

LOW END 32 BIT SYSTEMS: MARKET OUTLOOK

1983-1988

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LOW END 32 BIT SYSTEMS

INTRODUCTION

OVERVIEW

Digital Equipment Corporation is developing its strategic marketing plan for its new microVAX computer system. Such a system would combine low price packaging (relative to current VAX systems) with micro implementation of its popular VAX/VMS system. This system package, including 256 KB virtual memory, plus 5 1/4" Winchester disks storing up to 80 MB, would be scheduled for introduction in 1984 with the first full shipping year in 1985.

Digital Equipment Corporation recognizes the volatile nature of today's transitional market for "mid-performance" systems -- currently spanning the entire range from low end general purpose mainframes, to superminicomputers, to traditional minicomputers, down to powerful new microcomputers. To better prepare its entry, Digital requires an examination of the future arena in which its new microVax will compete (e.g., products, new technologies, marketing channels, competition, etc.). More specifically, Digital needs an "outsider's" analysis and interpretation of the potential for its microVax product -- including both an analysis of the new market developments over the next five years and a prediction for future product performance within this market -- to compare with its own internal projections for this product.

Digital's key questions include:

- How large is the 32 bit market currently and where will it be by 1988?
- What will fuel demand for 32 bit technology? How quickly will users migrate to the newly entering 32 bit systems -- that is, when will users become constrained by the current limitations imposed by 16 bit systems?
- From the supply side, how quickly will 32 bit design-ins be introduced on to the market? What factors will determine the future supply levels?
- Which application areas will develop most rapidly over the next five years? Will the market see an explosion of totally new applications that will significantly expand the usage of computers within organizations? If so, how will this impact new products -- both hardware, software and package systems?
- What will future computing styles be -- e.g., networking, standalone, multi-user, single user etc.?

- Given future market changes, how will current vendors fare in the the future markets?

With respect to its anticipated microVax product, Digital has some critical product concerns. Key among these concerns is the question as to how this system should be packaged and priced to maximize Digital's profits. That is, at what price levels would the concomitant sales volume of this system return the highest value and give Digital a commanding market lead.

In addition to this critical question, Digital's other concerns center upon effective timing of this entry into the market, finding the appropriate target audience (commercial versus technical), how much market leverage will be gained by the Digital name, and which specialty and core system capabilities need to be designed into the product to maximize sales. Digital is concerned about the impact of competition from increasingly more powerful high-end microcomputers as well as other mid-performance systems, in addition to safeguarding its present huge installed base of minicomputers (preventing vertical product line competition).

IDC POSITIONING

Through its worldwide network of research offices, IDC has already developed forecasts of the computer industry's performance based on its extensive network of industry contacts and compiled databases. IDC is expert in computer industry market survey and analysis. It is not expert in the fields of engineering, nor in computer manufacturing techniques. Therefore, the focus of its analysis has been designed to augment Digital's considerable knowledge in product engineering and manufacturing with a marketing view of new developments which will impact Digital's future market. As noted in the original study proposal, the primary objective of this survey is to provide Digital with compiled IDC data, plus IDC's informed opinion as to the future directions of the markets in which the proposed product will compete.

METHODOLOGY

To accomplish this task, IDC undertook a comprehensive review of all its internal resources including all online bibliographic databases, internal product/vendor literature, and compiled historical forecasts. To obtain the most up-to-date information available, IDC conducted an additional 25 telephone interviews with major chip manufacturers, venture capitalists, leading edge OEM's, computer manufacturers, software suppliers/developers and leading design engineers involved with all aspects of developing, packaging, and marketing 32 bit systems and software. In addition, IDC surveyed all of its top internal experts on

varied aspects of the industry including office automation, IBM "watch", micro industry, minicomputers, market channels and technology assessment. A complete listing of all surveyed sources is provided in the Appendix to this report.

CAVEATS

Before tackling Digital's key product questions, some caveats about the study and its results need to be noted. First, although the media, vendors and researchers refer to a "32 bit market", end users purchase solutions not bit sizes. With the exception of technically sophisticated customers, the specific architecture or hardware implementation of the system is in and of itself insignificant to the user. Performance (e.g., response times, throughput capacity, processing speed, etc.) is what is important. The fact that a system is 16, 24, or 32 bit is less important than whether or not the functionality delivered by the system meets the users current requirements and anticipated growth needs. Until very recently, classification of systems into distinct markets have tended to coincide with the bit size of the machines. Hence, the justification for referring to bit size markets. As product lines broaden and new, more powerful technologies are introduced, bit size market distinctions are blurring.

DEFINITIONS

Historically, IDC developed its market analysis classifications for mid-range systems based on the performance, packaging, and to some extent intended audience for a vendor's products. Although IDC has recognized the transitional nature of today's market (and the blurring of distinctions between various equipment categories) and will next year be realigning its classification scheme, competitive systems within each of the traditional classifications will be maintained for the purposes of this historical market analysis and five year future forecasts. Definitions for system inclusion in each category is provided below.

Low End General Purpose Mainframes: Characterized by IBM's System /3, System/38, 370, 4300, 303X and 308X and competitors, are general purpose systems designed for a wide variety of applications. They are character or byte oriented and programmed in higher level languages. Based on performance information provided by individual vendors, IDC classifies all general purpose mainframes into seven sub-classifications ranging from size class seven which consists of the IBM 3081 and powerful machines which compete with it down to lower size classes 2, 3 including low end IBM 4331, System 38/2 and System 3 systems. Due to recent competitive moves specifically by IBM, the low end 4300 family have received new price packaging and other enhancements such that these machines can now be considered competitive with the such machines

as the DEC VAX, DG MV and Prime system families. These low end general purpose mainframes (specifically 4300 and System/38's) will be considered in the component analysis as one spectrum of the competitive arena for mid-performance systems.

Minicomputers: IDC categorizes computers as minicomputers based primarily on the perceived marketplace for these products. Originally created to differentiate DEC's early PDP-8 products (from mainframes), minicomputers are general purpose in design, but are sold as tools as well as solutions; are available from makers in configurations ranging from board only to complete systems; are available to OEM's and are usually discounted in volume buys; are part of a family with low-end products generally in the \$1,000 - \$25,000 range; and, have at least 4K RAM.

Traditional minicomputers (e.g., DEC PDP 11 series, DG NOVA, HP 1000 series, etc.) are generally in the \$2,000 to \$25,000 basic price range, with historically 8-, 12-, and 16- bit words and 4 K more words of memory.

As traditional minicomputer vendors broadened their product lines both upward and downward to meet challenges from both the mainframe and microprocessor vendors, IDC differentiated these new systems from traditional product lines -- adding two new classifications.

On the low end, microminicomputers are based on LSI technology, and are generally downward extensions of existing minicomputer lines. These systems are available in some version for less than \$1,000, sometimes have no 4K minimum memory requirement, and are limited more by the speed of the processor than the speed of the memory. In general, microminis are those systems that compete primarily with DEC's LSI-11 and PDP 8A computers. On the high end, superminicomputers deliver significantly more performance than their minicomputer forbearers. Superminicomputers can have a word size of 16 bits or more, memory cycle times of one microsecond or less with maximum memory capacity extending to 64K words or more, and software that includes an assembler, an operating system and at least one high-level language compiler. Systems in this class include the DEC 11/45, 11/70, and VAX class systems.

Small Business Computers -- Here again, the classification of systems is dependent on marketplace perceptions and target audience. Small business computers (SBC) are those general-purpose computers marketed to smaller businesses (as the name implies), first time users, and increasingly to small units of large organizations as departmental systems. SBC's are primarily sold complete with application software for business use, and with all required peripherals for the system to perform its given task. Priced between \$20,000 and \$100,000 for the basic configuration, an SBC is sold as a solution to a specific problem, not as a tool.

An SBC may in fact be based on a minicomputer that has been configured into a packaged system to fit these definitions by an OEM, a systems vendors, or in some cases by the vendors themselves. SBC's include offerings from the major mainframe vendors (such as IBM System/34 and System/36); products such as DEC's Datasystem/300 from the minimakers; systems from firms such as Quantel that manufacture and support only SBC's; and products from companies marketing assembled systems from the components of other minicomputers. (Although there has historically been some overlap between the SBC and minicomputer categories, this overlap has been eliminated where possible in the presented forecasts.)

Microcomputers: For the purposes of this analysis, the microcomputer category contains all systems which are microprocessor based, programmable in a high level language with peripheral attachment capacity. Ranging in prices from \$50 to more than \$20,000, microcomputers were originally designed for individual use either in a single or multitasking environment. Systems are placed in this category on the basis of primary competition with established members such as Apple, IBM PC, Commodore VIC 20, Texas Instruments 99/4A, and Hewlett Packard 9800 or their successors. Board level computers are excluded from this category. Due to the rapid hardware changes in this market, IDC further differentiates systems into four distinct sub-categories:

Low End Systems: These are the very low cost, typically under \$2,000 retail systems that are sold primarily into the home. Typical systems included here are the Timex Sinclair 1000, Commodore VIC 20 and Texas Instruments 99/4A.

General Purpose Personal Computers: Currently, these systems comprise the bulk of the personal computer market in terms of dollar revenues. These include all systems that have functionality for more than one application and can perform reasonable processing tasks. Included here are such models as the IBM PC, Apple II E, Commodore 64, Osborne 1 and TRS Models II, III, 12, and 16. Price ceiling for systems in this range is approximately \$3,500. These systems are typically based on the 8 to 16 bit chips including the 8088, 8086, Z80, and 6502.

Advanced Personal Computers: Sometimes referred to as expert systems, these systems are on the leading edge of change in today's market. These systems are typified by radical innovations in software and hardware affording the user a high degree of functionality and peripheral content. These systems are best typified by Apple's LISA.

Special Purpose Personal Computers: Again, these systems are in the forefront of new developments in the microcomputer market. Systems in this category are designed primarily for special functions within the personal computer market. To

date, two types of systems have emerged -- the number crunching scientific systems (e.g., HP 9800, IBM XT) and systems which used to be known as the single station processing terminals such as the Datapoint 1560. Some of the newly introduced specially designed engineering or CAD workstation systems fit into this new category. Generally these packaged systems are priced within the \$7,000 - \$15,000 range.

PRESENTATION FORMAT

In today's market, the primary emphasis for 32 bit systems has been within the superminicomputer and the more powerful microcomputer markets emphasis has been placed on examining these two types of systems. However, when considering the wider market questions over the next five years, the full range of mid-range systems must be considered as well. Consequently, except where so noted, when discussing the overall mid-performance range systems market, all applicable segments -- low end general purpose mainframes, superminicomputers, minicomputers (including microminis and traditional minis), and high end microcomputers will also be discussed.

IDC includes in its worldwide estimates of markets all shipments of systems by U.S. vendors to all markets, plus all shipments by foreign based vendors to the U.S. market. Due to the difficulties inherent in reliably tracking international performance, IDC does not monitor foreign vendor shipments to foreign markets. For example, the forecasts would cover all shipments of Fujitsu to the U.S. market, but exclude Fujitsu's shipments within the Japanese or European markets. For estimation purposes, IDC has determined that its coverage of the worldwide computer market is approximately 80% of total shipments.

This report is intended to briefly summarize assumptions underlying the IDC forecasts as well as to present the actual forecast themselves. The results presented here are designed to document the more lengthy explanations of the market conclusions already presented to Digital in a formal presentation.

One final note, IDC has made every attempt possible within the scope of this study to flesh out the most current market information possible. However, the change and development in the computer industry is rapidly accelerating as new competitors, investment dollars, etc. pour in. IDC does not pretend to be omniscient, rather it presents here its most informed opinion based on the best available data as to the future potential of the 32 bit system.

SUMMARY RESULTS32 BIT MARKET SIZE

Almost 25,000 32 bit systems will be shipped in 1983 from all of the major equipment component markets, as shown in Table *. 1988 projections peg shipment growth at an annual compound growth rate of over 68% -- yielding an estimated 346,000 1988 32 bit shipments. Revenues (see Table 6) while showing somewhat lower annual growth will still post a respectable 45% through 1988 -- with 1988's CPU system shipments grossing over \$20 billion dollars (based on estimated shipment value).

IDC views the future marketplace for all 32 bit systems from microcomputers to low end general purpose mainframes as being one continuum product market delivering a wide spectrum of performance to end users. Unlike the historical developments of computer markets in which the introduction of new types of systems, e.g., minicomputers versus mainframes versus microcomputers were geared for specific markets packaged with specific features and options appropriate for a distinct target market, 1988 will see a melting of these distinctions. Vendors will begin to offer a variety of bundled and unbundled solutions based on a standard product line to meet the needs of individual computer users, multi-departmental users and central DP systems.

As illustrated in Figure 1 (and in Tables 7), 32 bit architecture will begin to invade systems in all equipment components of the mid range markets as customers seek improved performance and faster processing speeds over the current generation of popular 16 bit systems. (Note however that the projected rate of 32 bit processor infiltration in the microminicomputer markets by 32 bit processors is extremely low primarily because IDC expects these downward extensions of the traditional minicomputer product lines to begin to die natural deaths as the low priced micros invade and few new micromini products are introduced.)

High speed, high processor "gobbling" applications originally introduced on more powerful superminicomputers have already begun to migrate to smaller microprocessors (e.g., CAD engineering and design stations currently available on an IBM PC, inhouse technical publishing systems now configured on 6800 based Sun supermicro, etc.) already beginning a downward domino effect -- paving the way for an ever widening popularity of the 32 bit processors. Examining the development of the micro market (see Figure 2), bit size chips once introduced to the market historically have passed through four general steps -- pioneering, fast growth in shipments, peak production then maturity. As 8 bit chips have gradually overtaken 4 bit chips, and 16 bit chips have overtaken 8 bit chips in system design-ins, so will 32 bit come to replace the 16 bit. It is important to recognize that the smaller bit markets are not replaced altogether as larger bit chips are introduced. Rather, as

supply increases (and prices decline for the smaller bit chips), these chips become incorporated in smaller applications (e.g., watches, car instrumentation, etc.) while the more powerful chips become standard for personal and departmental computing. Each introduction of a new more powerful chip to date has been additive, rather than subtracting from the total shipment size. Historically, the elapsed time from introduction to maturity for new chips has been decreasing, or stated another way, technological development of new chips has accelerated the bit size evolutionary process. Thus, while the 4 bit and 8 bit chips have taken approximately 4-5 years to mature, IDC expects that the full 32 bit chip may only require 2-3 years. Figure 3 conceptually demonstrates the state of the micro chip market in 1983. As shown, while full 8 bit chips have passed peak production and popularity, the 32 bit systems are in the early stages of development and system design-ins.

As the race to increasingly downsize applications to fit smaller processors (and into smaller packages) accelerate, vendors are striving to improve overall price/performance ratios throughout their product lines -- particularly in the minicomputer and superminicomputers markets (e.g., Data General new announcements for the MV 10000 and IBM low end 4300 challenge). Almost universally, vendors with whom IDC spoke view straight price slashing as being a kamikazi mission similar to the race for the home computer market. Rather, among the traditional minicomputer makers, present strategies are aimed at maintaining the general psychological market price bands, while simultaneously increasing the total functionality.

However, the leading minicomputer vendors can no longer exercise a monopolistic hold over the pricing structures and user expectations that they enjoyed even five years ago. New start-up ventures (in both the mini and micro computer markets) will force a breakthrough of the traditional price/performance barriers erected by the "big" mid range computer players. Just as the superminicomputer vendors successfully challenged the price structures of the mainframe computers, so will new start-ups and supermicro vendors begin to reshape the end user's expectations for system packages and prices. However, as IBM has shown with its retaliatory moves with pricing for the 4300 line, superminicomputer vendors, due to size, installed base and market name, are not without significant weapons.

Based on its market research, IDC believes that the overall demand for the upcoming 32 bit systems will be virtually inexhaustible -- with the primary obstacle being one of chip and system supply, rather than user demand. Currently even high price premiums for the 32 bit chips over the 16 bit chips have not slowed the acceptance of these chips among system designers -- primarily because of the radical improvements on performance delivered by 32 bit systems.

However, IDC believes that strategic marketing, not engineering

product decisions may delay the full force of 32 bit systems releases until early 1985. Minicomputer vendors have significant investment in current product lines and will not be eager to introduce vertical competition with current product lines. Furthermore, despite the challenges from new mini and micro vendors, the entrenched minicomputer vendors will still maintain a significant hold on the market, at least until late 1984 or early 1985 when conditions may radically change.

IDC maintains that more powerful systems in the mid-range component markets in increasingly efficient packages will, despite deflecting attempts by the traditional mini vendors, begin to flood the market by 4Q/1984 and 1Q/1985 due to:

- major declines in the incremental costs of memory and storage costs allowing increasingly more powerful packages at more affordable prices while still preserving profit margins.
- increasing user sophistication recognizing the superior performance delivered by these systems.
- deeper computing penetration into all end user markets and new applications.
- declining barriers to new vendor entries.
- wider market momentum for the vendors to create and develop new products.

As shown in Table 3, worldwide superminicomputer shipments are expected to remaining quite strong -- particularly with the 32 bit system models. IDC expects that the present vendors will continue to do quite well in this arena -- with introductions of both sophisticated high end uniprocessors, as well as downsized systems. Increasing competition from the mainframe vendors, as well as the rising influx of non-proprietary microcomputers will cap shipment growth as well as to push down average system values throughout the superminimarket. IDC bases its projections on the fact that the next generation of full 32 bit chips are nearing full scale production (e.g., National Semiconductor 32032 scheduled delivery date 4Q/1983, Motorola 68000 family started in Q3/1979 with additional family entries to full 32 bit by Q1/1984, Zilog 80000 in Q2/1984, Intel iAPX by Q3/1984, and the HP FOCUS and AT&T BELLMAC already available, etc.). Further, the decline in average system prices, plus the downsizing to smaller system product lines, will stimulate greater demand for the systems -- both because more customers can actually afford the systems and because the entry level systems will better fit current needs of growing customers. OEM's have already begun to incorporate the new 32 bit designs into product lines currently under development.

Table 4 shows the forecast by dollar value of shipment. The projected annual compound growth rates for revenues is significantly lower than the unit forecasts -- generating less than 25% annual compound growth. This is due (as noted above) to the decline in overall prices of average systems and an increasing portion of the low end 32 bit shipments -- by 1988 this portion should exceed 40%.

Tables 13 and 14 present forecast for microcomputer both in units and in relative dollar shipment revenues. Although heavily outnumbered in terms of raw numbers by shipments of low end systems primarily to home markets, the advanced and high performance general purpose systems are still expected to post healthy gains over the next five years -- particularly in sales revenues generated. IDC expects that 1984 will see not only a shakeout of vendors in products (goodbye Victor, Fortune, Osborn, etc.), but also an even greater array of upward and downward compatible micro product families introduced -- targetted specifically for the Fortune 1000 market (e.g., IBM PC and PCjr). While the industry giants continue to hit the center markets with strong general purpose offerings, the small innovative vendors will continue to push the upper limits in the advanced category developing new integrated products, more powerful single and multi-user networking machines, and new graphics processing stations. The advance class of microcomputer in some ways a harbinger of technologies which one to two years later will be down sized to fit lower price, general purpose systems. Sales of 68000 systems (e.g., LISA, Sun Microsystems, Altos, etc.) have increased four fold within the last years. Once a core of applications software (and new vertical packages) is available, sales of these systems should increase even more dramatically. If IBM, NBI, Wang and Commodore do announce their rumored multi-tasking, integrated software (or operating system utilities) products, competition in the advance category may stiffen sharply (and overall shipments may increase even over IDC expectations). Given the dramatic performance improvements with the newer advanced micro products announced even within the last 8 months, these systems may exert powerful influence on the corporate buyer -- particularly in terms of price/packaging. This in turn indicates then when considering alternatives between up-front capital intensive investment for a departmental superminicomputer with end user workstations and a more staggered investment of a series of powerful micros, the buyer may perceive a better return from the seemingly lower cost micro option.

Suppliers and micro system vendors expect that over the next six to twelve months, sales from some of the lagging minicomputer giants such as Digital, Data General, etc. (except IBM) should start to accelerate as a recovering Fortune 1000 business markets begin to mature and to purchase micro computing products more actively. Key to these markets will be open architectures (to spawn third party applications software), interchangeable peripherals (with standardized data formats) and access to marketing channels. Dealers and distributors note a preference towards the established vendors with strong support, and maintenance -- many feel that by 1984 most market channels will be shut to smaller competitors -- regardless of major price incentives offered.

SUPPLY SIDE

On the supply side, key factors indicate that 32 bit systems will begin to flood the market. Applications to venture capitalists for the 32 bit product development projects will comprise an estimated 66%+ of the all 1983 requests for funding. This quoted figure represents an increase of approximately 80% over similar requests in 1982. In 1983 alone, over \$125 million has already been awarded to new and established firms involved with 32 bit product development.

Although the number of 32 bit microsystems currently on the market is far outshadowed by 16 and 8 bit systems in terms of the number of shipments, a survey of all leading microsystem vendors reveals that though currently only 25% of microsystem products use (have designed-in) 32 bit technology (i.e., 68000 or other), reported development plans indicate that 65% of anticipated 1988 products will use 32 bit architecture. Clearly, vendors have already begun to shift future product plans towards the more powerful bit chip.

Although Apple and many of the early entrants truly began the micro invasion, it has not been until IBM entered the market that it has become "legitimized" in the eyes of the consumer public. Despite the fact that IBM has gobbled up significant market share, its entrance has also served to expand the entire market for all competitors. Likewise in the 32 bit markets, the entrance of IBM (and the newly unleashed AT&T) may create a significant impact on the general market -- boosting total sales for all new and older 32 bit products. IBM has already begun moving more aggressively into the mid-range markets with recent 4300 price/packaging announcements, plus the rumored support for UNIX on the PC and XT models, and a rumored 80386/UNIX product in the works for introduction in late 1984. AT&T's new 32 bit micro entry scheduled for 3Q of 1984, if successful, may well accelerate interest in the 32 bit systems -- particularly when boosted by the Bell Laboratories' large scale UNIX commercial software development efforts currently underway.

Further movement on the supply side is evidenced by the explosive growth anticipated for the current 68000 based systems and full 32 bit systems (e.g., Apollo, Altos, Onyx, and Synapse). Hewlett Packard has been the first of the minicomputer vendors to announce a powerful supermicro with a package price below \$23,000; already HP has announced significant price discounts. Initial reactions to this product have been highly positive, and may set the standards for future entries.

DEMAND SIDE

Perhaps the single most important factor figuring prominently in the future of the 32 bit systems, will be the widescale commercial acceptance of the UNIX operating system. Not only can UNIX be ported between

systems of different sizes, it may well become a standard for porting between otherwise non-compatible systems from different vendors. Further, UNIX is fundamentally a multi-user, multi-tasking environment which provides significant programmer tools under its system utilities. For the software developer, UNIX provides a flexible user interface which can be easily modified to fit any specific application that is being developed. Running UNIX on multiple internal systems may not only save organizations from significant software conversion and modification costs, it may also free an organization from the tyranny of having to be a one system vendor (or compatible) shop. Further, widespread use of UNIX will allow users to transfer critical or shared data through a number of systems without having to standardize all systems.

UNIX acceptance may have important ramifications felt throughout the computer industry -- beyond merely the introduction of yet another operating system. If user organizations are freed from costly conversion when purchasing new systems, not only does this open up new system choices, it also frees significant capital for development of new applications. Software houses, vendors, and users with whom IDC spoke for this study, believe that with UNIX will come a "major explosion in the number of new applications the like of which the industry has not yet seen...". Although UNIX was first developed on the PDP series, to date its commercial success has been on the more powerful 32 bit systems. Figure 4 presents graphically IDC projections of the percentages of the mid-range system markets which will support the UNIX operating systems by 1988.

Already integrated office automation, data base management systems, expert systems (so called artificial intelligence systems), graphics, technical publishing systems, program development, and networking are key applications for 68000 and UNIX systems. Although users will never become computer bound per se, the rapidly increasing popularity of these applications will drive a user hunger for more processing power. These early 68000s, even though they are not full 32 bit systems, will pave the way for market acceptance for the newer full 32 bit system entries.

Perhaps the last stronghold of the 16 bit systems has been the huge pool of third party application software available for these systems. This is a significant advantage in the short term as low costs canned solutions are easy to obtain, can be easily supported, and have been standardized for a variety of systems.

Offsetting this advantage, software developers almost universally report that all new development work in progress is being done in C -- anticipating the day in which UNIX becomes commercially accepted. (AT&T will soon announce availability of third party UNIX commercial licenses.) Further, software houses also report currently executing conversion plans to UNIX and other 32 bit operating systems. Over the long term, if UNIX plus the 32 bit system can afford users with reduced software costs, (including development, customization and maintenance) users will

naturally migrate away from the 16 bit systems as the more powerful 32 bit become competitively priced and commercially available.

APPLICATIONS

In today's market, the 32 bit superminicomputer markets already saturating the technical and scientific targets, have begun increasingly to concentrate on the general commercial markets -- particularly for the newer low end systems. Superminicomputer vendors have made competitive moves to lure more commercially oriented customers including making COBOL available for writing business applications, improvised database management and query facilities, and new application development efforts. In 1983 alone, over 2,800 superminicomputers are being sold specifically for commercial (i.e., general business applications). These systems generate over \$450 million in annual shipment revenues for the vendors. By 1988, IDC expects that this figure will grow to over 33,000 units yielding a whopping \$4.3 billion.

When examining the market for microcomputers, business systems (i.e., those systems sold for professional, general business applications) currently account for 35% of the total microcomputer market (including all bit size machines. Due to the explosive growth in the micro market projected for the next five years, IDC expects that the business portion of those shipments will remain relatively stable. By 1982, the 68000 supermicros are split 60%-40% between the technical/scientific and business markets respectively. (Note that these supermicro systems do not include such strictly business oriented systems as ONYX and Zilog included under the Small Business Computer category.) As more supermicros (similar to Apple's LISA) are introduced into the market over the next two years, IDC expects that these more powerful systems will become increasingly more popular in the business and professional applications market.

FUTURE COMPUTING STYLES

IDC believes that by 1988, multi-tasking systems will be a universal requirement for all end user systems. As shown in Table 17, by 1988 the percentage of systems networking will grow from a 1983 low of 20% to between 80% and 90% by 1988. Multi-user systems will continue to predominate -- including approximately 25% of the microsystems equipped with multi-user capabilities.

End user computer configurations will vary widely depending on the availability of cash resources and more importantly the organizations' requirements for data sharing. According to end users, the ability to transfer data is the critical issue, not necessarily via standardization of all systems. Further, high reliability will also be key. Once accustomed to dependent on computers, end users will not tolerate system delays (hence the attraction to networking and high availability systems).

SUCCESS IN THE 32 BIT MARKET -CHIP MANUFACTURERS

Despite nearly 60%-80% higher prices for the 68000 chip, surveyed chip manufacturers and system vendors universally recognize Motorola has having the leading market edge with its 16/32 bit chip. Observers point to Motorola's early entry into the market with the accompanying widespread media attention as being the keys to its success to date. Motorola has created significant market momentum -- naturally attracting a number of new system designers and OEM's into its camp. Engineers and designers point out that the 68000 delivers a "radical improved performance than any other chip currently available in quantity on the market". IDC expects that Motorola will continued to enjoy a leading role in the chip market due to the sheer volume of its current production capacity, to the brand names of vendors already endorsing the chip and finally to its headstart in terms of the number of design-ins deals Motorola has already sewn up.

However, over the long run, respondents with whom IDC spoke noted that by 1984 Motorola will have significant competition. In the scientific arena, National Semiconductor (NSC) with its yet unexplored 19 member 16000 chip family (including the 32032) is pegged as the dark horse in the systems design-ins race. Engineers and designers who have had experience working with the new chips comment that NSC has significantly refined the throughput and virtual memory handling capabilities plus developed a more efficient language translation allowing full software portability within the 16000 family. Several OEM's and computer manufacturers comment that the NSC system may become the singular choice for scientific and engineering applications.

Zilog 80000 (available in November 1984) is expected to be most popular with builders of low end commercial processing systems. Building on its previous success in the general business applications arena, Zilog's new chip will be compatible with its Z80 and Z8000 predecessors. As several systems designers noted "this will be a strong incentive for current Zilog customers to migrate along with the manufacturer..."

Intel, despite its huge success with the 8086 and 8088 chips, is seen by designers as being slightly behind the market. However, most of the respondents comment that in no way could Intel be discounted as a major contender in the future -- particularly if the rumored 386/IBM system introduction is in fact a reality. Intel will be banking on its 186 and 286 chips for sales during the next two to three years -- providing a greater range of performance for both multi-tasking, multi-user systems plus to a limited degree software compatibility with its 16 bit precursors.

At this time, respondents mention only two other significant 32 bit

chip vendors -- AT&T and Hewlett Packard. Although currently restricted to specific markets (i.e., Hewlett Packard HP 9000 to the CAD/engineering applications and BELLMAC to internal Bell (Western Electric) products, both of these chips promise significant microprocessing performance and "could well be more serious contenders if adapted to and optimized for the wider commercial market..."

One radical new development may impact the eventual successors in the 32 bit market -- 32 bit CMOS technology. Currently under development by Fairchild Corporation, powerful CMOS chips could afford users more efficient packaging, lower power drain, and higher overall reliability. Several more optimistic engineers and designers believe that viable CMOS chips could reach full scale production by 1985 -- and could possibly disrupt the traditional NMOS, HMOS, etc., 32+ bit chip marketplace.

MICROCOMPUTERS

Despite the explosive growth to date in the microcomputer industry, the future among the 32 bit contenders is as yet uncertain. The field to date has been populated by pioneering start-up firms (e.g., Altos, Apple, Fortune, Eagle, etc.). Although these firms on the whole have done remarkably well with their first round of shipments, product refinements are just now beginning to be introduced and the market is heating up. As in nearly all of the system markets, the spectre of IBM looms. Further, entries by the major minicomputer vendors have yet to be introduced (with the exception of Hewlett Packard). These giants, with superior experience (and sales power) in selling to large organizations, into current customer bases, and even to some extent into departmental applications, could create a major shakeout within the 68000 and other 32 bit micro vendors. 1984 should be a critical year in which vendor directions in the 32 bit market become clearer.

SUPERMINICOMPUTERS

As shown by Tandem, Synapse, Auragen, Apollo and others, clearly the gutsy computer start-ups has plenty of opportunity within the now maturing superminicomputer market. With the huge investments by the financial community and the increasing ease with which new startups can assemble systems from commercially available components, start-ups should continue to play a catalyst role in this arena -- pressing the traditional superminicomputer vendors on packaging, pricing and performance fronts. Niche markets (e.g., high reliability, publishing systems, etc.) may continue to shelter older technologies as OEM's and systems houses express reluctance at undertaking costly software and hardware conversions. Further, as the more established superminicomputer vendors must be concerned with compatibility with previous systems and careful upgrading of current customers to prevent vertical product line competition., huge installed bases may become more of a confining burden

(slowing the introduction of new technology) than an advantage.

Already Hewlett Packard (HP) is off and running with its 9000 supermicro entry. Although most industry observers are not betting on this \$23,000 base price system as being a serious contender for universal applications within the 32 bit arena, many view HP's entry as being a sign of future systems to come from the mini vendors. In other product areas, HP has moved more aggressively into the business professional and office automation applications which may indicate that HP may be something of a force to reckon with in the near future.

Prime will continue to be a front runner in the superminicomputer market through at least 1986 -- spurred on by the momentum created by its current installed base. However, IDC does not expect Prime to be a leader in the low end systems market, despite the recent joint development announcement with Convergent Technologies.

Perkin Elmer (PE) and S.E.L. Gould predictably will continue to enjoy future success in the scientific and high end commercial systems market. With the recently announced software enhancements, and anticipated support for the UNIX operating system, both vendors should continue to perform well through 1988.

If successful in its bid to switch to direct end user selling, Data General (DG) after having mediocre growth years, may do surprisingly well -- particularly with its high performance systems. Further, industry respondent note that several new low end products are "in the works" and should soon be introduced and shipped. IDC expects that DG will gain in its overall market share and should regain a strong foothold in the low to mid-range markets by the end of 1986.

From a marketing standpoint, perhaps the most difficult obstacle for DG success within the business marketplace, is its "kludgy micro image". Marketers and end users alike commented (unsolicited) as to what they termed to be "mis-design and mis-engineering" on the recently introduced DG micro. DG reorganized management will have to not only deal with production of new low-end products, but also fight a stodgy image for its micro line.

Interviews almost universally view Digital as having stumbled seriously in the combined minicomputer/microcomputer market. (Note that IDC conducted these interviews during August of 1983, (i.e., before Digital had announced its latest micro products or released its financial statements). Although the multi-billion dollar resources of Digital can never be lightly dismissed, interviewees cited the following to support this perception of Digital.

- Digital squandered its customer base in not introducing new products at both ends of the performance spectrum -- leaving many users "with no choice for system expansion and worse no viable, compatible computing products (with available software) to support individual computing..."
- Respondents perceived Digital as having a "tarnished engineering image". Given the "huge turnover and management reorganizations", engineering and design respondents comment that Digital has lost many of its top engineering talents which once made Digital the "best in the industry".
- Software suppliers and OEM's comment that they felt that Digital had "... lost touch with its customers..." and further that Digital's engineering staff "... has become insulated inside Digital from the radical changes in marketing concepts and product packaging going on at all echelons within the computer industry..."
- Software suppliers, OEM's and system designers view Digital's decision to stick with proprietary architectures as being a critical mistake -- primarily because it slows development of any third party application software so particularly vital to success in the personal computing market.
- Motorola stole Digital's thunder with its 68000 chip -- sewing up the market " before Digital could get its "much promised" microVax and J11 products announced and out the door.
- OEM with whom IDC felt (not surprisingly) that Digital had mismanaged its traditional OEM base.
- Almost universally, respondents felt that Digital's most inexplicable mistake to date has been its "bungling" entry into the micro arena. Almost all of the respondents judged the execution of the hardware systems to be competent, but the lack of software and availability continue to hamper Digital's reputation in this market.

Although many of the reactions to Digital were in fact critical, many respondents continue to emphasize that Digital is and could continue to be a force to be reckoned with in the mid range system market. Many acknowledge the quality of the VAX lines -- although from a marketing perspective respondents feel that Digital "needs a killer product combined with some bold marketing moves" to regain its earlier position as a market leader.

Not surprisingly, respondents already have conceptions of the rumored microVax system. Most expect Digital to introduce a MicroVax which will

be capable of running both UNIX and VMS (supported by Digital) priced in the \$6-\$10K range for multi-user and the \$4-\$5K range for single user versions. All rate compatibility with application software designed for the more powerful VAX systems as critical to the new product. A high priced entry ("20K-\$30K") would be a "kiss of death for Digital as a significant, leading edge market force...", according to respondents. Although respondent feel that such a product would enjoy "moderate" success, due to its high price it would not be a "radical enough product to rekindle Digital's early minicomputer market success...".

LOW-END 32 BIT MARKET SCENARIO

Based on the research undertaken (the results of which have been discussed in the previous sections), IDC has analyzed its data and developed a market scenario for the proposed microVax product introduction. To do this, IDC first had to make several assumptions as to the overall market in which such a product would compete over the next five years. These assumptions include:

- There will be no major worldwide recessions or international monetary crisis which will significantly disrupt the computer market or consumer purchasing plans. IDC will assume a constant rate of inflation and that worldwide markets, increasingly a major source of revenue for mid-range system vendors, will continue to develop in a linear fashion.
- Japan, Inc. will continue to maintain a steady presence in the U.S. computer market.
- The entries of both IBM and AT&T into the low end 32 bit systems market will have a significant impact -- by both upsetting the market share balance, and more importantly increasing the total market size for all competitors.
- The exponential penetration of computers into new applications and new markets will continue for systems of all sizes and shapes.
- There will be no unforeseen leaps in new technological developments (as yet unknown) or introductions over the next five years.

Further, IDC also had to make a series of assumptions about the proposed product introductions -- including both required core and specialty requirements for market success. These include:

- As stated in the introduction to this report, the new system will be a low end VAX class product with 256 KB virtual memory plus 5 1/4" winchester drives capable of storing up to 80MB. Further, the system will come completely equipped with a high resolution monitor, basic software (plus graphics handling and network interface standard) and standard keyboard with I/O interfaces.
- The product will be introduced in 1984 -- with the first full shipment year not occurring till 1985.

- Digital, over the life of the product, will continue to provide enhancements maintaining its competitiveness with comparably priced and targetted products.
- A choice of fully supported UNIX or VM operating systems will be made available to potential customers. Buyers will have both multi- and single- user options available.
- The system will be based on a standard bus -- and will be fully compatible with other Digital peripherals.
- The average single unit (end user) price will decline (with some increasing performance) approximately 10%- 15% per year.
- OEM and systems houses will incorporate the proposed product into their own systems targeted for vertical or niche markets.

Using these assumptions, IDC has drawn an overall market scenario for worldwide unit shipments of low-end 32 bit systems. Figure 5 details total shipments of all systems. For each year, modal prices for systems sold in the largest quantities are detailed -- the top figure above the shipment line for the 32 bit micro systems with the bottom figure below the line for other mid-range systems. Between 1985 and 1986, IDC expects that the micro and other mid-range systems market will become indistinguishable from one another. Consequently, modal price ranges are combined. The adjoining list (with Figure 5) reviews a summary of the key assumptions by year discussed earlier taken when preparing the forecast. This base forecasts assumes that Digital will maintain its current product lines -- but will not add new product lines through 1988.

Figure 6 shows the same graphic presentation of base shipments for 32 bit systems. Also shown, is projected base for Digital current shipments as well as IDC estimates of the impact of the entry of the proposed product priced in the \$5K-\$10K range. IDC believes that such a product would increase Digital's overall shipment levels by about 20%, and would serve to increase the total market size at almost 8%. Conservative and liberal opinion at IDC differed widely. The most skeptical critics believe that given such a late entry -- even a low price microVax product would only serve to increase Digital's total shipments by as much as 10%-13% and would only increase the total market by less than 5%. The more optimistic observers enthusiastically felt that a superior engineered product could serve to boost Digital's sales by about 20% and impact the total market by over 10%.

Figure 7 shows a similar graphic presentation of the low end 32 bit -- this time with a representation of the potential impact of a microVax product priced somewhere between \$20K and \$30K. In this case, IDC experts were more closely in agreement. All felt that while such a priced entry would boost Digital's sales over the short term, in the long

term the most optimistic projection would indicate about 5% over base in 1988. Further, such an entry would not have a significant impact on the total market -- with projected increase of not more than 1%. IDC experts support this opinion by pointing to the increasingly competitive nature of the market, plus the already developing momentum of the 68000 micro based systems.

Further, IDC feels that a strategy of entering the market at a higher price and dropping prices in two years time will not be an effective strategy if Digital wishes to maintain an image as a leading edge supplier. Market conditions (e.g., new products, new technologies, etc.) change far more rapidly than do established vendor and product market reputations. In the lower priced packaged systems, "avant garde" engineering edge may be less important than a perceived marketing image. An image of market stumbling once formed is difficult to remold. Consequently, a strategy of preempting the market with a slightly lower priced, quality product sold through mass distributors or direct account sales into large organization may better position Digital to assume long term mastery of this market (particularly with the coming emphasis on upwardly compatible, departmental and personal computing systems), than a more conservative policy of entering on the high end and price cutting as competition stiffens.

RECOMMENDATIONS

Of critical importance to the study is the issue of user acceptance. Based on the research conducted for this study, vendor interviews, and limited user coverage, the data indicates that by 1985 the market for 32 bit systems will be a supply not a demand bounded market. IDC recommends that Digital undertake a more comprehensive survey of both its current customer base as well as users within large organization to better track actual computing requirements, anticipated computing styles, penetration of UNIX, etc. — short exploring in more depth from the users perspective some of the critical issues surrounding user acceptance of the 32 bit systems.

APPENDIX :

A. TABLES AND FIGURES

TABLE 1

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value +	1980	1981	1982	1983
Able Computer	Magnum	7/81	16	--	10	40	60
* Apollo	DN 400	3/81	30	--	74	150	NA
*	DN 420	3/81	32	--	50	237	NA
*	DN 600	8/82	75	--	--	63	NA
*	DN 300	2/83	20	--	--	--	NA
Sub-Total	DOMAIN				124	450	4,000
August	Series 300	11/81	125	--	3	6	12
BTI	5000	9/78	39	400	510	375	NA
	5000/ES	7/79	35	25	30	40	NA
*	8000	5/81	175	--	10	30	NA
Sub-Total			249	425	550	445	1,650
* Charles	UNI 68/15/7/27	2/82	16	--	--	33	70
* River Data	UNI 68/37	8/82	15	--	--	13	30
* Systems	UNI 68/47	8/82	18	--	--	7	10
*	UNI 68/80	10/81	31	--	2	8	10
*	Uni 68/05	12/82	12	--	--	2	10
Sub-Total				--	2	63	130

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS

1980-1983

Vendor	Model	Date First Shipped	Av. System Value +	1980	1981	1982	1983
Computer Automation	LSI 4/90	6/77	9	265	350	270	NA
	LSI 4/95	1/80	24	55	70	36	NA
Sub-Total				320	420	306	200
Computer Talk	CT-400	9/75	45	5	5	5	6
	CT-407	12/77	45	1	5	5	6
Sub-Total				6	10	10	12
Data General	NOVA 830/40	7/73	44	120	--	--	--
	EC 100-AP/130	2/75	40			2,300	--
	EC S200/230	2/75	55	600	700	500	300
	EC S 250	11/78	150	200	175	60	300
	EC C/300,330	2/75	150	NA	130	30	--
	EC C 350	11/78	180	550	375	230	100
	EC M/600	5/78	215	40	40	15	--
*	EC MV/6000	2/82	200	--	--	420	420
*	EC MV/8000	10/80	300	5	115	100	320
*	EC MV/1000	--/83	510	--	--	--	NA
*	EC MV/4000	12/82	70	--	--	10	NA
Sub-Total				1,515	1,535	3,665	4,400

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value +	1980	1981	1982	1983
Digital Equipment Corp	PDP 11/44	--/80	60	1,295	3,705	7,200	NA
	PDP 45,50,55	4/72	91	250	1,500	1,700	--
	PDP 11/60	6/77	75	325	400	600	NA
	PDP 11/70	7/75	175	1,900	1,400	1,200	NA
*	VAX 11/730	6/82	65	--	--	650	1,000
*	VAX 11/750	--/80	100	30	1,100	2,000	2,500
*	VAX 11/780	5/78	305	1,450	1,700	2,200	2,000
*	VAX 11/782	2Q/82	500	--	--	60	80
	Sub-Total			5,250	9,805	15,610	17,600
Digital Micro Systems	HEX-29	4/79	22	3	18	19	12
Digital Scientific Corp	META-4/400	4/70	90	30	30	35	40
	META-4/5010	10/78	40	2	2	1	--
	META-4/5030	6/79	150	4	4	5	10
	Sub-Total			36	36	41	50
* Formation	F/4000	8/81	134	--	5	50	25
* Forward Technology	Gateway 500	12/82	38	--	--	2	4
	Gateway 300	4/82	44	--	--	52	70
	Sub-Total			--	--	54	74
* Four Phase	Two Pi V/32	6/78	125	25	30	51	--
*	System 311	2/81	265	--	20	150	200
*	System 312	12/81	320	--	--	60	NA
	Sub-Total			25	50	261	220

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value +	1980	1981	1982	1983
General	18/30	7/69	50	40	80	30	--
Automation	16/440,460	7/75	30	120	60	30	--
	470,480	8/80	21	NA	300	440	200
	900	4/82	20	--	--	300	NA
*	Zebra	4/83	30	--	--	--	NA
Sub-Total				160	440	800	390
Harris	6024/3	2/70	90	30	20	15	--
	Slash 4	8/73	110	60	30	20	--
	Slash 5	5/72	50	50	40	35	--
	Slash 6	12/76	70	10	10	10	--
	Slash 7	10/75	180	5	5	2	--
	Series 100	10/75	190	5	5	1	--
	Series 200	10/75	240	3	5	3	--
	Series 1X5	9/77	175	45	35	20	--
	Series 5X0	12/78	300	30	20	10	--
	H80	2/81	100	--	49	50	NA
	H100	1/71	150	20	10	10	--
*	H300	9/81	200	--	10	70	NA
*	H500	1/79	250	50	105	200	NA
*	H800	3/80	275	40	75	160	NA
*	H800-2B	3/83	NA	--	--	--	NA
*	H800-2BP	3/83	NA	--	--	--	NA
*	H700	3/83	175	--	--	--	15
Sub-Total				348	409	676	210

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value	1980	1981	1982	1983
Hewlett	3000 I,II	11/72	200	--	--	--	--
Packard	3000 III	6/78	200	500	2,798	1,000	NA
	3000-33	1/79	135	600	500	1,000	NA
	3000-30	10/79	105	350	600	550	NA
	3000-44	3/81	52	--	800	1,900	NA
	3000-64	1/82	300	--	--	470	1,000
	3000-40	11/81	52	--	50	122	NA
*	9030,9040	1/83	45	--	--	--	NA
*	9020	1/83	45	--	--	--	NA
	Sub-Total			1,450	4,748	5,042	5,602
* HIS	6/92-6/96	10/81	490	--	25	646	NA
	6/43-6/76	1/77	165	NA	NA	NA	2,500
	DPS 6/95-96	8/83	NA	--	--	--	NA
	Sub-Total				25	646	3,150
* Intellimac	IN/700M	7/82	50	--	--	5	20
*	IN/7000K	4/82	35	--	--	25	50
	Sub-Total			--	--	30	70
MicroData	3200/3230	3/74	14	NA	NA	75	30
Modular	MC III	12/70	44	15	25	37	--
* Computer	MC IV	5/74	100	NA	75	NA	--
*	Classic 7830	9/79	47	30	100	226	NA
*	Classic 7840	12/80	22	87	63	51	NA
*	Classic 7860	1/78	49	NA	87	102	NA
*	Classic 7870	8/78	159	NA	NA	NA	NA
*	Classic 11/25	6/82	43	--	--	40	NA
*	Classic 11/40	6/82	82	--	--	120	NA
*	Classic 11/55	7/82	130	--	--	5	NA
*	Classic 11/75	5/82	153	--	--	60	NA
	Sub-Total			132	350	641	908

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value	1980	1981	1982	1983
* Perkin	8/32	6/75	160	80	75	NA	--
* Elmer	3230	3/81	150	--	50	376	--
*	7/32	7/74	36	NA	NA	NA	--
*	3220	5/79	105	826	225	--	
*	3210	9/81	80	--	93	491	NA
*	3240	10/79	192	130	170	70	NA
*	3250	2/82	190	--	--	126	NA
*	Cadam	5/78	220	5	8	12	NA
*	3210A	9/81	35	--	30	72	NA
*	3200MPS	2Q/83	300	--	--	--	NA
Sub-Total				1,041	651	1,147	1,629
Plessey	6600	4/83	25	--	--	--	150
Peripheral	6700	4/83	25	--	--	--	50
Sub-Total				--	--	--	200

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value	1980	1981	1982	1983
* Plexus	P/35	5/83	25	--	--	--	100
* Computers	P/60	5/83	47	--	--	--	100
Sub-Total				--	--	--	200
* Prime	300	9/73	58	NA	NA	NA	NA
*	400	6/76	207	NA	NA	NA	NA
*	500	6/76	330	NA	NA	NA	NA
*	150 II	6/80	65	0	30	50	--
*	250 II	6/80	75	0	420	469	--
*	350	7/78	116	20	--	--	--
*	450	2/79	75	NA	50	35	--
*	550	2/79	105	300	400	NA	--
*	550 II	7/81	110	--	100	1,250	--
*	650	2/79	165	NA	NA	51	NA
*	750	7/79	200	52	650	780	NA
*	850	7/81	370	--	NA	85	NA
*	950	-/83	NA	NA	NA	NA	NA
*	2250	10/82	50	--	--	85	NA
Sub-Total				372	1,650	2,805	2,800
* Q1 Corp.	6899 Bay	8/83	30	--	--	--	20
Raytheon	RDS 500	12/73	21	241	178	NA	125
	RDS 550	10/80	14	75	130	241	150
Sub-Total				316	308	241	
* Ridge Computer	Ridge 32	8/82	60	--	--	1	80

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value	1980	1981	1982	1983
Sperry	V-73	11/72	45	NA	120	230	--
Univac	V-74	5/74	80	30	15	12	--
	V-75	8/75	80	NA	20	12	--
	V-76	1/76	16	NA	200	120	--
	V-77-500	3/81	60	--	50	150	NA
	V-77-600	3/77	18	NA	NA	NA	NA
	V-77-700	3/81	90	--	20	104	NA
	V-770800	3/79	95	200	120	NA	NA
Sub-Total					545	628	500
* Stratus	Stratus/32	2/82	200	--	--	35	75
* Systems	32/30,35	9/76	80	10	8	NA	--
* Engineering	32/55,57	8/75	125	40	30	32	--
* Labs	32/75,77	3/78	150	NA	85	NA	125
*	32/27	2/81	60	--	100	698	800
*	32/87	11/81	350	--	NA	221	275
Sub-Total					233	951	1,200

TABLE 1 (Continued)

DEVELOPMENT OF SUPERMICOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983

Vendor	Model	Date First Shipped	Av. System Value	1980	1981	1982	1983
Tandem	Non-Stop/II	5/76	170	748	956	1,548	NA
Texas Instruments	980 A/B	10/72	40	868	1,200	NA	--
	990/12	11/79	52	NA	NA	NA	NA
	Sub-Total			868	1,200	NA	NA
Three Rivers Computer	PERQ System D/L	8/80	29	40	350	510	NA
		3/83	35	--	--	--	NA
	Sub-Total			40	350	510	NA

TABLE NOTES:

* Indicates 32 bit systems

-- Indicates data not applicable to system.

NA Indicates data not available.

+ Average System Value based on IDC datafile extrapolation, listed in \$000.

TABLE 2
 WORLDWIDE SUPERMINICOMPUTER SHIPMENTS: 1980-1988
 (UNITS -- \$M)

	1980		1981		1982		1983		1984		1985		1986		1987		1988	
	Units	%	Units	%	Units	%	Units	%	Units	%	Units	\$	Units	\$	Units	\$	Units	\$
16 Bit	18,410	1,810	22,000	2,184	26,031	2,358	30,680	2,611	31,920	2,583	31,650	2,426	30,820	2,201	29,220	1,815	28,980	1,853
32+ Bit	5,390	797	8,100	1,319	11,469	1,812	16,620	2,365	27,180	3,351	41,650	5,124	30,820	2,201	82,080	10,539	115,930	13,590
Total	23,800	2,607	30,100	3,503	37,500	4,170	47,300	4,976	59,100	5,934	73,300	7,550	90,500	9,865	111,300	12,354	114,910	15,443

TABLE 3

WORLDWIDE SUPERMINICOMPUTER SHIPMENTS

1983-1988

(UNITS)

Vendor	1983	1984	1985	1986	1987	1988
Able Computer	60	105	130	140	150	160
Apollo	4,000	4,600	5,200	6,500	7,150	8,000
August Systems	12	36	72	133	240	310
BTI	1,650	1,220	1,290	980	1,005	980
Charles River Data Systems	130	205	254	270	340	360
Computer Automation	200	280	347	360	350	350
Computer Talk	12	24	30	30	30	30
Data General	4,400	5,910	8,796	11,765	16,600	24,000
Digital Equipment Corporation	17,600	20,749	24,922	31,675	38,500	51,000
Digital MicroSystems	12	28	30	30	40	45
Digital Scientific Corporation	50	60	60	65	70	75
Formation	25	35	40	45	50	55

TABLE 3 (Continued)
 WORLDWIDE SUPERMINICOMPUTER SHIPMENTS
 1983-1988
 (UNITS)

	1983	1984	1985	1986	1987	1988
Four Phase	220	290	320	350	350	300
General Automation	390	500	900	1,000	1,100	1,100
Harris	210	230	285	275	375	400
Hewlett Packard	5,602	6,670	8,100	9,000	10,000	11,100
HIS	3,150	3,660	4,100	4,300	4,500	4,600
Intellimac	70	90	140	150	160	165
MicroData	30	30	30	30	30	30
Modular Computer	908	950	1,070	1,000	950	900
Perkin Elmer	1,629	2,955	5,860	8,145	10,000	15,000
Plessey Peripherals	400	320	320	310	300	250
Plexus Computers	200	300	372	400	450	500
Prime	2,800	3,937	4,398	7,240	10,000	15,000

TABLE 3 (Continued)
 WORLDWIDE SUPERMINICOMPUTER SHIPMENTS
 1983-1988
 (UNITS)

	1983	1984	1985	1986	1987	1988
QI Corporation	20	28	35	61	80	100
Raytheon Data Systems	275	300	372	260	200	180
Ridge Computers	80	90	100	110	140	150
Sperry Univac	500	560	600	640	680	710
Stratus	75	169	313	500	690	980
Systems Engineering Laboratories	1,213	1,280	1,500	1,600	2,400	3,200
Tandem	1,300	1,768	2,200	3,000	3,600	4,300
Texas Instruments	NA	NA	NA	NA	NA	NA
Three Rivers Computer Systems	NA	NA	NA	NA	NA	NA
Other	77	1,721	1,124	1,036	770	620
Total Market	47,300	59,100	73,300	90,500	111,300	144,910

TABLE 4

WORLDWIDE SUPERMINICOMPUTER SHIPMENTS (EXTRAPOLATED BASED ON AVERAGE SYSTEM REVENUES)
 1983-1988
 (DOLLARS--\$M)

	1983	1984	1985	1986	1987	1988
Able Computer	29.6	35.6	38.0	50.0	74.0	154.0
Apollo	200.0	237.0	302.0	395.0	494.0	618.0
August Systems	1.5	2.0	2.8	5.0	8.0	10.2
BTI	77.5	95.0	121.0	75.0	60.0	44.0
Charles River Data Systems	2.1	3.0	3.5	4.0	4.3	4.6
Computer Automation	2.2	3.0	3.1	3.2	3.0	3.5
Computer Talk	.5	1.0	1.0	1.0	.9	.6
Data General	418.0	475.0	604.0	789.0	988.0	1,390.0
Digital Equipment Corporation	1,238.0	1,484.0	1,812.0	2,565.0	3,460.0	4,169.0
Digital MicroSystems	.26	.5	.8	.8	.7	.5
Digital Scientific Corporation	5.5	5.9	6.0	6.3	6.9	7.0
Formation	3.4	5.0	5.0	4.9	4.8	4.7

TABLE 4 (Continued)

WORLDWIDE SUPERMINICOMPUTER SHIPMENTS (EXTRAPOLATED BASED ON AVERAGE SYSTEM REVENUES)
 1983-1988
 (DOLLARS--\$M)

	1983	1984	1985	1986	1987	1988
Four Phase	61.6	71.0	91.0	69.0	62.0	45.0
General Automation	8.2	10.0	12.0	15.0	16.0	16.5
Harris	42.0	50.0	52.0	56.0	58.0	60.0
Hewlett Packard	560.0	593.0	679.0	740.0	865.0	926.0
HIS	346.0	356.0	377.0	394.0	494.0	617.0
Intellimac	2.8	3.0	3.2	3.8	4.2	4.9
MicroData	.42	1.0	1.2	1.9	2.0	2.4
Modular Computer	636.0	593.0	529.0	493.0	530.0	585.0
Perkin Elmer	420.0	534.0	755.0	987.0	1,359.0	1,544.0
Plessey Peripherals	10.0	12.0	15.0	10.0	8.0	5.0
Plexus Computers	6.0	8.0	15.0	20.0	20.0	20.0
Prime	308.0	356.0	453.0	591.0	865.0	1,125.0

TABLE 4 (Continued)

WORLDWIDE SUPERMINICOMPUTER SHIPMENTS (EXTRAPOLATED BASED ON AVERAGE SYSTEM REVENUES)

1983-1988

(DOLLARS--\$M)

	1983	1984	1985	1986	1987	1988
QI Corporation	.6	1.0	1.2	1.3	1.4	1.5
Raytheon Data Systems	5.9	6.0	8.0	5.0	3.0	1.4
Ridge Computers	4.8	6.0	8.0	8.0	7.0	6.0
Sperry Univac	25.0	30.0	38.0	49.0	35.0	28.4
Stratus	15.0	18.0	23.0	49.0	74.0	98.0
Systems Engineering Laboratories	343.0	420.0	528.0	640.0	679.0	662.0
Tandem	221.0	237.0	302.0	395.0	410.0	430
Texas Instruments	NA	NA	NA	NA	NA	NA
Three Rivers Computer Systems	NA	NA	NA	NA	NA	NA
Other	NA	NA	NA	NA	NA	NA
Total Market	4,976.0	5,934.0	7,550.0	9,865.0	12,354.0	15,443.0

TABLE 5

TOTAL 32+ BIT MID-RANGE SYSTEMS MARKET ¹

1983-1988

(UNIT SHIPMENTS)

Component Segment	1983	1984	1985	1986	1987	1988
Microcomputers	1,005	2,230	5,950	8,570	11,764	17,470
Minicomputers ²	918	3,100	20,450	32,843	74,134	115,310
Superminis	16,620	27,180	41,655	59,680	82,080	115,930
Small Business Computers	3,516	12,800	25,530	38,900	55,900	88,490
Low End General Purpose Mainframes	2,610	3,400	4,400	5,480	7,090	9,200
Total	24,669	48,710	97,985	145,473	230,968	346,400

¹ Includes all 32+ bit mid-range systems -- low or high end performance range.

² Minicomputer category includes traditional and microminicomputers only.

TABLE 6

TOTAL 32+ BIT MID-RANGE SYSTEMS MARKET

1983-1988

(DOLLAR/SHIPMENTS--\$M) ¹

Component Segment	1983	1984	1985	1986	1987	1988
Microcomputers	10	20	48	56	59	97
Minicomputers	34	112	715	1,117	2,224	3,113
Superminis	2,365	3,351	5,124	7,664	10,539	13,590
Small Business Computers	158	512	893	1,167	1,680	2,654
Low End General Purpose Mainframes	392	442	484	575	673	828
Total	2,959	4,437	7,264	9,579	15,175	20,282

¹ Based on average system values per component.

TABLE 7

32+ BIT CAPTURE RATE BY COMPONENT SEGMENT OF
MID-RANGE SYSTEMS MARKET
1983-1988

Component Segment	1983	1984	1985	1986	1987	1988
Microcomputers	14%	20%	40%	45%	50%	55%
Minicomputers	1%	2%	10%	13%	25%	34%
Superminis	35%	46%	57%	66%	74%	81%
Small Business Computers	4%	15%	25%	35%	45%	55%
Low End General Purpose Mainframes	90%	93%	95%	96%	97%	98%

TABLE 8

32+ BIT MID-RANGE SYSTEMS BY APPLICATION AREA

(UNIT SHIPMENTS)

1983-1988

	Automation & Control	Communi- cations	Data Oriented	Commercial Data Processing	Problem Solving/ Computation
1983	914	405	2,229	10,531	10,605
1984	1,677	776	3,845	25,567	18,357
1985	8,901	2,444	5,041	37,447	38,879
1986	22,797	3,439	1,742	48,798	41,621
1987	23,648	6,995	3,258	68,680	71,204
1988	41,868	10,437	5,060	89,349	92,325

TABLE 9

32+ BIT MID-RANGE SYSTEMS BY APPLICATION AREA BY COMPONENT SEGMENT

(UNIT SHIPMENTS)

1983-1988

		Automation & Control	Communi- cations	Data Oriented	Commercial Data Processing	Problem Solving Computations	Total
◊ Minicomputers	1983	0	17	28	350	523	918
	1984	155	93	93	1,364	1,395	3,100
	1985	2,045	1,227	614	7,770	8,794	20,450
	1986	6,569	1,642	986	14,122	9,524	32,843
	1987	18,534	4,448	2,224	32,619	16,309	74,134
	1988	34,590	7,000	3,500	53,040	17,680	115,310
Superminis	1983	914	316	100	4,770	10,520	16,620
	1984	1,522	544	163	9,187	15,764	27,180
	1985	2,332	875	250	14,994	23,199	41,650
	1986	3,402	1,313	358	22,738	31,869	59,680
	1987	4,761	1,888	492	32,750	42,189	82,080
	1988	6,404	2,539	662	44,054	56,751	115,930
Small Business Computers	1983	0	0	0	3,340	176	3,516
	1984	0	0	0	12,160	640	12,800
	1985	0	0	0	24,253	1,277	25,530
	1986	0	0	0	36,955	1,945	38,900
	1987	0	0	0	53,105	2,795	55,900
	1988	0	0	0	84,066	4,424	88,490
Low End General Purpose Mainframe	1983	0	22	88	2,000	600	2,610
	1984	0	27	10	2,611	752	3,400
	1985	0	44	44	3,344	968	4,400
	1986	0	55	55	4,164	1,205	5,480
	1987	0	71	71	5,387	1,559	7,090
	1988	0	60	24	7,000	2,116	9,200
Microcomputers	1983	0	50	30	101	824	1,005
	1984	0	112	67	245	1,806	2,230
	1985	0	298	179	833	4,640	5,950
	1986	86	429	343	1,296	6,416	8,570
	1987	353	588	471	2,000	8,352	11,764
	1988	874	874	874	3,494	11,354	17,470

TABLE 10

WORLDWIDE SUPERMINCOMPUTER SHIPMENTS BY APPLICATION AREA

(UNITS)

1983-1988

Applications	1983		1988	
	16 Bit	32+ Bit	16 Bit	32+ Bit
Automation and Control	2,209	914	2,165	6,404
Communications	982	316	952	2,539
Data Oriented	337	100	34	662
Commercial Data Processing	11,842	4,770	12,554	44,054
Problem Solving/ Computational	15,309	10,520	13,155	56,751
TOTAL	47,300		139,270	

TABLE 11

WORLDWIDE SUPERMINCOMPUTER SHIPMENTS BY APPLICATION AREA

(\$ -- MILLIONS)

1983-1988

Applications	1983		1988	
	16 BIT	32+ BIT	16 BIT	32+ BIT
Automation and Control	162	121	107	825
Communications	70	33	48	275
Data Oriented	29	14	16	92
Commercial Data Processing	1,026	693	740	619
Problem Solving/ Computational	1,324	1,954	759	13,471
TOTAL	2,611	2,365	1,670	15,282

TABLE 12
 DEVELOPMENT OF MICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
 1980-1983
 (Units)

VENDOR	MODEL	DATE FIRST SHIPPED	AVERAGE PRICE	1980	1981	1982	1983
Apple	Lisa	---/83	8000	--	--	--	20,000
	Apple II/III	5/77	2,500	67,000	75,000	90,000	440,000
	Apple III	11/80	6,000	4,000	6,000	30,000	40,000
Atari	400	9/79	300	65,000	160,000	145,000	130,000
	800	9/79	650	5,000	31,000	106,000	120,000
Commodore	Pet/CBM	10/77	995	132,000	137,000	140,000	110,000
	VIC 20	6/81	150	---	50,000	950,000	NA
	SuperPet	7/81	1995	---	20,000	50,000	50,000
	64	8/82	400	---	---	50,000	NA
	128	3/83	795	---	---	---	100,000
	B,BX700	7/83	2995	---	---	---	120,000
CompuCorp	625	6/77	8,500	50	50	---	---
	655	4/79	6,500	NA	NA	1,000	NA
	665	4/79	7,000	NA	NA	2,100	NA
	675	6/79	9,978	400	500	1,000	NA
	685	5/81	11,600	---	50	1450	NA
	685E	5/82	13,600	---	---	550	NA
	686	5/82	15,995	---	---	300	NA
	745	8/82	4,495	---	---	300	NA
	775	1/83	7,400	---	---	---	500
	785	1/83	10,200	---	---	---	NA
	790	1/83	11,700	---	---	---	NA
	Simplifier	7/82	5,700	---	---	1,500	NA
	Convergent Technologies	AWS	11/81	6,795	---	100	400
IWS		10/80	16,000	500	2,500	3000	NA
AWS Turbo		1/82	6,900	---	---	20,000	40,000
AWS Turbo Color		2/83	12,990	---	---	---	NA
Burroughs B20		6/82	14,000	---	---	3,600	NA
NCR Worksaver		4/82	8,500	---	---	1,000	NA

TABLE 12 (Continued)

DEVELOPMENT OF MICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS

1980-1983

(Units)

VENDOR	MODEL	DATE FIRST SHIPPED	AVERAGE PRICE	1980	1981	1982	1983
Cromemco	System Zero/D	12/80	4,990	NA	NA	NA	NA
	System Zero	12/80	2,990	NA	NA	NA	NA
	System One	12/81	7,585	---	NA	NA	NA
	System Three C-10	8/77 --/83	10,943 2,500	NA ---	NA ---	NA ---	NA ---
Datapoint	1100	--/77	12,000	500	1,500	2,000	---
	2200	9/77	12,000	50	1,500	2,000	---
	1500	--/73	9,100	500	500	500	---
	1560	11/82	6,500	---	---	1,000	---
	1800	--/75	12,000	NA	NAS	NA	20,000
DEC	MiniMinc	10/79	11,000	250	500	750	1,000
	Data Sys 150	3/79	15,000	300	500	---	---
	VT100(18XX kit)	1/82	5,000	---	---	3,000	5,000
	DECmate	1/83	3,790	---	---	---	20,000
	Rainbow	--/82	3,245	---	---	1,150	NA
	325	--/82	3,995	---	---	1,250	NA
	350	--/82	4,995	---	---	NA	NA
Franklin	Ace 1000	8/82	1,395	---	---	17,000	23,000
	Ace 1200	3/83	2,495	---	---	---	20,000
Hewlett Packard	98 - Series	11/77	13,200	15,000	25,000	28,000	49,000
	83-87	1/80	3,450	10,000	22,000	36,000	75,000
	120	12/82	2,775	---	---	550	6,500
	125	9/82	6,200	---	---	8,100	19,500
IBM	5100	11/75	13,000	NA	NA	1,000	---
	5110	2/78	17,000	NA	NA	3,000	---
	5120	2/80	15,000	NA	NA	1,500	---
	5150	10/81	4,500	---	75,000	135,000	NA

TABLE 12 (Continued)

DEVELOPMENT OF MICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS
1980-1983
(Units)

VENDOR	MODEL	DATE FIRST SHIPPED	AVERAGE PRICE	1980	1981	1982	1983
IBM (Cont.)	PCXT Sys 23 3471-3-4	--/83	7,500	---	---	---	NA
		7/81	12,530	---	12,000	13,000	NA
		NA	NA	NA	NA	NA	---
Intertec Data	Superbrain (QD) Compustar	10/79	3,450	5,000	10,000	15,000	20,000
		1/81	3,500	---	5,000	5,000	9,000
NEC	205 200 PC 8000 APC	7/80	11,039	30	50	15-	---
		6/82	6,990	---	---	850	6,000
		5/81	2,300	---	5,000	20,000	20,000
		7/82	3,298	---	---	6,000	10,000
North Star Computers	Advantage New Ad	9/81	4,295	---	6,000	6,000	15,000
		--/83	NA	---	---	---	14,000
Ontel	OP-1 150X	--/74	6,500	5,000	6,000	10,000	11,000
		6/81	6,500	---	2,000	4,000	10,000
Sanyo	MBC-2000 MBC-300 MBC-1000 MBC-555	5/82	3,550	---	---	900	NA
		6/82	6,495	---	---	2,000	15,000
		5/82	1,995	---	---	16,000	20,000
		9/83	995	---	---	---	NA
Sinclair (U.S. Only)	XZ80/81	1/82	150	---	---	500,000	910,000
Tandy/Radio Shack	TRS 80-I TRS 80-II TRS 80-III TRS 80-IV	9/77	1,000	NA	NA	NA	---
		7/79	6,500	50,000	60,000	70,000	NA
		9/81	2,000	---	40,000	53,000	NA
		--/83	1,999	---	---	---	NA

TABLE 12 (Continued)

DEVELOPMENT OF MICROCOMPUTER MARKETS: SUPPLIER/MODEL WORLDWIDE SHIPMENTS

1980-1983

(Units)

VENDOR	MODEL	DATE FIRST SHIPPED	AVERAGE PRICE	1980	1981	1982	1983
Tandy/Radio Shack (Cont.)	TRS 90-Color	9/81	399	---	40,000	72,000	NA
	TRS 80/16	--/82	9,000	---	---	9,000	23,000
	TRS 80/100	---/82	850	---	---	---	100,000
Tektronix	4051	12/75	5,996	2,000	3,000	550	NA
	4052	7/79	16,500	1,000	2,000	2,800	NA
	4054	7/79	22,500	NA	NA	NA	NA
Televideo	801	9/81	3,295	---	920	1,000	NA
	803	3/83	2,495	---	---	---	NA
	816	2/82	12,995	---	---	450	2,800
	800A	9/81	1,695	---	4,000	4,550	20,000
	802	12/81	3,495	---	500	2,105	6,000
	802H	12/81	6,995	---	200	6,430	12,000
	806	9/81	7,195	---	600	2,000	3,500
1605	4/83	3,495	---	---	---	NA	
Texas Instruments	99/4	11/79	1,000	500	10,000	9,500	NA
	99/4A	7/81	150	---	100,000	400,000	NA
	742-771	--/77	10,000	NA	NA	NA	---
Xerox	510	9/79	17,000	300	1,000	2,800	---
	515	3/81	6,300	---	1,000	1,470	---
	820	6/81	4,995	---	15,000	21,000	30,000
	16/8	8/83	4,000	---	---	---	6,000
Zenith	Z89-ZF110	10/79	4,000	10,000	20,00	22,000	21,000
	ZW-100	3/83	7,000	---	---	---	8,000

TABLE NOTES

-- Indicates data not applicable to system.

NA Indicates data not available

+ Average Price based on retail configurations sold as reported by vendor.

TABLE 13
 WORLDWIDE MICROCOMPUTER SHIPMENTS
 1983--1988
 (UNITS--000)

Vendor	1982	1983	1984	1985	1986	1987	1988
Apple	300	573	1,004	1,041	1,142	1,138	1,588
Atari	350	659	669	744	571	706	853
Commodore	1,200	2,100	3,683	4,908	6,282	7,700	8,000
Compucorp	6	14	22	29	38	47	32
Convergent Technology	240	57	89	133	190	235	317
Cromemco	16	29	45	30	38	47	32
Datapoint	21	57	89	119	171	212	285
DEC	6	26	89	119	171	212	317
Franklin	17	43	67	59	38	24	32
HP	60	150	234	312	457	588	794
IBM	215	600	1,785	3,718	4,949	6,030	12,100
Intertec Data	12	29	45	66	76	94	127
NEC	18	36	40	59	76	94	95

TABLE 13 (Continued)

WORLDWIDE MICROCOMPUTER SHIPMENTS
1983--1988
(UNITS--000)

Vendor	1982	1983	1984	1985	1986	1987	1988
Northstar	14	29	44	59	76	94	127
Ontel	9	21	22	29	38	47	64
Osborn	120	15	--	--	--	--	--
Sanyo	19	39	56	59	57	47	64
Sinclair	500	910	1,003	1,338	1,522	1,822	2,100
Tandy	210	430	670	892	1,332	1,647	2,100
Textronix	2	4	7	11	13	14	19
Televideo	20	45	67	104	133	188	286
TI	470	545	848	1,084	1,114	1,141	906
Xerox	24	36	45	59	76	94	128
Zenith	12	29	45	59	72	89	95
Other	134	115	4,933	3,079	1,405	1,218	1,397
Total	3,785	7,165	11,161	14,872	19,037	23,528	31,763

TABLE 14
 WORLDWIDE MICROCOMPUTER SHIPMENTS ¹
 1983--1988
 (DOLLARS)

Vendor	1982	1983	1984	1985	1986	1987	1988
Apple	855	1,579	1,796	1,893	2,063	2,445	2,564
Atari	101	178	180	208	252	272	321
Commodore	624	1,144	1,796	2,272	2,751	3,260	3,847
Compucorp	52	93	133	169	206	245	289
Convergent Technology	202	395	598	757	917	1,086	1,282
Cromemco	97	197	269	302	343	380	385
Datapoint	230	395	493	568	688	815	961
DEC	36	197	314	378	459	543	641
Franklin	24	39	59	75	91	82	64
HP	274	493	643	814	986	1,168	1,378
IBM	1,108	2,072	3,592	4,734	6,421	8,150	1,122
Intertec Data	33	59	75	95	92	109	128
NEC	230	414	538	681	802	950	1,122

TABLE 14 (Continued)

WORLDWIDE MICROCOMPUTER SHIPMENTS ¹
 1983--1988
 (DOLLARS)

Vendor	1982	1983	1984	1985	1986	1987	1988
Northstar	57	98	134	170	206	217	224
Ontel	110	197	284	189	206	217	224
Osborn	215	--	--	--	--	--	--
Sanyo	45	78	105	113	115	136	128
Sinclair	75	108	149	189	229	245	256
Tandy	454	789	1,048	1,325	1,376	1,630	1,603
Techtronix	39	69	90	95	91	109	128
Televideo	78	138	194	227	252	299	384
TI	62	108	134	170	206	217	224
Xerox	119	217	284	340	389	408	417
Zenith	42	78	120	151	161	163	160
Other	229	948	1,945	3,019	1,566	4,021	4,108
Total	5,390	9,866	14,967	18,934	22,931	27,167	32,058

¹ Shipments include total system revenues.

TABLE 15

TOTAL WORLDWIDE MICROCOMPUTER SHIPMENTS BY HARDWARE TYPE

(EXCLUDES PERIPHERALS, SOFTWARE, SERVICES)

(UNITS --000/DOLLARS--MILLIONS)

1983-1988

	1983		1984		1985		1986		1987		1988		UNITS
	Units	\$	Units	\$	Units	\$	Units	\$	Units	\$	Units	\$	
Microcomputers													
Special Purpose	104	1,248	126	1,260	148	1,332	171	1,368	1,960	1,372	318	1,939	
Advanced	22	198	94	658	206	1,236	346	1,730	534	2,617	331	3,436	
General Purpose	2,401	5,282	3,427	6,854	4,440	7,548	5,646	8,469	7,055	9,712	9,529	11,435	
Low-End	4,638	436	7,514	676	10,078	856	12,874	1,029	15,743	1,181	20,964	1,342	
Total	7,165	7,164	11,161	9,448	14,872	10,972	19,037	12,596	23,528	14,882	31,763	18,152	

WARNING: Dollar estimates based on list, single quantity average CPU prices to end users.
 1988 dollar estimates based on anticipated single quantity average system prices to end users.

TABLE 16

TOTAL WORLDWIDE MICROCOMPUTER MARKET BY BIT SIZE

1983--1988

(UNITS -- 000)

Bit Size	1983	1984	1985	1986	1987	1988
≤ 8	2,150	2,790	2,821	2,800	2,800	2,800
16	3,295	6,109	5,800	5,790	5,700	5,600
≥ 32	1,005	2,230	5,950	8,570	11,764	17,470
New Markets	--	20	300	1,878	3,264	5,893
Total	7,165	11,161	14,871	19,038	23,528	31,763

TABLE 17

1983/1988 ESTIMATES OF WORLDWIDE MICROCOMPUTER SHIPMENTS BY HARDWARE TYPE

(INCLUDES PERSON DISTRIBUTION BY HARDWARE TYPE)

(UNITS -- 000)

1983-1988

1983

Applications	Total Shipments	<u>Percent of Hardware Shipments</u>			
		Special	Advanced	General Purpose	Low End
Business	2,405	40.0%	48.0%	76.0%	3.9%
Home	4,307	0.0%	0.0%	6.3%	91.0%
Scientific	177	60.0%	54.0%	7.1%	0.0%
Educational	276	0.0%	3.0%	10.6%	5.1%
TOTAL	7,165	100.0%	100.0%	100.0%	100.0%

1988

Applications	Total Shipments	<u>Percent of Hardware Shipments</u>			
		Special	Advanced	General Purpose	Low End
Business	9,751	40.0%	47.0%	70.0%	2.0%
Home	20,837	0.0%	0.0%	10.0%	88.0%
Scientific	508	55.0%	45.0%	12.0%	0.0%
Educational	667	5.0%	8.0%	8.0%	10.0%
TOTAL	31,763	100.0%	100.0%	100.0%	100.0%

TABLE 18

32+ BIT WORLDWIDE MICROCOMPUTER BY TARGET MARKET

1983--1988

(UNITS -- 000)

Application	1983	1984	1985	1986	1987	1988
Business	645	1,443	3,500	4,369	6,491	9,300
Home	0	232	1,830	3,435	4,390	6,995
Scientific	160	220	270	321	376	508
Education	200	335	350	445	507	667
Other	0	0	0	0	0	0
Total	1,005	2,230	5,950	8,570	11,764	17,470

Most of these installations located in university and college engineering, and other scientific laboratories.

TABLE 19
 TOTAL WORLDWIDE MICROCOMPUTER SHIPMENTS
 BY OPERATING SYSTEMS SUPPORTED ¹
 1983-1988
 (UNITS--000)

	1983	1984	1985	1986	1987	1988
CP/M or MP/M	5,732	8,929	9,666	13,327	14,117	19,058
MS-DOS or PC-DOS	2,078	3,906	5,948	6,663	7,059	7,941
Unix, Xenix and Lookalikes	1,505	3,348	5,948	8,567	12,940	19,058
Oasis/Pick	1,075	1,786	2,677	3,617	4,706	7,941
Other	358	670	1,189	1,904	2,588	4,764

¹ Totals equal more than 100 percent due to multiple operating systems support. Estimates based on claims for vendor supported operating systems. Figures represent IDC's best estimates.

TABLE 20

IDC ESTIMATES OF TOTAL 32+ BIT SHIPMENTS BY CONFIGURATION

1983-1988

(UNITS)

	1983	1984	1985	1986	1987	1988
Networking	4,883	19,984	48,993	87,284	161,678	294,440
Single User	150	584	1,470	2,619	6,467	11,778
Multi-User	4,733	18,900	47,523	84,665	155,211	282,662
Standalone	19,786	29,226	48,992	58,189	69,290	51,960
Single User	854	1,461	2,940	4,073	4,850	5,000
Multi-User	18,932	27,765	46,052	54,116	64,440	46,960
TOTAL	24,669	48,710	97,985	145,473	230,968	346,400

FIGURE 1
INFILTRATION OF 32 BIT PROCESSORS
IN MID RANGE MARKETS
1983 - 1988

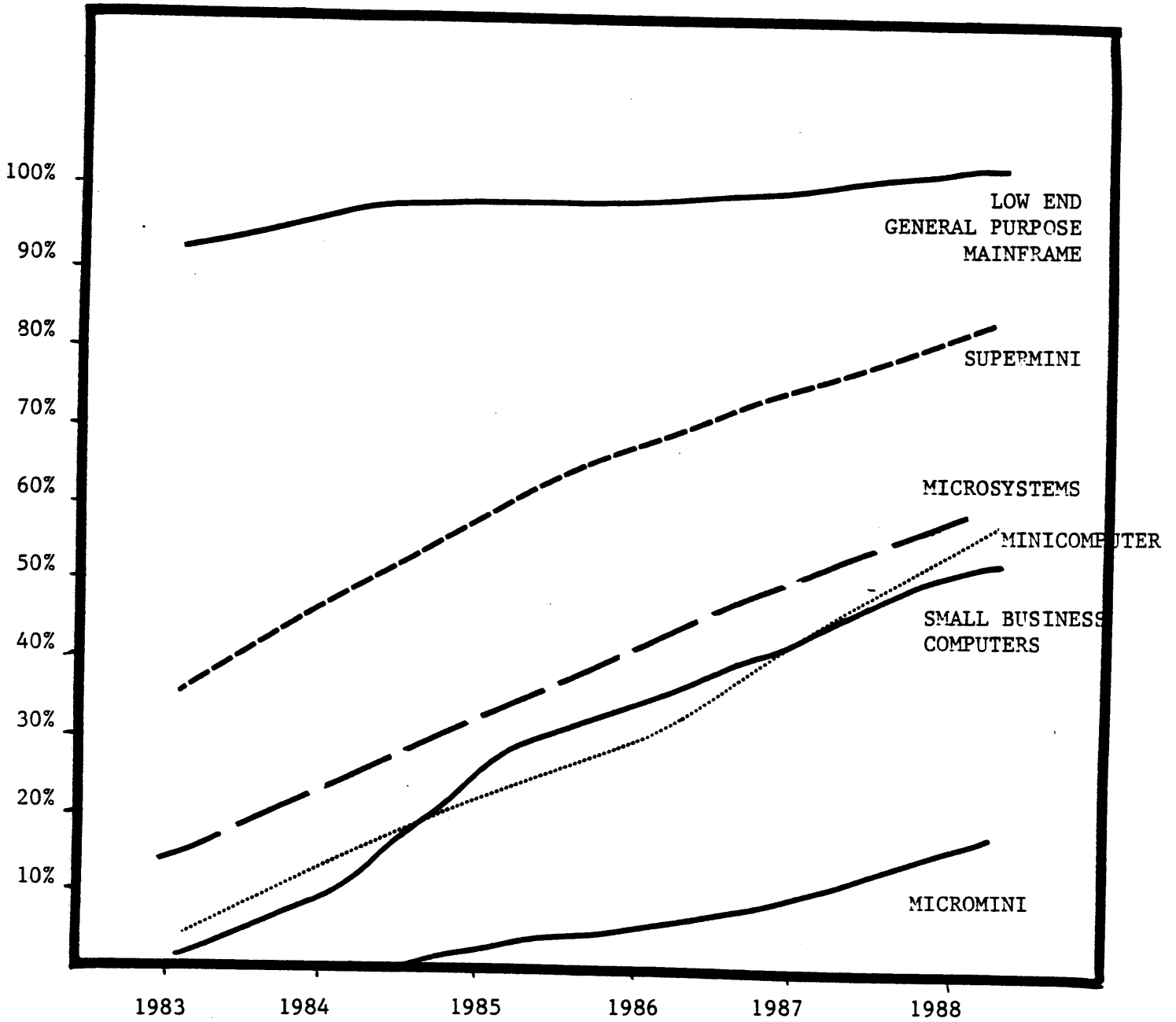
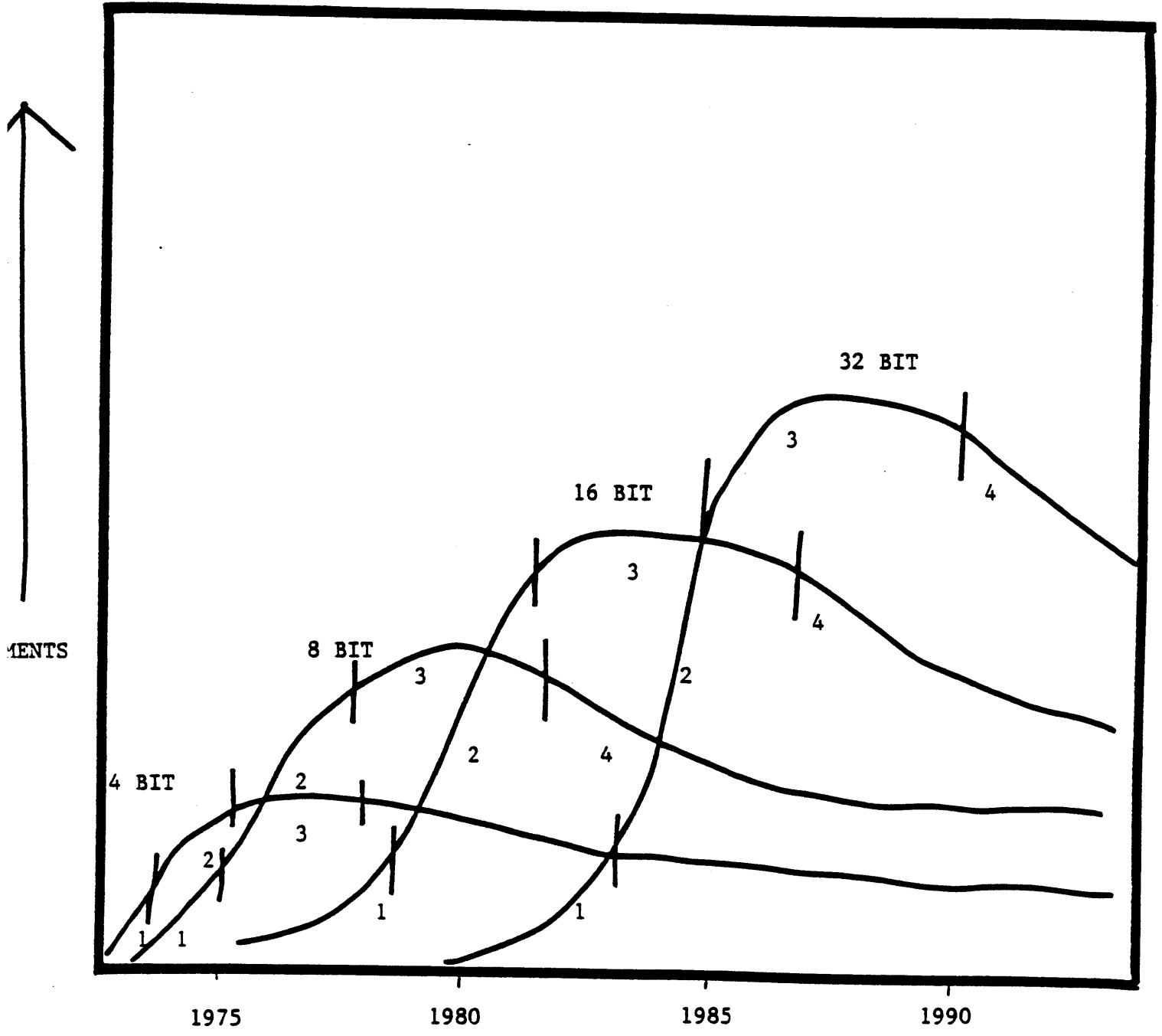


FIGURE 2

BIT SIZE EVOLUTION OF MICRO MARKET



STAGES

- 1 PIONEERING
- 2 FAST GROWTH
- 3 PEAK PRODUCTION
- 4 MATURITY

FIGURE 3

1983 MICRO MARKET CHIP STAGES

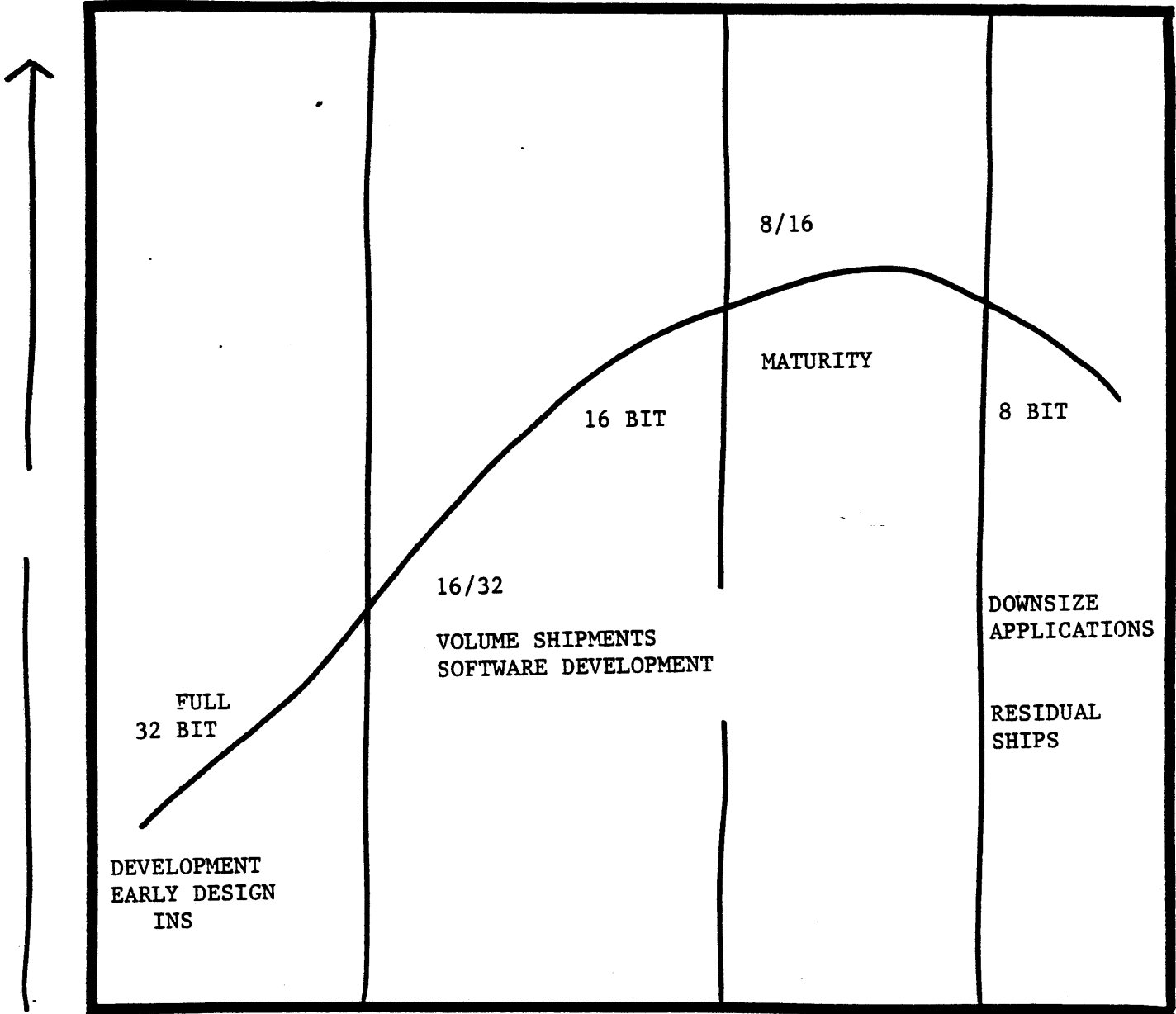


FIGURE 4

TOTAL MID-RANGE SYSTEM PRODUCTS WITH UNIX CAPABILITY

1983

1988

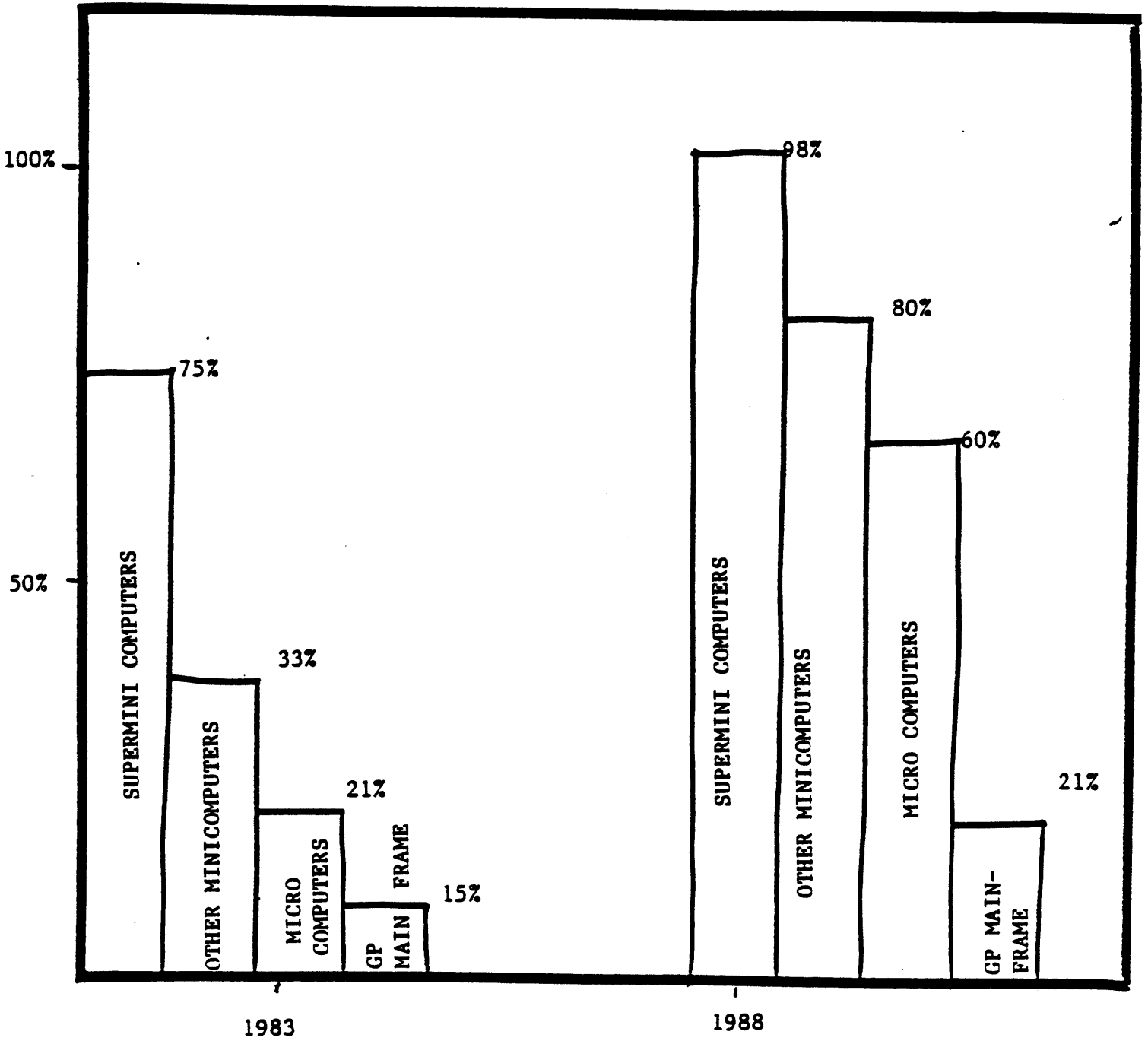
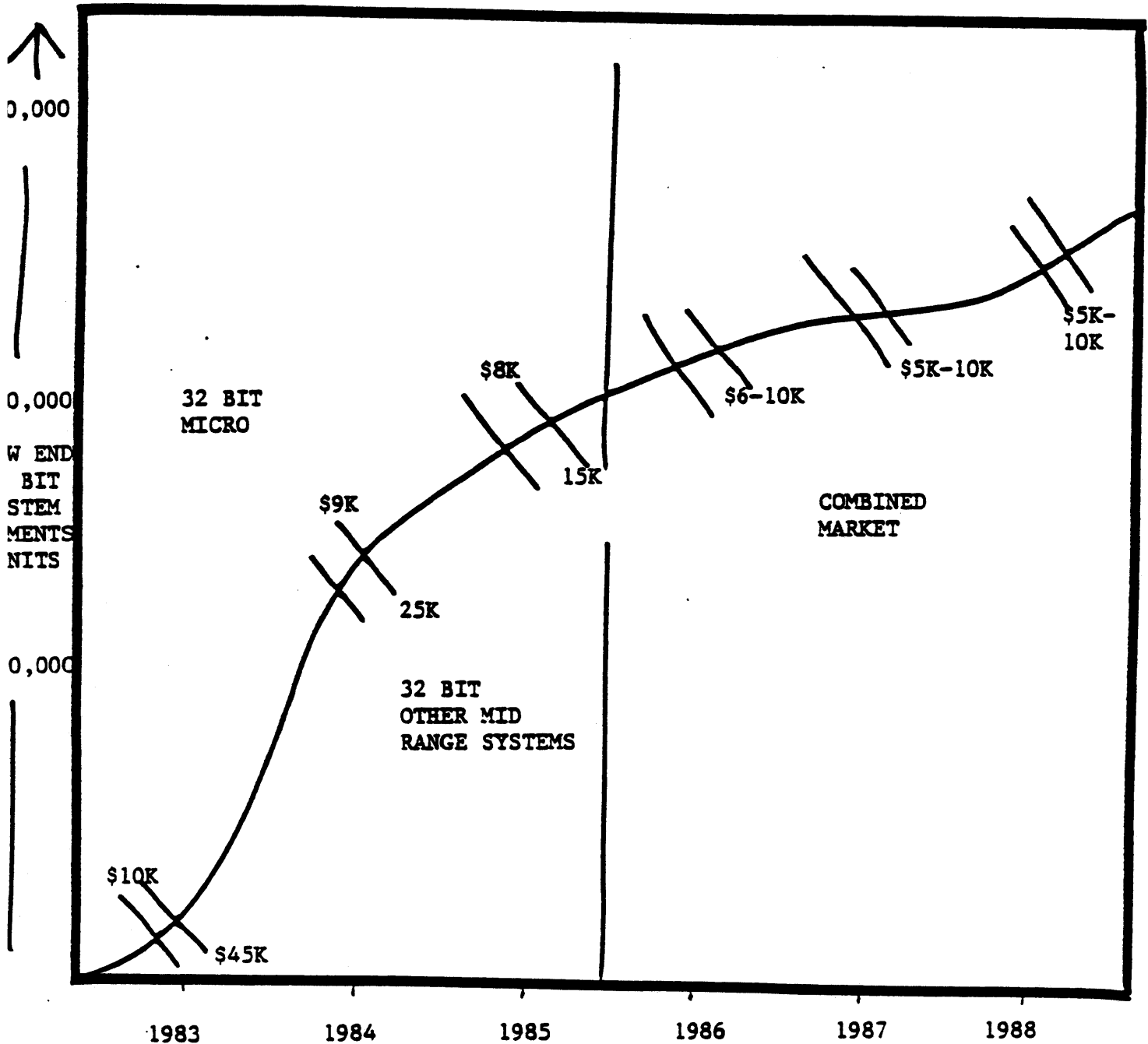


FIGURE 5

WORLDWIDE UNIT SHIPMENTS FOR TOTAL LOW-END
32 BIT SYSTEMS BASED ON CORE SYSTEM/MARKET REQUIREMENTS

(IDC OPINION)



ASSUMPTIONS:

- STEADY DIGITAL PRESENCE -- NO NEW PRODUCT LINES

FORCAST ASSUMPTIONS

1983

- 16 BIT PEAK POPULARITY IN COMMERCIAL SYSTEMS.
- 32 BIT: PIONEERING STAGE.
- UNIX: INCREASING MEDIA COVERAGE.
- NEW VENTURES FORCING PRICE/PACKAGING IMPROVEMENTS.
- LARGE MINI VENDORS STILL DOMINATE.
- COMMERCIAL APPLICATIONS SW BECOMING INCREASINGLY AVAILABLE.

1985

- MINI/MICRO DISTINCTIONS BLUR
- FULL 32 BIT PRODUCTIONS: DEMAND OUTFRONS SUPPLY
- IBM/ATT COMMITTED.
- MICROS FORCE PRICE DECREASES.
- COMPETITION HEATS UP.
- IMPROVED TECHNOLOGY.
- UNIX ON ITS WAY TO ACCEPTANCE.
- PLENTIFUL SOFTWARE.
- SCI/TECH AND TP SYSTEMS UPWARDLY MIGRATE.

1988

- FULL RANGE OF SYSTEM OPTIONS.
- OEM ACCEPTANCE OF 32 BIT SYSTEMS.
- MULTIVENDOR USER INSTALLATIONS.
- 32 BIT CHIP HITS MATURITY: NEW CHIP IN PIONEERING STAGE.
- FULL NETWORKING FUNCTIONS STANDARD.

FIGURE 6

IMPACT OF DIGITAL PRODUCT ENTRY PRICED

\$5-10K RANGE

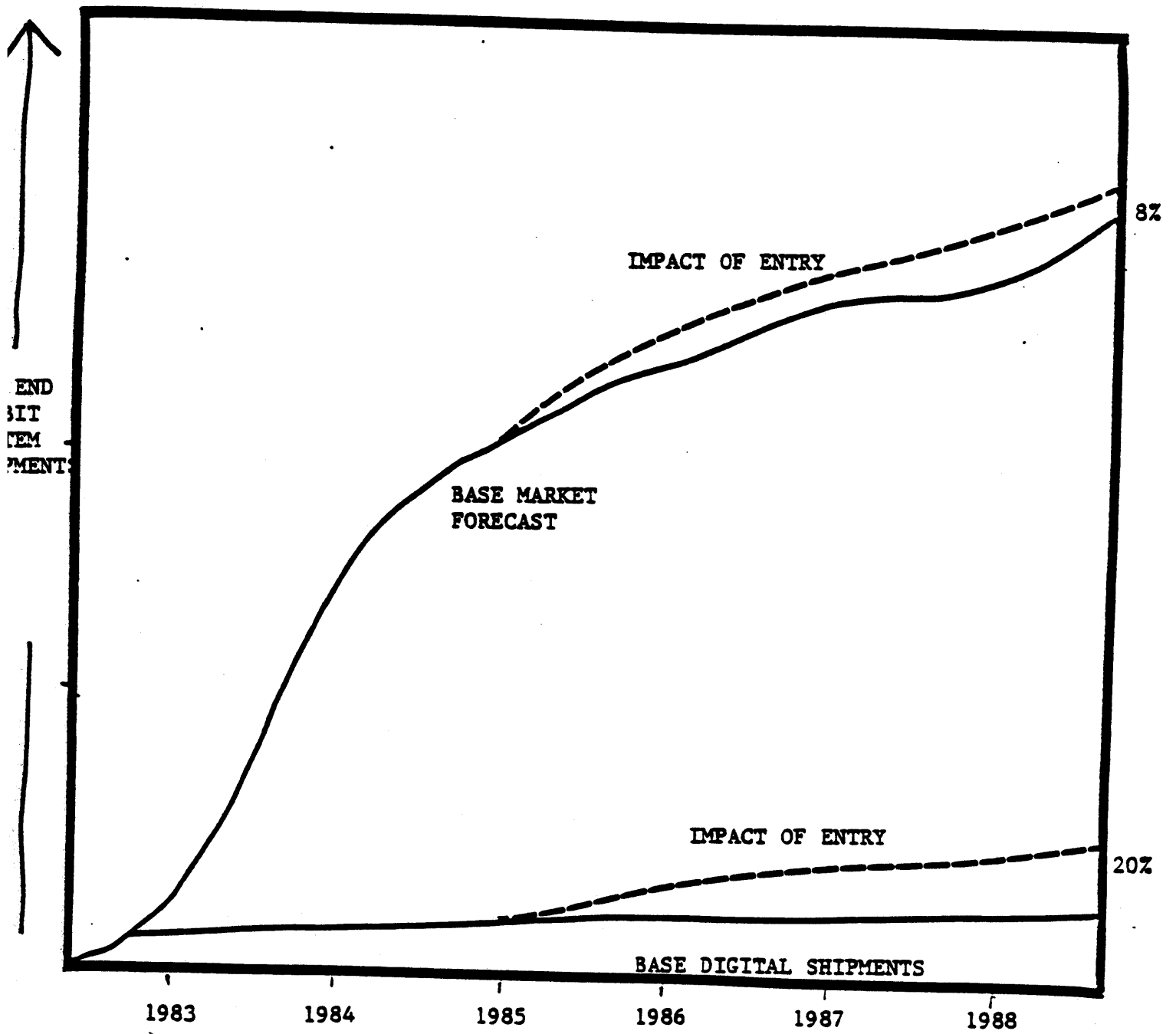
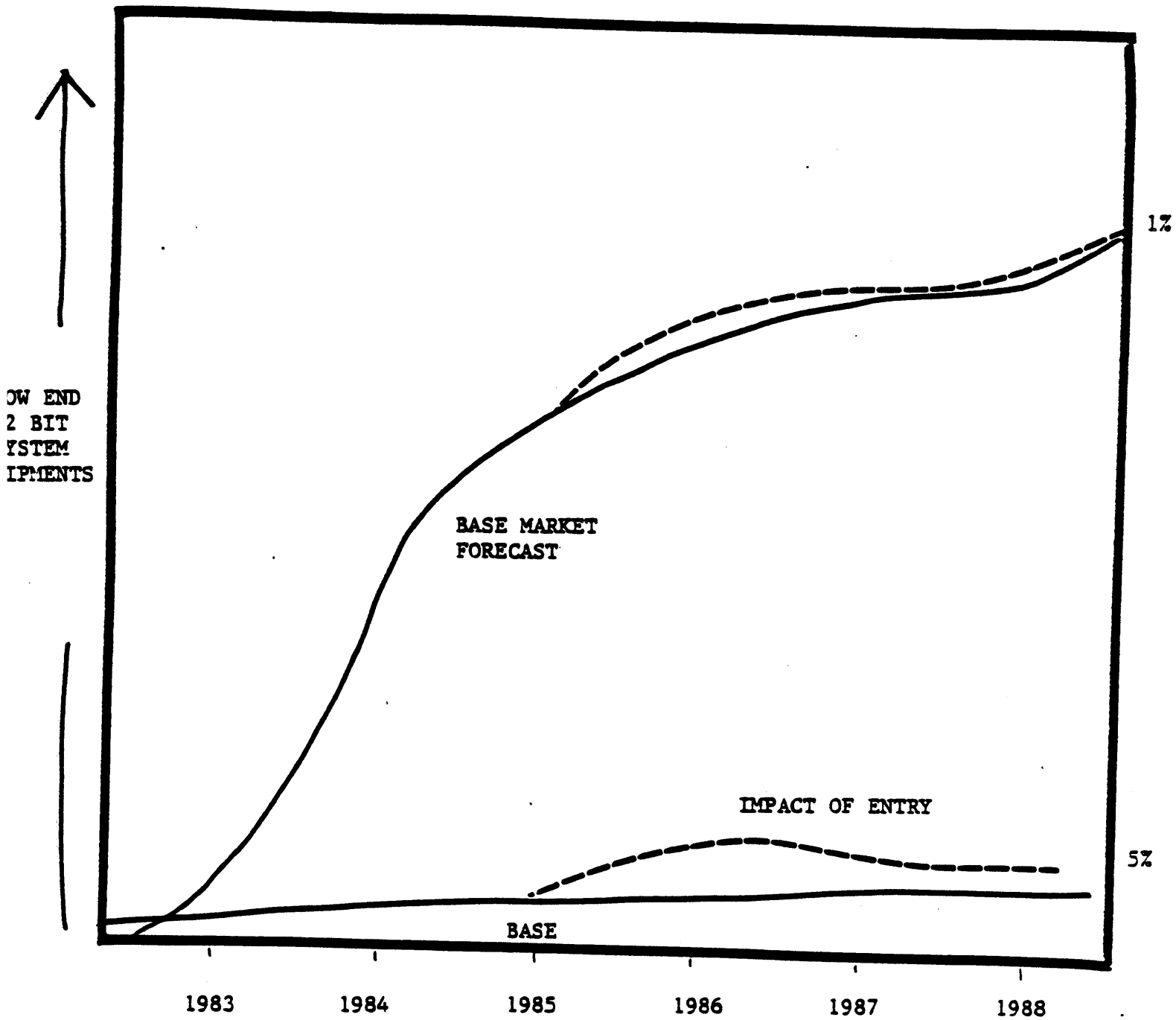


FIGURE 7

IMPACT OF DIGITAL PRODUCT ENTRY
PRICED IN \$20K-\$30K



APPENDIX:
SURVEYED ORGANIZATIONS

- CONDUCT TELEPHONE INTERVIEWS WITH (25):

- + CHIP MANUFACTURERS:
(Intel, National Semiconductor, Motorola)
- + VENTURE CAPITALISTS:
(Technology Ventures, Hambrecht and Quest, First National Bank Corporation, Morgan Stanley)
- + LEADING EDGE OEMS:
(Intergraph, Masscomp, Atex, MicroTel, Logicon)
- + COMPUTER MANUFACTURERS:
(Pyramid Technology, Altos, Hewlett Packard, Bell Labs, Plexus)
- + SOFTWARE SUPPLIERS/DEVELOPERS:
(VisiCorp, MicroSoft, Oracle)
- + DESIGN ENGINEERS (6)

- DEBRIEF IDC EXPERTS.

- + AARON GOLDBERG, Research Manager Micro-Mini Markets
- + WILL ZACHMAN, VP Technology Assessment
- + JACK HART, Director -- IBM Watch
- + ELLEN LEVIN, Manager Micro Marketing Focus
- + MOLLY UPTON, Director Publications/Editor OARS
- + LLOYD COHEN, Manager Industry Analysis/Computer Census.
- + TOM ELLIOT, Director of Research, OA Specialist
- + TOM WILLMOTT, Manager EDP/OA User Research Programs