate	Maxtor 1240S Seagate Barrac.
ARRAY SIZE: Inches: H x W x D	62 x 35 x 37	62 x 35 x 37	62 x 35 x 37	7 x 19 x 27	5.25 x 19 x 25.62
POWER: Power backup	4600 watts None**	4600 watts None**	4600 watts None**	300 watts	
FIRST CUSTOMER SHIPMENT	4/92	4/92	12/93	1/93	12/93
COMMENTS	*RAID 5 plus synch. spindles dual parity **Dual AC feed	*RAID 5 plus synch. spindles dual parity **Dual AC feed	*RAID 5 plus synch. spindles dual parity **Dual AC feed	Baydel controller	UltraStor 144F controller

MANUFACTURER	MICROACCESS	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICRONET TECHNOLOGY	MICROPOLIS
ARRAY MODEL	San Francisco	Micro Mirror	Performance +	RAIDbank	RAIDION LS 4200
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	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	MicroAccess NetWare	Macintosh	PC compatible NetWare	PC compatible Various	SCSI host NetWare, OS/2, LAN server, oth
RAID level Configured by:	1/5 Host	1 Preset	0/1** Preset	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	.48 5.56	2.02 38.92	1/.5/1 12/6/10	2.100, 4.200 65.10
Minimum drives per array	3	2	4	2/2/3	2/3
Maximum drives per array	5	2	28	6 + spare	32
Concurrent host channels	1	1	4	1	1, 4
Array interface to host	SCSI-2	SCSI-2	SCSI-2, EISA	SCSI-2,EISA,MCA	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512 per drive	N/A	N/A	--	.512 per drive
Cache function (Read, Write)	Read, Write	N/A	N/A	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes-per drive Yes-per drive	No Yes Yes	No No No	No No Yes	Yes-duplexing Yes-per drive Yes per drive
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-foregrnd	Manual-backgrnd	Man,Auto-backgr	Auto-backgrnd*
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	Host dependent 10	33 10	Host dependent 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	240, 2780	1020, 2780	500, 1000, 2000	2100
Nominal disk diameter, height	Drive dependent	3.5", 5.25"*	3.5", 5.25"*	3.5", 41.3 mm	5.25"
Average positioning time (msec)	Drive dependent	8, 15	8, 14	9, 10.5	11.5
Average rotational delay (msec)	Drive dependent	4.8, 6.8	4.8, 6.8	5.6	5.6
Drive models	Micropolis	Various	Various	Seagate 3160NC, 12400NC,31200NC	RM 2100
ARRAY SIZE: Inches: H x W x D	26 x 13 x 21	6.5 x 7.75 x 12*	6.5 x 7.75 x 12*	6.5 x 18 x 18	5.5 x 11 x 13.8**
POWER: Power backup	250 watts Battery option	50 watts None	50 watts None	54 watts None	50 watts/drive None
FIRST CUSTOMER SHIPMENT	9/93	3/90	10/91	4Q93	10/92
COMMENTS	Micropolis software	*Size may vary depending upon drives supplied	*Size may vary depending upon drives supplied **Mirrored RAID 0	Uses single connector drives	*Optional online spare **Per module

MANUFACTURER	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROPOLIS	MICROTECH INTERNATIONAL
ARRAY MODEL	RAIDION LS 6040	RAIDION LT 2100	RAIDION LT 3520	RAIDION VOT 101	XLerator RAID
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User
MARKET	PCM	PCM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host OS/2, LAN server, other	SCSI host OS/2, LAN server, other	SCSI host OS/2, LAN server, other	SCSI host Various	Apple System 7
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/5 Host	0/1
Array capacity (Gbytes) MIN MAX	6.04 93.62	2.1 28	3.5 54	9/6 84/81	Drive dependent Drive dependent
Minimum drives per array	2/3	2/3	2/3	3	2
Maximum drives per array	32	32	32	28	7
Concurrent host channels	1, 4	1, 4	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	NuBus
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512 per drive	.256 per drive	.256 per drive	8, 64	--
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes-duplexing Yes-per drive Yes per drive	 Yes-per drive Yes per drive	No Yes-per drive Yes per drive	No Yes-per drive Yes per drive	No No No
Spare drive (None/Auto/Manual)	Auto-backgrnd*	Auto-backgrnd*	Auto-backgrnd*	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	No	No	No	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	20 10	10 10
DRIVES: Formatted capacity/drive(MB)	3022	1050	1760	3000	500-8000
Nominal disk diameter, height	5.25", 82.6 mm	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	3.5", 5.25"
Average positioning time (msec)	12	10	10	13	11
Average rotational delay (msec)	5.6	5.6	5.6	5.6	11
Drive models	RM 3020	LM 1050	LM 1760	Micropolis AV	Quantum Seagate
ARRAY SIZE: Inches: H x W x D	5.5 x 11 x 13.8**	2.2 x 8.4 x 9.9	2.2 x 8.4 x 9.9**	22.75 x 19 x 10	4 x 12.8
POWER: Power backup	50 watts/drive None	30 watts/drive None	30 watts/drive None	30 watts None	5 watts+drives None
FIRST CUSTOMER SHIPMENT	5/93	4/93	6/93	2Q94	1993
COMMENTS	*Optional online spare **Per module	*Optional online spare	*Optional online spare **Per drive module	For video servers	ATTO software

MANUFACTURER	MORTON MANAGEMENT	MORTON MANAGEMENT	MORTON MANAGEMENT	MYLEX	MYLEX
ARRAY MODEL	GBR-RD-2600	GBR-RD-6000	GBR-RD-NC	CAC-960P	DAC-960-1/2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	OEM, PCM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Board
Host platform, software environment	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	PC compatible LAN Mgr., OS/2, NetW., UNIX,DOS	PC compatible NetWare, OS/2, SCO UNIX 3.24	PC compatible NetWare, OS/2 SCO UNIX 3.24
RAID level Configured by:	5	5	0/1/3/5	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	2.6	12	6.5 6.5	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	7	7	6	2	2
Maximum drives per array	7	7	6	7/14/21	7/14
Concurrent host channels	1	1	1	1	1, 2
Array interface to host	EISA, ISA,UChan	EISA, ISA,UChan	EISA	PCI	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	N/A	4, 64	4, 64
Cache function (Read, Write)	N/A	N/A		Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No Yes Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 5	10 10	132 10	33 20
DRIVES: Formatted capacity/drive(MB)	420	2000	1300	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	3.5", 5.25"
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	Hewlett-Packard Seagate,Fujitsu
ARRAY SIZE: Inches: H x W x D	7 x 198 x 19	7 x 198 x 19	7 x 198 x 19	4.25 x 10	4.25 x 10
POWER: Power backup	350 watts None	350 watts None	350 watts None	20 watts+drives Battery	20 watts+drives None
FIRST CUSTOMER SHIPMENT	4Q92	1993	1994	1Q94	1/93
COMMENTS	Software based array	Software based array	Digi-Data controller		

MANUFACTURER	MYLEX	MYLEX	MYLEX	MYLEX	MYLEX
ARRAY MODEL	DAC-960-3	DAC-960-5	DAC-960P	DAC-960S DB-960S	DAD-1200-3
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Board	Board	Board	Subsystem
Host platform, software environment	PC compatible NetWare, OS/2 SCO UNIX 3.24	PC compatible NetWare, OS/2 SCO UNIX 3.24	SCSI host Various	SCSI host Various	SCSI NetWare, OS/2 DOS
RAID level Configured by:	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Port, Panel	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	2 17.5
Minimum drives per array	2	2	2	2	2
Maximum drives per array	21	20	21	14, 28**	21
Concurrent host channels	1	1		1, 2**	1
Array interface to host	EISA	EISA	PCI	SCSI-2	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 64	4, 64	4, 32	2, 32	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
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 20	33 20	132 10	10 10	33 20
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	Drive dependent	Drive dependent	3.5", 5.25"
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	Hewlett-Packard Seagate,Fujitsu	Hewlett-Packard Seagate,Fujitsu	Various	Various	Hewlett-Packard Seagate,Fujitsu
ARRAY SIZE: Inches: H x W x D	4.25 x 10	4.25 x 10	4.75 X 13	4.75 x 13	30.5 x 13 x 22
POWER: Power backup	20 watts+drives None	20 watts+drives None	20 watts+drives None	20 watts+drives Battery	400 watts None
FIRST CUSTOMER SHIPMENT	1/93	5/92	4/94	--	9/92
COMMENTS				Also mirrored striping, spanning **With DB-960S upgrade	

MANUFACTURER	MYLEX	NATIONAL PERIPHERALS	NATIONAL PERIPHERALS	NEC	NEC
ARRAY MODEL	IDA S 2000	5000	5020	N1137-32	N1137-33
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM, PCM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	PC compatible NetWare, OS/2 SCO UNIX 3.24	Sun 4/470,4/490 600 MP	Sun 4/470,4/490 600 MP	OPA A-VX	OPA A-VX
RAID level Configured by:	0/1/5/6*/7* Host	0/1/5 Port	0/1/5 Port	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	1	1	5	5
Maximum drives per array	21	20	20	5	5
Concurrent host channels	1	1, 4	1, 4	1	1
Array interface to host	EISA	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	2	2	--	--
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 Yes Yes	-- -- --	-- -- --
Spare drive (None/Auto/Manual)	Auto-backgrnd	Auto-background	Auto-background	None	None
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 20	10 10	10 10	5 5	5 5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	165	331
Nominal disk diameter, height	3.5", 5.25"	5.25", 82.6 mm	3.5", 41.3 mm	3.5", 25.4 mm	3.5", 41.3 mm
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	Hewlett-Packard Seagate,Fujitsu	Seagate Elite	Various	D3865	D3872
ARRAY SIZE: Inches: H x W x D	30.5 x 13 x 22	55 x 22 x 36	38 x 21 x 33	17.8 x 7.7 x 14.5	17.8 x 7.7 x 14.5
POWER: Power backup	400 watts None	3.6 KVA Battery	3.6 KVA Battery	-- --	-- --
FIRST CUSTOMER SHIPMENT	1/93	1Q93	1Q93	2Q92	2Q92
COMMENTS	*RAID 6,7 is combined RAID 1,0. 486 DX-2/66. Disk array server.				

MANUFACTURER	NEC	NEC	NEC	NEC	NEC
ARRAY MODEL	N1137-34	N7759-89	OP-450-30004 OP-450-30005 OP-450-31001	OP-450-30001 OP-450-30002 OP-450-30003	OP-450-5103 SCSI Mirroring Module
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	Board	Board	Board
Host platform, software environment	OPA A-VX	UP4800 UNIX	NEC Express Various	NEC Express, EISA PCs	EISA PC
RAID level Configured by:	3 Preset	3 Preset	0/1/5	0/1/5	1 Preset
Array capacity (Gbytes) MIN MAX	1.7 1.7	1.7 1.7	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	5	7	7	6
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI
Cache size (min, max: MB)	--	--	4, 64	4, 64	4, 16
Cache function (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	None	Manual-backgrnd	Manual-backgrnd	--
ARRAY PERFORMANCE: Boot from array?	Yes	No	Yes	Yes	
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 5	5 5	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	425	425	540-2000	540-2000	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 5.25"
Average positioning time (msec)	14	14	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	8.3	8.3	Drive dependent	Drive dependent	Drive dependent
Drive models	D3881	D3881	Various	Various	Varies
ARRAY SIZE: Inches: H x W x D	17.8 x 7.7 x 14.5	27.6 x 13.6 x 30	-- --	-- --	EISA standard
POWER: Power backup	-- --	-- --	--	--	-- --
FIRST CUSTOMER SHIPMENT	2Q92	4Q92	1/94	12/93	6/92
COMMENTS					Requires EISA SCSI host adapter OP-450-6301

MANUFACTURER	NETFRAME	NETFRAME	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION	NETWORK APPLIANCE CORPORATION
ARRAY MODEL	NF250 FT	NF450 FT	FAServer 450	FAServer 1300	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	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Board	Subsystem
Host platform, software environment	NetFRAME NetWare, UNIX, OS/2	NetFRAME NetWare, UNIX, OS/2	NAC NFS	NAC NFS	NAC NFS
RAID level Configured by:	0/1/5** Host	0/1/5** Host	4 Preset	4 Preset	4 Preset
Array capacity (Gbytes) MIN MAX	4/2 90/45	4/2 224/112	1 27.3	1 27.3	1 27.3
Minimum drives per array	3	3	2	2	2
Maximum drives per array	45	120	14	14	14
Concurrent host channels	1, 3	1, 8	1	1	1
Array interface to host	NetFRAME	NetFRAME	EISA	EISA	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 12	4, 32	16, 128	16, 128	16, 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)	Duplexing Yes No	Duplexing Yes Yes	No No No	No Yes Option	No Yes Option
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	None	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	12.5 5, 20	12.5 5, 20	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	2000	2000	1000, 2100	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5". 41.3 mm	3.5". 41.3 mm
Average positioning time (msec)	9.5	9.5	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.6	5.6	Drive dependent	Drive dependent	Drive dependent
Drive models	Hitachi, H-P, Seagate*	Hitachi, H-P, Seagate*	DEC, Seagate, Fujitsu	DEC, Seagate, Fujitsu	DEC, Seagate,
ARRAY SIZE: Inches: H x W x D	26 x 19 x 19	42 x 19 x 19	29 x 10 x 22	7 x 19 x 23	12.8 x 19 x 23
POWER: Power backup	500 watts UPS option	1500 watts UPS option	Cache battery	Cache battery	Cache battery
FIRST CUSTOMER SHIPMENT	3/94	3/94	3/94	4/94	4/94
COMMENTS	*Optional drives 200 MB-2 GB **Requires Novell software	*Optional drives 200 MB-2 GB **Requires Novell software	Includes server	Includes server	Includes server

MANUFACTURER	NETWORK CONNECTION	NONSTOP NETWORKS	PACE TECHNOLOGIES	PACIFIC MICRO DATA	PACIFIC MICRO DATA
ARRAY MODEL	T.R.A.C. Array	No-Stop Network	Pace RAID-5	MAST VII	MAST VIII
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Software	Subsystem	Subsystem	Subsystem
Host platform, software environment	T.R.A.C. DOS, OS/2, UNIX NetWare, other	PC compatible DOS, Windows, NetWare	Pace Various	ISA, EISA, MCA NetWare, UNIX, DOS, OS/2, oth	ISA, EISA, MCA NetWare, UNIX, DOS, OS/2, oth
RAID level Configured by:	0/1/4/5	1 Preset	0/3/5 Host	0/1/3/5 *	0/1/3/5 *
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 13	1 16
Minimum drives per array	2	2	5	2	2
Maximum drives per array	35	20	20	7	8
Concurrent host channels	1	1	1	1, 3	1, 2
Array interface to host	EISA	--	SCSI, SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	--	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	0, 128	4, 64**	4, 64**
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	-- -- --	No No No	Option** Yes Per drive	Option** Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	*	*
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	Drive dependent Drive dependent	20 10	10 Various	10 Various
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1050, 4000	1050, 4000
Nominal disk diameter, height	3.5", 5.25"	Drive dependent	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm
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 Quantum	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	--	Varies	20 x 14.5 x 12	8.75 x 17.75 x 16
POWER: Power backup	250 watts None	-- --	20 watts+drives None	250 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	6/92	1990	1/93	2/93	1Q94
COMMENTS		Mirrored drives can be in different hosts	Digi-Data controller	*Depends on controller used **With Mylex controller	*Depends on controller used Avail. w/Mylex, DPT, Chantal SW Also sld w/o dr **W/Mylex contr

MANUFACTURER	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS	PARITY SYSTEMS
ARRAY MODEL	6000	6010	6100	6200	6210
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
Host platform, software environment	Sun, H-P, SGI, IBM UNIX, RISC	Sun, H-P, SGI, IBM UNIX, RISC	Sun, H-P, SGI, IBM UNIX, RISC	Sun, H-P, SGI, IBM UNIX, RISC	Sun, H-P, SGI, IBM UNIX, RISC
RAID level Configured by:	0/3/5 Port, Panel	0/3/5 Port, Panel	0/3/5 Port, Panel	0/3/5 Port, Panel	0/3/5 Port, 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	2	2
Maximum drives per array	7	7	21	28	28
Concurrent host channels	1, 3	1, 3	1, 3	1, 3	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)	32 MB RD,64K WR	32 MB RD,64K WR	32 MB RD,64K WR	32 MB RD,64K WR	32 MB RD,64K 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 No	No Yes No	No Yes No	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
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)	1000-4100	1000-4100	1000-9100	1000-4100	1000-4100
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 5.25"	3.5", 5.25"	3.5", 41.3 mm	3.5", 41.3 mm
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	None	None	None	Battery option	None
FIRST CUSTOMER SHIPMENT	1Q93	1Q93	1Q93	1Q94	1Q94
COMMENTS		Rack mount version of 6000		Dual AC power	Dual AC power Rack mount version of 6200

MANUFACTURER	PEAK TECHNOLOGIES	PEAK TECHNOLOGIES	PEAK TECHNOLOGIES	PEAK TECHNOLOGIES	PERCEPTIVE SOLUTIONS
ARRAY MODEL	FA-7040	FA-7080	FA-7140	FA-7180	dataSHADOW
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	Board
Host platform, software environment	SCSI host	SCSI host	SCSI host	SCSI host	PC compatible UNIX, PTPLANS
RAID level Configured by:	0/3/5 Port	0/3/5 Port	0/3/5 Port	0/3/5 Port	1 Host
Array capacity (Gbytes) MIN MAX	5.3/4.2/4.2	10.5/8.4/8.4 70/56/56	5.3/4.2/4.2	10.5/8.4/8.4 70/56/56	Drive dependent Drive dependent
Minimum drives per array	5 + spare	5 + spare	5 + spare	5 + spare	2
Maximum drives per array	5 + spare	35 + 7 spare	5 + spare	35 + 7 spare	28
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	ISA, EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	ESDI, SCSI, IDE
Cache size (min, max: MB)	--	--	0, 128	0, 128	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	No Yes Yes	No Yes Yes	No Yes Yes	N/A N/A N/A
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	20 10	20 10	20 10	4-7 2-5
DRIVES: Formatted capacity/drive(MB)	1050	2100	1050	2100	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	10.5	8.9	10.5	8.9	Drive dependent
Average rotational delay (msec)	5.6	4.7	5.6	4.7	Drive dependent
Drive models	H-P, Seagate	H-P, Seagate	H-P, Seagate	H-P, Seagate	Various
ARRAY SIZE: Inches: H x W x D	22 x 10 x 24	22 x 10 x 24	22 x 10 x 24	22 x 10 x 24	N/A
POWER: Power backup	90 watts+drives None	90 watts+drives None	90 watts+drives None	90 watts+drives None	N/A None
FIRST CUSTOMER SHIPMENT	2Q93	2Q93	3/94	3/94	1Q90
COMMENTS	Digi-Data controller	Digi-Data controller	Digi-Data controller	Digi-Data controller	

MANUFACTURER	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERCEPTIVE SOLUTIONS	PERIPHERAL LAND, INC.	PERIPHERAL LAND, INC.
ARRAY MODEL	quickRAID	quickSHADOW	VesaCACHE	MiniArray	MiniArray 040
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Single User
MARKET	OEM, PCM	OEM, PCM	OEM, PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Board	Software	Board	Subsystem	Subsystem
Host platform, software environment	PC compatible	PC compatible	PC compatible	Macintosh NuBus	Macintosh Quad. (900/950)
RAID level Configured by:	1	1	1	0/1	0/1
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	1 2, 6	1 4.2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	4	4	2	2
Concurrent host channels	1	1	1	1	1
Array interface to host	ISA, EISA	--	VESA	SCSI-2	SCSI-2
Drive interface	IDE	IDE	IDE	SCSI-2	SCSI-2
Cache size (min, max: MB)	.5, 8	8*	1, 16	--	--
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
Spare drive (None/Auto/Manual)	Manual-backgrnd		Manual-backgrnd	Manual	Manual
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	2/33 Drive dependent	4 Drive dependent	Host dependent Drive dependent	5	8.4
DRIVES: Formatted capacity/drive(MB)	DD, 504 max.	DD, 520 max.	DD, 520 max.	330-2600	660-4200
Nominal disk diameter, height	Drive dependent	Drive dependent	Drive dependent	3.5", 41.3 mm	3.5"
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 models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	4 x 14	--	4 x 14	Drive dependent	Drive dependent
POWER: Power backup	N/A None	-- --	N/A N/A	Drive dependent --	Drive dependent --
FIRST CUSTOMER SHIPMENT	1993	1993	4Q93	6/92	6/92
COMMENTS		*With PSI controller			

MANUFACTURER	PERIPHERAL LAND, INC.	PERIPHERAL LAND, INC.	PRECISION COMPUTERS	PRECISION COMPUTERS	PRO ENGINEERING
ARRAY MODEL	QuickSCSI	QuickArray	486-XX EISA	Pentium-XX	EZRAID
DISK/TREND GROUP	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Board	Subsystem	Subsystem	Subsystem	Software
Host platform, software environment	Macintosh NuBus	Macintosh Quad. NuBus (700/900/950)	NetWare, UNIX, DOS OS/2	NetWare, UNIX, DOS OS/2	PC compatible OS/2
RAID level Configured by:	0/1	0/1	0/1/4/5 Host	0/1/4/5 Host	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent 2	1 4	2 4	2 4	Drive dependent 8
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	5	5	7 per control.
Concurrent host channels	1	1	1	1	1, 7
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Various
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	Various
Cache size (min, max: MB)	--	--	--	--	1, 4*
Cache function (Read, Write)	--	--	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	No Yes Option	No Yes Option	-- -- --
Spare drive (None/Auto/Manual)	Manual	Manual	Manual-backgrnd	Manual-backgrnd	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	7.5 Drive dependent	10	20 10	20 10	Host dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1000	1052-2000	1052-2000	Drive dependent
Nominal disk diameter, height	Drive dependent	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	10.5	10.5	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	5.56	5.56	Drive dependent
Drive models	Various	Various	Hewlett-Packard Seagate	Hewlett-Packard Seagate	Various
ARRAY SIZE: Inches: H x W x D	Drive dependent	Drive dependent	33.75 x 10.83 x 23.75	33.75 x 10.83 x 23.75	--
POWER: Power backup	Drive dependent --	Drive dependent --	225 watts None	225 watts None	-- --
FIRST CUSTOMER SHIPMENT	4/91	2Q93	11/92	1Q94	3/94
COMMENTS			UltraStor controller	UltraStor controller	*In driver

MANUFACTURER	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	480	680	ISA SCSI Xelerator	1050	2000
DISK/TREND GROUP	Single User	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	OEM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Subsystem	Subsystem
Host platform, software environment	Apple Macintosh System 7	Apple Macintosh System 7	PC compatible DOS, Windows, NetWare, OS/2	Apple Macintosh System 7	Apple Macintosh System 7
RAID level Configured by:	0/1 Host	0/1 Host	0/1* Host	0/1 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	.960/.480	1.36/.680	Drive dependent Drive dependent	2.1/1.05	4/2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	7	2	2
Concurrent host channels	1	1	1	1	1
Array interface to host	SCSI-2	SCSI-2	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 No No	No No No	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	None	None	Manual-foregrnd	None	
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	480	680	Drive dependent	1050	2000
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	6	6	Drive dependent	5	5
Average rotational delay (msec)	6.6	6.6	Drive dependent	5.5	5.5
Drive models			Various		
ARRAY SIZE: Inches: H x W x D	8 x 6 x 10	8 x 6 x 10	4.75 x 10.72 x 0.875	8 x 6 x 10	8 x 6 x 10
POWER: Power backup	125 watts None	125 watts	3.8 watts None	125 watts	125 watts
FIRST CUSTOMER SHIPMENT			12/92		
COMMENTS			*Supports concurrent RAID 0 and RAID 1		

MANUFACTURER	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY	PROCOM TECHNOLOGY
ARRAY MODEL	2650	900	LFRAID/1.1	LFRAID/2.1	LFRAID/4.2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Apple Macintosh System 7	Apple Macintosh System 7	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other	SCSI host NetWare, UNIX, NT, other
RAID level Configured by:	0/1 Host	0/1 Host	0/1/3/5 Host	0/1/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	5.3/2.65	1.8/.9	2.4/1.2/1.6/1.6	3.2/1.6/2.1/2.1	6.3/3.2/4.2/4.2
Minimum drives per array	2	2	2	2	2
Maximum drives per array	2	2	7	7	7
Concurrent host channels	1	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)	--	--	--	--	16
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	No Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)			Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	2650	900	540	1050	2100
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	5	6	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	5.5	6.6	Drive dependent	Drive dependent	Drive dependent
Drive models			Various	Various	Various
ARRAY SIZE: Inches: H x W x D	8 x 6 x 10	8 x 6 x 10	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	125 watts	125 watts	120 watts Cache battery	120 watts Cache battery	120 watts Cache battery
FIRST CUSTOMER SHIPMENT			1993	1993	1993
COMMENTS			CMD controller	CMD controller	CMD controller

MANUFACTURER	PROCOM TECHNOLOGY	R-SQUARED	RAAC TECHNOLOGIES	RAAC TECHNOLOGIES	RAAC TECHNOLOGIES
ARRAY MODEL	LFRAID/4.4	ULTIMA	ESP200	ESP500	ESP1000
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
Host platform, software environment	SCSI host NetWare, UNIX, NT, other	SCSI host UNIX	PC compatible Various	PC compatible Various	PC compatible Various
RAID level Configured by:	0/1/3/5 Host	0/3/5 Panel	0/1 Preset	0/1/5 Host	0/1/5 Host
Array capacity (Gbytes) MIN MAX	 6.6/3.3/4.4/4.4	6 56	Drive dependent Drive dependent		Drive dependent Drive dependent
Minimum drives per array	2	2	2	2	2
Maximum drives per array	7	28	4	4	8
Concurrent host channels	1	1	1		1
Array interface to host	SCSI-2	SCSI-2	EISA/ISA	EISA/ISA	EISA/ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	32	4, 32	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 Yes Yes	No Yes Yes	Option Yes Yes	Option Yes Yes	Option Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	33 10	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	2200	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
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	Varies	10.5 x 19 x 17	35.25 x 19 x 19	44 x 19 x 19
POWER: Power backup	120 watts Cache battery	25 watts+drives Cache battery	375 watts None	-- None	400 watts None
FIRST CUSTOMER SHIPMENT	1993	1993	2Q94	2Q94	1992
COMMENTS	CMD controller	CMD controller	DPT controller Ruggedized	DPT controller Ruggedized	DPT controller Ruggedized

MANUFACTURER	RAID POWER	RAIDTEC	RAIDTEC	RAIDTEC	RAIDTEC
ARRAY MODEL	ULTRARAID 55	FlexArray MX	FlexArray	FlexArray IX	Ruac IX
DISK/TREND GROUP	Net/Mini/Multi	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	OEM, PCM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Board
Host platform, software environment	SCSI host NetWare, AUX, Syst.7,VMS,oth.	Various DOS, UNIX, OS/2 NetWare, Syst.7	Various DOS, UNIX, OS/2 NetWare, Syst.7	Various DOS, UNIX, OS/2 Netware, Syst.7	Various DOS, UNIX, OS/2 Netware, Syst.7
RAID level Configured by:	0/3/5 Port, Panel	0/1 Panel	0/1/3/5 Host	0/1/3/5 Panel	0/1/3/5 Panel
Array capacity (Gbytes) MIN MAX	4 56	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	28	2	6	6	35
Concurrent host channels	1, 3	1	1	1	1
Array interface to host	SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2	SCSI, SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	32	N/A	N/A	N/A	N/A
Cache function (Read, Write)	Read, Write	N/A	N/A	N/A	N/A
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-background	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 10	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	1000-4000	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
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, H-P, Fujitsu	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	22.25 x 7.29 x 22.44	6.5 x 9.25 x 12.75	15.75 x 15.6 x 15.6	15.75 x 15.6 x 15.6	5 x 17 x 12
POWER: Power backup	250 watts UPS, battery	120 watts	300 watts	300 watts	140 watts
FIRST CUSTOMER SHIPMENT	1Q93	1Q94	3Q92	1Q93	1Q94
COMMENTS	CMD controller Tower or rack mount	3 SCSI channels including host	Requires array software, no internal array controller	6 SCSI channels including host	6 SCSI channels including host

MANUFACTURER	RANGER TECHNOLOGIES	RANGER TECHNOLOGIES	RANGER TECHNOLOGIES	SANYO ICON	SANYO ICON
ARRAY MODEL	Drive Card	Plug & Go	Plug & Go S	MMX-400 MMX-600 MMX-700	MRX-100
DISK/TREND GROUP	Single User	Single User	Single User	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	Captive, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	PC compatible DOS, UNIX Netware	PC compatible DOS, OS/2, Windows	PC compatible DOS, OS/2, Windows	Sanyo Icon NetW.,VINES,NT, UNIX,OS/2,other	SCSI host NetWare, UNIX, DOS, OS/2, Pick
RAID level Configured by:	0/1/3/5 Preset	1 Preset	1 Preset	0/1/5 Host	0/1/5 Port
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	2 52*	2 14.8
Minimum drives per array	2	2	2	3	3
Maximum drives per array	2	2	2	14	8
Concurrent host channels	1	1	1	1, 12	1, 12
Array interface to host	ISA,EISA,PCI*	Parallel port	SCSI-2	SCSI-2	SCSI, SCSI-2
Drive interface	SCSI-2	IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	Option	32, 512	32, 512
Cache function (Read, Write)	--	--	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No Yes Yes	No No No
Spare drive (None/Auto/Manual)	None	None	None	Manual-backgrnd	Manual
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	Bus dependent 10	Bus dependent 10	Bus dependent 10	10 10	10 2.75/3.03/4.8
DRIVES: Formatted capacity/drive(MB)	250-5300	250-5300	250-5300	1000-4000	1000-4000
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 5.25"	5.25", 82.6 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	12-14	12-14
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	8.3-5.6	8.3-5.6
Drive models	Various	Various	Various	Hitachi, DEC	Hitachi, DEC
ARRAY SIZE: Inches: H x W x D	4.5 x 1.25 x 13.25	1.75 x 8 x 8.5	1.75 x 8 x 8.5	69 x 54 x 20	25.5 x 9 x 27
POWER: Power backup	5 watts+drives None	5 watts+drives None	5 watts+drives None	1.44 KVA None	600 watts None
FIRST CUSTOMER SHIPMENT	6/93	6/93	6/93	1994	10/92
COMMENTS	Uses array software *VESA also available	Uses array software External mount	Uses array software External mount	400 series is 48" high *180 GB for MMX-700	Expandable to 360 GB

MANUFACTURER	SANYO ICON	SANYO ICON	SANYO ICON	SANYO ICON	SEE FIRST TECHNOLOGY
ARRAY MODEL	MRX-300	MRX-400 MRX-600	MRX-500	MRX-500FT	Array System
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
Host platform, software environment	SCSI host NetWare, UNIX, DOS, OS/2, Pick	SCSI host NetW.,VINES,NT, UNIX,OS/2,other	SCSI host NetWare, UNIX, DOS, OS/2, Pick	SCSI host NetWare, UNIX, DOS, OS/2, Pick	DEC, Sun, SGI, HP, RS/6000,oth UNIX, NetWare
RAID level Configured by:	0/1/5 Port	0/1/5 Host	0/1/5 Port	0/1/5 Port	1/3/5
Array capacity (Gbytes) MIN MAX	2 52	2 52	2 52	2 52	1.25 8
Minimum drives per array	3	3	3	3	5
Maximum drives per array	14	14	14	14	7
Concurrent host channels	1, 12	1, 12	1, 12	1, 12	1
Array interface to host	SCSI, 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)	32, 512	32, 512	32, 512	32, 512	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 Yes Yes	No No No	Yes Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual	Manual-backgrnd	Manual	Manual	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	No	Yes	No	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 2.75/3.03/4.8	10 10	10 2.75/3.03/4.8	10 2.75/3.03/4.8	10 10
DRIVES: Formatted capacity/drive(MB)	1000-4000	1000-4000	1000-4000	1000-4000	1000-2000
Nominal disk diameter, height	5.25", 82.6 mm	3.5", 5.25"	3.5", 5.25"	3.5", 5.25"	3.5", 41.3 mm
Average positioning time (msec)	12-14	12-14	12-14	12-14	Drive dependent
Average rotational delay (msec)	8.3-5.6	8.3-5.6	8.3-5.6	8.3-5.6	Drive dependent
Drive models	Hitachi, DEC	Hitachi, DEC	Hitachi, DEC	Hitachi, DEC	DEC, IBM
ARRAY SIZE: Inches: H x W x D	38.5 x 25.5 x 35	69 x 54 x 20	54 x 25.5 x 35	54 x 51 x 35	21.5 x 10 x 14
POWER: Power backup	1440 watts None	1.44 KVA None	1440 watts None	1440 watts None	120 watts None
FIRST CUSTOMER SHIPMENT	10/92	1994	10/92	10/92	8/93
COMMENTS	Expandable to 360 GB	400 series is 48" high	Expandable to 360 GB	Expandable to 360 GB, can be duplexed	CMD controller

MANUFACTURER	SEEK SYSTEMS	SEEK SYSTEMS	SEEK SYSTEMS	SEQUENT COMPUTER SYSTEMS	SEQUOIA SYSTEMS
ARRAY MODEL	S401	S430	Xcelerator	WINSERVER 3000	DD5003
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	PCM	Captive, OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Subsystem	Subsystem
Host platform, software environment	SCSI host	SCSI host	SCSI host Various, UNIX	Sequent Windows NTAS, UNIX	Sequoia series 40 Wilt Topix
RAID level Configured by:	3/5	1/3/5	3/4/5 Port	0/1/5/10*	1 Preset
Array capacity (Gbytes) MIN MAX	1 50	1 50	Drive dependent Drive dependent	.55 144	1.8 176
Minimum drives per array	5	5	5	2	
Maximum drives per array	30	30	40	10	100
Concurrent host channels	1	1	1, 4	1	2
Array interface to host	SCSI, SCSI-2	SCSI, SCSI-2	SCSI-2	EISA	VME
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	4, 16, 64	16, 64	32, 1000	--	1, variable
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 Option	No No Option	Yes Yes Yes (option)	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	5, 10 5	5, 10 5	10, 20 10, 20	33 10	20 5.2
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	1.8
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	Drive dependent	3.5", 41.3 mm	3.5"
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	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	Varies	36.5 x 22.3 x 33.5	5.5 x 17 x 17
POWER: Power backup	129 watts Battery option	129 watts Battery option	45 watts Cache battery	1.3 KVA None	300 watts Battery
FIRST CUSTOMER SHIPMENT	--	11/93	2Q94*	1993	1994
COMMENTS	Baydel controller		*RAID 3 2Q94 *RAID 5 3Q94	May include up to 6 CPUs *Combined RAID 0 and RAID 1 mode	

MANUFACTURER	SEQUOIA SYSTEMS	SEQUOIA SYSTEMS	SERAPH	SERAPH	SILICON VALLEY COMPUTER
ARRAY MODEL	DS310	DS4003	Gemini SE	AU-1	ADP 104 ADP 108*
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi	Single User
MARKET	Captive, OEM	Captive, OEM	PCM	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Board
Host platform, software environment	Sequoia series 400 Wilt Topix	Sequoia series 40 Wilt Topix	Apple System 7	Apple Appletalk	PC compatible DOS, UNIX, OS/2 Windows
RAID level Configured by:	1 Preset	1 Preset	0/1/4/5 Host	0/1/4/5	0/1 Preset
Array capacity (Gbytes) MIN MAX	.9 36	.880 88	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	2	5	2
Maximum drives per array	80	100	2	7	4
Concurrent host channels	2	2	1-5	1-5	1
Array interface to host	Multibus	VME	NuBus	NuBus	16 bit ISA Bus
Drive interface	SCSI	SCSI-2	SCSI-2	SCSI-2	IDE
Cache size (min, max: MB)	1, variable	1, variable	--	--	.016, .032
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	No No No	No No Yes	-- -- --
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	None	Manual-backgrnd	None
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	5 3.3	20 3.5	10 10	10 10	3 max. 9 max.
DRIVES: Formatted capacity/drive(MB)	903	880	500-2900	1000-2100	Drive dependent
Nominal disk diameter, height	5.25"	3.5"	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	13	10	Drive dependent	Drive dependent	Drive dependent
Average rotational delay (msec)	8.3	5.6	Drive dependent	Drive dependent	Drive dependent
Drive models	Various	Various	Seagate ST31200 ST12400 Barrac.	Seagate ST31200 ST12400 Barrac.	Various IDE drives
ARRAY SIZE: Inches: H x W x D	5.25 x 18 x 30	5.5 x 17 x 17	4 x 10 x 10.5	21 x 7.5 x 18	4.75 x 13
POWER: Power backup	500 watts Battery	300 watts Battery	60 None	300 watts None	2 watts None
FIRST CUSTOMER SHIPMENT	1989	1994	8/93	10/93	9/92
COMMENTS			Buslogic controller with Seraph drives Trillium array software	Buslogic controller with Seraph drives Trillium array software	*Includes floppy controller

MANUFACTURER	SILICON VALLEY COMPUTER	SOLID COMPUTER	SOLID COMPUTER	SOLID COMPUTER	SOLID COMPUTER
ARRAY MODEL	ADP 111	B5H M5H	B5S M5S	M20	N20
DISK/TREND GROUP	Single User	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM		PCM		
ARRAY CONFIGURATION: Type	Board	Software	Software	Subsystem	Subsystem
Host platform, software environment	PC compatible DOS, UNIX, OS/2 Windows	SCSI host NetWare, UNIX	SCSI host NetWare, UNIX	Sun, RS/6000, DG AViiON NetWare, UNIX	SCSI host NetWare, UNIX
RAID level Configured by:	0/1 Preset	0/1/3/5 Port	0/1/5 Port	0/1/3/5 Port	0/1/3/5 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	5	5	5	5
Maximum drives per array	4*	10	5	20	20
Concurrent host channels	1	1	1	1	1
Array interface to host	32 bit VESA	EISA, ISA, MCA	EISA, ISA, MCA	EISA, ISA, MCA	EISA, ISA, MCA
Drive interface	IDE	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.032	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	No Yes (M models) Yes	No Yes (M models) Yes	Yes (option) Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	None	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	3 max. 9 max.	IF dependent 10	IF dependent 10	IF dependent 10	IF dependent 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	1.05, 2.1, 3.5	1.05, 2.1, 3.5	1.05, 2.1, 3.5	1.05, 2.1, 3.5
Nominal disk diameter, height	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	10, 9, 9	10, 9, 9	10, 9, 9	10, 9, 9
Average rotational delay (msec)	Drive dependent				
Drive models	Various IDE drives				
ARRAY SIZE: Inches: H x W x D	4.75 x 13				
POWER: Power backup	2 watts None				
FIRST CUSTOMER SHIPMENT	4Q93				
COMMENTS	*Also supports 2 additional nonmirrored IDE channels	M models have hot swap drives	Requires RAID software or NetWare for array function. M models have hot swap drives		

MANUFACTURER	SOLID COMPUTER	SOLID COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE COMPUTER
ARRAY MODEL	WSR425	WSR805	CLx	D3x	D5x
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
Host platform, software environment	SCSI host NetWare, UNIX	SCSI host NetWare, UNIX	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	"7" Preset	"7" Preset	"7" Preset
Array capacity (Gbytes) MIN MAX	5.3/2.7/4.2/4.2 5.3/2.7/4.2/4.2	10/5/8/8 10/5/8/8	2 420	2 45	2 99
Minimum drives per array	5	5	3	3	3
Maximum drives per array	5	5	48	12	12
Concurrent host channels	1	1	1 to 12	1 or 2	1, 2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-1/2	SCSI-1/2	SCSI-1/2
Cache size (min, max: MB)	--	--	16-256	4, 64	4, 64
Cache function (Read, Write)	Read	Read	Read, Write	Read, Write	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No No	Yes Yes Yes	No Yes Yes	No Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Auto	Auto	Auto
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	10 10	10 or 20 Drive dependent	10 or 20 Drive dependent	10 or 20 Drive dependent
DRIVES: Formatted capacity/drive(MB)	1050	2000	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 5.25"	3.5", 5.25"	3.5", 5.25"
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	Fujitsu Seagate	Fujitsu Seagate	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	16 x 9 x 17	16 x 9 x 17	14 x 16.5 x 15.5	14 x 16.5 x 15.5	14 x 16.5 x 15.5
POWER: Power backup	-- None	-- None	2160 KVA --	1440 KVA --	1440 KVA --
FIRST CUSTOMER SHIPMENT	1992	1992	4Q92	2Q92	2Q92
COMMENTS	Digi-Data controller	Digi-Data controller	UPS required	UPS required	UPS required

MANUFACTURER	STORAGE COMPUTER	STORAGE COMPUTER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS
ARRAY MODEL	R3x	R5x	Concept 750	Concept 810 Concept 810SW	Concept 51-S
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	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Most PC & UNIX networks, plus midrange syst.	Most PC & UNIX networks, plus midrange syst.	SCSI host Various	SCSI host, VME, PC AT	RS/6000, Sun AIX, VME UNIX,
RAID level Configured by:	"7" Preset	"7" Preset	3/5 Host	3 Host, Preset	3 Host, Preset
Array capacity (Gbytes) MIN MAX	2 106	2 230	8 50	2 10	3 48
Minimum drives per array	3	3	5	4	2
Maximum drives per array	27	27	28	5	36
Concurrent host channels	1 to 4	1 to 4	2	1	2
Array interface to host	SCSI-2	SCSI-2	SCSI-2	VME,PCAT,SCSI-2	SCSI-2
Drive interface	SCSI-1/2	SCSI-1/2	SCSI-2	SCSI-2	ESDI
Cache size (min, max: MB)	4, 256	4, 256	8, 32	N/A	.25, 1
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	N/A	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	Optional Yes Yes, optional	No No No	No No No
Spare drive (None/Auto/Manual)	Auto	Auto	Auto-background	No	No
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	No	No
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 or 20 Drive dependent	10 or 20 Drive dependent	Up to 20 Varies	20 peak* 5	18.24 2.75
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	2100	2100	1320
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm
Average positioning time (msec)	Drive dependent	Drive dependent	8	8.3	14
Average rotational delay (msec)	Drive dependent	Drive dependent	4.17	4.17	8.3
Drive models	Various	Various	Seagate Barracuda	Seagate ST12550	Hitachi DK516-15
ARRAY SIZE: Inches: H x W x D	14 x 19 x 28.5	14 x 19 x 28.5	24 x 10 x 14	3.5 x 19 x 21	8.75 x 19 x 30
POWER: Power backup	2160 KVA --	2160 KVA --	 Optional UPS*	250 watts	800 watts None
FIRST CUSTOMER SHIPMENT	1Q92	1Q92	3/94	1Q94	3/92
COMMENTS	UPS required	UPS required	*Battery backup of write buffer	*Concept 810SW has SCSI-2 interface i960 processor	

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE CONCEPTS
ARRAY MODEL	Concept 550	Concept 51	Concept 151	Concept 510	Concept 71 FCS
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Very High Perf.	Very High Perf.
MARKET	OEM, PCM	OEM, PCM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host Various	DEC, Sun, PC VMS, VME UNIX, DOS	VME Bus, PC-AT Proprietary	VME Bus, Q-Bus, PC-AT Proprietary	Any fiber channel host Proprietary
RAID level Configured by:	3 Host	3 Host, Preset	0/3 Host	3 Host	0/3 Host
Array capacity (Gbytes) MIN MAX	1.5 6	3 108	35.6 324	3 7.5	12 96
Minimum drives per array	2	2	18	2	5
Maximum drives per array	8	72	27	5	48
Concurrent host channels	1	2	2	2	1
Array interface to host	SCSI-2	Proprietary	Proprietary	Proprietary	FSC, IPI-3
Drive interface	ESDI	ESDI	ESDI	ESDI	IPI-2
Cache size (min, max: MB)	None	.25, 1	2.3, 3.5	.25, 1	1, 4
Cache function (Read, Write)	None	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	Yes Yes Yes
Spare drive (None/Auto/Manual)	No	No	No	No	No
ARRAY PERFORMANCE: Boot from array?	Yes	No	No	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 3	20 2.75	20 2.75	12 3	100 5.22
DRIVES: Formatted capacity/drive(MB)	1320	1320	1320	760	1760
Nominal disk diameter, height	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm
Average positioning time (msec)	14	14	14	Drive dependent	12
Average rotational delay (msec)	8.3	8.3	8.3	Drive dependent	5.58
Drive models	Hitachi DK516-15	Hitachi DK516-15	Hitachi DK516-15	Various	IBM
ARRAY SIZE: Inches: H x W x D	28.5 x 11.25 x 30	8.75 x 19 x 30	30.5 x 19 x 30	5.25 x 19 x 27	7 x 19 x 19.5
POWER: Power backup	450 watts None	800 watts None	2400 watts None	Drive dependent None	Drive dependent Cache battery
FIRST CUSTOMER SHIPMENT	2/91	4/89	7/92	1/91	4/93
COMMENTS	Rack mount or desk side tower				

MANUFACTURER	STORAGE CONCEPTS	STORAGE CONCEPTS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	Concept 71	Concept 71-SW	LANStor-CDA-06	LANStor-CDA-08	LANStor-CDAB-08
DISK/TREND GROUP	Very High Perf.	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM, PCM	OEM, PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	VME bus, PC AT, Proprietary	SCSI host Proprietary	PC compatible NetWare	PC compatible NetWare	PC compatible NetWare
RAID level Configured by:	3 Host, Preset	3 Host, Preset	0/5 Host	0/5 Host	0/5 Host
Array capacity (Gbytes) MIN MAX	8 96	8 96	6.4 102.4	8.4 134.4	8.4 134.4
Minimum drives per array	4	4	5	5	5
Maximum drives per array	48	48	80 + spare*	80 + spare*	80 + spare*
Concurrent host channels	1	1	1	1	1
Array interface to host	Proprietary	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Drive interface	IPI-2	IPI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	N/A	N/A	1	1	1
Cache function (Read, Write)	N/A	N/A	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)	No	No	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	No	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	24+ 4.16	24+ 4.16	10 5	10 5	10 5
DRIVES: Formatted capacity/drive(MB)	1760	1760	1600	2101	2105
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm
Average positioning time (msec)	12	12	10	10	8
Average rotational delay (msec)	5.58	5.58	5.56	5.56	4.17
Drive models	IBM	IBM	DEC DSP3160	DEC DSP3210	Seagate ST12550
ARRAY SIZE: Inches: H x W x D	7 x 19 x 19.5	7 x 19 x 19.5	7 x 17 x 21	7 x 17 x 21	7 x 17 x 21
POWER: Power backup	Drive dependent None	Drive dependent None	250 watts None	250 watts None	250 watts None
FIRST CUSTOMER SHIPMENT	9/93	11/93	1993	1993	1993
COMMENTS			AT&T controller *Nonoperating spare. EISA, ISA Micro Channel adapter avail.	AT&T controller *Nonoperating spare. EISA, ISA Micro Channel adapter avail.	AT&T controller *Nonoperating spare. EISA, ISA Micro Channel adapter avail.

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE DIMENSIONS
ARRAY MODEL	LANStor-CDAL-04	LAN6-FEP-RC RAIDCard System	LAN7-FE-RC	RaidMaster	ReFlex
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	Software	Subsystem
Host platform, software environment	PC compatible NetWare	PC compatible NetWare, OS/2	PC compatible NetWare, OS/2	PC compatible NetWare	PC compatible NetWare
RAID level Configured by:	0/5 Host	0/1/5 Host	0/1/5 Host	0/1/5 Host	0/1 Host
Array capacity (Gbytes) MIN MAX	4.2 67.2	1 25.2	1 29.4	Drive dependent Drive dependent	1.05/.525 25.2/12.5
Minimum drives per array	5	3	3	3	2
Maximum drives per array	80 + spare*	12	14	28	24
Concurrent host channels	1	1, 2	1, 2	1	1
Array interface to host	SCSI-2	SCSI-2,EISA,MCA	SCSI-2,EISA,MC	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1	4, 64	4, 64	N/A	1
Cache function (Read, Write)	Read, Write	Read, Write	Read, Write	N/A	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes	No Yes Yes	No No No	N/A N/A N/A	With duplexing Yes Option
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto-background	Auto-background	Auto-backg,fore	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	33 10	33 10	10 5	10 5
DRIVES: Formatted capacity/drive(MB)	1050	545, 1050, 2105	545, 1050, 2105	Drive dependent	525-2100
Nominal disk diameter, height	3.5", 25.4 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent	3.5", 41.3 mm
Average positioning time (msec)	9	8*	8*	Drive dependent	14-9.5
Average rotational delay (msec)	5.56	4.17*	4.17*	Drive dependent	6.8, 5.56
Drive models	Seagate ST31200	Seagate ST12550	Seagate ST12550	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17 x 21	7 x 17 x 21	7 x 17 x 21	N/A	7 x 17 x 21
POWER: Power backup	250 watts None	250 watts None	250 watts None	N/A N/A	250 watts None
FIRST CUSTOMER SHIPMENT	1993	1993	1993	3Q93	1993
COMMENTS	AT&T controller *Nonoperating spare. EISA, ISA Micro Channel adapter avail.	*ST12550 With Mylex controller	*ST12550 With Mylex controller	Modified Integra array software	Requires RaidMaster controller array

MANUFACTURER	STORAGE DIMENSIONS	STORAGE DIMENSIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS	STORAGE SOLUTIONS
ARRAY MODEL	ReFlex-P	ReFlex-X	CM-02 RACa-ray	CM-03 RACa-ray	CM-04 RACa-ray
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
Host platform, software environment	PC compatible NetWare	PC compatible NetWare	Various	EISA, MCA, Sun, RS/6000	Various
RAID level Configured by:	0/5 Host	0/5 Host	0/3/5 Serial Port	0/3/5 Host, Port	0/3/5 Serial Port
Array capacity (Gbytes) MIN MAX	1.05/.525 25.2/12.5	2.1/1.05 50.4/25.2	4 60	3 20	4 60
Minimum drives per array	2	2	5	3	5
Maximum drives per array	24	24	35	5	35
Concurrent host channels	1	1	1	1, 2	1, 2
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	--	--	4, 128
Cache function (Read, Write)	Read, Write	Read, Write	--	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	With duplexing Yes Yes	With duplexing Yes Yes	No Yes Yes	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Manual-backgrnd	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 5	10 5	20 10	20 10	20 20
DRIVES: Formatted capacity/drive(MB)	525-2100	525-2100	1050,2160,4200	1050,2160,4200	1050,2160,4200
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5",25.4/41.3m	3.5",25.4/41.3m	3.5",25.4/41.3m
Average positioning time (msec)	14-9.5	14-9.5	8.5/9.2/8.4	8.5/9.2/8.4	8.5/9.2/8.4
Average rotational delay (msec)	6.8, 5.56	6.8, 5.56	5.6/5.6/4.17	5.6/5.6/4.17	5.6/5.6/4.17
Drive models	Various	Various	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	7 x 17 x 21	7 x 17 x 21	18.3 x 8.1-26.3 x 14.5	18.3 x 8.1-26.3 x 14.5	18.3 x 8.1-26.3 x 14.5
POWER: Power backup	250 watts None	250 watts None	180-420 watts None	180-420 watts None	180-420 watts None
FIRST CUSTOMER SHIPMENT	1993	1993	6/93	6/94	9/94
COMMENTS	Requires RaidMaster controller array	Requires RaidMaster controller array	Digi-Data controller	Digi-Data controller	Digi-Data controller

MANUFACTURER	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STORAGE TECHNOLOGY	STRATUS COMPUTER	SUN MICROSYSTEMS
ARRAY MODEL	Alpine 9600	Iceberg 9200	Nordique 9100	D600 (K121)	Online: DiskSuite 1.0
DISK/TREND GROUP	Net/Mini/Multi	Mainframe	Mainframe	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Software
Host platform, software environment	AS/400 OS/400	IBM mainframe MVS/XA-ESA, VM/XA-ESA	IBM mainframe MVS/XA-ESA, VM/XA-ESA	Stratus VOS/FTX	Sun SPARC Solaris
RAID level Configured by:	5 Panel	5+ Host	5 Service func.	1 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	10.2 25.7	100* 400*	15 120	.319 Varies by syst.	Drive dependent Drive dependent
Minimum drives per array	10	32	10	2	2
Maximum drives per array	24	128/string	80	Varies by syst.	128
Concurrent host channels	4	12	4	2, 10	--
Array interface to host	IPI	IBM	IBM	Proprietary	--
Drive interface	SCSI	ESDI	SCSI-2	SCSI	--
Cache size (min, max: MB)	0	64, 512	128, 1024	--	--
Cache function (Read, Write)	0	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	Option -- --
Spare drive (None/Auto/Manual)	Auto	Auto	None	Manual-backgrnd	Auto-background
ARRAY PERFORMANCE: Boot from array?	--	--	--	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent 5	4.5 2.8*	4.5 6	5 Drive dependent	Drive dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	1342	1450	1890	*	Drive dependent
Nominal disk diameter, height	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 41.3 mm	5.25"	Drive dependent
Average positioning time (msec)	13.5	13.5	8 RD/9 WR	Drive dependent	Drive dependent
Average rotational delay (msec)	7.5	7.5	4.17	Drive dependent	Drive dependent
Drive models	H-P	H-P	Seagate Barracuda	D602, D603, D604, D605	Various
ARRAY SIZE: Inches: H x W x D	62.1 x 32 x 36.3	72 x 27.7 x 32	72 x 34 x 74	Varies	--
POWER: Power backup	2.6 KVA Battery	3.3 KVA	5.5 KVA	Drive dependent Battery	-- --
FIRST CUSTOMER SHIPMENT	9/92	1994	1993	3/91	9/91
COMMENTS	Mfg. by Array Technology	*Assumes 2.6x data compression	Mfg. by Data General	*Drive capacity D602: 319 MB D603: 665 MG D604: 1460 MB D605: 3200 MB	

MANUFACTURER	SUN MICROSYSTEMS	TANDEM COMPUTERS	TANDEM COMPUTERS	TANGENT COMPUTER	TANGENT COMPUTER
ARRAY MODEL	SPARCstorage Model 100	4500	4510	Multiserver-2	Driveserver-2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive	Captive	Captive, PCM	Captive, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SPARC servers Solaris	Tandem Nonstop	Tandem Nonstop	Tangent NetWare, UNIX, OS/2, NT, Other	Tangent NetWare, UNIX, OS/2, NT, Other
RAID level Configured by:	0/1/5* Host	1 Host	1 Host	0/1/"6"* Host	0/1/"6"* Host
Array capacity (Gbytes) MIN MAX	6.3/3.2/5.3 31.3/15.7/26.1	2 6	4 12	Drive Dependent	Drive Dependent
Minimum drives per array	6	2	2	2	2
Maximum drives per array	30	6	6	10	10
Concurrent host channels	1, 2	2	2	1, 4	1, 4
Array interface to host	S-bus/Fibre	SCSI over fiber	SCSI over fiber	EISA	EISA
Drive interface	SCSI-2	SCSI	SCSI	SCSI-2	SCSI-2
Cache size (min, max: MB)	4	0, 56	0, 56	.512, 16	.512, 16
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 No	Yes Yes Yes	Yes Yes Yes	Duplexing Option Option	Duplexing Option Option
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Auto-background	Auto-background	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	25/50 duplexed 20	1900 2400	2500 4500	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	1050	1000	2000	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 25.4 mm	5.25", 82.6 mm	5.25", 82.6 mm	3.5", 5.25"	3.5", 5.25"
Average positioning time (msec)	9	15	12	Drive dependent	Drive dependent
Average rotational delay (msec)	5.56	8.3	5.6	Drive dependent	Drive dependent
Drive models	Seagate	Various	Various	Seagate, DEC	Seagate, DEC
ARRAY SIZE: Inches: H x W x D	8.94 x 21.06 x 19.46	10.5 x 25 x 36	10.5 x 25 x 36	Varies	Varies
POWER: Power backup	 Cache battery	180 watts Dual AC	180 watts Dual AC	300 watts None	300 watts None
FIRST CUSTOMER SHIPMENT	2Q94	4Q91	3Q93	1993	1993
COMMENTS	*Can operate as combined RAID 1/RAID 0			*RAID "6" is combined RAID 1/RAID 0	External mount version of Multiserver-2. *RAID "6" is combined RAID 1/RAID 0

MANUFACTURER	TANGENT COMPUTER	TANGENT COMPUTER	TD SYSTEMS	TD SYSTEMS	TEXAS MICROSYSTEMS
ARRAY MODEL	Multiserver-3	Raid5server	OMNISERVE 2	OMNISERVE 3	FTSA-ES
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive, PCM	Captive, PCM	OEM, PCM	OEM, PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Board	Board	Subsystem
Host platform, software environment	Tangent NetWare, UNIX, OS/2, NT, Other	Tangent NetWare, UNIX, OS/2, NT, Other	All SCSI hosts Various	All SCSI hosts Various	Texas Micro DOS, OS/2, NT
RAID level Configured by:	0/1/"6"* Host	0/1/4/5 Host	0/1 Preset	0/1 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive Dependent	Drive Dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	1	2	2	2
Maximum drives per array	10	35	14	14	3
Concurrent host channels	1, 4	1	1, 2	1, 2	1
Array interface to host	EISA	EISA	SCSI-2	SCSI-2	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	.512, 16	--	--	--	--
Cache function (Read, Write)	Read, Write	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Duplexing Option Option	Option Option Option	-- -- --	-- -- --	No No Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto-background	Manual-backgrnd	Manual-backgrnd	None-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	10/20 10/20	10/20 10/20	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	540-2000
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	Drive dependent	Drive dependent	3.5", 41.3 mm
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	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	Varies	Varies	1.625 x 5.75 x 8.25	1.625 x 5.75 x 8.25	7 x 16.9 x 16
POWER: Power backup	300 watts None	450 watts None	10-20 watts --	10-20 watts --	110 watts Internal UPS
FIRST CUSTOMER SHIPMENT	1994	1993	1/93	1Q94	1993
COMMENTS	*RAID "6" is combined RAID 1/RAID 0 Pentium based	Software array Tower or rack mount	Options to connect up to 5 hosts; dual ported controllers	Options to connect up to 5 hosts; dual ported control. Fast and wide SCSI version	Rack mount option

MANUFACTURER	TEXAS MICROSYSTEMS	TEXAS MICROSYSTEMS	THINKING MACHINES	TOTAL TEC SYSTEMS	TRANSOFT
ARRAY MODEL	FTSA-LT	FTSA-PC	CM-5 Scalable Disk Array	TRAID	DataDock T1000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Very High Perf.	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	Captive	PCM	OEM, PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	Texas Micro DOS, OS/2, NT	Texas Micro DOS, OS/2, NT	CM-5 systems UNIX NFS	DEC, SCSI host UNIX, NT, NetWare, VMS	PC, Macintosh UNIX
RAID level Configured by:	0/1 Host	0/1 Host	3 Host	0/3/5 Host	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	7.2 3238.0	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	2	2	8	5	3
Maximum drives per array	4	3	3072	28	5
Concurrent host channels	1	1	384	1, 3	1-5
Array interface to host	ISA	ISA	Proprietary(NI)	SCSI-2, DSSI	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	3, 1536	32	--
Cache function (Read, Write)	--	--	Read	Read, Write	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	No No Yes	Optional Optional Optional	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	None-background	None-background	Auto-background	Auto-background	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	8 5	8 5	4224 10	10, 4 10	20 10
DRIVES: Formatted capacity/drive(MB)	540-2000	540-2000	1200	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	3.5", 41.3 mm	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	9.4	Drive dependent	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	7	Drive dependent	Drive dependent
Drive models	Various	Various	IBM Corsair IIE	Seagate, DEC RZ	Various
ARRAY SIZE: Inches: H x W x D	7 x 16.9 x 16	7 x 16.9 x 16		22.25 x 7.25 x 22.5	14 x 7.5 x 16.5
POWER: Power backup	100 watts Internal UPS	110 watts Internal UPS	Varies	170 watts Cache battery	200 watts None
FIRST CUSTOMER SHIPMENT	1Q94	1993	10/92	4Q93	4Q92
COMMENTS	Rack mount option	Rack mount option	Scalable	CMD Technology controller Rack mount version available	AT&T ADP-93 controller

MANUFACTURER	TRANSOFT	TRICORD SYSTEMS	TRICORD SYSTEMS	TRILLIUM RESEARCH	TRILLIUM RESEARCH
ARRAY MODEL	DataDock T2000	ISS	PowerRaid/ Enhanced IIOP	REMUS LTD.	REMUS 1.2
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Single User	Net/Mini/Multi
MARKET	OEM, PCM	Captive	Captive	PCM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Board	Software	Software
Host platform, software environment	PC, Macintosh UNIX	ES/4000,ES/5000 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
RAID level Configured by:	0/1/3/5 Host	0/1/4/5 Host	0/1 Host	0/1 Host	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	.500 8396	Drive dependent 70	Drive dependent 70
Minimum drives per array	3	2	2	2	2
Maximum drives per array	20	28	14	6	6
Concurrent host channels	1-5	--	--	1	1, 2
Array interface to host	SCSI-2	Proprietary	Proprietary	NuBus, SCSI	NuBus, SCSI
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)	Yes-up to 4 Yes Yes	Yes Yes Yes	Yes Yes Yes	N/A N/A N/A	N/A N/A N/A
Spare drive (None/Auto/Manual)	Manual-backgrnd	Auto-background	Auto-background	Manual-backgrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	267 20	133 10	Board dependent Drive dependent	Board dependent Drive dependent
DRIVES: Formatted capacity/drive(MB)	Drive dependent	520-3000	520-3000	Drive dependent	Drive dependent
Nominal disk diameter, height	Drive dependent	3.5", 5.25"	3.5", 5.25"	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	DD500FT,DD3000H DD1000-2100FT	D500F, D1000F3, D2100F, D3000H	Various	Various
ARRAY SIZE: Inches: H x W x D	28.5 x 12.5 x 28	--	--	N/A	N/A
POWER: Power backup	400 watts None	-- None	-- UPS	N/A	N/A
FIRST CUSTOMER SHIPMENT	4Q92	4/93	6/92	1Q94	3Q93
COMMENTS	AT&T ADP-93 controller	Board mounts to system back panel	Board mounts on subsystem motherboard	Operates with controller from ATTO, FWB, Seraph,Buslogic Sixty-Eight Thousand	Operates with controller from ATTO, FWB, Seraph,Buslogic Sixty-Eight Thousand

MANUFACTURER	TWINCOM	TWINCOM	TWINCOM	ULTRASTOR	ULTRASTOR
ARRAY MODEL	Dual Mirror	Multi Mirror	Network Mirror	124F	144F
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	OEM
ARRAY CONFIGURATION: Type	Software	Software	Software	Board	Board
Host platform, software environment	Various Most UNIX versions	Various Most UNIX versions	Various Most UNIX versions	PC compatible UNIX, NetWare, OS/2, DOS	SCSI host UNIX, NetWare, OS/2, DOS
RAID level Configured by:	1 Preset	1 Preset	1 Preset	0/1/4/5 Host	0/1/3/4/5 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	1	1
Maximum drives per array	2	32	32	35	35
Concurrent host channels	1, 2	1, 4	1, 4	1	1
Array interface to host	Host dependent	Host dependent	Host dependent	EISA Bus	SCSI-2
Drive interface	Drive dependent	Drive dependent	Drive dependent	SCSI, SCSI-2	SCSI, SCSI-2
Cache size (min, max: MB)	Host dependent	Host dependent	Host dependent	*	*
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	-- -- --	-- -- --	-- -- --	No No No	No No No
Spare drive (None/Auto/Manual)	Manual, Auto	Manual, Auto	Manual, Auto	Auto-backg,fore	Auto-backg,fore
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Host dependent Drive dependent	Host dependent Drive dependent	Host dependent Drive dependent	33 max. 10 max.	20 max. 10 max.
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	Any supported by OS	Any supported by OS	Various	Various
ARRAY SIZE: Inches: H x W x D	--	--	--	4.5 x 13	1.625 x 5.75 x 8
POWER: Power backup	-- --	-- --	-- --	15 watts	15 watts
FIRST CUSTOMER SHIPMENT	1986	1989	1992	2/92	12/92
COMMENTS	Mirrors system disk	Mirrors multiple pairs	Mirrors over a network	*1 MB buffer	*1 MB buffer Supports command tag queing

MANUFACTURER	UNBOUND	UNBOUND	UNBOUND	UNBOUND	UNBOUND
ARRAY MODEL	MacRAID T-3	RAIDSTOR	RAIDSTOR-F5	RAIDSTOR-SLT3	RAIDSTOR-T3
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	OEM	OEM	OEM	OEM	OEM
ARRAY CONFIGURATION: Type	Subsystem	Board	Subsystem	Subsystem	Subsystem
Host platform, software environment	Mac Quadra System 7	SCSI host Solaris, UNIX, NetWare	SCSI host Solaris, UNIX, NetWare	SCSI host Solaris, UNIX, NetWare	SCSI host Solaris, UNIX, NetWare
RAID level Configured by:	0/3/5 Host, Preset	0/3/5 Host, Preset	0/3/5 Host, Preset	0/3/5 Host, Preset	0/3/5 Host, Preset
Array capacity (Gbytes) MIN MAX	5 50	7.5/6/6 70/56/56	7.5/6/6 140/112/112	7.5/6/6	7.5/6/6 70/56/56
Minimum drives per array	5	5	5	5	5
Maximum drives per array	35	35	35	5	35
Concurrent host channels	1, 5	1	1	1	1
Array interface to host	NuBus	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, 64	8, 64	8, 64	8, 64	8, 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	Option Yes Yes
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10	20 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, height	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	3.5", 41.3 mm	3.5", 41.3 mm
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	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8	3.25 x 5.75 x 8
POWER: Power backup	25 watts*	25 watts* None	25 watts*	25 watts*	25 watts*
FIRST CUSTOMER SHIPMENT	8/92	4/92	1/93	1/93	4/92
COMMENTS	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power	Digi-Data controller *Plus drive power

MANUFACTURER	UNISON INFORMATION SYSTEMS	UNISYS	UNISYS	UNISYS	UNISYS
ARRAY MODEL	RD5-1	MasCab-2	QCIC/PBAY	UCR 6000	M9760
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Mainframe
MARKET	PCM	Captive	Captive	Captive	Captive
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Subsystem	Subsystem
Host platform, software environment	SCSI host UNIX	Unisys UNIX	Unisys UNIX	U6000 UNIX	Unisys 2200, 1100 1100 O/S
RAID level Configured by:	0/3/5 Port	0/1 Host	0/1 Host	3 Preset	0/1 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	4 16	11.36 90.92
Minimum drives per array	3	2	2	4 + parity	4
Maximum drives per array	35	33	96	8 + 2 parity	32
Concurrent host channels	1	5	16	1	4
Array interface to host	DSSI, SCSI-2	EISA	Proprietary	SCSI-2	BMCFIPS61
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	1, 32	--	--	16, 64	128, 3072
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 No No	Option No No	No Yes Yes	Yes Yes Yes
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual	Manual	Manual-backgrnd	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	No	No	No	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	20 10	10 10	10 10	20 10	4.5 5
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1000-2000	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	3.5", 5.25"	3.5", 5.25"	3.5", 41.3 mm	5.25", 82.6 mm
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	Seagate	Various
ARRAY SIZE: Inches: H x W x D	20 x 20 x 23	26.5 x 12 x 17	22.75 x 19 x 30	7 x 19 x 26.5*	67.9 x 24.1 x 33
POWER: Power backup	1000 watts None	300watts+drives None	500 watts None	150 watts Battery	.7-2.79 KVA Battery
FIRST CUSTOMER SHIPMENT	4Q93	5/92	4/92	3/94	2Q92
COMMENTS	Digi-Data controller	Veritas software	Veritas software	*Rack mount tower also available	EMC controller

MANUFACTURER	UNISYS	UNISYS	UNISYS	UNITROL DATA PROTECTION SYSTEMS	VANGUARD TECHNOLOGIES
ARRAY MODEL	USP 2010	USR 3000	USR 4000	Immunity 2	ARRAYSERVER
DISK/TREND GROUP	Mainframe	Mainframe	Mainframe	Net/Mini/Multi	Net/Mini/Multi
MARKET	Captive	Captive	Captive	PCM, OEM	PCM
ARRAY CONFIGURATION: Type	Subsystem	Subsystem	Subsystem	Software	Subsystem
Host platform, software environment	Unisys 2200 series 051100	Unisys A,V,2200 series MCP, 051100	Unisys A,V,2200 series MCP, 051100	IBM PC Compat. PC/MS-DOS, most LANs, Windows	Vanguard
RAID level Configured by:	0/1 Host	0/1 Host	0/1 Host	1 Preset	0/1/4/5 Host
Array capacity (Gbytes) MIN MAX	15.8	2.4 6	1.6 4	Drive dependent Drive dependent	Drive dependent Drive dependent
Minimum drives per array	5	7	5	2	2
Maximum drives per array	20	7	5	2	14
Concurrent host channels	4	1, 2	1, 2	1, 2	1
Array interface to host	BMCFIPS6I, SCSI	SCSI-2	SCSI-2	IDE, SCSI	EISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	IDE, SCSI	SCSI-2
Cache size (min, max: MB)	--	--	--	1, host depend.	--
Cache function (Read, Write)	--	--	--	--	--
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Yes Yes Yes	NA Option Option	NA Option Option	-- -- --	No No Yes
Spare drive (None/Auto/Manual)	Man,Auto-backgr	Manual-backgrnd	Manual-backgrnd	Manual-foregrnd	Manual-backgrnd
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	--	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	4.5 5	10 10	10 10	-- Drive dependent	33 10
DRIVES: Formatted capacity/drive(MB)	1034-1970	805-1970	805-1970	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 5.25"	3.5", 5.25"	3.5", 5.25"	--	3.5", 5.25"
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	Various
ARRAY SIZE: Inches: H x W x D	70 x 34 x 36	5.1 x 19 x 29.7	6.9 x 19 x 32	--	25 x 9 x 18
POWER: Power backup	1.17 KVA None	.13 KVA None	.4 KVA None	-- --	250 watts None
FIRST CUSTOMER SHIPMENT	2Q94	1994	1993	1990	1Q93
COMMENTS	Software based array	Software based array Optional dual AC power	Software based array	Error logging to good disk Duplexing adapter avail. Network support	UltraStor 124F controller

MANUFACTURER	VERITAS SOFTWARE	VERITAS SOFTWARE	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	VxMirror	VxVM	GDT2000*	GDT2020	GDT3000A
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	Software	Board	Board	Board
Host platform, software environment	Various UNIX	Various SCO UNIX, UNIX SVR4.X	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 Host	0/1/5 Host	0/1	0/1/4/5	0/1
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
Maximum drives per array	Host dependent	Host dependent	14	14	35
Concurrent host channels	Host dependent	Host dependent	1-2	2	2-5
Array interface to host	--	Various	ISA	ISA	EISA
Drive interface	--	SCSI, ESDI, IDE	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--	--	1, 64	4, 64	4, 128
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 No
Spare drive (None/Auto/Manual)	Manual-backgrnd	Manual-backgrnd	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	--	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	Drive dependent Drive dependent	Drive dependent Drive dependent	8	8 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	Drive dependent	Various	Various	Various
ARRAY SIZE: Inches: H x W x D	--	--			
POWER: Power backup	-- --	-- --			
FIRST CUSTOMER SHIPMENT	1993	1991	1992	1993	1992
COMMENTS		Can mirror logical disks. Device driver independent. RAID 5 avail. 4/94.	RAID 4/5 upgradable		RAID 4/5 upgradable

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	VORTEX COMPUTERSYSTEME (ICP-VORTEX)
ARRAY MODEL	GDT3000B	GDT3010A	GDT3020A	GDT3050A	GDT6000
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	Board	Board	Board	Board	Board
Host platform, software environment	SCSI host 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	0/1/4/5	0/1/4/5	0/1
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	3	3	3	2
Maximum drives per array	7	7	35	35	35
Concurrent host channels	1	1	2-5	5	2-5
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)	1, 64	4, 64	4, 128	4, 128	--, 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-background	Auto-background	Auto-background	Auto-background	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	33 10	Drive dependent Drive dependent	33 10	33 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	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	1993	1993	1994
COMMENTS	Array operation requires upgrade to basic board				RAID 4/5 upgradable

MANUFACTURER	VORTEX COMPUTERSYSTEME (ICP-VORTEX)	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS
ARRAY MODEL	GDT6020	Flash RAID	FlashCluster CI	FlashDisk 2	FlashDisk Array
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	Subsystem	Subsystem
Host platform, software environment	PC compatible NetWare,OS/2,NT DOS,UNIX,Wind.	VAX, Alpha, Sun RS/6000,H-P,SGI	VAX, Alpha Open VMS	DEC, most workstations	PC compatible DOS, OS/2, NetWare, UNIX
RAID level Configured by:	0/1/4/5	0/3/5 Host, Panel	0/1/3/5 Host	1 Preset	0/1/3/5 Host
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent	3 112	1 1136	1 280	1 280
Minimum drives per array	3	3	1	1	1
Maximum drives per array	35	28	284	70	14
Concurrent host channels	2-5	1, 21	1, 6	5	5
Array interface to host	PCI	SCSI-2, DSSI	CI, DSSI	SCSI-2	EISA, ISA
Drive interface	SCSI-2	SCSI-2	SCSI-2	ESDI	SCSI-2
Cache size (min, max: MB)	--, 64	-, 32	-, 512	16, 560	4, 128
Cache function (Read, Write)	Read, Write	Read	Read	Read	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No No No	Option Option Option	Option Option Option	No Option Option	Option Option Option
Spare drive (None/Auto/Manual)	Auto-background	Auto-background	Auto-background	Manual	Auto-background
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	33 10	10 10	8.75/4 10	5 2.750	24 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	1300	Drive dependent
Nominal disk diameter, height	Drive dependent	3.5", 41.3 mm	3.5", 41.3 mm	5.25", 82.6 mm	Drive dependent
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	14	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	8.3	Drive dependent
Drive models	Various	Various	Various	Varies	Various
ARRAY SIZE: Inches: H x W x D		*	*	*	*
POWER: Power backup		Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent	Drive dependent Drive dependent
FIRST CUSTOMER SHIPMENT	1994	1Q94	12/93	6/92	12/93
COMMENTS		*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units	*Varies with tabletop, rack, pedestal units

MANUFACTURER	WINCHESTER SYSTEMS	WINCHESTER SYSTEMS	WYSE	ZENITH DATA SYSTEMS	ZZYXZ Workstations & Peripherals
ARRAY MODEL	FlashCluster DSSI	FlashServer EISA	7000 i Model 760	OASYS I	ZRS-3000
DISK/TREND GROUP	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi	Net/Mini/Multi
MARKET	PCM	PCM	PCM	Captive	PCM
ARRAY CONFIGURATION: Type	Subsystem	Board	Subsystem	Software	Subsystem
Host platform, software environment	VAX, Alpha Open VMS	PC compatible DOS, OS/2, UNIX NetWare	Wyse	EISA NetWare, UNIX, SCO, MS LAN Mgr	Sun, H-P, SGI, other
RAID level Configured by:	0/1/3/5 Host	0/1/3/5 Host	0/1 Host	5 Host	0/3/5 Host,Panel,Port
Array capacity (Gbytes) MIN MAX	1 1372	Drive dependent Drive dependent	Drive dependent Drive dependent	.6 6	Drive dependent Drive dependent
Minimum drives per array	1	1	2	3	2
Maximum drives per array	343	28	6	7	28
Concurrent host channels	5	1	1	1, 2	1, 3
Array interface to host	SCSI-2, DSSI	EISA	SCSI-2	SCSI-2	SCSI-2
Drive interface	SCSI-2	SCSI-2	SCSI-2	SCSI-2	SCSI-2
Cache size (min, max: MB)	--, 128	4, 128	.512, 16	--	8, 32
Cache function (Read, Write)	Read	Read, Write	Read, Write	--	Read, Write
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	Option Option Option	-- -- --	No No No	No No No	No Yes Yes-per drive
Spare drive (None/Auto/Manual)	Auto-background	Manual-backgrnd	Manual-backgrnd	Auto-background	Man,Auto-backgr
ARRAY PERFORMANCE: Boot from array?	Yes	Yes	Yes	Yes	Yes
Transfer rate: host (MB/Sec) drive (MB/Sec)	10, 4 10	33 6	10 10	10 10	10 10
DRIVES: Formatted capacity/drive(MB)	Drive dependent	Drive dependent	Drive dependent	Drive dependent	Drive dependent
Nominal disk diameter, height	3.5", 41.3 mm	Drive dependent	3.5", 41.3 mm	3.5", 1.6"	3.5", 41.3 mm
Average positioning time (msec)	Drive dependent	Drive dependent	Drive dependent	10.5	Drive dependent
Average rotational delay (msec)	Drive dependent	Drive dependent	Drive dependent	7	Drive dependent
Drive models	Various	Various	Various	Any SCSI	Micropolis Seagate
ARRAY SIZE: Inches: H x W x D	*	5.1 x 14.4	23.5 x 7.75 x 19.75	Internal to server	24 x 24 x 30
POWER: Power backup	Drive dependent Drive dependent	N/A None	630 None	384 watts UPS option	-- Cache battery
FIRST CUSTOMER SHIPMENT	12/93	1993	1993	1992	7/93
COMMENTS	*Varies with tabletop, rack, pedestal units		DPT controller	Tower mounted 2-server subsystem Integra software	CMD CR5000 controller

MANUFACTURER	ZZYXZ Workstations & Peripherals				
ARRAY MODEL	ZRS-5000				
DISK/TREND GROUP	Net/Mini/Multi				
MARKET	PCM				
ARRAY CONFIGURATION: Type	Subsystem				
Host platform, software environment	Sun, H-P, SGI, other				
RAID level Configured by:	0/3/5 Host, Panel, Port				
Array capacity (Gbytes) MIN MAX	Drive dependent Drive dependent				
Minimum drives per array	2				
Maximum drives per array	28				
Concurrent host channels	1, 3				
Array interface to host	SCSI-2				
Drive interface	SCSI-2				
Cache size (min, max: MB)	8, 32				
Cache function (Read, Write)	Read, Write				
Redundancy: Controller (Yes/No) Fan (Yes/No) Power supply (Yes/No)	No Yes Yes-per drive				
Spare drive (None/Auto/Manual)	Man, Auto-backgr				
ARRAY PERFORMANCE: Boot from array?	Yes				
Transfer rate: host (MB/Sec) drive (MB/Sec)	10 10				
DRIVES: Formatted capacity/drive(MB)	Drive dependent				
Nominal disk diameter, height	5.25", 82.6 mm				
Average positioning time (msec)	Drive dependent				
Average rotational delay (msec)	Drive dependent				
Drive models	Micropolis Seagate				
ARRAY SIZE: Inches: H x W x D	24 x 24 x 30				
POWER: Power backup	-- Cache battery				
FIRST CUSTOMER SHIPMENT	7/93				
COMMENTS	CMD CR5000 controller				

MANUFACTURER PROFILES

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 normally estimates the annual volume of disk drive array sales by manufacturers. Because few companies had a high level of disk drive array sales in 1993, this figure is reported explicitly only for firms with major 1993 sales. "1993 total net sales" covers the fiscal year ending in 1993 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, 1993, 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 1993 is used, as cited by the Federal Reserve Bulletin.

Country	Currency	Currency units/U.S. dollar
Canada	Canadian dollar	1.29
France	French franc	5.67
Germany	Deutschmark	1.65
Japan	Yen	111.0
Taiwan	Taiwan dollar	26.4
United Kingdom	Pound	.667

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.

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 does not offer a board level array product, it has offered array software bundled with some controllers, using software products from Integra and other firms.

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 DIGITAL INFORMATION CORPORATION (ADIC)
14737 NE 87th Street
Redmond, WA 98073

ADIC was formed in 1983 as a backup solutions provider for the PC market and has expanded its product line to include tape and optical storage subsystems. The company has indicated it is considering introducing a disk drive array in 1994. An appropriate fault tolerant enclosure and drive subsystem for use with Novell SFT III and other duplexing systems has already been announced.

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 is anticipated to begin in late 1994, at which time the firm is expected to ship a PCI bus array controller operating in RAID-0/1/3/5 modes.

AMPERIF CORPORATION
9232 Eton Avenue
Chatsworth, CA 91311-4296

Amperif Corporation was founded in 1976, and for many years existed primarily as a producer of high capacity, high performance disk subsystems for the Sperry mainframe computer marketplace. In December, 1992, Amperif announced its Viking development program for a disk array RAID-5 subsystem, targeted at the IBM mainframe on-line transaction processing (OLTP) market. The Viking program took longer than planned, and distribution arrangements with Memorex Telex and Comparex faded away during 1993. Storage Technology purchased Amperif in October, 1993, and is continuing the Viking development program, but no timetable for market introduction has been announced.

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.

AREAL TECHNOLOGY
2075 Zanker Road
San Jose, CA 95131

Founded in 1988, Areal became an early producer of 2.5" disk drives and was the first to incorporate glass media in the 2.5" form factor, thereby achieving unusually high drive capacity. The firm worked with Allodyne to develop a 5.25" form factor disk drive array family with arrays containing five or nine 2.5" drives, but decided its priorities lay in other directions and cancelled its array program in mid-1993.

ARRAY TECHNOLOGY CORPORATION (Subsidiary of Tandem Computers)
4775-B Walnut Street
Boulder, CO 80301

Array Technology was originally started in 1987 with funding from Seagate Technology to develop high performance arrays, and was later sold to the management group. With the need for further funding, Array Technology was sold to Tandem Computers in April, 1990, and operated as a wholly owned subsidiary of Tandem.

Array Technology specialized in designing RAID-0/1/3/5 arrays with a high degree of fault tolerance. Arrays sold under its own name used up to 20 high capacity 5.25" drives and were marketed for the UNIX workstation market. After the agreement to manufacture the Alpine array for sale by a Storage Technology subsidiary in the IBM AS/400 market ended in recriminations and lawsuits in 1993, the company was sold to EMC and currently exists only as a development facility.

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. While not offering an array as of the second quarter of 1994, the firm has indicated that it will offer array controller modules that plug into its existing subsystem models later in 1994.

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 the "Stallion" 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

1993 total net sales: $1,412,150,000 (FY ending 6/27/93) Net income: ($53,738,000)

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.

ASTRIX COMPUTER CORPORATION (Subsidiary of Four D Corporation)
1546 Centre Point Drive
Milpitas, CA 95035

Astrix, founded in 1989, manufactured fault tolerant servers and workstations incorporating disk drive arrays. A European marketing headquarters was established in Katowice, Poland. The company employed purchased controllers to fabricate the array subsystems. The servers operated in RAID-5 mode, while the workstations could operate as RAID-5 or RAID-1/0 depending upon the controller used. Astrix ceased operations in late 1993.

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

1993 total net sales: $67,156,000,000 Net income: ($3,794,000,000)

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.

AT&T coordinates its array activities through the former NCR Peripheral Products Division in Wichita, Kansas. The firm 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. AT&T also offers 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.

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

1993 total net sales: $21,763,000 Net income: $8,126,000

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. 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 Microsystem workstations is a major objective of Auspex, and the company has also licensed the controller used by IBM in the recently announced 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 1994, was considering doing so later in the year.

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-5 and RAID-0 operating modes.

BLUE LANCE
1700 West Loop South, Suite 1100
Houston, TX 77027

Blue Lance is a system integrator and software development firm specializing in Novell network management tools. Purchased hardware and software elements are integrated into array subsystems (less drives) which are sold through other VARs and integrators who add the disk drives. Blue Lance also sells a limited number of subsystems. The firm has a strong customer base for custom services in the metropolitan Houston area. In late 1993, Blue Lance decided not to integrate array subsystems, redirecting its efforts toward custom software development for its customers.

BOX HILL SYSTEMS CORP.
161 Avenue of the Americas, Suite 903
New York, NY 10013

Privately held Box Hill 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 with support for several popular minicomputers.

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, now 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. While BusLogic's original controllers did not include specific support for arrays, controllers shipping in the Spring of 1994 have RAID-0, 1, 3 and 5 functionality.

CAMBEX CORPORATION
360 Second Avenue
Waltham, MA 02154

1993 total net sales: $46,160,000 (FY ending 8/31/93) Net income: ($2,407,000)

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.

CAMBRIDGE TECHNOLOGIES
9265 Activity Road
San Diego, CA 92126

Cambridge Technologies was founded in October, 1991, to design, manufacture and market a line of RAID disk array PCBs and subsystems. The company's first product was its model CDA 3003-ISA, which was designed to manage an array of three IDE interface disk drives while providing higher data availability, disk fault tolerance and higher performance.

The CDA 3003-ISA utilizes a proprietary technique for implementing several features of various RAID levels simultaneously. The CDA 3003-ISA is a plug replacement product for previous generations of Western Digital WD1003 disk controllers. By utilizing this design approach, the CDA 3003-ISA is fully compatible with existing BIOS and Operating Systems and requires no special software drivers for proper system operation. Also featured is an RS-232 serial port, the ability to provide remote status and transparent data compression. The CDA 3003-ISA was followed by RAIDPAK, a disk subsystem featuring up to three Western Digital disk drives packaged in a 5.25" footprint box along with the CDA 3003-ISA RAID controller board and associated cables and hardware.

Because the original design of the Cambridge array controller could not accommodate drives with capacities exceeding 512 megabytes, the CDA 3003 and related products were withdrawn in 1993. Cambridge expects to reenter the market in the second half of 1994 with new disk drive arrays.

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 early 1994, the firm announced future availability of a disk array subsystem providing RAID-0/1/3/5 capabilities. Drives, fans and power supplies can be hot-swapped. The array will attach to SCSI interfaced hosts and will operate with UNIX, Windows NT, or OS/2. Production is planned for the second quarter of 1994.

CHANTAL SYSTEMS (A Division of BusLogic)
7220 Trade Street
San Diego, CA 92121

Chantal Systems was founded in 1978 to provide software products for the UNIX and the Novell NetWare environments. Its early product NetCal, is a Novell NetWare work group scheduler product. In June of 1990, Chantal introduced its first RAID software product, the PARAGON Disk Array Software (DAS) for the UNIX world, and in November of 1991 followed with a Novell NetWare version of PARAGON. An updated version of PARAGON with greatly improved RAID-5 performance and other improvements was introduced in February, 1993. Chantal was purchased by BusLogic in 1993 and its products were folded into the BusLogic product line.

The PARAGON software is a RAID 0, 1 or 5 implementation aimed at 386 and 486 class computer platforms. Its CORNERSTONE software product is a subset of the PARAGON RAID package and functions as a standard SCSI device driver under UNIX and Novell NetWare environments. 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 PARAGON RAID software is compatible with systems utilizing the EISA, ISA and Micro Channel bus architectures.

CIPRICO, INC.
2800 Campus Drive
Plymouth, MN 55441

1993 total net sales: $9,213,000 (FY ending 9/30/93) Net income: ($1,777,000)

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. Current models utilize 5 to 9 drives, with capacity dependent upon a variety of possible drive models.

CLEARPOINT RESEARCH CORPORATION
35 Parkwood Drive
Hopkinton, MA 01748

Clearpoint was founded in 1982 as a manufacturer and distributor of add-in solid state memory, and later added disk drive and tape drive subsystems for the DEC market. In September, 1992, the company announced its Freedom disk drive array series, RAID-0/3/5 subsystems intended for DEC, Sun, IBM and H-P system markets. However, poor business results caught up with the firm in late February, 1993, and Clearpoint dismissed most of its employees and closed most of its facilities. The product line was eventually sold to Peak Technologies.

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. Over the intervening years 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.

CMS ENHANCEMENTS
2722 Michelson Drive
Irvine, CA 92715

CMS Enhancements is a manufacturer and distributor of computer add-on and add-in equipment and software. The firm has undergone recent management changes and is planning to change 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, but hardware based arrays are planned for addition during 1994.

COMPAQ COMPUTER CORPORATION
20555 SH 249
Houston, TX 77070

1993 total net sales: $7,191,000,000 Net income: $462,000,000

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 arrays than any other supplier. The array product line underwent extensive revision in 1993, with almost all array based systems being replaced with newer versions.

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 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.

CONCURRENT COMPUTER CORPORATION
2 Crescent Place
Oceanport, NJ 07757

1993 total net sales: $220,464,000 Net income: $3,869,000
(FY ending 6/30/93)

Concurrent started life as Interdata, a supplier of minicomputers, in 1966. The firm was subsequently purchased by Perkin-Elmer and operated as a subsidiary 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 available for Concurrent's systems using IPI interfaced disk drives.

CONLEY CORPORATION
16 West 22nd Street
New York, NY 10010

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.

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

Established when Conner Peripherals acquired Archive, Conner SSG provides a variety of 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.

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

Consensys offers an array controller that can support 8 IDE drive channels, 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

1993 total net sales: $451,835,000 (FY ending 1/2/94) Net income: $9,120,000

The existing Control Data Systems organization resulted from the continuing 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 current products include mainframe computers, UNIX-based servers and workstations, peripherals, system software and application hardware. The firm is undergoing a planned transition from a mainframe 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 equity 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. Existing array products are RAID-0/3 configurations, used with both mainframes and UNIX networks, with the ability to utilize up to 32 high performance 5.25" and 8" drives.

CONVEX COMPUTER CORPORATION
3000 Waterview Parkway
Richardson, TX 75080

1993 total net sales: $193,119,000 Net income: ($61,304,000)

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, reservoir simulation, 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 position in CONVEX by Hewlett-Packard. Part of this agreement included an announcement 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.

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 array controller in the form factor of a full size 5.25" drive.

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.

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

1993 total net sales: $894,857,000 Net income: $60,855,000

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 current RAID-3 capability is based on utilization of the DCA-3 disk array channel adapter, which is a RAID-3 controller capable of handling 40 IPI-2 parallel transfer drives. The high performance option using DD-60 drives has a potential capacity of over 62 gigabytes and sustained transfer rate of 80 megabytes per second. The high capacity option using DD-62 drives offers over 87 megabytes capacity and a peak transfer rate of 32 megabytes per second. Late in 1993, Cray Research also added RAID-1/5 arrays capable of 67 megabytes per second transfer rates, using a subsystem purchased on an OEM basis from IBM, utilizing Maximum Strategy's controllers.

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

Dallas Digital is a system reseller and storage subsystem integrator. Together with Datalink and Cranel Corporation, Dallas Digital is a member of the Tripac joint venture that creates products saleable by all three companies, including disk drive arrays, and is expected to initiate an array program in 1994.

DATA GENERAL CORPORATION
4400 Computer Drive
Westboro, MA 01580

1993 total net sales: $1,077,869,000 (FY ending 9/26/93) Net income: ($60,479,000)

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. First introduced in 1989, the AViiON product line generated revenues exceeding $300 million in the 1992 fiscal year. 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 product for captive sales, which has already been superseded by later generations, 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, and Storage Technology.

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 saleable 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.

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 are based upon CMD controllers, Seagate drives and a variety of array enclosures.

DELL COMPUTER CORPORATION
9505 Arboretum Blvd.
Austin, TX 78758

1993 total net sales: $2,873,165,000 (FY ending 1/31/94) Net income: ($39,024,000)

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.

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

1993 total net sales: $14,371,369,000 (FY ending 7/3/93) Net income: ($251,330,000)

Digital Equipment is 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 has aggressively developed high capacity 3.5" and 5.25" drives, for both captive and OEM sales.

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. Most of the announced subsystems operate in RAID-0/1/3/5 modes.

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 several different array controllers from third parties, including Raidtec, CMD, Storage Computer and TD Systems.

DISTRIBUTED PROCESSING TECHNOLOGY
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.

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.

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

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-5 arrays. The RAID-1 units 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.

EMC CORPORATION
171 South Street
Hopkinton, MA 01748

1993 total net sales: $782,621,000 (FY ending 1/1/94) Net income: $127,122,000

Established in 1979, EMC has become a born-again growth company in the last three 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 lack of equivalent disk drive array subsystems 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.

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.

In mid-1994 Encore will launch a RAID level 3 and 5 I/O subsystem which will incorporate the Interphase Cougar 4220 SCSI-2 host bus adapter module in the high performance data I/O path. This RAID offering will initially range in size from 6 to 32 gigabytes in capacity, utilizing 5.25" SCSI-2 disk drives, and supporting up to 15 I/O channels simultaneously with up to 572 megabytes of read/write cache. 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 INCORPORATED
2040 Polk Street, Suite 215
San Francisco, CA 94109

FWB is a supplier of add-on storage subsystems and other products to the Apple 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.

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 are built around the Ciprico controller and Seagate disk drives.

GIGATREND INCORPORATED
2234 Rutherford Road
Carlsbad, CA 92008

GigaTrend is a subsystem integrator with most of its activity in tape backup subsystems. In 1993, the firm announced a disk drive array using purchased controllers. The firm subsequently commenced an acquisition of UltraStor, but the Chapter 11 status of that firm had left the acquisition status uncertain as of the time of publication.

HAMMERMAN ASSOCIATES, INC.
6925 Oakland Mills Road
Columbia MD 21045

Hammerman Associates is a system integrator serving the Baltimore-Washington DC metropolitan area. Arrays provided by HAI will operate with NetWare, UNIX and DOS in RAID-0, RAID-1, RAID-3 or RAID-5 modes. A variety of purchased controllers is used.

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

1993 total net sales: $20,317,000,000 (FY ending 10/31/93) Net income: $1,777,000,000

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 5.25" and 3.5" high capacity drives, with both types used extensively with H-P computer systems. The OEM disk drive program has also proved to be successful for H-P. 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 H-P's visibility in the OEM market. H-P's credentials as an OEM disk drive producer were significantly enhanced with its announcement of the first 1.3" drive in 1992, with several mobile computer markets targeted.

Since early 1992, H-P has offered a family of RAID-0/1/3/5 arrays for UNIX workstation and multiuser applications, using both 5.25" and 3.5" H-P disk drives, supplemented in 1993 with an array program for personal computers, using Mylex controllers. H-P has had a long-standing array development activity, and the company is expected to become a significant competitor in several disk drive array markets.

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.
3130 De La Cruz Boulevard
Santa Clara, CA 95054

Integra, a major 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's current focus is to provide disk drive array technology on a licensed basis to system vendors at the OEM level. IBM, Zenith Data Systems and others currently offer software based arrays licensed from Integra. The company has entered into agreements with a number of companies, including Adaptec, allowing its software to be bundled with its partners' products.

INTERNATIONAL BUSINESS MACHINES CORPORATION
Route 22
Armonk, NY 10504

1993 total net sales: $62,716,000,000 Net income: ($7,987,000,000)

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 year and a half, 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 technology include 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 eventual choice of array technology for use with mainframe computers. EMC has developed a rapidly growing business during the last three years based on its Symmetrix heavily cached 5.25" 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 has been delayed at least until mid-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 later in the year, possibly reducing the appeal of competitive products such as the Iceberg. IBM's competitors expect the firm's first mainframe arrays to appear in the third quarter of 1994, utilizing the 9340 controller with a cached high performance array and the 9990 controller with a large, fault tolerant modified RAID-5 array.

INTERNATIONAL DATA SYSTEMS
12800 Garden Grove Boulevard
Building E
Garden Grove, CA 92643

IDS is a subsystem integrator offering SCSI and EISA interfaced storage subsystems. Its array offerings included the Espirit line of array subsystems, introduced in 1992 and updated in 1993 with larger capacity 3.5" disk drives. RAID modes 0/1/4/5 were supported. Shipments of arrays did not meet expectations and the firm elected to discontinue the array product line at the end of 1993.

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 model 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

1993 total net sales: $39,721,000 Net income: ($2,572,000)

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-0/5 arrays using 1 and 2 gigabyte 3.5" drives.

JABA SYSTEM INC.
80 Shields Court
Markham, Ontario L3R 9T5
Canada

A system integrator specializing in equipment for the Digital Alpha series, Jaba started up in the power supply business and expanded into computer systems in 1991. Disk drive arrays were introduced in late 1993 using third party array controllers.

JTS CORPORATION (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.

LAURA TECHNOLOGIES
Tentime Division
106 South 54th Street
Chandler, AZ 85226

Laura Technologies was founded in Australia but is now a Canadian based conglomerate. It was founded in 1970 and originally was a management services and real estate investment company. In 1991, the firm bought Conan Corporation, which produced SCSI controllers, and had established the brandname "Tentime", which was adopted as the divisional name for the purchased corporation.

Laura Technologies products include SCSI adapters, autochanger software drivers for SCO UUIX, optical drive subsystems, and DAT tape storage subsystems. Support for mirroring is included for the Powercache SE SCSI controllers.

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-0/1/5 arrays, which also include tape drive options, are offered for a variety of PC, NetWare and UNIX network applications.

LOMAS DATA PRODUCTS, INC.
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.

LOVIEL COMPUTER CORPORATION
5599 West 78th Street
Edina, MN 55439

Loviel, which ceased array operations in 1993, was an independent manufacturer of disk and tape drive equipment for the personal computer market. The firm produced RAID-0/1/3/5 array subsystems, using NCR controllers, plus software arrays, for Macintosh applications, concentrating on the prepress and imaging markets, but dropped its array efforts due to the departure of key staff.

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.

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 uses Maximum Strategy RAID-3 arrays to provide its systems with fast I/O and a degree of fault tolerance.

MASS MICROSYSTEMS, INC. (Subsidiary of Ramtek Corporation)
810 West Maude Avenue
Sunnyvale, CA 94086

MASS Microsystems was founded in 1987 and rapidly became a major factor in the add-on market for Macintosh storage peripherals. After several management changes and major changes in the product line during 1992, MASS Microsystems agreed in December to a merger, in which it emerged as a wholly owned subsidiary of Ramtek Corporation in 1993. MASS Microsystems introduced a family of RAID-0/1 and RAID-0/1/3/5 arrays for the Mac market using a Raidtec controller, with first deliveries beginning in March, 1993, but the product was not successful and the firm withdrew from the array market pending introduction of new array products.

MAXIMUM STRATEGY, INC.
2185 Old Oakland Road
San Jose, CA 95131

Founded in September, 1986, Maximum Strategy has succeeded in becoming a supplier of array subsystems to a number of major system manufacturers, including IBM, MasPar, 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 arrays. Maximum Strategy has had a long-term product development relationship with IBM. 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. This relationship is expected to continue in the future.

Maximum Strategy arrays emphasize performance. The Gen 4 array subsystem, first shipped in 1992, provides HIPPI host interfaces and an IPI-2 drive interface, as well as partitioning to allow simultaneous RAID-1/3/5 operation. Other arrays attach to the VME bus or the Micro Channel bus.

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.

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 characteristics. In October, 1992, Mega Drive introduced its new MR series of disk array subsystems, offering RAID 0, 1, 3 and 5 levels.

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. Based on the model chosen, it can employ from 5 to 245 disk drives per system. Also 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.

MICROACCESS INC.
48017 Fremont Boulevard
Fremont, CA 94538

MicroAccess was founded in 1991 as a manufacturer of 100 mbps Ethernet controllers and hubs. In 1993, MicroAccess introduced the San Francisco, a fault tolerant server with array subsystem using Micropolis 1 gigabyte drives and other components, for use in NetWare environments.

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.

About 90% of the business for MicroNet array products comes from the Macintosh market with the remaining portion from the newer RAPID ACCESS series for the PC DOS 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.

MICROPOLIS CORPORATION
21123 Nordhoff Street
Chatsworth, CA 91311

1993 total net sales: $382,926,000 Net income: ($19,916,000)

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. 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 93 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.

MICROTECH INTERNATIONAL
158 Commerce Street
East Haven, CT 06512

Microtech was founded in 1985 as a supplier of add-on and add-in products to the Apple Macintosh market. Included is the XLerator, a controller capable of operating with ATTO software in RAID-1 and RAID-0 modes.

MICRO TECHNOLOGY INC. (MTI)
5065 East Hunter 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, 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. The company is privately held.

MORSE TECHNOLOGY, INC.
17531 Railroad Street
City of Industry, CA 91748

Morse Technology, Inc. was founded originally to develop, manufacture and market PC motherboards. Over the years, its product line has expanded to include computer monitors and host bus adapter cards. In December, 1992, the company introduced its model KP 8050, an IDE hard drive accelerator controller for the EISA bus which offered RAID-1 support. The company ceased operations in 1993.

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.

MYLEX CORPORATION
34551 Ardenwood Boulevard
Fremont, CA 94537

1993 total net sales: $45,233,700 Net income: ($4,444,200)

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 controllers attach to the host EISA bus and can be used with many PC compatible systems. A SCSI to SCSI version and a PCI version will be shipped in 1994. 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.

NETFRAME SYSTEMS, INC.
1545 Barber Lane
Milpitas, CA 95035

1993 total net sales: $66,935,000 (FY ending 1/1/94) Net income: $7,223,000

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 two 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 1994.

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.

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. Im 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 includes an array operating in RAID-5 mode, and also incorporates 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 have since been announced by IBM as the PS/2 Server 295 and the PS/2 Server 195. Over a period of years, IBM is expected to become the primary manufacturer as well as the exclusive distributor of other products designed by Parallan.

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. 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.

PEAK TECHNOLOGIES GROUP, INC.
600 Madison Avenue, 26th Floor
New York, NY 10022

1993 total net sales: $86,349,000 Net income: ($7,441,000)

In the first quarter of 1993, Peak Technologies bought the Freedom disk drive array product line from Clearpoint, adding it to the MESA line of storage products that had been acquired earlier. Operations relating to arrays are carried out in Columbia, MD. Peak is known as an integrator and distributor of bar coded automatic data collection equipment and printers for computer systems as well as data storage subsystems. Disk drive arrays are fabricated with purchased controllers. They provide RAID-0/3/5 capability, and are available in rack, tabletop or tower configurations.

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. Since that time the firm's product line of add-on peripherals has been 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. Since mid-1992, PLI has offered SCSI adapters with RAID-0/1 capability for a variety of Macintosh models.

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 UltraStor controllers. The original array systems used an Intel 486 processor, but the system announced in 1994 uses the Pentium chip.

PRO ENGINEERING, INC.
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.

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.

RANGER TECHNOLOGIES
9128 Jordan Avenue
Chatsworth, CA 91311

Storage subsystems and system integration are the primary activities of Ranger Technologies. The firm's arrays include third party array software combined with internally and externally packaged disk drives.

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.

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.

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

1993 total net sales: $41,019,000 (FY ending 6/30/93) Net income: ($31,033,000)

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.

SOLBOURNE COMPUTER, INC.
1900 Pike Road
Longmont, CO 80501

In 1986, Solbourne began operations as a manufacturer of SPARC workstations. Since 1989 the company has produced primarily SPARC multiprocessor servers for networks using Oracle financial applications. Solbourne provides an optional mirrored disk capability with its BoSS disk subsystems.

STORAGE COMPUTER CORPORATION
11 Riverside Street
Nashua, NH 03062

Storage Computer's array development activities started in 1984 as a project within Cab-Tek, Inc., a privately held company that manufactures 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 company'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.

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 Matrix Array family of disk array subsystems was first introduced in April, 1989, with the model Concept 51. Since that time the company has added five more models to the family, the latest being the Concept 71 FCS, a fibrechannel based offering to the very high performance computer market. The Matrix Array product line offers up to 324 gigabytes of data storage. With its orientation to high performance, the company is expected to offer arrays to the video-on-demand market in the future.

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, Apple, Compaq and Novell.

SDI's disk drive arrays are available in RAID-5 configurations for PC compatible hosts with either the ISA, EISA or Micro Channel bus. RAID-0 arrays are available for the Macintosh, with a wide selection of drive capacities. In 1993, the company expanded its product line, which now included 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 well supported by array management software utilities.

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. Since mid-1992, the firm has been shipping a RAID-0/5 array. In SSI's array each drive's individual enclosure contains its own power supply, to facilitate usage in the array or as independent drives.

STORAGE TECHNOLOGY CORPORATION
2270 South 88th Street
Louisville, CO 80027

1993 total net sales: $1,404,752,000 (FY ending 12/31/93) Net income: ($77,796,000)

Storage Technology's "Iceberg" array for mainframe applications is easily the most famous disk drive array program so far, despite the fact that deliveries are 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 has been offered since late 1992, resulting in indifferent sales and a lawsuit with the manufacturer. The high-end Iceberg array project, which uses purchased 5.25" drives, was to be available in the first half of 1992, but the schedule slipped so that general availability of Iceberg is not expected until the second quarter of 1994 at the earliest.

STRATUS COMPUTER, INC.
55 Fairbanks Boulevard
Marlboro, MA 01752

1993 total net sales: $513,680,000 (FY ending 1/2/94) Net income: $16,607,000

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 is produced by Stratus on a contract manufacturing basis, and the company also has OEM arrangements with Olivetti, Ericsson Telecom and NEC. The Stratus D600 Peripheral Subsystem utilizes disk drive controllers which provide mirrored RAID-1 capability, using standard industry disk drives with capacities from 319 megabytes to 3.2 gigabytes.

SUN MICROSYSTEMS, INC.
2550 Garcia Avenue
Mountain View, CA 94043

1993 total net sales: $4,308,606,000 (FY ending 6/30/93) Net Income: $156,726,000

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.

SYSTEMS INDUSTRIES
1855 Barber Lane
Milpitas, CA 95035

Systems Industries was founded in 1968. The company's first products were systems for automating scientific instruments, but in the process of development, it was discovered that the minicomputers typically used had inadequate amounts of mass storage available. Systems Industries began selling storage subsystems for DEC and Data General computers in 1971 and exited the instrument activity in 1976. In 1989, SI began marketing "eaSIshadow", a software product allowing DEC processors running under VMS 5.0 or above to operate drives in a mirrored mode. The array product line was augmented in 1992 with a RAID-3 array that attaches to a host SCSI-2 channel on DEC or Sun systems, using purchased controllers. In late 1993, SI was purchased by MTI, which is continuing to market the SI array products under its own name.

TANDEM COMPUTERS INC.
19333 Vallco Parkway
Cupertino, CA 95014

1993 total net sales: $2,030,960,000 (FY ending 9/30/93) Net income: ($517,727,000)

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, Array Technology, having been reduced to only a development facility, was sold to EMC. 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.

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.

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.

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 with the ability to attach 3,072 3.5" drives, each with 1.2 gigabytes capacity, for a theoretical total array capacity of 3.2 terabytes.

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, with storage capacity to 12 gigabytes.

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 AT&T 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

1993 total net sales: $80,024,000 Net income: $8,999,000

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 array board.

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 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
15 Hammond Drive
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. Each RAID controller provides 3 to 5 independent channels and supports from 1 to 35 disk drives per controller. 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.

UNBOUND, INC.
17951 Lyons Circle
Huntington Beach, CA 92647

UNBOUND, Inc. was founded in 1984 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.

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's disk drive array subsystems use Digi-Data controllers, offering RAID levels 0, 3 and 5.

UNISYS CORPORATION
P.O. Box 500
Blue Bell, PA 19424

1993 total net sales: $7,742,500,000 Net income: $565,400,000

With roots deep in the history of the computer business, Unisys is a manufacturer of mainframes, minicomputers, and networking equipment. The 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, information distribution, 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 UNIX-based systems. In smaller UNIX-based systems, the arrays are implemented using software modules added to the UNIX operating system, while a subsystem with RAID-1 capability purchased from EMC is offered with Unisys mainframe systems.

UNITROL DATA PROTECTION SYSTEMS INC.
815 Hornby Street
Vancouver, British Columbia V6Z 2E6 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 trying to develop 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.

VANGUARD TECHNOLOGIES, INC.
590 Herndon Parkway, Suite 300
Herndon, VA 22070

Vanguard 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.

VERITAS SOFTWARE CORPORATION
4800 Great America Parkway
Santa Clara, CA 95054

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. At present, the Veritas modules operate with UNIX SVR4 and SCO UNIX. The company has licensed the use of its technology to system manufacturers that include UNIX SVR4 with their systems. The SCO UNIX version is 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 market. 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 active or entering the array market.

VORTEX SYSTEMS, INC.
800 Vinial Street
Pittsburgh, PA 15212

Vortex, which ceased operations in 1993 after investors withdrew support, was an independent supplier of data storage subsystems for computer network applications, founded in 1987. After initial concentration on optical disk drive backup subsystems, Vortex introduced a SCSI controller with mirroring capability in 1992, for Banyan VINES and OS/2 markets.

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

1993 total net sales: $21,780,000 (FY ending 9/30/93) Net income: ($8,277,000)

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. 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

ACER CO.
347 Wu Lin Fung Chen Road
Lung Tan Hsiang
Taoyuan
Taiwan

1992 total net sales: $463,712,000 (FY ending 12/92)   Net income: $2,083,000

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.

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.

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 SCSI 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.

FUJITSU LTD.
6-1, Marunouchi 2-chome
Chiyoda-ku, Tokyo 100

1993 total net sales: $31,166,079,000 (FY ending 3/93) Net income: ($293,500,000)

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.

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.

HITACHI, LTD.
4-6 Kanda-Surugadai
Chiyoda-ku, Tokyo 101

1993 total net sales: $67,844,490,000 (FY ending 3/93) Net income: $695,796,000

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 3390 equivalent drives 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.

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-4, and RAID-5. The controller has an EISA host bus and SCSI-2 drive ports, and is intended for use on IBM PC compatible platforms. The firm expects to market the controller on an OEM basis.

NEC CORPORATION
5-33-1, Shiba
Minato-ku, Tokyo 108

1993 total net sales: $31,643,671,000 (FY ending 3/93) Net income: ($406,554,000)

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 14", 9", 8", 5.25", 3.5" 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.

SANYO ICON (Subsidiary of Sanyo Electric Co., Ltd.)
18301 Von Karman
Irvine, CA 92715

1992 total net sales: $14,096,066,000 (FY ending 11/92) Net income: ($11,604,000)

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 offers 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. Sanyo Icon markets its LANser MRX disk array products through a series of Value Added Systems Integrators (VASIs) in the U.S. Overseas, all Sanyo Icon products are sold through a distributor network in Canada, Europe, South Africa, South America, Australia and the Pacific Rim. Sanyo Electric markets the products in Japan.

European Manufacturers

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.

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.

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.

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.

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 has been reselling Integra RAID-5 software arrays for personal computer applications.

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 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 also manufactures a disk drive array subsystem attaching to UNIX-based platforms. While headquartered in Europe, the firm markets in the U.S. as well. The array subsystem supports RAID modes 0, 3 and 5.

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, now 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. 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.

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. ISA, EISA and PCI bus array controllers, all made in Germany by Vortex, are available. Almost all of the firm's sales are in Europe.

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.

ZENITH DATA SYSTEMS (Subsidiary of Groupe Bull)
2150 East Lake Cook Road
Buffalo Grove, IL 60089

Zenith has been remarketing a version of Integra's OASYS array software since 1992 on its EISA bus based servers.

DISK/TREND ON DISK

1994 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.

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 1994 DISK/TREND Report as a separately purchased option to subscribers to the corresponding 1994 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.

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.

   <u>Installing AutoImport</u>: 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: A:INSTALL C:\AIMP 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
   F (Flexible disk drive data)
   R (Rigid disk drive data)
   O (Optical disk drive data)
   A (Disk drive array data)
   V (Removable data storage data)

   YY= Table number, as shown in the appropriate report volume

   Examples:
   File RT10.WK1 is Rigid Disk Drive Report Table 10
   File FT2.WK1 is Flexible Disk Drive Report Table 2
   File OT1.WK1 is Optical Disk Drive Report Table 1
   File AT3.WK1 is Disk Drive Array Report Table 3
   File VT1.WK1 is Removable Data Storage Report Table 1

   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	Flexible 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 3,4	Tables 5 to 12	Tables 3 to 7
MASKD	<-- All Product Group Application Tables ---->			N/A
MASKE	N/A	Drive Height, Track Density, Drive Capacity	Write-Once/ Erasable Analysis	N/A
MASKF	N/A	Applications Summary	N/A	N/A
MASKG	*	Product Group Market Share	*	*
MASKH	Tables 7,8	N/A	N/A	N/A
MASKI	Product Group Price/Megabyte	N/A	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	1993 Rigid Report	1993 Flexible Report	1993 Optical Report	1994 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
6	MASKC	--	MASKC	MASKC
7	MASKH	MASKF	MASKC	MASKC
8	MASKH	MASKA	MASKC	--
9	MASKC	MASKA	MASKC	--
10	MASKC	MASKE	MASKC	MASKA
11	MASKC	MASKD	MASKC	MASKA
12	--	MASKG	MASKC	--
13	--	MASKA	--	--
14	MASKA	MASKA	--	--
15	MASKA	MASKE	--	MASKA
16	--	MASKD	--	MASKA
17	--	MASKG	MASKA	--
18	MASKD	MASKA	MASKA	--
19	MASKI	MASKA	--	--
20	--	--	--	MASKA
21	MASKA	--	MASKD	MASKA
22	MASKA	MASKE	--	--
23	--	MASKE	MASKA	--
24	--	MASKD	MASKA	--
25	MASKD	MASKG	--	MASKA
26	MASKI	MASKA	--	MASKA
27	--	MASKA	--	--
28	MASKA	--	--	--
29	MASKA	--	MASKE	--
30	--	MASKD	MASKD	
31	--	MASKG	--	
32	MASKD		MASKA	
33	MASKI		MASKA	
34	--		--	
35	MASKA		--	
36	MASKA		MASKD	
37	--		MASKA	
38	--		MASKA	
39	MASKD		MASKA	
40	MASKI		MASKA	
41	--		--	
42	MASKA		--	
43	MASKA		MASKE	
44	--		MASKA	
45	--		MASKA	
46	MASKD		--	
47	MASKI		--	

Cross reference (continued)

Table Number	1993 Rigid Report	1993 Flexible Report	1993 Optical Report	1994 Array Report
48	--		MASKE	
49	MASKA		MASKA	
50	MASKA		MASKA	
51	--		--	
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 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. When the opening screen appears, select the "TRANSLATE" menu item using the arrow keys or just type "T". (The AutoImport menu system works just like the menus in Lotus 1-2-3.)

3. When the next screen appears, enter the name of the mask to use on the top line where the highlighted space is. 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. Press "ENTER".

4. Select the output file name. Type /OFT (Output:File:Type-in)

   Enter the name of the file. The file name form recommended is ?Tnn, where ? is the type of report (R, 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. Press "ENTER".

   Examples: RT4 FT12 OT14 AT20 VT10

5. Enter the input file name using the same file naming convention as above. Type /IT (Input:Type-in)

   Enter the name of the file, including the extension, which will be of the form yy? where yy is the year of the report and ? is the report type as above.

   Examples: RT4.94R FT12.94F OT14.94O AT19.94A VT10.94V

6. The default spreadsheet type to which the 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 typing /TS (Task:Spreadsheet)and then selecting your preference from the menu of choices displayed.

7. You are ready to translate. Type "G" for "GO" or select "GO" using the arrow keys. 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 (Quit) to return to the AutoImport main menu and then /E (Exit) 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 "Mask" using the arrow keys or type "M".

2. Name the 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, F, O, A, or V), nn is the table number and yy is the report year.

   Example: AT10.94A

   To name the file, type /FIT (File:Input:Type-in). When the highlighted blank space appears, fill it in with the 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 type /LH (Line:Header). 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, typing /LH, 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. Type /AY (Auto:Yes). 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. Type /CW to adjust width and then use arrow keys to move right column margin clear of the column of values.

   o Set cursor on last position of column to the right of the left margin labels. Type /DCO to delete this one column from the mask.

   o Now place the cursor in the first space to the right of the left margin label column. Type /C and then adjust the column width to encompass all places in the values column you have been working with. This will restore the mask column, also.

5. Save the mask in a mask file. Type /FMS (File:Mask:Save). Fill in the name of the mask file.

   Example: AT10MSK

6. Save the output file. Type /FOT (File:Output:Type-in). 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 /Q (quit). This returns you to the AutoImport main menu. To leave AutoImport, type /E.

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= F (Flexible disk drive data)
   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: AS194 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.