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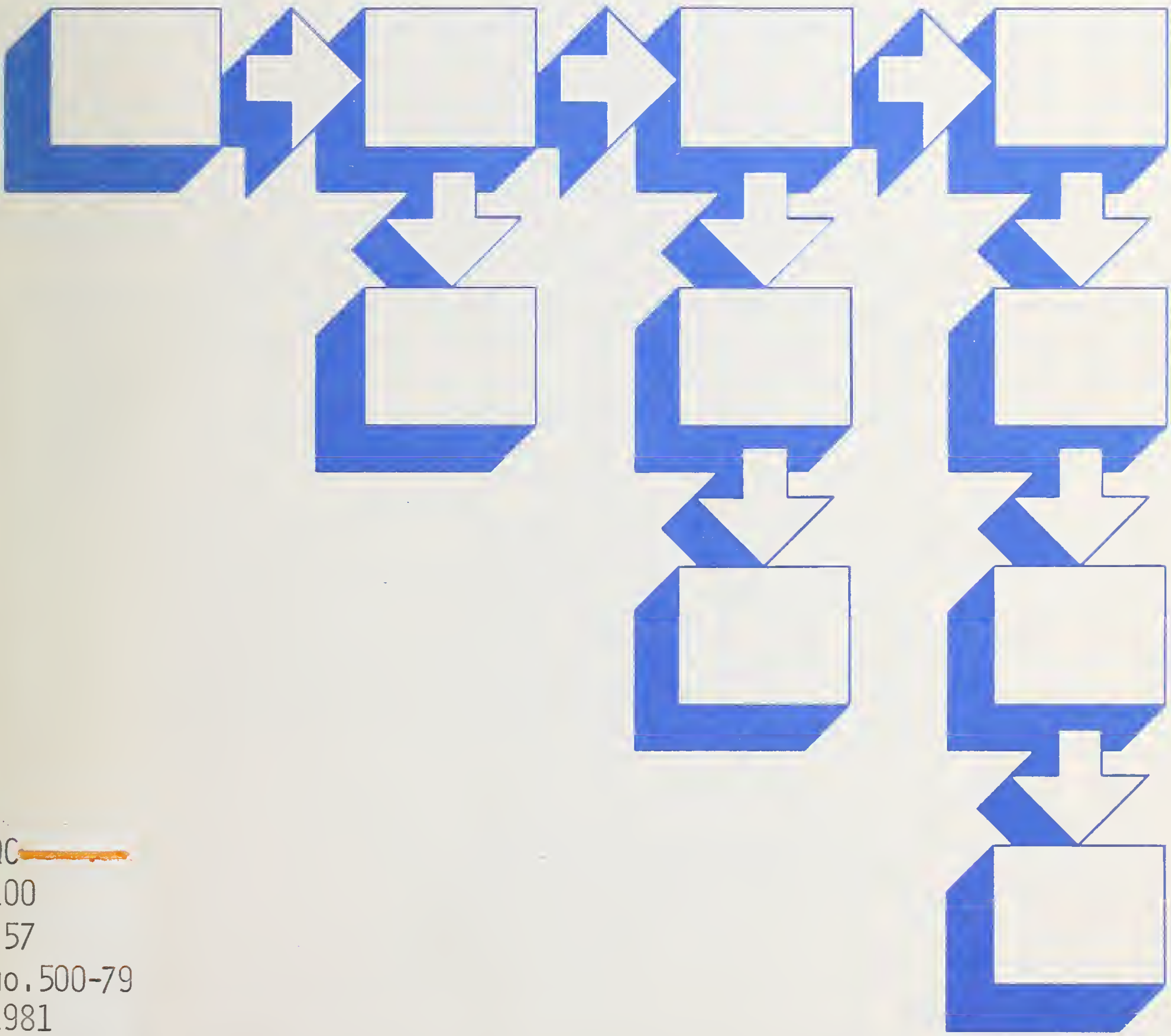
Computer Science and Technology

NBS Special Publication 500-79

An Assessment and Forecast of ADP in the Federal Government



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An Assessment and Forecast of ADP in the Federal Government

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based on the findings of the
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U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Bureau of Standards
Ernest Ambler, Director

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Reports on Computer Science and Technology

The National Bureau of Standards has a special responsibility within the Federal Government for computer science and technology activities. The programs of the NBS Institute for Computer Sciences and Technology are designed to provide ADP standards, guidelines, and technical advisory services to improve the effectiveness of computer utilization in the Federal sector, and to perform appropriate research and development efforts as foundation for such activities and programs. This publication series will report these NBS efforts to the Federal computer community as well as to interested specialists in the academic and private sectors. Those wishing to receive notices of publications in this series should complete and return the form at the end of this publication.

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FOREWORD

The Institute for Computer Sciences and Technology (ICST) was established in the National Bureau of Standards in 1966 pursuant to the authorities delegated to the Secretary of Commerce by Public Law 89-306, enacted by the Congress on October 30, 1965. This Act has as its objective to "provide for the economic and efficient purchase, lease, maintenance, operation, and utilization of automatic data processing equipment by Federal departments and agencies." Under authority delegated to the National Bureau of Standards by the Secretary of Commerce, the Institute for Computer Sciences and Technology provides scientific and technical services to the central management agencies, i.e., the Office of Management and Budget and the General Services Administration, to support the formulation of Federal ADP policies. The Institute develops and recommends Federal Information Processing Standards and participates in the development of voluntary ADP standards.

ICST contracted with the International Data Corporation (IDC) in FY 80 to acquire some of the data necessary to support impact assessments and cost/benefit analyses of ADP standards. These impact assessments and cost/benefit analyses are critical to the planning and prioritizing of Federal Information Processing Standards.

This report presents a summary of IDC's findings and further analysis of these findings by ICST personnel. It presents not only the current status of Federal ADP but also projected ADP trends in the Federal Government for 1979 to 1985. The historical and future data relating to the Federal Government were provided by International Data Corporation and do not necessarily represent the views of the Institute for Computer Sciences and Technology nor the National Bureau of Standards.

The author acknowledges the professional expertise of Miss Nancy Scull, Mr. Kenneth McPherson and Mr. Eric Killorin. The author also wishes to acknowledge the extensive assistance provided by ICST staff member Mr. E. Edward Bortner III in the formulation and preparation of the graphs in this report. The graphs were produced on the Univac 1108 computer utilizing the DISSPLA graphics package. The author also wishes to thank ICST staff members Mrs. Jackie Jones and Mrs. Mary Ellen Crane for assisting in the manuscript preparation.

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EXECUTIVE SUMMARY

Section One

The number of computers in the Federal installed base increased from 6000 in 1974 to 10,800 in 1979 and is predicted to grow to over 29,000 by 1985. Federal general purpose computers are expected to grow at only 1 percent per year in number of units through 1985 while minicomputers should show rapid growth, 21 percent per year in number of units, through 1985. In 1974 minicomputers represented about 48 percent of the Federal computers by number. They represented 70 percent by 1979 and are expected to be about 80 percent of the installed computers by 1985. Over the same period the dollar value of minicomputers grew from $56.3 million in 1974 (2 percent of the inventory by dollar value) to $191.5 million in 1979 (4 percent of the inventory by dollar value) and is expected to reach $8,665.7 million by 1985 (10 percent of the inventory by dollar value). The small general purpose computers, size classes 2, 3 and 4, have decreased both in number and dollar value from 1974 to 1979 and are expected to continue decreasing, while the larger general purpose computers, size classes 5, 6 and 7, have increased both in number and in dollar value. These large, general purpose computers are expected to increase at a rate of 6.5 percent per year through 1985.

IDC expects both 1600 phase encoded and 6250 group encoded tape drives to increase in the future, with 6250 drives increasing the most; low density, 800 NRZI tape drives to decrease slightly by 1985; and floppy disk drives to increase significantly over the next 5 years with over 2 million in use by 1985. Of the four types of floppy disk drives, the 8-inch, 2-sided floppy disk drive is expected to be the most popular by 1985. IDC predicts that rigid disks will increase from 176,790 ($901.6 million) in 1979 to 215,110 ($1,097.1 million) in 1985.

General purpose terminals are expected to increase from the installed base of 188,500 ($694.3 million) to 844,933 ($2,879.2 million) in 1985, with CRT´s increasing from about 58 percent of the 1979 total to about 72 percent in 1985. Key-to-tape terminals and keypunches will decrease in number, while the number of key-to-disk/diskette devices will remain fairly constant. The Federal installed base of teleprinters, intelligent terminals and graphic terminals will increase. Graphic terminals are predicted to increase from 4,390 units ($49.3 million) in 1979 to 42,995 ($430 million) in 1985. Optical character recognition equipment is also predicted to increase from a 1979 installed base of 995 ($45.8 million) to 5,511 ($253.7 million) in 1985.

The number of printers is expected to increase by nearly 150,000 from the 1979 installed base of 54,319 ($367.3 million) to 202,300 ($2,003.0 million) in 1985. Both impact and non-impact printers are predicted to increase during this time period.

The number of auxiliary storage devices is not projected to increase substantially during the 5-year forecast period; however, add-on core memory will increase significantly from the 1979 base of 2,730 megabytes ($108.6 million) to 7,005 megabytes ($202.4 million) in 1985 with much of that increase attributable to minicomputer add-on core (1,200 megabytes in 1979 to 4,860 projected for 1985.)

In communications equipment, a shift from acoustic couplers and low-speed modems to higher speed modems is expected to occur during the forecast period. Acoustic couplers and 0-600 bps modems represented 55 percent of the number of modems in 1979 (25 percent of the dollar value) and are predicted to represent 36 percent by 1985 (12 percent of the dollar value). Acoustic couplers and 0-600 bps modems will still outnumber other types of modems in 1985. A shift in the dominant type of multiplexer is also predicted, with frequency division multiplexers declining in usage and low-end statistical multiplexers showing the greatest increase. High-end statistical multiplexers should increase significantly; while time division multiplexers only slightly. The number of communications processors is expected to increase from 663 ($19.6 million) in 1979 to 1,865 ($55.1 million) in 1985.

Although standalone word processors are currently the dominant type of word processor installed and should also be in 1985, high-end electronic typewriters (costing over $4,000) and clustered word processors should become more popular. In 1979 there were 37,400 ($332.2 million) standalone word processors, representing 90 percent of the total number of word processors. By 1985 it is predicted that there will be 99,179 ($1,006.1 million) standalone units, representing 57 percent of the total word processors. High-end electronic typewriters are expected to have grown from .2 percent of the installed word processors in 1979 to 16 percent of the installed base in 1985, and clustered word processors from 10 percent to 27 percent during the same time period.

In 1979, the dollar value for all storage media was $111.2 million, divided among magnetic tape reels (57 percent), floppy disks (17 percent), rigid disk (17 percent) and digital cassettes and cartridges (8 percent combined). By 1985 the projected dollar value for all storage media is $234.4 million, with the percentage of magnetic tape declining to 47 percent, floppy disks declining to 13 percent, rigid disks increasing slightly to 18 percent and digital cassettes and cartridges increasing to 13 percent and 8 percent respectively.

Section Two

Use of assembly language programming has been decreasing and the use of COBOL on general purpose computers has been increasing. It was estimated that over 50 percent of Federal installations were using COBOL as their principal programming language in 1979. This number was predicted to increase to over 60 percent by 1985. BASIC, assembly and RPG were expected to decline in use as a principal languages by 1985.

The primary uses of computers in the Federal Government and the United States in general were estimated to be accounting, inventory, personnel and other commercial applications. This is not expected to change over the next 5 years.

Operating systems in the United States and the Federal Government are expected to be enhanced to support a "user-friendly" environment, to improve system performance and to provide additional security and integrity features.

Section Three

Software spending patterns were analyzed for the U.S. general purpose computer population and, by extrapolation, estimated for the Federal Government. IDC estimated that the Federal Government spent approximately $559 million on software, with $116.9 million (21 percent) on system software, $66 million (12 percent) on utility software and $376.2 million (67 percent) on application software. For system software, 53 percent of these expenditures were for internally developed software; for utility software, 50 percent were for internally developed software; and for applications software, 83 percent were for internally developed software. It appears that the degree of customization for application software is much greater in the Federal Government than in the United States as a whole. IDC has insufficient information to estimate software spending for minicomputers and other computers.

Section Four

Installation workload by mode of operation and by application was indirectly estimated for the Federal Government based on U.S. figures. Mode of operation figures are given for remote batch, on-line and batch operations. For minicomputers, "other" computers and size class 2 general purpose computers, batch operations were estimated as representing 55 percent of their workload. For size classes 6 and 7 general purpose computers, the largest size classes of general purpose computers, on-line operations were estimated as representing 70 percent of their workload. Commercial type applications, including accounting, inventory, accounts payable, and personnel, represented the largest workload. IDC estimates these applications represent about 68 percent of the installations' workloads.

Section Five

There are an estimated 574 data base management systems (DBMS) installed in the Federal Government, 491 of these on general purpose systems and 83 on minicomputers. IDC estimates that the installed value of the 491 DBMS in the Federal Government is $30.2 million.

When the growth rate of DBMS in the United States was studied from 1975 to 1985, the number of general purpose computers with DBMS was predicted to increase from 4 percent in 1975 to 28 percent in 1985. However, the growth rate in the number of DBMS installed or the rate of DBMS implementation slows over time. By 1984-1985 the growth rate of the number of DBMS installed was predicted to be 7 percent.

Section Six

Data processing related contract services in the Federal Government amounted to an estimated $2.3 billion in 1979. These services are expected to grow at an annual compound rate of 15 percent, which will amount to $5.2 billion in dollar value by 1985.

Approximately 21 percent of all contract services, or $470 million, in 1979 were for systems analysis and programming services. By 1985 it is estimated that these services will represent $837 million or 16 percent of all contract services.

Processing services amounted to $438 million in 1979, or 19 percent of all contracted services. By 1985, processing services should equal $796 million, having grown approximately 11 percent annually. Of these processing services, $98 million in 1979 and $190 million in 1985 were for remote problem solving services.

Facilities management contracts amounted to approximately $300 million or 13 percent of all contract services in 1979. This figure is expected to grow 1.5 percent annually to $327 million by 1985. Facilities maintenance contracts will drop to only 6 percent of all contract services by 1985.

Network services include both voice and data communications: These contracts represented $668 million in 1979, or 29 percent of all contract services, making this the largest segment of all contract services. Network services, overall, should grow by 20 percent annually, which will amount to $1.9 billion in value by 1985.

Maintenance services represented $250 million in contracts in 1979, or 11 percent of the total contract services. These contracts are expected to grow at an annual rate of 14 percent, amounting to $556 million in 1985.

Research and consulting services have the highest projected growth rate of all the contract services. This segment represented $146 million in 1979 (6 percent of total contracts) and is predicted to grow at an annual rate of 29 percent to $687 million by 1985 (13 percent of total contracts).

Section Seven

An estimate of the state of software and software development in the Federal Government is presented. The total dollar value of software in the 30 Federal sites studied was $24.7 million. Of this total, $2.3 million was for systems software, $20.8 million for applications software and $1.6 million for utilities software. IDC estimates that 60 percent of the total dollar value of the software was for software that was developed in-house. Applications software was predicted to show the largest growth of the three types of software through 1985.

For the Federal sites that IDC studied, an average of over 2000 computer programs was installed in each. The average size of a computer program installed was estimated to be 2,070 lines of code.

When IDC studied programming languages used for in-house software development at these selected sites, COBOL was mentioned the most frequently, followed by FORTRAN, PL/1 and BASIC, in that order.

Analysis by IDC of the average software program life-cycle in these selected sites indicated that over 33 percent of the total time spent was for requirement study and preliminary design, approximately 47 percent for detailed design and coding and 20 percent for testing and debugging. The average dollars spent for this program life cycle was over $43,000.

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AN ASSESSMENT AND FORECAST OF ADP IN THE FEDERAL GOVERNMENT

Introduction

The Institute for Computer Sciences and Technology (ICST) contracted with International Data Corporation (IDC) in FY 80 to acquire some of the data necessary to support impact assessments and cost/benefit analyses which are critical to the planning and prioritizing of Federal Information Processing Standards. This report presents a summary of IDC's findings and further analysis by ICST personnel. The seven sections are summarized below.

1. Section One presents numbers and dollar value of ADP equipment installed in the Federal Government and forecasts those through 1985. Included are CPUs, magnetic tape drives, disk drives, terminals, printers, storage media, word processors and communication equipment. Also in this section are ratios of peripheral devices to mainframes for 1979 through 1985.

2. Section Two presents an analysis of typical operating systems, programming language, and application patterns based on observed distributions in commercial installations.

3. Section Three presents estimates of the amount spent for software in the general computer population and, by extrapolation, at Federal Government computer sites.

4. Section Four focuses on analysis of installation workload by mode of operation and by application. Mode of operation includes on-line, batch and remote batch.

5. Section Five considers various aspects of the implementation of data base management systems (DBMS) used in Federal Government computer installations.

6. Section Six deals with the scope of contract services in the Federal Government and includes a 5-year forecast for seven categories of contract services.

7. Section Seven presents findings on the state of software and software development in 30 Federal Government agencies.

DEFINITIONS

Computers: For the purposes of this report, CPUs are classified in three categories.

A. General purpose computers: General purpose computers are typically byte or character-oriented CPUs programmable in high-level languages. IDC categorizes these CPUs in six size classes, numbered 2 through 7, defined according to currently marketed IBM products and systems from other manufacturers that compete directly with them.* (Size class 1 computers were moved to the small business computer category in 1977, and size class 1 was eliminated.)

> Size class 2 contains the smallest general purpose computers. They are usually the lowest cost machines and are considered entry level equipment. They have relatively limited I/O channels and limited software. In general the main memory capacity is from 16-64K bytes. The average monthly rental of these machines is approximately $1,250-$2,500. Examples of computers in this category are: the IBM System 3 Models 4, 6, 8, and 10; Honeywell H-61 Models 58 and 60; Univac 9200; NCR Century 50 and 75; and Singer 10.

> Size class 3 computers are generally considered small-scale computers, although some models do approach what is considered to be medium-scale. Some members of this size class are the smallest model of a family of larger computers or the largest member of a small business data processing computer family. The main memory capacity is generally 32-128K bytes, although some size class 3 computers have main memory as large

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* Certain commercial products are identified in this section in order to cite relevant examples. In no case does such identification imply recommendation or endorsement by the Institute for Computer Sciences and Technology nor the National Bureau of Standards.

as 256K bytes. The average monthly rental is $2,500-$9,000. Examples of this size class are: NCR Century 100, 101 and 151; Burroughs B-1800 and B-500; Univac 90 Models 25 and 30, and 9300; Honeywell H-Level 62, and H-2020; and IBM 370/115, System 3 Models 12 and 15, and 360/20.

Size class 4 computers are considered medium-scale computers. The average main memory capacity is 64-512K bytes. The average monthly rental for size class 4 computers is approximately $8,000-$20,000. Examples of computers in this category are: IBM 370/125, 135, 138, and 360/30 and 40; Honeywell H-2040, 2050 and 1200; Univac 90/60; Burroughs B-2500/2700/2800 and B-3500/3700/3800; NCR Century 200, 201 and 250; CDC Cyber 71 and 171; DEC 10/40 and 50; and Xerox Sigma 5 and 6.

Size class 5 computers are also considered medium-scale computers but usually have a much larger main memory capacity of 128K-2M bytes, with some models having memory which exceeds 4M bytes. The average monthly rental of a size class 5 computer is $21,000-$45,000. Representatives of this size class are: IBM 370/145, 148 and 360/50; Honeywell H-66/10, 17, 20, 27 and H3200; Univac 90/70, 9700, 1100/10 and 20 and Spectra 70/45 and 46; Burroughs B-4500 and 4800; NCR Century 300, 8580 and 8590; CDC Cyber 72, 3200, 3500, DEC 10/60 and 70; Itel AS/4; and XDS Sigma 7.

Size class 6 computers are generally considered large-scale computers. Some of the models have main memories as large as 8M bytes. The average monthly rental of these computers is $45,000-$95,000. Examples of size class 6 computers include: IBM 3031 and 3032, 360/65, 370/155 and 158; CDC Cyber 172, 173, 174, 73, 6400 and 6500; Itel AS/5 and AS/6; DEC 10/80 and 90; IDS Sigma 9; Burroughs 6500 and 6700; Univac 1100/40, 81 and 82, 1106 and Spectra 70/60, 6 and 7; Honeywell H-66/40 and 60, 6050/60, 6070 and 6080; and Amdahl 470/5.

Size class 7 computers are the largest computers in the general purpose category and in the United States installed base. These computers represent the largest models of a manufacturer's product line. The largest members of this size class can have main memory capacity of 16M bytes. The average monthly rental of these machines is approximately $100,000 - $200,000. Representatives of this size class are: IBM 3033, 370/165 and 168; Univac 1100/83 and 84, 1108 and 1110; CDC Cyber 175, 176, 75 and 76, Star 100, 6600 and 7600; Amdahl 470/6 and 7; Cray 1A; Burroughs B-7700 and 7800; Honeywell H-66/80 and 85, H68/80 and G-6180.

B. Minicomputers: The classification of certain computers as minicomputers is based on marketplace definitions as perceived by IDC. Minis are general purpose in design but are sold as tools, not just solutions; are available from the makers as complete systems, not just boards; are available to OEMs (Original Equipment Manufacturers) and usually are discounted in volume purchases, are purchased by consumers rather than rented or leased and are part of a family that has at least one product in the $2,000-$25,000 price range and comes with at least 4K RAM (Random Access Memory).

C. Other Computers: Other computers include small business computers, military computers, desktop computers, and others. These categories are combined for purposes of analysis in this report.

Peripheral Equipment: Peripheral Equipment has been categorized according to the following definitions:

A. Magnetic Tape Equipment: Tape drives include 800 NRZI, 1600 phase encoded, and 6250 group encoded devices. Certain tape equipment which is field upgradable has been assigned to the lowest density grouping for this analysis.

B. Disk Drives: These peripherals are classified as floppy disk drives or rigid disk drives, where floppy disk drives include 8" and 5-1/4" single- and double-sided disk drives.

C. Terminals: Terminals are categorized as CRT, teleprinter, intelligent, or remote batch.

D. Printers: Printers are defined as impact or non-impact line or serial printers.

E. Storage Media: Media include magnetic tapes (800 NRZI, 1600 phase encoded, and 6250 group encoded), rigid disks, flexible disks, digital cassettes, and cartridges.

F. Word Processors: Word processors are defined to include standalone, shared logic and hybrid systems, as well as high-end electronic typewriters.

G. Communications Equipment: Communications equipment includes modems, multiplexors, communications processors, and lines specified by speed.

Section One

FEDERAL GOVERNMENT INSTALLED BASE AND SYSTEM CONFIGURATION ESTIMATES*

Summary

Section One presents numbers and dollar values of ADP equipment installed in the Federal Government including some historical data and forecast data through 1985. Included in this section are CPUs, magnetic tape drives, disk drives, terminals, printers, storage media, word processors and communication equipment.

Methodology

IDC utilized information from several major sources, including detailed analysis of the IDC U.S. Computer Installation Data File and the GSA Federal ADP Inventory data files, a review of financial statements and related information for major computer industry vendors, market estimates provided by various computer and peripheral vendors and searches of related information bases. A majority of IDC's research effort was devoted to developing a sound basis for estimation of the Federal Government installed base of computer and related hardware, expressed both in terms of number of units and dollar value of units.

For all categories of equipment other than CPU's, IDC estimated the Federal Government installed base using three different sources. This approach was utilized to provide checks that ensure consistent estimates.

1. System configuration estimates were derived from information in IDC's U.S. Computer Installation Data File for each size class of general purpose computers, for minicomputers, and for "other" computers.

*Certain commercial products are identified in this section in order to cite relevant examples. In no case does such identification imply recommendation or endorsement by the Institute for Computer Sciences and Technology nor the National Bureau of Standards.

2. Manufacturers´ financial data were evaluated to estimate the portion of total revenue derived from the Federal Government. The estimates were translated into shipment and installed base estimates for each relevant peripheral category.

3. Estimates of installed base (by industry) were used to provide a third perspective on Federal Government installed base estimates. The industry estimates were developed by IDC as part of its ongoing research and based upon vendor contacts.

Information from each of these three sources was evaluated in the context of IDC´s overall industry knowledge and understanding of possible inaccuracies. These three estimates were combined with IDC knowledge concerning relationships between dollar value of shipments and manufacturer revenues, to yield consistent estimates of the dollar value of the Federal Government installed base of ADP equipment and related items.

The projection or forecast of the installed base of each of the computer groups and size classes is based on the assumption that historical relationships between Federal Government implementation and installations in the rest of the United States will remain constant. Since Federal Government procurement procedures may be altered to meet changing policy requirements, this assumption may prove invalid. However, prior and current relationships between Federal and U.S. computer implementation were the best available indications of the future growth of the Federal Government installed base.

Federal Government CPUs

IDC´s estimates of the historical, current and projected installed base of each of the computer groups and size classes are presented in Figures A1 - A8. The installed base is represented in number of units and dollar value. A constant average dollar value per CPU has been applied over the term of the forecast. Note that the numbers of CPUs estimated by IDC are significantly less than the numbers in the "Automatic Data Processing Equipment Inventory in the United States Government" as of the end of Fiscal Year 1979, produced by the General Services

Administration (GSA), and "Computers in the Federal Government: A Compilation of Statistics-1978," NBS Spec. Pub. 500-46.

The differences in the numbers of Federal computers occur for several reasons. There are numerous computers that IDC does not count as part of the Federal Government installed base that are included in the GSA inventory. IDC identified 663 communication processors that were in the GSA inventory but did not include them as part of the installed base figures. These processors are listed under data communications equipment and represent a dollar value of $19.6 million in 1979. IDC also considers some products listed as CPUs by GSA to be single-station processing terminals or clustered processing terminals. In addition, a large number of entries on the GSA file were not recognized by IDC as CPU model numbers. If the model numbers had typographical errors or were otherwise bad entries they were not counted. IDC did not attempt to ascertain what the entries should have been.

Figure A1 displays IDC's installed base numbers for 1974 to 1979 and the projected figures for 1980 to 1985. Figure A1 graphically shows the increase in the number of minicomputers being the major influence in the overall increase in the number of Federal computers. The total general purpose, mini and other computer installed base and projected base numbers are given in Figure A2.

Figure A3* shows the total dollar value of the Federal computers and the total dollar value for the general purpose, mini and other computers. This figure graphically shows that the total dollar value of the Federal computers is greatly influenced by the dollar value of the general purpose computers. Thus the forecast for the number of Federal computers is greatly influenced by the significant growth in the number of minicomputers. The forecast of the dollar value of Federal computers is greatly influenced by the significant growth in the dollar value of the general purpose computers. (Again, note that a constant dollar value was applied in these forecast figures.) The actual dollar values of the installed base and projected base numbers are given in Figure A4.

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*The notation "M = million", "K = thousand" has been adopted in this report.

Figure A5 shows a line graph of the number of general purpose CPUs in the Federal Government from 1974 projected to 1985 by size class. This graph shows that the smaller size classes, 2, 3 and 4, will decline in number and the larger size classes, 5, 6 and 7, increase in number. Figure A6 shows a line graph of the dollar value of these size classes. This shows that the dollar value of size classes 2, 3, 4 and 5 will remain fairly constant while the value of size classes 6 and 7 will increase significantly. Thus it is the increase in these two size classes which significantly increases the dollar value of the Federal installed base. The actual numbers and dollar values for these graphs are given in Figure A7 and A8.

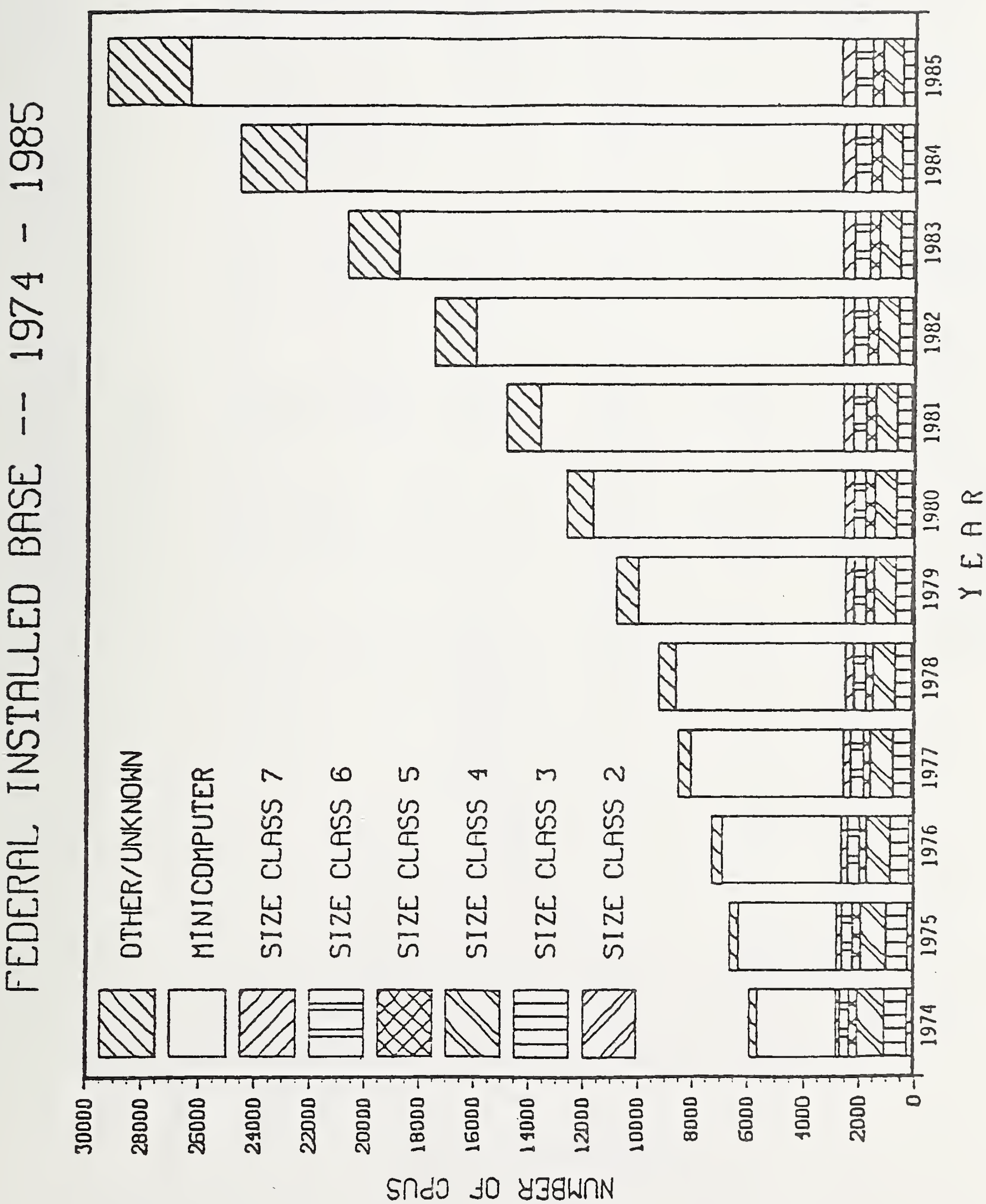

FEDERAL INSTALLED BASE -- 1974 - 1985
OTHER/UNKNOWN
MINICOMPUTER
SIZE CLASS 7
SIZE CLASS 6
SIZE CLASS 5
SIZE CLASS 4
SIZE CLASS 3
SIZE CLASS 2
NUMBER OF CPUS
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
YEAR

FIGURE A1

GENERAL PURPOSE, MINI and OTHER CPUs
INSTALLED BASE and FORECAST NUMBERS
(Federal Government) 1974 - 1985

Computer type	1974	1975	1976	1977	1978	1979
Group A (General Purpose):	2,819	2,759	2,591	2,536	2,468	2,474
Group B (Minicomputers):	2,846	3,574	4,327	5,550	6,181	7,539
Other:	255	275	339	438	594	776
TOTAL	5,920	6,608	7,257	8,524	9,243	10,789

CPU	1980	1981	1982	1983	1984	1985
Group A (General Purpose):	2,531	2,574	2,596	2,621	2,651	2,691
Group B (Minicomputers):	9,122	11,038	13,356	16,161	19,554	23,661
Other:	969	1,210	1,512	1,888	2,359	2,946
TOTAL	12,622	14,822	17,464	20,670	24,564	29,298

FIGURE A2

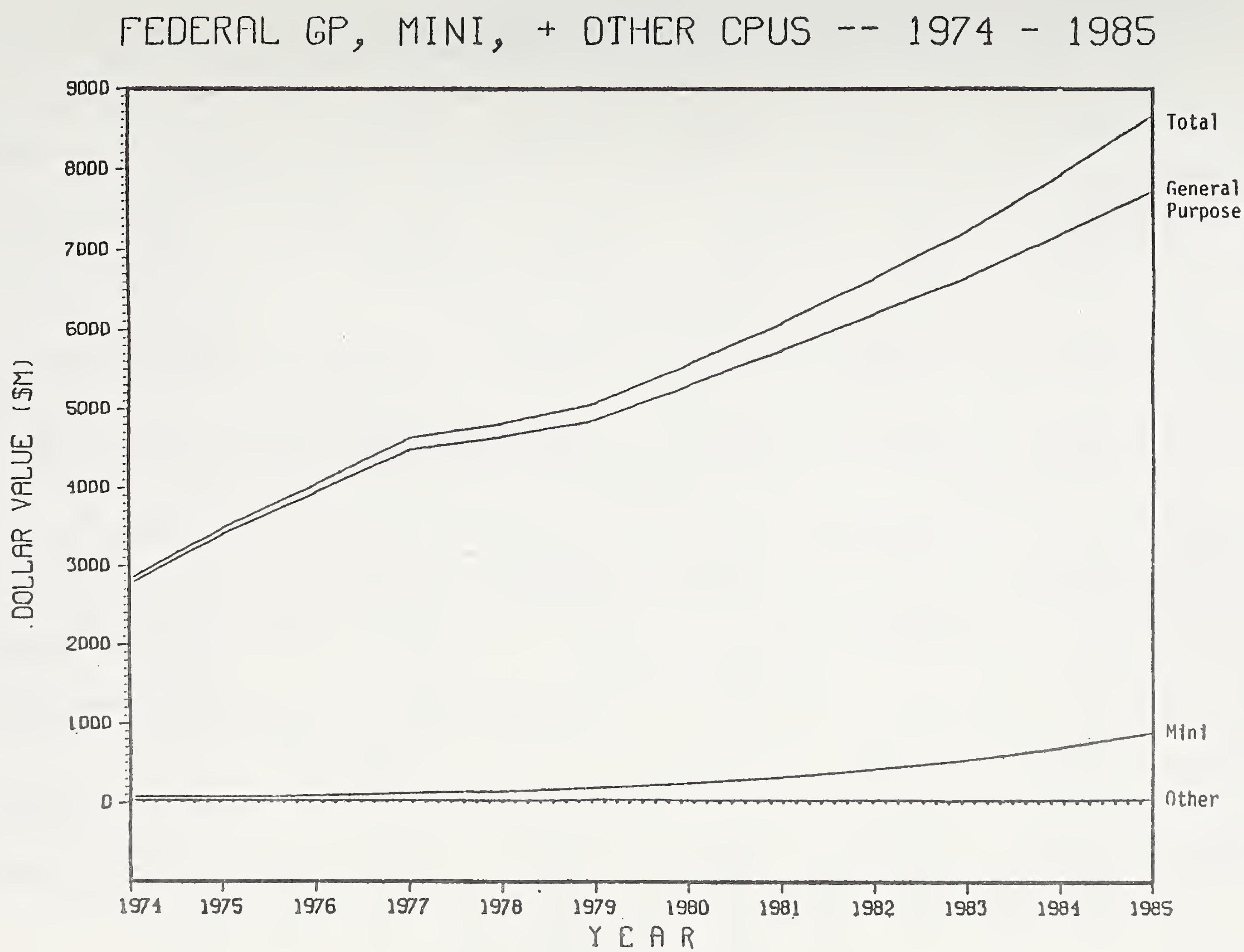

FEDERAL GP, MINI, + OTHER CPUS -- 1974 - 1985
DOLLAR VALUE ($M)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
YEAR
Total
General Purpose
Mini
Other

FIGURE A3

GENERAL PURPOSE, MINI and OTHER CPUs
INSTALLED BASE and FORECAST DOLLAR VALUE
(Federal Government) - 1974 - 1985

Computer type	1974	1975	1976	1977	1978	1979
Group A (General Purpose):	$2,761.5	$3,408.1	$3,948.8	$4,496.3	$4,654.0	$4,869.5
Group B (Minicomputers)	56.3	70.8	90.4	124.3	145.9	191.5
*Other:	4.7	3.9	4.9	6.2	9.5	12.9
TOTAL	$2,822.5	$3,482.8	$4,044.1	$4,626.8	$4,809.4	$5,073.9

CPU	1980	1981	1982	1983	1984	1985
Group A (General Purpose):	$5,297.4	$5,740.3	$6,197.8	$6,654.0	$7,188.1	$7,731.7
Group B (Minicomputers)	249.1	323.4	422.0	544.6	696.1	884.9
*Other:	15.7	19.7	24.6	31.5	39.3	49.1
TOTAL	$5,562.2	$6,083.4	$6,644.4	$7,230.1	$7,923.5	$8,665.7

*Dollar value of small business systems only. System value of special government design systems was unable to be determined due to widely varying specifications and origin of equipment.

FIGURE A4

FEDERAL GENERAL PURPOSE CPUS -- 1974 - 1985

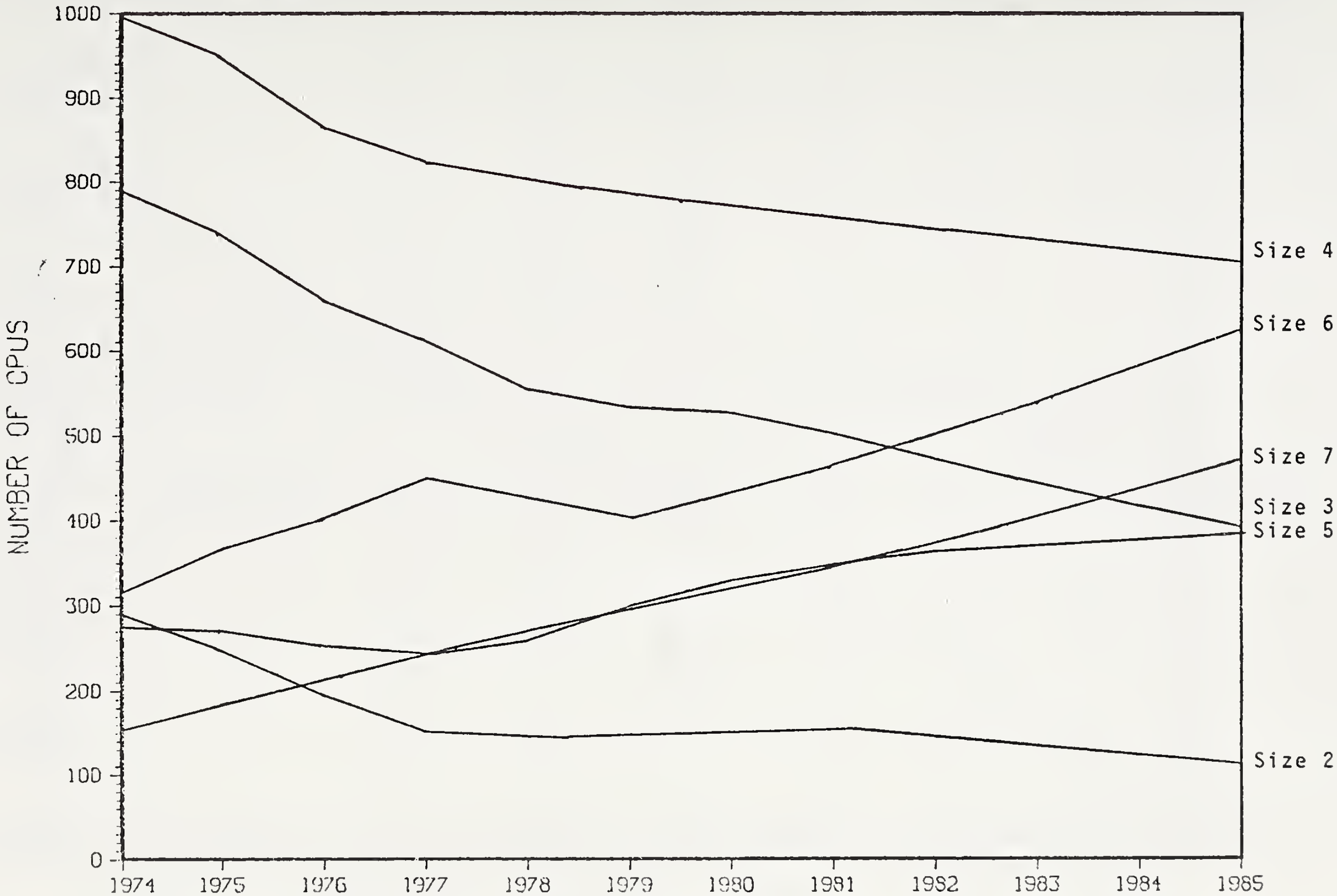


Figure A5

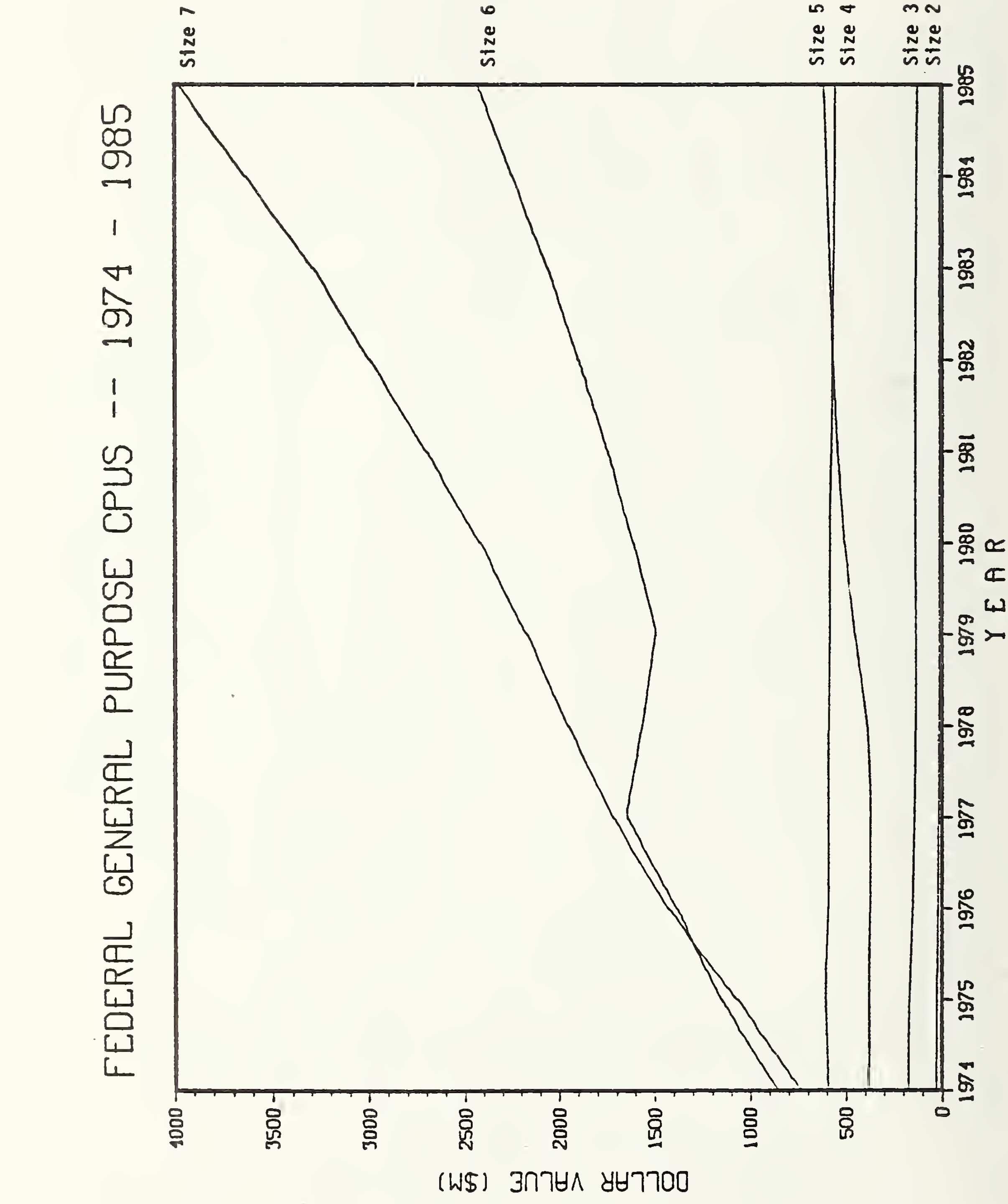

FEDERAL GENERAL PURPOSE CPUS -- 1974 - 1985
DOLLAR VALUE ($M)
0
500
1000
1500
2000
2500
3000
3500
4000
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
YEAR
Size 7
Size 6
Size 5
Size 4
Size 3
Size 2

Figure A6

GENERAL PURPOSE CPUs by SIZE CLASS
INSTALLED BASE and FORECAST NUMBERS
(Federal Government) 1974 - 1985

Size Class	1974	1975	1976	1977	1978	1979
2	288	245	192	150	144	148
3	787	735	656	609	552	531
4	995	946	862	821	801	784
5	272	269	250	242	260	300
6	314	368	402	450	424	402
7	154	186	215	244	271	297
Unknown	8	10	14	20	16	12
TOTAL	2,819	2,759	2,591	2,536	2,468	2,474

Size Class	1980	1981	1982	1983	1984	1985
2	152	155	143	132	121	111
3	525	500	470	442	415	390
4	770	756	742	729	716	703
5	330	350	364	371	378	386
6	433	466	502	541	583	627
7	321	347	375	406	438	474
TOTAL	2,531	2,574	2,596	2,621	2,651	2,691

FIGURE A7

GENERAL PURPOSE CPUs by SIZE CLASS
INSTALLED BASE and FORECAST DOLLAR VALUE
(Federal Government) 1974 - 1985

Size Class	1974	1975	1976	1977	1978	1979
2	$27.1	$23.5	$19.2	$15.2	$14.8	$15.9
3	175.5	165.4	148.9	140.1	133.0	136.8
4	597.0	610.2	588.7	591.9	586.3	582.6
5	373.7	381.7	369.5	367.4	390.8	460.0
6	854.1	1,153.7	1,384.9	1,645.2	1,557.7	1,488.7
7	730.4	1,068.2	1,428.7	1,721.7	1,958.0	2,173.7
Unknown	3.7	5.4	8.9	14.8	13.4	11.8
TOTAL	$2,761.5	$3,408.1	$3,948.8	$4,496.3	$4,654.0	$4,869.5

Size Class	1980	1981	1982	1983	1984	1985
2	$16.9	$17.4	$16.2	$15.0	$13.9	$12.9
3	141.8	140.0	136.3	132.6	128.7	124.8
4	585.2	574.6	567.6	561.3	554.9	551.9
5	514.8	549.5	575.1	589.9	604.8	621.5
6	1,615.1	1,752.2	1,902.6	2,066.6	2,250.4	2,439.0
7	2,423.6	2,706.6	3,000.0	3,288.6	3,635.4	3,981.6
TOTAL	$5,297.4	$5,740.3	$6,197.8	$6,654.0	$7,188.1	$7,731.7

FIGURE A8

<u>Estimates of Federal Government Peripheral Equipment</u>

Peripheral installed base estimates for the Federal Government were derived in a four step process.

Equipment was classified into categories as specified in the following part of this section.

Typical system ratios were derived from IDC's Computer Installation Data File. The ratio indicates the average number of peripherals of a specific type installed on a given class. More specifically,

$$SR_{i,j,k} = NPER_{i,j,k} / NSYS_{j,k}$$

where:

$SR_{i,j,k}$ = System Ratio for the ith peripheral category on the jth manufacturer's systems in the kth group or size class.

$NPER_{i,j,k}$ = The total number of peripherals in category i (rigid disk, for example) installed on the jth manufacturer's systems in the kth group or size class.

$NSYS_{j,k}$ = The installed base of manufacturer j in size class k.

System ratios were applied to Federal Government CPU installed base estimates (aggregated by manufacturer and group or size class) to provide estimates of the Federal Government's installed base of specific peripherals on systems from each manufacturer in each size class. Summing these estimates over all size classes and manufacturers yields estimates of the Federal Government installed base.

Federal Government installed base estimates are combined with non-Federal Government estimates to generate a total installed base estimate. This total estimate is then compared with IDC projections for total installed base by equipment type. System ratios are adjusted using additional data, including IDC installed base estimates for each peripheral, individual manufacturer's estimates of the Federal Government installed base of specific peripheral equipment categories, and vendor revenue estimates to generate the final installed base estimate for each peripheral type. This procedure minimizes potential error due to biases in use of individual information sources in compiling estimates.

IDC classified most -- in terms of units installed -- relevant peripheral models into categories. However, some older peripheral models could not be specifically categorized. In addition, some records in the IDC U.S. Computer Installation Data File identify only the general peripheral category -- tape drive, disk drive, etc. -- and manufacturer name, but not specific model or functional names. Peripherals which could not be placed in more specific categories during the initial peripheral identification analysis have been assigned to specific categories on a proportional basis, modified by IDC knowledge concerning product lines of individual manufacturers. Thus, unknown disk drives -- those which could not be positively identified as rigid or floppy -- were assigned to rigid or floppy disk categories in the same proportion that known disk drives fell into the two categories. This procedure was modified when knowledge of a specific vendor's disk drive product line indicated that all disks appropriately would be placed in only one category.

Certain peripheral types of equipment such as floppy disks could not be projected accurately via the means listed above. Since the configuration ratios derived above were based solely upon the relationship to CPUs, the proliferation of floppy disk drives on terminals or word processing equipment would not appear. Methods such as the evaluation of publicly available corporate information, including operating characteristics and financial information, and discussions with computer industry vendors were utilized to complete the needed data.

Magnetic Tape Drives were divided into three categories -- 800 NRZI, 1600 phase encoded, and 6250 group encoded. Estimates include only those tape drives that are used on computer systems; therefore, they exclude tape drives installed on certain word processing systems. Some tape drives are field-upgradable from one density to the next. Since tape drives are identified by model numbers which are not changed during the upgrading procedure, IDC could not determine the actual density of upgraded drives. Drives which could be field-upgraded have been assigned to the lowest possible density grouping. Figure A9 graphically presents IDC's estimate of the Federal Government installed base and projected base of tape drives by recording density. Figure A10 graphically presents the dollar value of this installed base. In both the number and dollar value of the 6250 group, encoded tape drives exceed the 800 NRZI and the 1600 phase encoded tape drives. The tables of numbers for these graphs are given in Figure A11.

Disk Drives were classified as rigid or floppy, where floppy disks include both 8" and 5 1/4" drives recording on one or both sides. IDC estimates by number and dollar value for the disk drive market are presented in Figures A12, A13 and A14. Rigid disk drives have been excluded from Figures A12 and A13 to highlight the trends of floppy disk drives.

Figure A15 shows the total number of floppy disk, rigid disk and magnetic tape drives from 1979 to 1985. With almost 2 billion floppy disk drives projected by 1985, the floppy disk drives significantly outnumber magnetic tape and rigid disk drives. However when the dollar values are plotted for this same time period (Figure A16), the dollar value of magnetic tape drives clearly exceeds the value of floppy disk and rigid disk drives. Thus, although floppy disks were projected to significantly increase in number by 1985, magnetic tape drives and rigid disk drives should only show a slight increase. The total dollar value of the

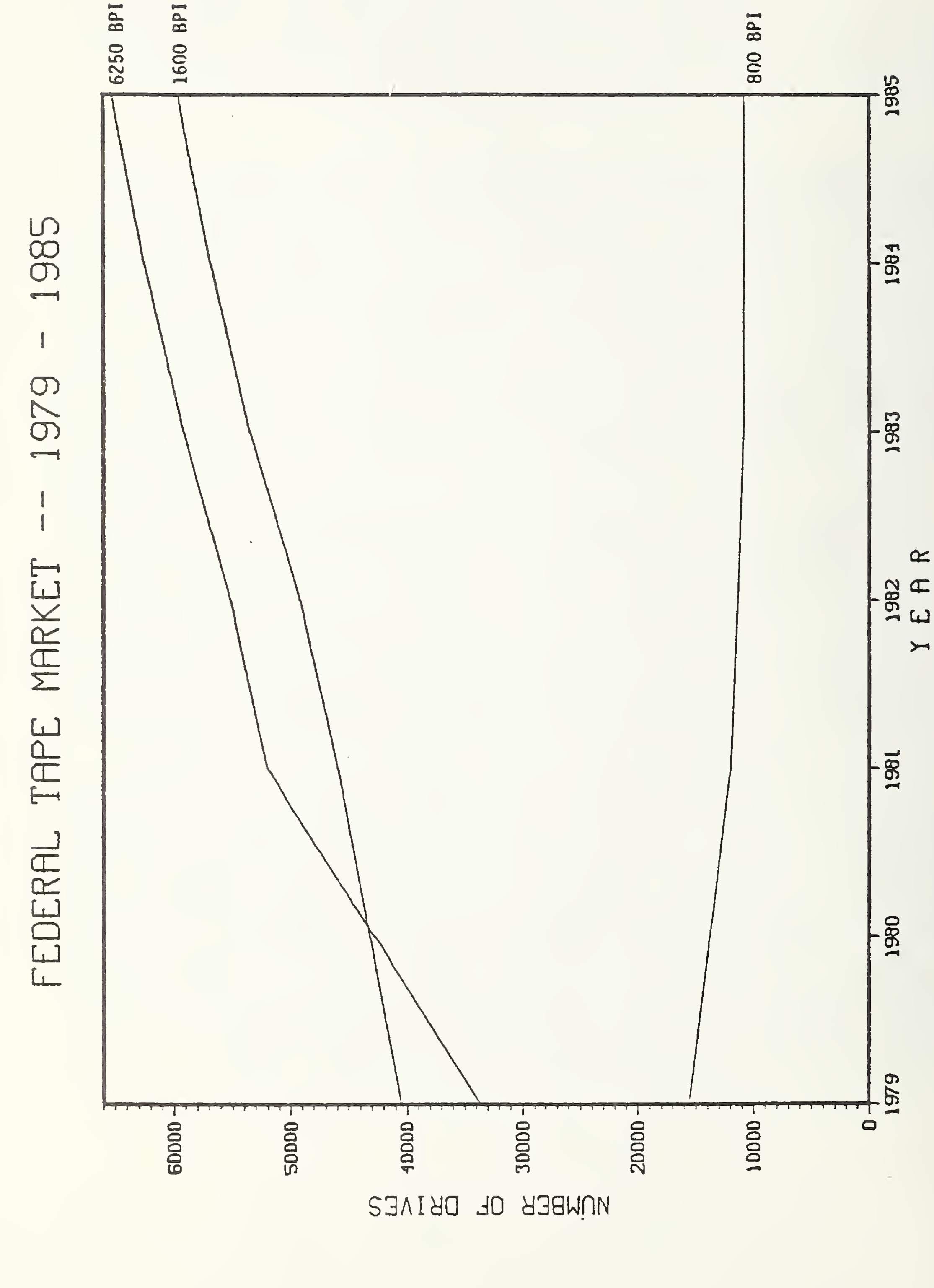

FEDERAL TAPE MARKET -- 1979 - 1985
6250 BPI
1600 BPI
800 BPI
NUMBER OF DRIVES
0
10000
20000
30000
40000
50000
60000
1979
1980
1981
1982
1983
1984
1985
YEAR

Figure A9

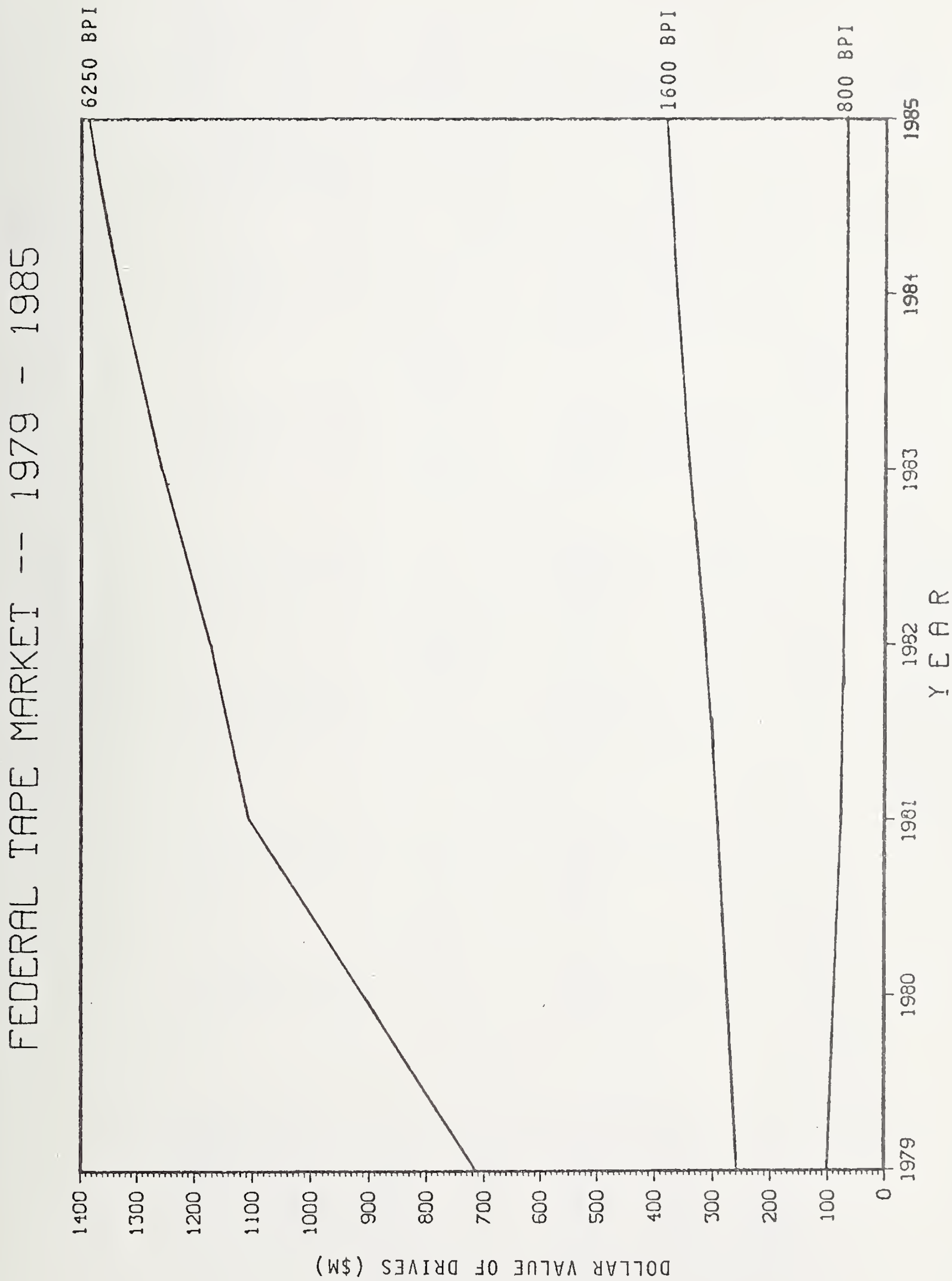

FEDERAL TAPE MARKET -- 1979 - 1985
DOLLAR VALUE OF DRIVES ($M)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1979
1980
1981
1982
1983
1984
1985
YEAR
6250 BPI
1600 BPI
800 BPI

Figure A10

MAGNETIC TAPE DRIVES
INSTALLED BASE and FORECAST (#s and $s)
(Federal Government) 1979 - 1985

Product	1979 #	1979 $M	1980 #	1980 $M	1981 #	1981 $M
Tape Drives:						
800 NRZI	15,539	$99.2	13,720	$87.6	11,858	$75.7
1600 Phase Encoded	40,563	259.2	43,240	276.3	45,991	293.8
6250 Group Encoded	33,562	713.2	42,780	909.0	52,035	1,105.7
TOTAL TAPE DRIVES	89,664	$1,071.6	99,740	$1,272.9	109,884	$1,475.2

Product	1982 #	1982 $M	1983 #	1983 $M	1984 #	1984 $M	1985 #	1985 $M
Tape Drives:								
800 NRZI	11,270	$72.0	10,795	$68.9	10,780	$68.8	10,780	$68.8
1600 Phase Encoded	49,220	314.5	53,529	341.9	56,856	363.3	59,662	331.2
6250 Group Encoded	55,200	1,172.9	59,156	1,257.0	62,560	1,329.3	65,292	1,387.4
TOTAL TAPE DRIVES	115,690	$1,159.4	123,480	$1,667.8	130,196	$1.761.4	135,734	$1,837.4

FIGURE A11

FEDERAL DISK MARKET -- 1979 - 1985

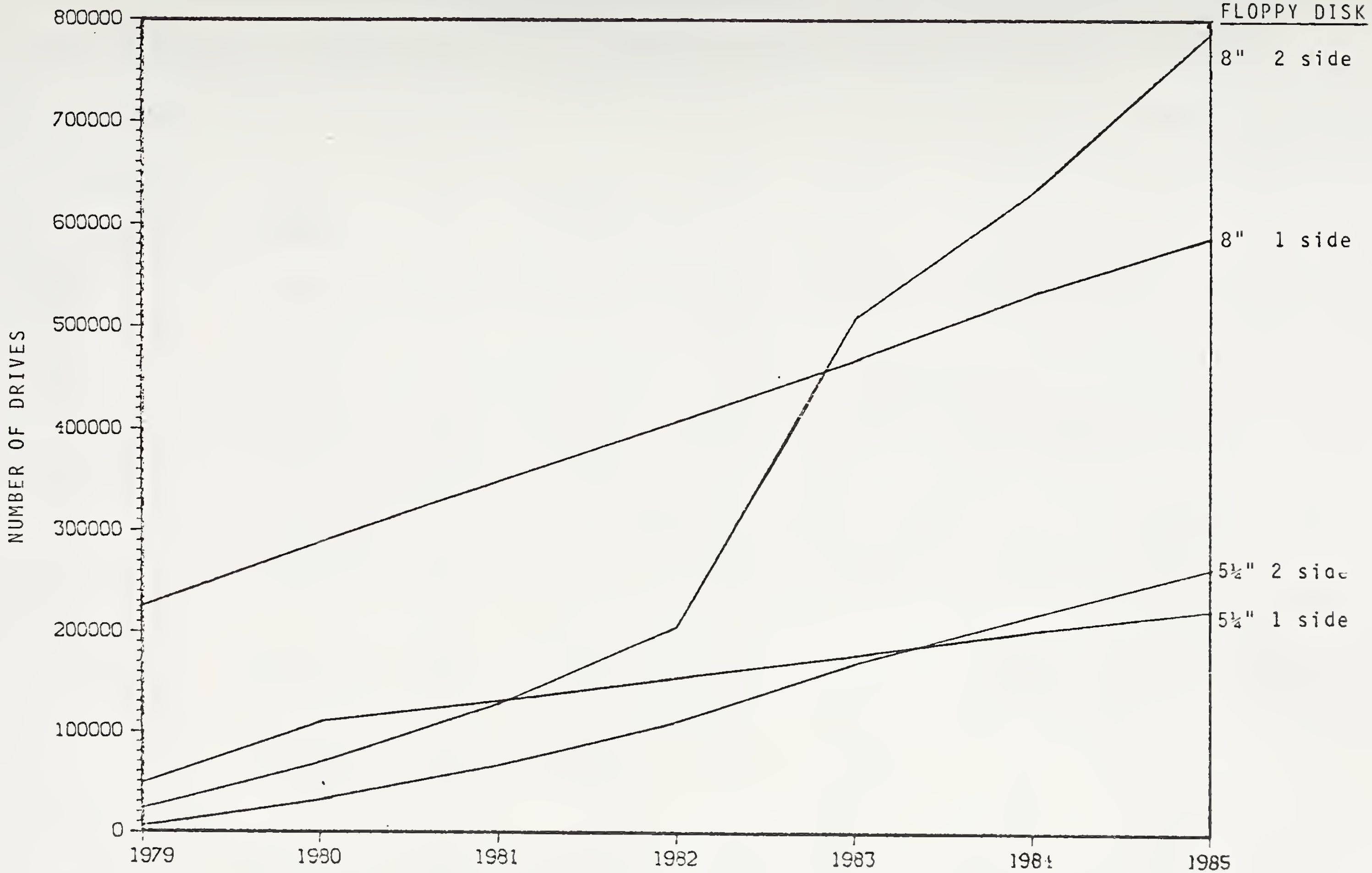
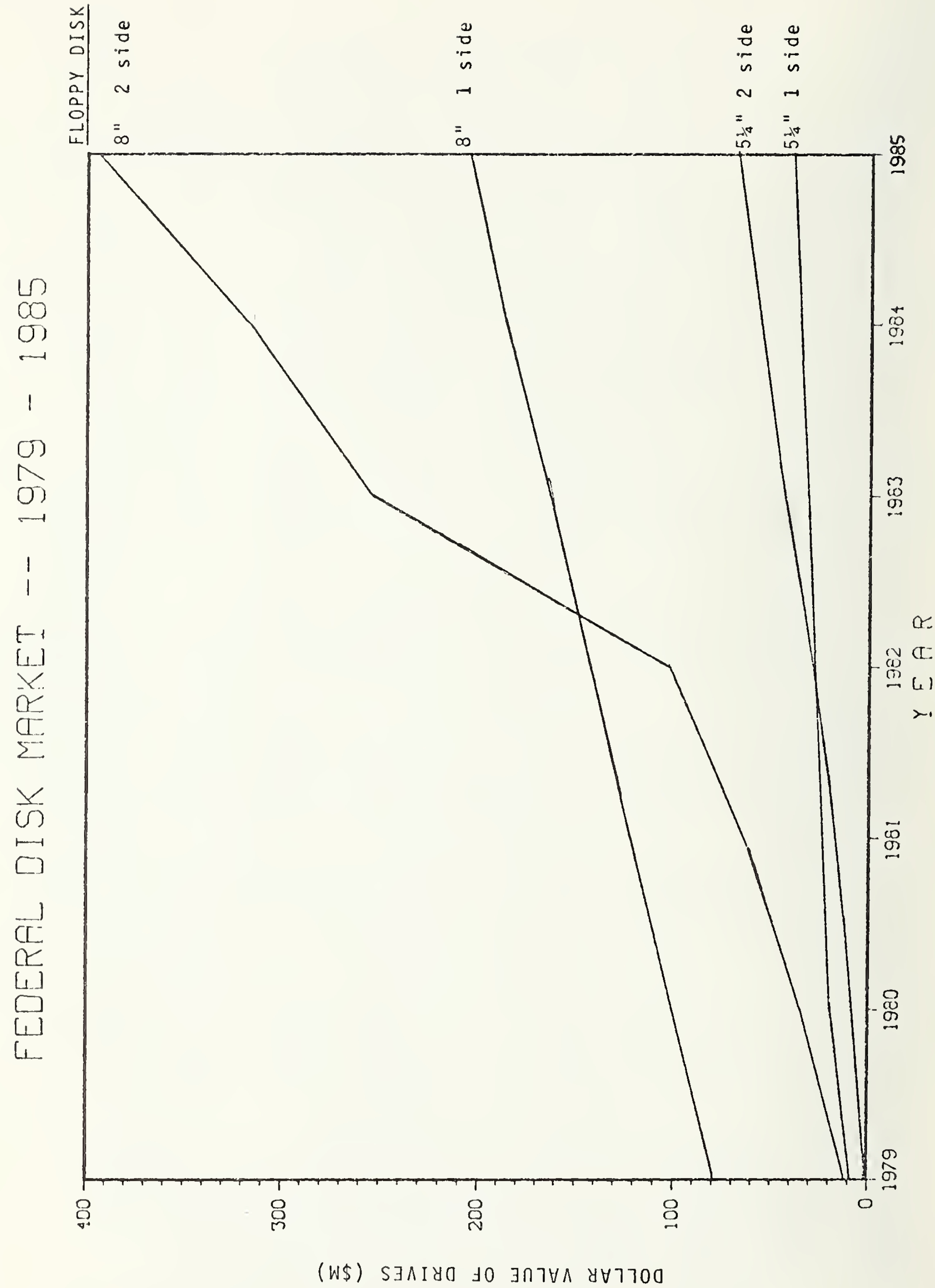


Figure A12



FEDERAL DISK MARKET -- 1979 - 1985
FLOPPY DISK
8" 2 side
8" 1 side
5¼" 2 side
5¼" 1 side
DOLLAR VALUE OF DRIVES ($M)
0
100
200
300
400
1979
1980
1981
1982
1983
1984
1985
YEAR

Figure A13

DISK DRIVES INSTALLED BASE
and FORECAST (#s and $s)
(Federal Government) 1979 - 1985

Product	1979		1980		1981	
	#	$M	#	$M	#	$M
Disk Drives:						
8" Floppy - two side	23,250	$11.6	69,750	$34.9	128,850	$64.4
8" Floppy - one side	225,000	78.7	288,750	101.0	349,050	122.2
5 1/4" Floppy two side	5,400	1.4	32,400	8.4	66,900	17.4
5 1/4" Floppy one side	48,000	8.6	111,000	20.0	132,000	23.7
Rigid	176,790	901.6	183,460	935.6	191,000	974.6
TOTAL DISK DRIVES	478,440	$1,001.9	685,360	$1,099.9	867,900	$1,202.3

Product	1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M
Disk Drives:								
8" Floppy - two side	205,650	$102.8	508,200	$254.1	632,550	$316.2	789,300	$394.7
8" Floppy - one side	408,600	143.0	467,700	163.7	533,400	186.7	586,800	205.4
5 1/4" Floppy two side	111,300	28.9	169,950	44.2	217,500	56.6	263,250	68.4
5 1/4" Floppy one side	156,000	28.1	178,000	32.0	202,500	36.5	222,750	40.1
Rigid	199,330	1,016.6	205,310	1,047.1	209,700	1,069.5	215,110	1,097.1
TOTAL DISK DRIVES	1,080,880	$1,319.4	1,529,160	$1,541.1	1,795,650	$1,665.5	2,077,210	$1,805.7

FIGURE A14

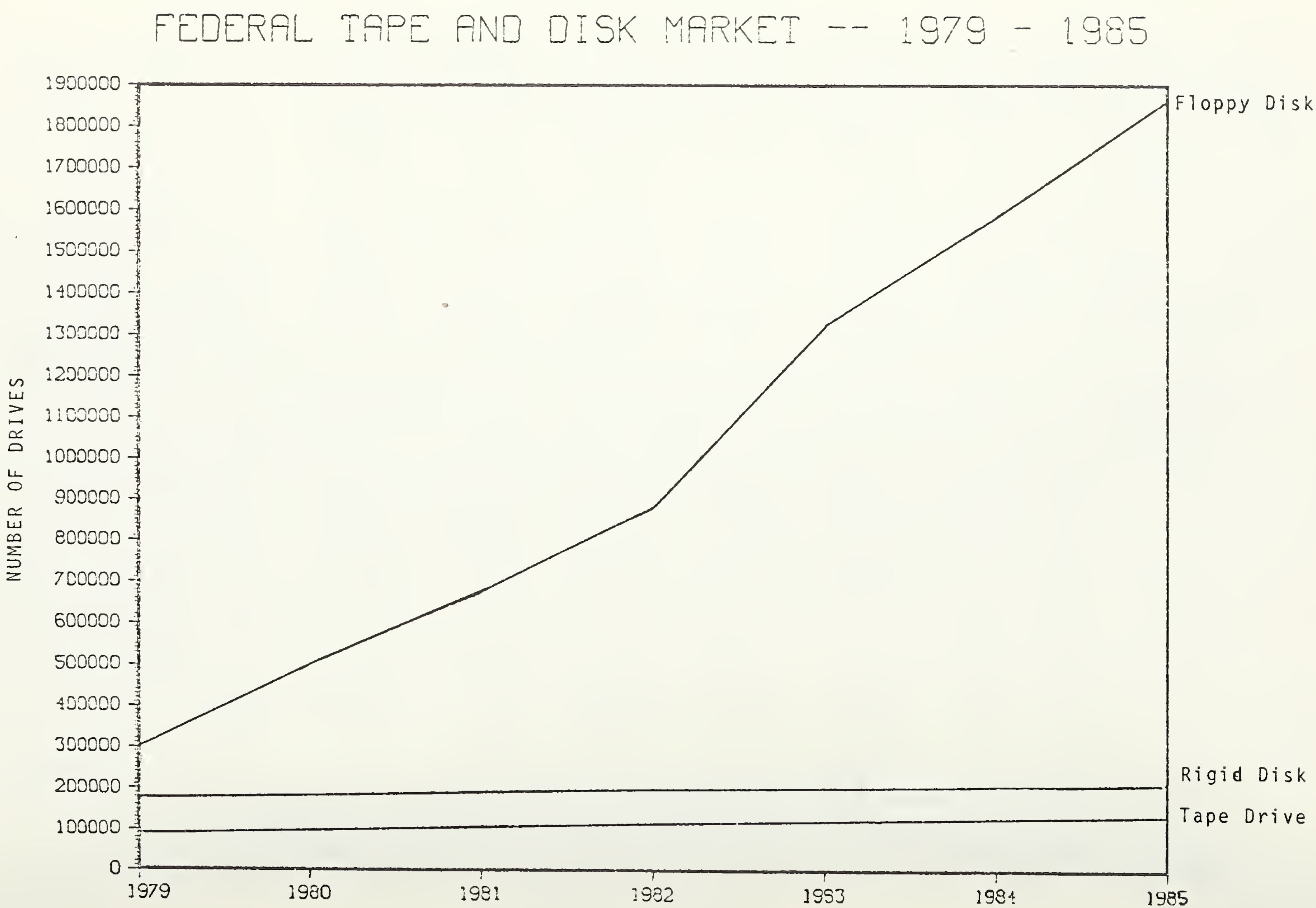

FEDERAL TAPE AND DISK MARKET -- 1979 - 1985
NUMBER OF DRIVES
1900000
1800000
1700000
1600000
1500000
1400000
1300000
1200000
1100000
1000000
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
1979
1980
1981
1982
1983
1984
1985
YEAR
Floppy Disk
Rigid Disk
Tape Drive

Figure A15

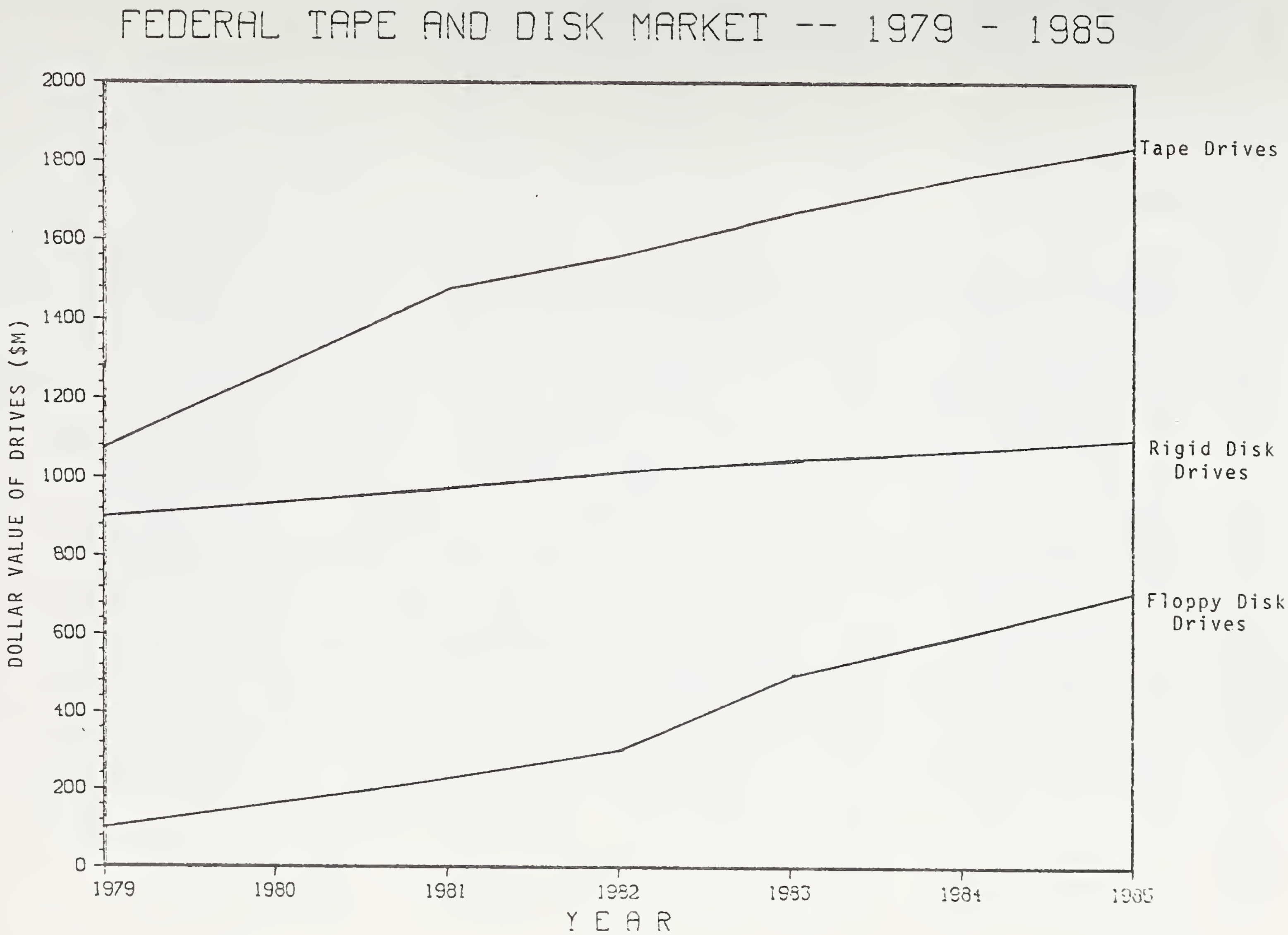

FEDERAL TAPE AND DISK MARKET -- 1979 - 1985
DOLLAR VALUE OF DRIVES ($M)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
1979
1980
1981
1982
1983
1984
1985
YEAR
Tape Drives
Rigid Disk Drives
Floppy Disk Drives

Figure A16

floppy disk drives still does not equal or exceed the value of magnetic tape drives or rigid disk drives.

In the United States, rigid disk drives are predicted to increase at a much greater rate than they are in the Federal Government. IDC believes that the large increase in U.S. rigid disks will be caused by the increase of these rigid disks primarily on small business systems. At the current time the Federal Government has very few small business computers, less than 100 in 1979, according to NBS calculations. Thus a large increase of rigid disks on these small business systems does not significantly affect the total number of Federal rigid disks.

Terminals When IDC first examined the data entry and terminal markets, it was relatively easy to define specific types of products. Product specifications were clear and applications were well defined. As a result, IDC was able to identify a number of different types of data entry and terminal markets based on clear-cut physical and functional differences. As these definitions were formulated, IDC kept in mind the possibilities of technological and competitive trends that could affect the foundations on which the definitions were based. Consequently, the early definitions were purposely flexible to allow for any evolutions that might transpire over the coming years. Despite many technological advances and changes in the very nature of the different markets, the early definitions still are well-suited for describing today's data entry and terminal markets. As time has gone by, the terminology has taken on increased meaning, but the previously determined distinctions continue to provide a meaningful segmentation of the terminal markets.

There are two major distinctions which have never changed, and these pertain to the physical aspect of the product in question. The first differentiation is made between machine-oriented and operator-oriented products. The second major distinction is the use of a CRT or a printer as output for a keyboard product. Further segmentations within these dominant groupings are described below and are generally based on the functional capabilities of the device rather than the application of the terminal.

Machine-Oriented devices use some machine-readable media as the primary input mode. These devices generally do not employ any sort of keyboard for actual data entry.

1. <u>Remote Batch Terminals</u> are primarily card-oriented devices that use line printers for output. Some include typewriter-like units as well, while others use tape drives instead of card readers. Early remote batch terminals were hardwired while later models are processor based and thus offer additional capabilities for some programmability. In today's market, there are some products that do not utilize machine-readable media for input that are often referred to as "remote batch terminals." For example, when a clustered processing terminal is said to be used as a remote batch terminal, what is meant is that the processing terminal is performing batch applications at a remote site, not that it necessarily uses cards for input. Over the years, the term "remote batch" has been carried over to other terminal products that are now capable of performing "remote batch" applications in addition to other functions. Because IDC's definitions are based on functions rather than applications, the definition of remote batch terminals in this report includes only those devices which use machine-readable media for input.

2. <u>Optical Character Recognition</u> (OCR) equipment includes general-purpose data entry devices as well as page and document readers capable of machine recognition of either machine or hand-printed characters. Excluded from consideration are

journal tape, bar code, marksense, MICR readers, and OCR wands used as peripheral devices to POS terminals.

Operator-Oriented devices utilize a keyboard for input and either a printer or a CRT for output.

There are several major types of operator-oriented terminals, two of which are not user-programmable. The first group represents data entry oriented devices that are generally key-to-storage in nature and do not provide on-line communications or processor capabilities. This group includes the following submarkets:

1. Keypunches include 80-column unbuffered units as well as 80- and 96-column buffered versions.

2. Key-to-Tape devices typically include all units consisting of a keyboard and tape drive whether in a reel or cassette configuration.

3. Key-to-Diskette devices include primarily the IBM 3740 keystations Models 1 and 3 and 3742. IBM-compatible replacement products are also included. While there may now be other products from a variety of vendors that use diskettes as a means of storage, the definition that is used here is very narrow in that it excludes products that have even limited processing capabilities. For that reason, the 3741-3 and 3741-4 from IBM are not included in this category but are found in the Single-Station Processing category.

4. Key-to-Disk systems have traditionally been defined as keypunch and then key-to-tape replacement products. As such, the early models had limited capabilities. However, as time has gone by, some vendors have added communications capabilities and even some degree of processing power to these systems. Despite the fact that the traditional key-to-disk product has evolved into a more sophisticated device, the product as a "class" or type of data entry product has maintained its own data-entry-oriented identity. Therefore, key-to-disk products remain in this category rather than being transferred to the clustered processing category.

The second major group of terminals which are not user programmable are of the interactive variety and are classified further according to functional capabilities as well as usage of printers or CRTs for output.

1. Conversational terminals are essentially limited function, interactive devices typically characterized by keyboard/printer products from Teletype Corporation and competitive replacement products, as well as the CRT-based devices from ADDS or Lear Siegler. While it is possible that some of these products have a small buffer, that feature does not necessarily allow for corrections to be made before the data are transmitted. As such, these devices are truly "conventional" in nature.

2. Editing Terminals definitely contain a buffer which allows data entered to be checked for errors, then corrected by

inserting or deleting lines or characters before data transmission takes place. This category includes keyboard/printers that have editing capabilities as well as CRTs with such error correction features.

Within the editing CRT type of interactive terminal, IDC has identified four additional subgroupings.

1. Editing CRTs -- 3270-Type are primarily IBM 3270s plus plug-compatible replacements. In addition to the plug-for-plug type of 3270, there are also products which, because of their programmable controller, can emulate the 3270 protocol. While there are many vendors which offer 3270 protocol through an optional software package, the only emulating 3270-type terminals included here are those which are sold exclusively as IBM 3270 cluster replacements. In these instances, the programmable controller performs the same function as an IBM 3271 or 3272 remote or local controller rather than the function of a true processing terminal. A true processing terminal is capable of performing the 3270 applicaations as just one of its several functions.

2. Editing CRTs -- IBM GSD-Type are interactive terminals manufactured and marketed by IBM's General Systems Division. At present the GSD-Type Editing CRTs include the models 525Xs and 497Xs. It is expected that as this market develops, current 3270 plug-compatible suppliers will announce plug- compatible 525Xs, for example, to compete in that potentially lucrative market.

3. <u>Editing CRTs -- HUB-Type</u>, a newly segmented subgrouping this year, are interactive terminals manufactured by the non-IBM mainframe suppliers -- Honeywell, Univac, Burroughs -- which have the editing capabilities of inserting and deleting lines and characters prior to transmission. In addition, this category includes products manufactured by other suppliers which are capable of emulating these HUB terminals and hence can compete as a replacement device.

4. <u>Editing CRTs -- Other</u> have the same editing capabilities of the products mentioned above but connect to minicomputers, small business computers and, in some cases, desktop computers. As such, they are generally Teletype compatible. Many of these devices are manufactured by the minicomputer suppliers themselves, although products manufactured by independents which can emulate these devices are also included in this category.

The third major grouping of terminals includes those that are not necessarily key-to-storage or interactive but are processing terminals. This group is distinguished from all other groups by the fact that the products are user-programmable through the accessibility of resident random access memory. In general these products are processor-based and allow the user, through some high-level language, the ability to program the system, enter and process the data, and then generate reports from that data. There are two major types of processing terminals.

1. <u>Single-Station Processing Terminals</u> are standalone terminal systems where the processor is incorporated into the

single station. While only one function can be performed at any given time, due to the single workstation, these products are generally capable of performing several different kinds of functions. Within this category, although not specifically identified at this time, are different levels of products depending on the degree of programmability offered. Some single-station processing terminals have their own operating systems which allow extensive programming capabilities. Others operate under a firmware program control prespecified by the vendor.

2. Clustered Processing Terminals are devices which are configured in a clustered environment and employ a shared processor capable of processing the data entered at the keystations and then generating reports based on that data. As with single-station processing terminals, there are levels of sophistication within this class. While all clustered processing terminals are generally multifunctional in nature, only some of them can perform these functions concurrently. In addition, some of these products are primarily data entry-oriented and do not offer high-level languages or file management software. The more sophisticated clustered processing terminals are often used for distributed processing applications, while the less sophisticated systems are better suited for distributed data entry.

For this report IDC's terminal categories have been condensed to generate three principal categories and nine specific product groups.

General Purpose Terminals include four subcategories:

1. CRT Terminals, including editing and conversational teleprinters
2. Teleprinters, including editing and conversational teleprinters
3. Intelligent Terminals, including both single station and clustered processing terminals
4. Remote Batch Terminals, which are machine-oriented in IDC's terminology

Date Entry Terminals include each of the three categories used in IDC's market forecasts:

1. Keypunches
2. Key-To-Tape
3. Key-To-Disk

Other terminals include two specific terminal groups:

1. OCR terminals
2. Graphic terminals

The estimates of the number and dollar value of Federal terminals from 1979 to 1985 are presented in Figure A17, A18, A19 and A20. Terminal market estimates include terminals used for applications such as communications and access to computer services. These applications often involve use of standalone terminals which are not directly associated with specific computer systems. Therefore, terminal market estimates will exceed levels which would be indicated by straightforward extrapolation of the largest product group of terminals currently in the CRT type. These will still be the most popular in 1985. However, teleprinters, intelligent, graphic and OCR terminals will also show a significant increase. Key-To-Tape terminals show the largest decline.

Printers are divided into four categories -- line impact, serial impact, line non-impact, and serial non-impact -- for this analysis. The installed base and forecast numbers and dollar values for printers are given in Figure A21. The numbers and dollar values are only for printers used on general-purpose, mini and small business computers and intelligent terminals. The non-impact figures do not include low-end electrostatic/thermal printers. The dollar amount in this forecast reflects a 5 percent declining average purchase price for non-impact printers, per year, through 1985. The largest growth area for printers is the growth in the non-impact printers.

Mass Memory is defined to include both auxiliary storage and add-on core memory. Mass memory installed base and market forecasts are presented in Figures A22 and A23. Auxiliary storage devices are not predicted to increase dramatically; however, add-on core will increase in number and dollar value because of the predicted large increase in minicomputer add-on core. The predicted dollar value of minicomputer add-on core in 1985 is almost as great as the value of all add-on core in 1979.

Storage Media include 800 NRZI, 1600 phase encoded and 6250 group encoded magnetic tape reels, rigid disk platters, 8" and 5-1/4" floppy disks (one and two side), digital cassettes and digital cartridges. The numbers and dollar value of total reels of tape, diskettes, platters, cartridges and cassettes are presented graphically in Figures A24 and A25. The actual numbers for these graphs

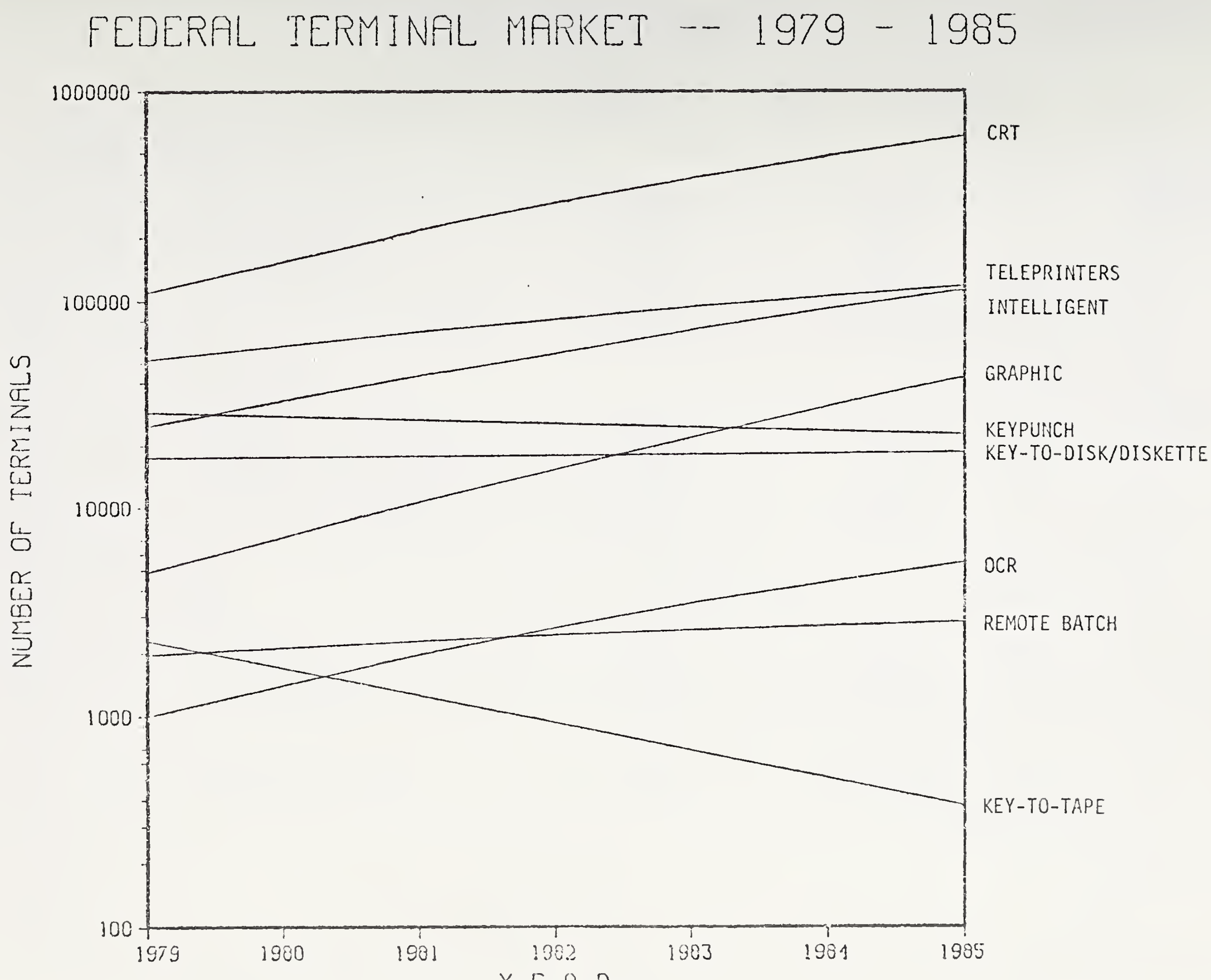

FEDERAL TERMINAL MARKET -- 1979 - 1985
NUMBER OF TERMINALS
1000000
100000
10000
1000
100
1979
1980
1981
1982
1983
1984
1985
YEAR
CRT
TELEPRINTERS
INTELLIGENT
GRAPHIC
KEYPUNCH
KEY-TO-DISK/DISKETTE
OCR
REMOTE BATCH
KEY-TO-TAPE

Figure A17

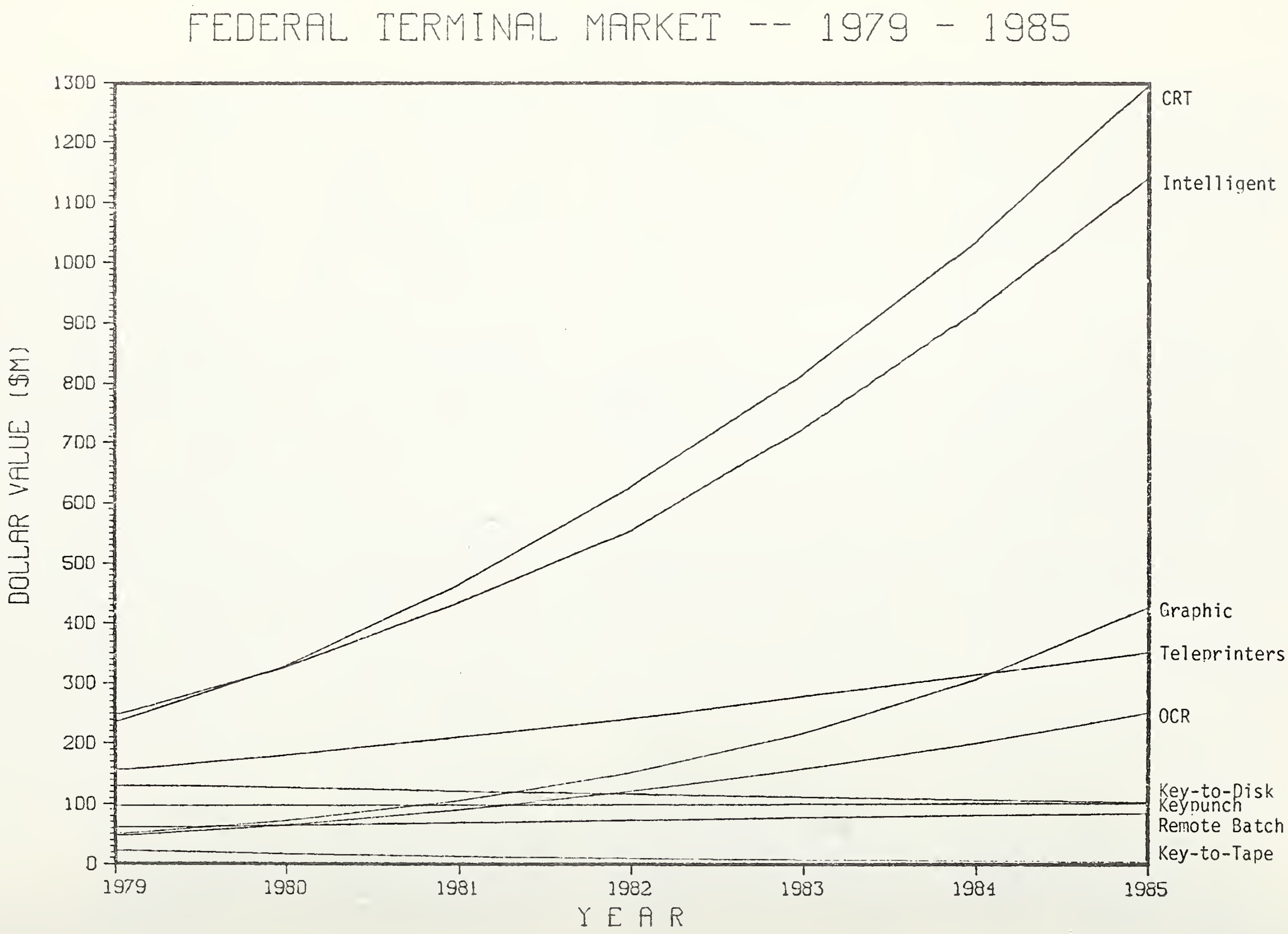

FEDERAL TERMINAL MARKET -- 1979 - 1985
DOLLAR VALUE ($M)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
1979
1980
1981
1982
1983
1984
1985
YEAR
CRT
Intelligent
Graphic
Teleprinters
OCR
Key-to-Disk
Keypunch
Remote Batch
Key-to-Tape

Figure A18

TERMINAL INSTALLED BASE (#s and $s)
(Federal Government) 1979

Terminal Type	# Units	Dollar Value (M)
<u>General</u> <u>Purpose</u>:		
CRT	109,900	$234.2
Teleprinters	51,980	154.5
Intelligent	24,650	246.5
Remote Batch	1,970	59.1
Total General Purpose:	188,500	$694.3
<u>Data</u> <u>Entry</u>:		
Keypunch	28,860	$129.9
Key-To-Tape	2,280	20.5
Key-To-Disk/Diskette	17,500	96.5
Total Data Entry:	48,640	$246.9
<u>Other</u>:		
OCR	995	$45.8
Graphic	4,930	49.3
Total Other:	5,925	$95.1
TOTAL Terminals	243,065	$1,036.3

FIGURE A19

TERMINAL FORECAST OF INSTALLED BASE (#s and $s)
(Federal Government) 1980 - 1985

	1980		1981		1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M	#	$M	#	$M
General-purpose:												
CRT	154,959	$330.2	218,492	$465.6	294,964	$628.6	383,453	$817.1	486,986	$1,037.8	608,732	$1,297.2
Teleprinters	60,817	180.7	71,155	211.5	81,828	243.2	94,102	279.7	106,336	316.0	119,096	354.0
Intelligent	32,785	327.9	43,603	436.0	55,684	556.8	72,555	725.6	92,145	921.5	114,260	1,142.6
Remote-Batch	2,128	63.8	2,297	68.9	2,458	73.7	2,605	78.2	2,735	82.1	2,845	85.4
Total General-purpose	250,089	$902.6	335,547	$1,182.0	434,934	$1,502.3	552,715	$1,900.6	688,202	$2,357.4	844,933	$2,879.2
Data Entry:												
Keypunch	27,706	$124.7	26,597	$119.7	25,533	$114.9	24,512	$110.3	23,532	$105.9	22,590	$101.7
Key-To-Tape	1,687	15.2	1,248	11.2	924	8.3	684	6.1	506	4.5	374	3.4
Key-To-Disk/Diskette	17,675	97.5	17,852	98.4	18,030	99.4	18,211	100.4	18,393	101.4	18,577	102.4
Total Data Entry	47,068	$237.4	45,697	$229.3	44,487	$222.6	43,407	$216.8	42,431	$211.8	41,541	$207.5
Other:												
OCR	1,403	$64.6	1,978	$91.0	2,671	$122.9	3,472	$159.8	4,409	$202.9	5,511	$253.7
Graphic	7,247	72.5	10,653	106.5	15,341	153.4	21,937	219.4	30,931	309.3	42,995	430.0
Total Other	8,650	$137.1	12,631	$197.5	18,012	$276.3	25,409	$379.2	35,346	$512.2	48,506	$683.7
TOTAL TERMINALS	306,407	$1,277.1	393,875	$1,608.8	497,433	$2,001.2	621,531	$2,496.6	765,973	$3,081.4	934,980	$3,770.4

FIGURE A20

PRINTER INSTALLED BASE AND FORECAST (#s and $s)*
(Federal Government) 1979 - 1985

Printer type	1979		1980		1981	
	#K	$M	#K	$M	#K	$M
Impact						
Line	34.8	$261.2	45.6	$324.9	55.9	$378.6
Serial (Character & Matrix)	19.3	$77.0	25.2	95.8	30.9	111.6
Total Impact	54.0	$338.2	70.8	$420.7	86.8	$490.2
Non-Impact						
Line, Page & Serial	.2	$29.1	.3	$40.6	.6	$75.3
TOTAL	54.3	$367.3	71.1	$461.3	87.4	$565.5

Printer type	1982		1983		1984		1985	
	#K	$M	#K	$M	#K	$M	#K	$M
Impact								
Line	69.0	$443.4	83.5	$510.0	101.7	$590.3	121.5	$669.6
Serial (Character & Matrix)	38.1	130.7	46.2	150.4	56.2	174.1	67.1	197.4
Total Impact	107.1	$574.1	129.7	$660.4	157.9	$764.4	188.6	$867.0
Non-Impact								
Line, Page & Serial	1.4	$159.0	3.7	$381.3	7.8	$717.2	13.7	$1,136.0
TOTAL	108.5	$733.1	133.4	$1,041.7	165.7	$1,481.6	202.3	$2,003.0

*Printers used only on general purpose, mini, and small business computers, and intelligent terminals.

Does not include low-end, electrostatic/thermal printers.

FIGURE A21

AUXILLIARY STORAGE DEVICES
INSTALLED BASE AND FORECAST (#s and $s)
(Federal Government) 1979 - 1985

Class of Equipment	1979		1980		1981	
	#	$M	#	$M	#	$M
Auxilliary Storage Devices (Units)	5,070	$51.0	5,400	$53.6	5,625	$56.3

Class of Equipment	1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M
Auxilliary Storage Devices (Units)	5,900	$59.1	6,150	$61.4	6,325	$63.3	6,500	$65.2

FIGURE A22

ADD-ON CORE
INSTALLED BASE AND FORECAST (#s and $s)
(Federal Government) 1979 - 1985

Class of Equipment	1979		1980		1981	
	#	$M	#	$M	#	$M
IBM Add-on Core (MB)	670	$37.3	775	$42.7	860	$46.7
Independent Add-on Core (MB)	860	$38.9	985	$43.1	1,080	$45.9
Minicomputer Add-on Core (MB)	1,200	$32.4	1,680	$44.4	2,280	$58.2
TOTAL Add-on Core	2,730	$108.6	3,440	$130.2	4,220	$150.8

Class of Equipment	1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M
IBM Add-on Core (MB)	920	$48.9	950	$50.3	975	$50.9	985	$51.3
Independent Add-on Core (MB)	1,140	$47.6	1,160	$48.2	1,160	$48.2	1,160	$48.2
Minicomputer Add-on Core (MB)	3,000	$73.3	3,660	$85.2	4,260	$93.6	4,860	$102.9
TOTAL Add-on Core	5,060	$169.8	5,770	$183.7	6,395	$192.7	7,005	$202.4

FIGURE A23

FEDERAL STORAGE MEDIA MARKET -- 1979 - 1985

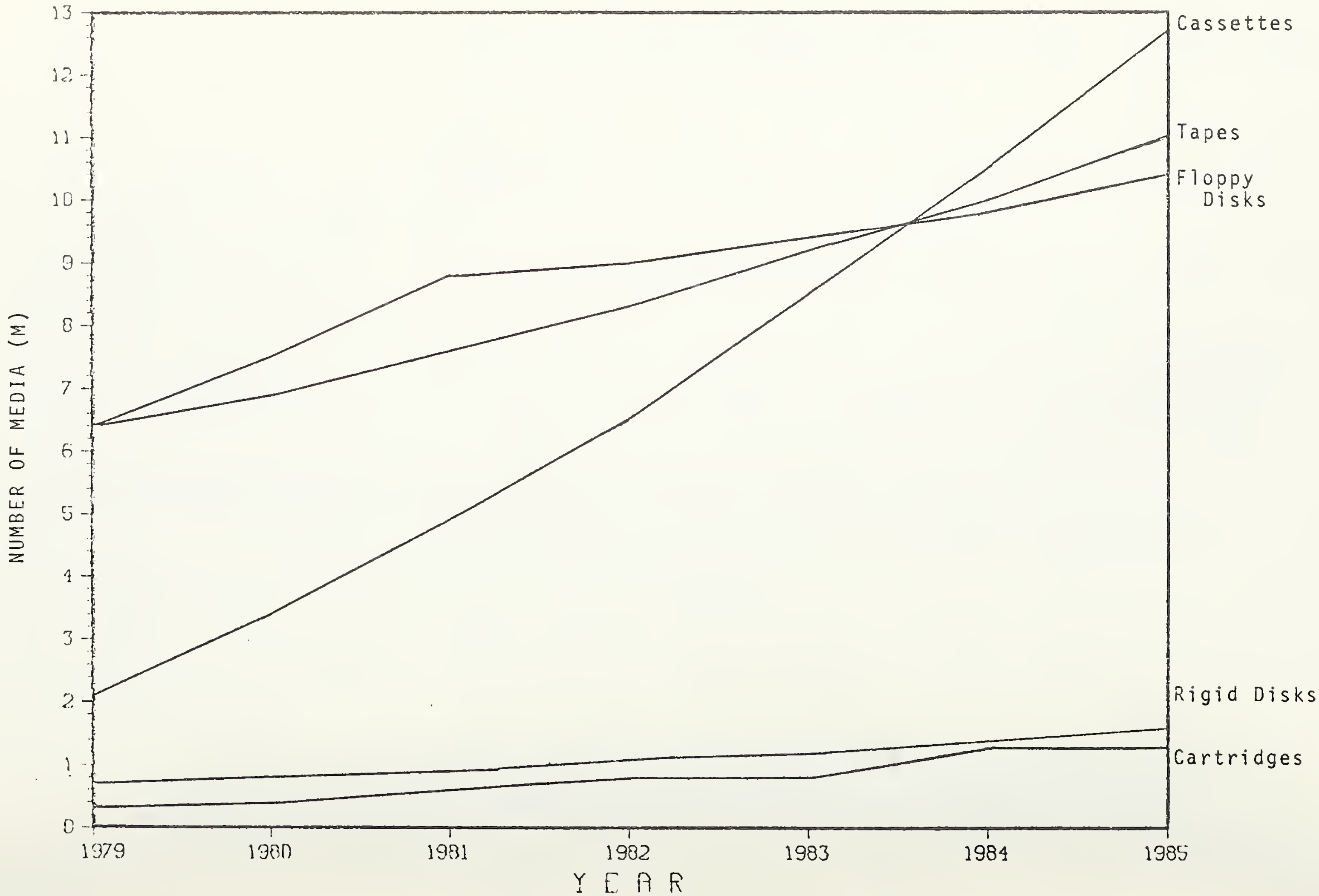


Figure A24

FEDERAL STORAGE MEDIA MARKET -- 1979 - 1985

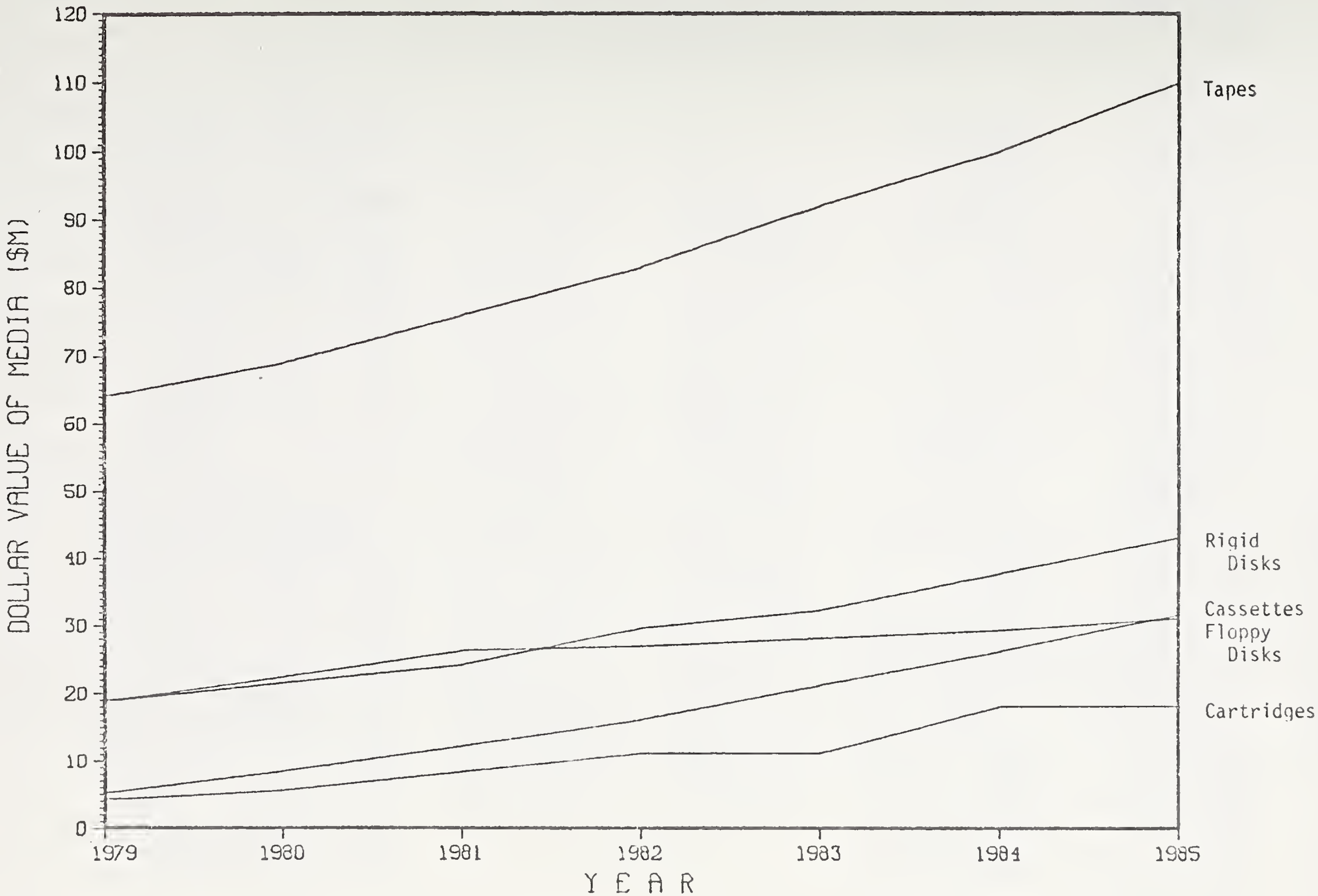


Figure A25

are given in Figures A26 and A27.

Word Processing. IDC defines a word processor as an electronic device which provides for the storing, editing, and reproduction of textual information. To qualify as a word processor, the device must have automated typing functions and removable media. The various word processing devices referred to in this report are defined as follows.

> Electronic Typewriters: Have automated typing functions and electromagnetic printheads which make them more reliable than electric typewriters because they have fewer moving parts. Electronic typewriters that participate in the word processing market fall into the latter of the following two categories:
>
> > Low-End: Low-priced (less than $3,000) with no removable media and an internal memory of 1,000 characters or less. They have limited text entry/editing capability and are competitive with electric typewriters.
> >
> > High-End: Priced at $4,000 and above and with removable media and single-line displays, they are competitive with the low-end of the word processor market. A communications option is available on Qyx Levels 2-5.
>
> Standalone Nondisplay: A processing terminal with a keyboard and printer in a single independent station. It is not dependent on the logic of another system for its operation. Typing and playback are performed on the same unit so the keyboard cannot be used for input during printing. These devices have no display mechanism such as a CRT. They may be able to communicate with other systems but the majority cannot. The IBM Magnetic Card/Selectric Typewriter (MT/ST) is an example of the standalone nondisplay.

STORAGE MEDIA INSTALLED BASE (#s and $s)
(Federal Government) 1979

Media Type	Number (M)	Dollar Value (M)
Magnetic Tape: (Reels)		
800 NRZI	2.0	$20.0
1600 Phase Encoded	3.6	36.0
6250 Group Encoded	.8	8.0
Total Tape	6.4	$64.0
Floppy Disk: (Diskettes)		
8" - two side	.4	$1.1
8" - one side	4.7	13.9
5 1/4" - two side	.1	.3
5 1.4" - one side	1.2	3.6
Total Floppy Disk	6.4	$18.9
Rigid Disk (Platters)	.7	$18.9
Digital Cassettes	2.1	$5.2
Digital Cartridges	.3	$4.2
*TOTAL Dollar Value:		$111.2

*Total number count felt inappropriate due to dissimilar media types.

FIGURE A26

STORAGE MEDIA
FORECAST OF INSTALLED BASE (#s and $s)
(Federal Government) 1980 - 1985

Media type	1980		1981		1982		1983		1984		1985	
	#M	$M	#M	$M	#M	$M	#M	$M	#M	$M	#M	$M
Magnetic Tape: (Reels)												
Low Density												
(800)	1.8	$18.0	1.6	$16.0	1.3	$13.0	1.1	$11.0	1.0	$10.0	.8	$8.0
(1600)	4.0	40.0	4.5	45.0	5.0	50.0	5.5	55.0	5.8	58.0	6.3	63.0
High Density (6250)	1.1	11.0	1.5	15.0	2.0	20.0	2.6	26.0	3.2	32.0	3.9	39.0
Total Tape	6.9	$69.0	7.6	$76.0	8.3	$83.0	9.2	$92.0	10.0	$100.0	11.0	$110.0
Floppy Disk: (Diskettes)												
8" - two side	.5	$1.5	.6	$1.8	.8	$2.4	1.1	$3.3	1.4	$4.2	1.8	$5.4
8" - one side	5.3	15.9	6.0	18.0	5.5	16.5	5.0	15.0	4.5	13.5	4.1	12.3
5 1/4" - two side	.1	.3	.2	.6	.2	.6	.3	.9	.3	.9	.4	1.2
5 1/4" - one side	1.6	4.8	2.0	6.0	2.5	7.5	3.0	9.0	3.6	10.8	4.1	12.3
Total Floppy Disk	7.5	$22.5	8.8	$26.4	9.0	$27.0	9.4	$28.2	9.8	$29.4	10.4	$31.2
Rigid Disk (Platters)	.8	$21.6	.9	$24.3	1.1	$29.7	1.2	$32.4	1.4	$37.8	1.6	$43.2
Digital Cassettes	3.4	$8.5	4.9	$12.3	6.5	$16.2	8.5	$21.3	10.5	$26.3	12.7	$31.8
Digital Cartridges	.4	$5.6	.6	$8.4	.8	$11.2	.8	$11.2	1.3	$18.2	1.3	$18.2
TOTAL Dollar* Value		$127.2		$147.4		$167.1		$185.1		$211.7		$234.4

*Total number count felt inappropriate due to dissimilar media types

FIGURE A27

Standalone Single-Line Display: A similar configuration to the nondisplay standalone with a single line (21-32) character) LED or gas plasma display added to the unit.

Standalone Display: A keyboard and separate printer and video screen (typically twenty-four 80-character lines) which allow for visual verification of text and facilitates revision and formatting. All editing is performed on the screen so all additions or corrections can be made before the text is printed in hard copy form.

Clustered System: A multi-terminal (display or nondisplay) configuration attached to a central processing unit (CPU), usually a minicomputer, which handles communications and maintains a central document data base. Output peripherals are also shared. The term "clustered system" reflects a definitional change in this report. Shared logic was formerly used to define multi-terminal configurations. This change was made to reflect the fact that the trend is away from dumb terminals supported by a minicomputer in the traditional shared logic arrangement. The dominant trend today is toward microprocessor-based intelligent terminals sharing disks and some control functions with a CPU. Lower per-station costs, larger storage, and more sophisticated programming are advantages of clustered systems.

Hybrid System: Either a standalone or clustered system which combines word and data processing capabilities in one system.

In the report, word processing system market projections have been aggregated to present information on three submarkets.

1. The high-end electronic typewriter market includes products such as higher level Qyx equipment.

2. Standalone word processors include standalone display, standalone line display, and standalone non-display systems.

3. Clustered word processing systems include both clustered and hybrid systems.

Word processing installed base estimates and forecasts are presented in Figures A28, A29 and A30. The standalone word processors, both by number and by dollar value, form the largest segment of this word processing group.

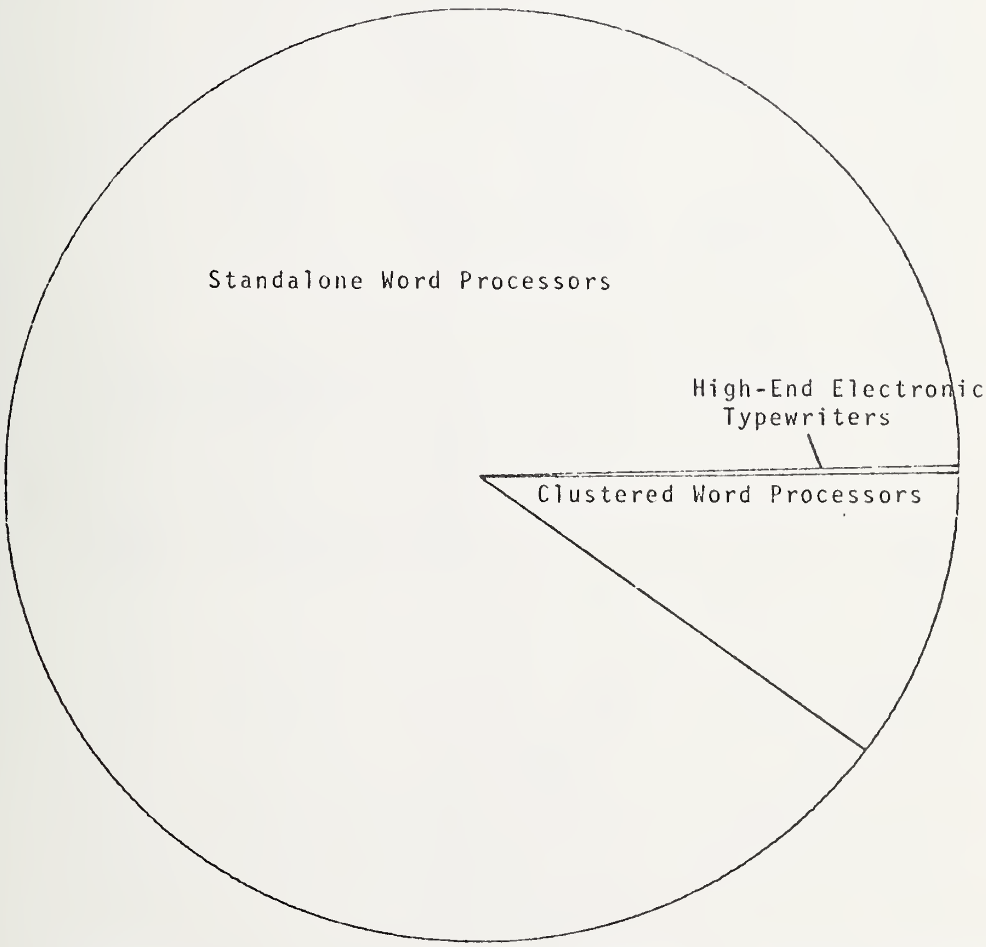
Communications Equipment

Modems: Modems modulate and demodulate digital data for transmission over analog facilities and convert that signal back to digital at the receiving station for use by a terminal or computer.

The specific types of modems covered in this report are acoustic couplers, those long-haul modems operating at speeds up to 9,600 bits per second (bps.), and short-haul modems - over 9,600 bps.

1. Acoustic Couplers. Acoustic couplers differ from traditional modems in that they convert digital signals into audible tones instead of electrical impulses to facilitate transmission over analog lines. These audible tones can be picked up by an ordinary telephone handpiece when placed into the acoustic coupler's special cradle. Acoustic couplers have the advantage of making a terminal as portable as the nearest telephone. They are also less expensive than comparable modems. Their disadvantages are that they are more susceptible to interference such as noise and crosstalk than a modem. This increases the incidence of transmission error, which is why traditional modems are suggested for use when transmission is to be conducted for more than a couple of hours a day or if the terminal can do without portability.

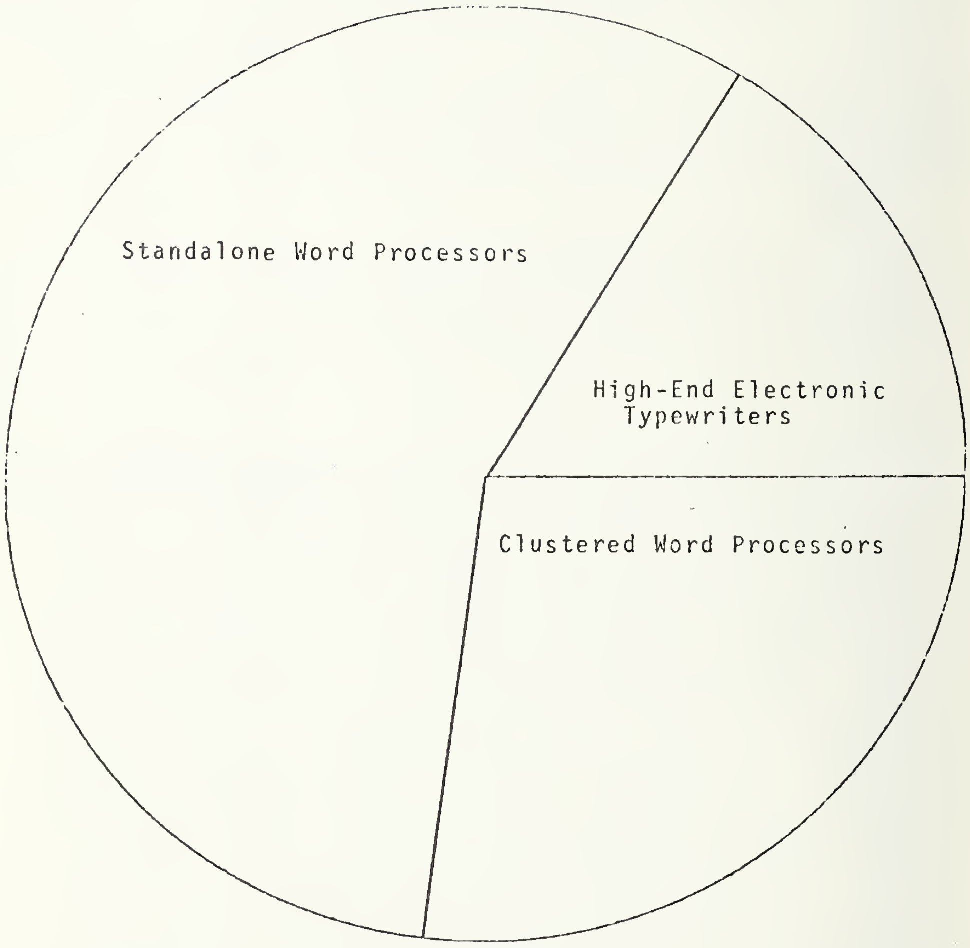
FEDERAL WORD PROCESSING EQUIPMENT: 1979



Equipment	Number	% of Total Number
High-End Electronic Typewriters	100	.24
Standalone Word Processors	37,400	89.63
Clustered Word Processors	4,225	10.13

Figure A28

FEDERAL WORD PROCESSING EQUIPMENT: 1985



Equipment	Number	% of Total Number
High-End Electronic Typewriters	28,600	16.37
Standalone Word Processors	99,179	56.76
Clustered Word Processors	46,952	26.87

Figure A29

WORD PROCESSING EQUIPMENT
INSTALLED BASE AND FORECAST (#s and $s)
(Federal Government) 1979 - 1985

Product	1979		1980		1981	
	#	$M	#	$M	#	$M
High-End Electronic Typewriter	100	$ .4	450	$2.7	1,450	$8.6
Standalone Word Processor	37,400	332.2	44,506	451.5	52,962	537.2
Clustered Word Processor	4,225	63.2	6,549	98.0	10,150	151.8
TOTAL	41,725	$395.8	51,505	$552.2	64,562	$697.6

Product	1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M
High-End Electronic Typewriter	3,750	$22.1	8,250	$48.7	16,250	$95.9	28,600	$168.7
Standalone Word Processor	63,024	639.3	75,000	760.8	87,000	882.5	99,179	1,006.1
Clustered Word Processor	15,530	232.3	23,296	348.5	33,778	505.3	46,952	702.3
TOTAL	82,304	$893.7	106,546	$1,158.0	137.028	$1,483.7	174,731	$1,877.1

FIGURE A30

IDC feels that although acoustic couplers serve a specific function that set them apart from traditional modems, they are sufficiently similar in terms of technology to the low-speed modems that they will be forecast as a part of the market. There will always be a market for acoustic couplers but technological changes will make the trade-off between them and low-speed modems more difficult, possibly resulting in some hybrid product.

2. 0-600 bit per second Modems. These modems are usually referred to as low-speed modems. They are used primarily for attachment to interactive terminals such as teleprinters and low-speed CRT terminals. Transmission at these speeds is asynchronous. There are a large number of vendors who make such devices.

   The price of a low-speed modem can range anywhere from a low of $150 to as much as $500. There has been little activity in this area in terms of technological changes and prices have been relatively stable. It should be noted that the average cost in this market includes acoustic couplers and circuit boards.

3. 1,200 bit per second Modems. Both 1,200 bps and 2,400 bps modems are also known as medium-speed modems. At 1,200 bps the modem is operating asynchronously and does not require the added sophistication of clocking, which is necessary for the synchronous transmission of higher-speed modems. Recent technological developments have made available a full- duplex 1,200 bps modem. Although more expensive then traditional 1,200 bps modems, the full-duplex feature allows simultaneous bidirectional transmission on two rather than four lines. This product should bolster the growth in this type of modem over the next 5 years.

4. 2,400 bit per second Modems. These modems are used to transmit input to and from a CRT terminal or low-speed remote batch terminals. Within certain speed ranges there are

trade-offs between the use of one speed or another. In most cases users select the speed requirements by evaluating which speed will best utilize time on the network based on type of terminal and amount of data to be transmitted. The average unit price for a 2,400 bps modems in 1979 was estimated to be $1,100. This lack of effect of time on the price of the 2,400 area is due to the expected release of full-duplex models, sometime in 1980 or 1981, which will add to the total value.

5. 4,800 bit per second Modems. 4,800 bps and 9,600 bps modems are normally referred to as high-speed modems. 4,800 bps modems require that conditioned lines be used for transmission. Therefore lines must be "dedicated" or leased from the operating company to ensure that they are suitable for high-speed transmission. Conditioning is required to clear the line of noise which would severely effect the error rate of transmitted information. Only recently has a low cost and reliable 4,800 bps modem been available; this is due to improved microprocessor technology.

6. 9,600 bit per second Modems. The 9,600 bps market is very similar in all respects to the 4,800 bps market. These high-speed modems are for use in machine-to-machine communications, usually high-volume remote batch transmission or computer-to-computer interaction.

7. Short-Haul Modems. As the name short-haul suggests, these modems are distance restricted. A short-haul modem is used for operations over special cables (metallic or coaxial), within a limited distance, at speeds up to 50,000 bps, for a fraction of the cost of comparably fast long-haul modems. The distance limit in most cases is about 10 miles but recently short-haul modems with capabilities of up to 50 miles have been introduced. These modems offer an alternative to the long-haul modem where a remote site is

communicating with a host located across town or on a different floor in a large office building. The price of these modems ranges from $200 to $2,000, with the average price being about $700.

The installed base estimates and forecasts for modems are given in Figures A31, A32, A33 and A34.

Multiplexers: A multiplexer takes several lower speed lines and combines them for transmission over one high-speed line. The benefit to users is the cost savings incurred by using a single high-speed line for long distance transmission rather than multiple long distance lines at lower speeds. Multiplexers are categorized by the technique used for combining multiple data streams onto one facility. There are Frequency Division Multiplexers (FDM) and Time Division Multiplexers (TDM). Another category of multiplexer, which is actually a type of Time Division Multiplexer, is known as the Statistical Multiplexer, or Stat Mux.

1. Frequency Division Multiplexers. FDMs operate by sending multiple data streams at varying frequencies. In order to transmit, the data must first be modulated; then the frequencies are combined and sent. At the receiving station the FDM separates the different frequencies, then demodulates them. Modems are not required when an FDM is used. The frequency division multiplexer is limited by the transmission rates obtainable. Only low-speed (usually a maximum of 2 lines at 600 bps each) transmission can be achieved. There are still applications which require the use of FDMs, but the growth rate has been declining over the past few years, and it is expected that more cost effective TDMs and Stat Muxs will replace FDMs. It should be noted that FDMS for strictly voice transmission are not included. An average unit price of $3,000 is used in estimating the total dollar value installed through 1985.

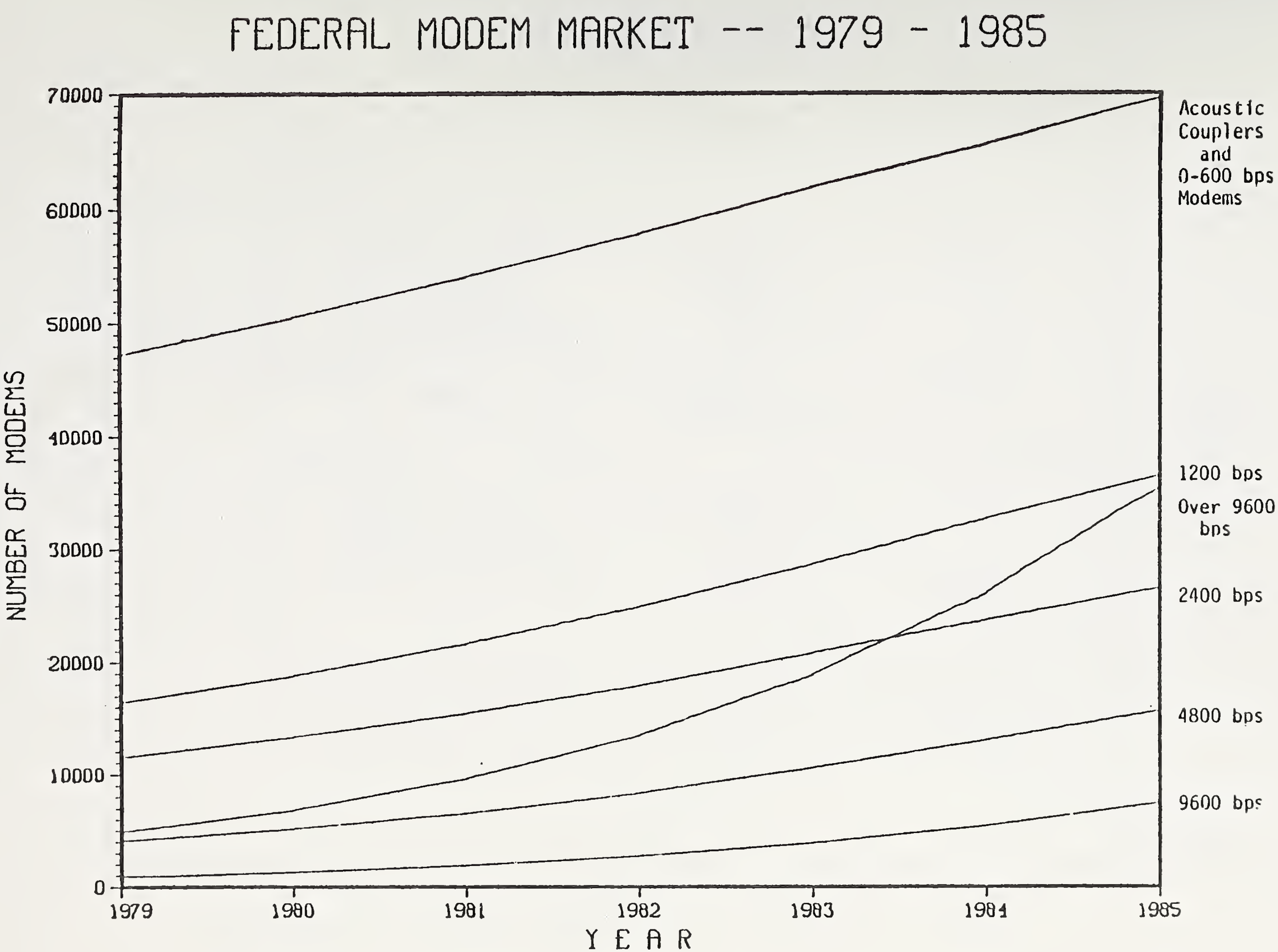

FEDERAL MODEM MARKET -- 1979 - 1985
70000
60000
50000
40000
30000
20000
10000
0
NUMBER OF MODEMS
1979
1980
1981
1982
1983
1984
1985
YEAR
Acoustic Couplers and 0-600 bps Modems
1200 bps
Over 9600 bps
2400 bps
4800 bps
9600 bps

Figure A31

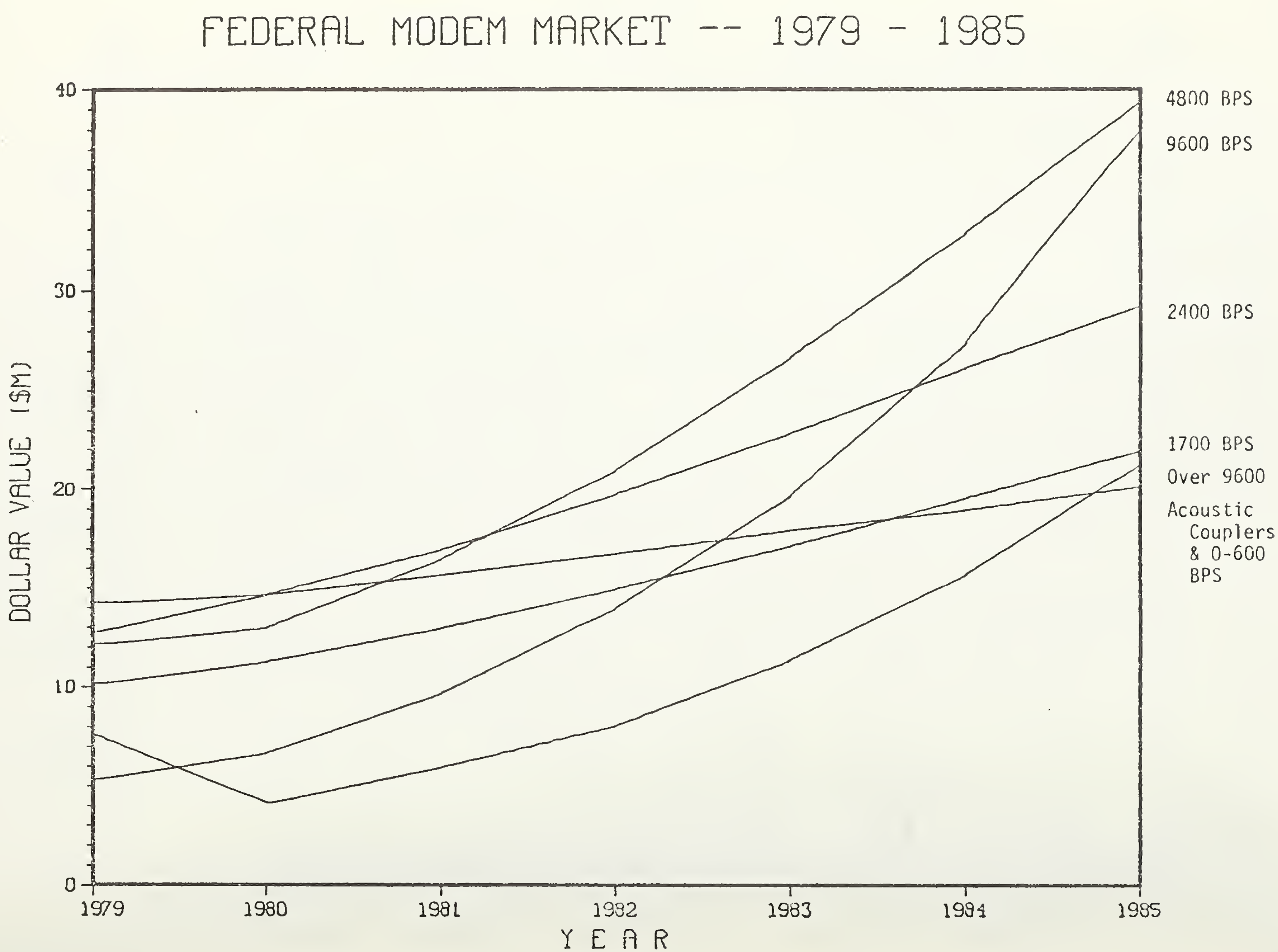

FEDERAL MODEM MARKET -- 1979 - 1985
DOLLAR VALUE ($M)
0
10
20
30
40
1979
1980
1981
1982
1983
1984
1985
YEAR
4800 BPS
9600 BPS
2400 BPS
1700 BPS
Over 9600
Acoustic Couplers & 0-600 BPS

Figure A32

DATA COMMUNICATIONS EQUIPMENT
INSTALLED BASE (#s and $s)
(Federal Government) 1979

Device	# Units	Dollar Value (M)
Modems:		
Acoustic Couplers and 0-600 bps Modems	47,240	$14.2
1,200 bps Modems	16,400	10.1
2,400 bps Modems	11,520	12.7
4,800 bps Modems	4,100	12.1
9,600 bps Modems	900	5.3
Over 9,600 bps Modems	4,930	7.6
Total Modems	85,090	$57.0
Multiplexers:		
Frequency Division	1,180	$4.2
Time Division	764	7.6
Low-End Statistical	258	.7
High-End Statistical	220	3.3
Total Multiplexers:	2,422	$15.8
Communication Processors:	663	$19.6
TOTAL Data Communications	88,175	$92.4

FIGURE A33

DATA COMMUNICATION EQUIPMENT
FORECAST OF INSTALLED BASE (#s and $s)
(Federal Government) 1980 - 1985

	1980		1981		1982		1983		1984		1985	
	#	$M	#	$M	#	$M	#	$M	#	$M	#	$M
Modems:												
Acoustic Couplers & 0-600 bps Modems	50,547	$14.7	54,085	$15.7	57,871	$16.8	61,922	$18.0	65,637	$19.0	69,575	$20.2
1,700 bps Modems	18,860	11.3	21,689	13.0	24,942	15.0	28,684	17.2	32,700	19.6	36,623	22.0
2,400 bps Modems	13,363	14.7	15,501	17.0	17,982	19.8	20,859	22.9	23,779	26.2	26,632	29.3
4,800 bps Modems	5,207	13.0	6,613	16.5	8,398	21.0	10,666	26.7	13,119	32.8	15,743	39.4
9,600 bps Modems	1,332	6.7	1,945	9.7	2,800	14.0	3,949	19.7	5,489	27.4	7,574	38.0
Over 9,600 bps Modems	6,902	4.1	9,663	6.0	13,528	8.1	18,939	11.4	26,136	15.7	35,545	21.3
Total Modems	96,211	$64.5	109,496	$77.9	125,521	$94.7	145,019	$115.9	166,860	$140.7	191,692	$170.2
Multiplexers:												
Frequency Division	1,096	$3.28	999	$2.99	919	$2.76	845	$2.54	778	$2.33	715	$2.15
Time Division	802	8.02	842	8.42	884	8.84	929	9.29	975	9.75	1,024	10.24
Low-End Statistical	387	.97	581	1.45	871	2.18	1,306	3.27	1,959	4.90	2,939	7.35
High-End Statistical	273	4.10	338	5.07	419	6.29	520	7.80	634	9.51	761	11.42
Total Multiplexers	2,548	$16.37	2,760	$17.93	3,093	$20.07	3,600	$22.90	4,346	$26.49	5,439	$31.16
Communication Processors	822	$24.3	1,019	$30.1	1,265	$37.4	1,567	$46.3	1,912	$56.5	1,865	$55.1
TOTAL DATA COMMUNICATIONS	99,581	$105.17	113,275	$125.93	129,878	$152.17	150,186	$185.10	173,118	$223.69	198,996	$256.46

FIGURE A34

2. Time Division Multiplexers. The TDM combines several data streams onto one line by assigning bits of characters to some fixed time-frame, transmitting these frames in sequence at the receiving station. The information is synchronized so that the data can be recovered at the other end. The time division multiplexer market will be limited by the recent influx of low-cost statistical multiplexers and the increased cost benefits they provide. The price for a TDM varies depending on the number of low-speed lines that are required. IDC found that in a "typical" configuration a TDM costs approximately $10,000. This figure is used throughout the forecast.

3. Statistical Multiplexers, also known as Intelligent Multiplexers, use the same technique as the TDM for transmission, but differ in that they are capable of accomodating more low-speed ports than there is space for on the high-speed line. This is accomplished based on the probability that not all low-speed ports (terminals) will be in use at the same time. The statistical multiplexer uses its intelligence to ignore inactive terminals, thus freeing it to poll another active terminal. This cuts substantially into the amount of dead space being carried on the lines, increasing network efficiency. Problems occur with contention when a terminal accessing the network finds the multiplexer is fully loaded. Some statistical multiplexers are capable of polling terminals on a priority basis, but the real problem of contention must be faced by the individuals managing the network.

   New product announcements within the past 2 years have made it necessary to split the statistical multiplexer market into two categories.

1. High-End Statistical Multiplexer. These multiplexers have been in existence for a few years. These units are normally capable of handling up to 128 lower speed lines, in some cases up to 248, and can output on more than one line. Automatic loop monitoring, multidropping, and automatic operation are some of the features available, which result in an average unit price of $15,000.

2. Low-end Statistical Multiplexer. The low-end differs from the high-end primarily in the number of lines that can be handled, usually between 4 and 16. They do not have the sophistication in terms of network diagnostics that those machines in the high-end might have, but the average price tag of $2,500 has made this low- end unit very popular among vendors as well as users.

The installed base estimates and forecasts for multiplexers are given in Figures A33, A34, A35 and A36.

<u>Communications Processor</u> A communications processor is a computer which has been specifically programmed to perform one or more of the following functions:

1. Front End Processing -- The front end processor interfaces between the mainframe computer and the data communications network for the purpose of off-loading the communications responsibilities from the CPU. Front ends can be either hardwired or programmable.

2. Message Switching -- The message switcher is sometimes referred to as a traffic director or network node. It has the responsibility of receiving messages and directing them to their proper destination. Most message switchers use auxiliary storage for store and forward functions. The message switcher is usually a minicomputer and in some applications is used as a concentrator as well.

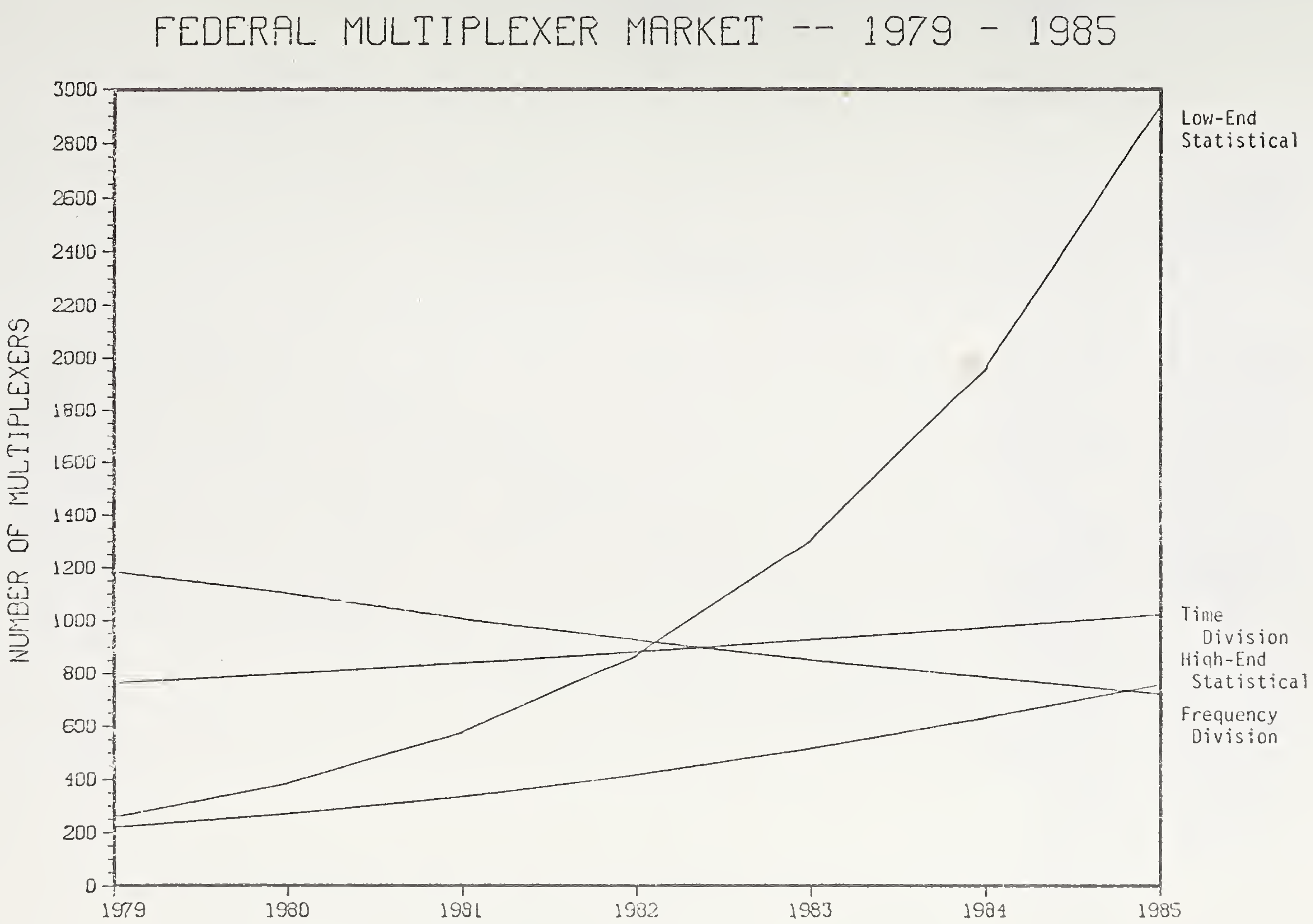

FEDERAL MULTIPLEXER MARKET -- 1979 - 1985
NUMBER OF MULTIPLEXERS
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
1979
1980
1981
1982
1983
1984
1985
Y E A R
Low-End Statistical
Time Division
High-End Statistical
Frequency Division

Figure A35

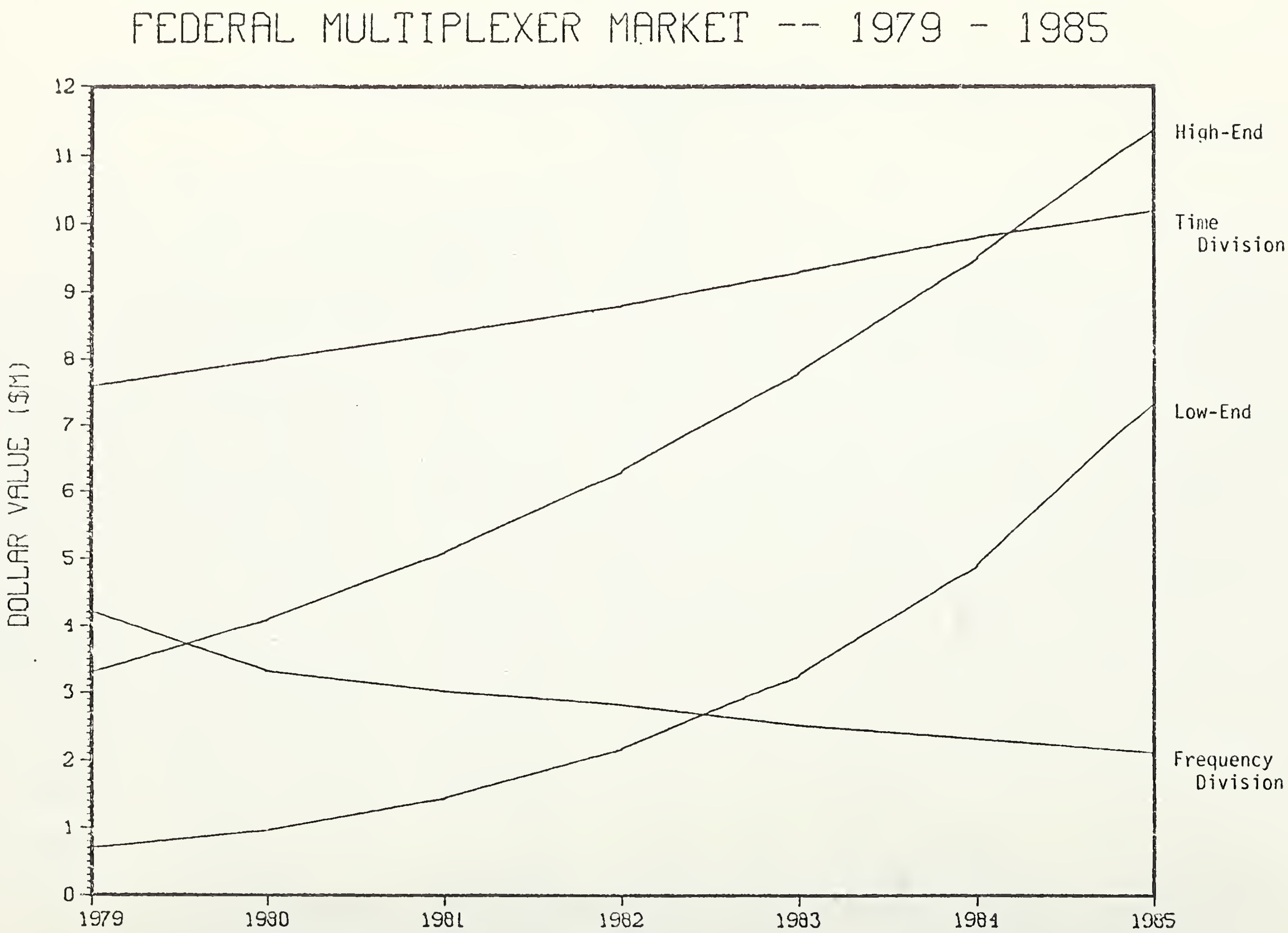

FEDERAL MULTIPLEXER MARKET -- 1979 - 1985
DOLLAR VALUE ($M)
0
1
2
3
4
5
6
7
8
9
10
11
12
1979
1980
1981
1982
1983
1984
1985
YEAR
High-End
Time Division
Low-End
Frequency Division

Figure A36

3. Remote Concentrator -- The remote concentrator combines low-speed data streams for transmission over the fewer high-speed lines. Usually minicomputers are used here, and some more powerful models are capable of performing message switching functions.

The overall average unit price for communications processors has been estimated at approximately $100,000. The installed base estimates and figures for communications processors are given in Figures A33 and A34.

Section Two

PROGRAMMING LANGUAGES, APPLICATIONS, AND OPERATING SYSTEMS

Introduction

This section of the report presents IDC's analysis of typical operating systems, programming languages, and application patterns, based on observed distributions in commercial installations.

IDC regularly collects information on principal programming languages for each general purpose system listed in the Computer Installation Data File. The report represents analyses of programming languages from three perspectives.

1. System Information -- The principal programming language was analyzed for each CPU on the IDC Computer Installation Data File.

2. Installed Base Analysis -- Historical trends in programming language implementation provided a basis for evaluation of probable trends in implementation through 1985.

3. Analysis of Interrelationships -- Analysis of individual system installations on the IDC Computer Installation Data File provided insight into relationships between programming languages, operating systems, and applications.

Programming Languages

Figure B1 lists the programming languages currently included in the IDC Computer Installation File. The entries in this listing are not consistent for a number of reasons. Some reporting installations were more specific than others (FORTRAN IV vs. FORTRAN). Since only a primary language was required for an installation, some installations reported two equally used languages as one primary language. Thus several entries are combinations of languages. IDC did not alter these entries for this listing.

Programming Languages on the IDC Computer Installation Data File

ALC
MIIS
MUMPS
RPG-3
DACL
DATA/IV
DATASHARE
IDEA
MOBOL
TAL
PASCAL
SYBOL
NONE
COMPASS
FARGO
BASIC
MACHINE LANG
ASSEMBLY LANG
ALGOL
PL/1
APL
DIBOL
COBOL
COBOL-B
COBOL-D
COBOL-C
COBOL-H
ANSI COBOL

COBOL/PL-1
COBOL/FORTRAN
FORTRAN
FORTRAN II
FORTRAN IV
SPS
SPS-II
SPS/FORTRAN
SYMBOLIC-SPS
AUTOCODER/1401
AUTOC/EASYTRAN
AUTOCODER/SPS
GRASP
CORAL
PAL
RPG/COBOL
RPG
RPG/BAL
CLEO
PLAN
USERCODE
NICOL
EMA
TAB
PROSA 300
BAP
LOGEL
FAP

APS
MAP
GAP-GE
MACRO
EASYTRAN
EASYCODER
GECOM
NEAT/NEAT 3
NEAT/BEST
SALT
S-4
OSAS
FOCAL
COLPAC
DAP 16
ADPAC
RPG-2
AUTOCODER
AUTOCODER/1440
COBOL-F
SAAL
FASP
APRIL
MSP
DATABUS (DPNT)
OTHER

FIGURE B1

Figures B2, B3, and B4 present the distribution of programming language implementation for major mainframe vendors in the United States for 1975, 1977, and 1979, respectively.* When viewed over time, these tables illustrate several major trends in programming language implementation.

1. Users were moving away from assembly language programming between 1977 and 1979, after significant increases in assembly language programming between 1975 and 1977.

2. Users were increasingly turning to COBOL as their principal programming language.

These two trends are indicative of increasing user willingness to accept increased system overhead costs in return for decreased costs in acquiring and training programming staff. IDC expects this trend to continue through 1985, manifested in at least two forms.

1. COBOL will continue to grow in importance, although at a lesser rate than experienced during the past 5 years. In part, this continued growth reflects the reality that the largest stock of programmers are familiar with COBOL, and that a major portion of current applications software is written in COBOL. Even if more sophisticated and user-friendly software is developed during the next 5 years, vendors will face a difficult marketing task in educating users, programmers, and systems managers to new technologies. However, the growth of COBOL implementation will moderate as implementation levels begin to encroach on areas where more specialized languages maintain their comparative advantage.

2. IDC expects the introduction of various programming languages -- or alternatives to programming languages -- which approach true English language programming for some applications. However, difficulties in developing

----

* Certain computer manufacturers were identified in this section by IDC. In no case does such identification imply recommendation or endorsement by the Institute for Computer Sciences and Technology nor the National Bureau of Standards.

PROGRAMMING LANGUAGES VERSUS MANUFACTURER
(1975)
(U.S. General Purpose Computers)

	Burroughs	CDC	HIS	IBM 360/370	NCR	Univac
BASIC	3.1%	0.7%	0.9%	0.3%	0.5%	1.0%
ASSEMBLY	14.5	12.4	4.4	5.4	0.8	11.1
COBOL	65.6	15.2	71.4	52.7	19.7	27.9
COBOL/FORTRAN	2.1	11.0	1.9	2.5	1.5	3.6
FORTRAN	0.9	43.1	3.0	1.7	0.3	4.3
RPG	4.8	-	1.5	18.5	1.0	33.4
PL 1	-	-	-	4.8	-	-
NEAT 3/BEST	-	-	-	-	70.9	-
OTHER	9.0	17.6	16.9	14.1	5.6	18.7
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

FIGURE B2

PROGRAMMING LANGUAGES VERSUS MANUFACTURER
(1977)
(U.S. General Purpose Computers)

	Burroughs	CDC	HIS	IBM 360/370	NCR	Univac
BASIC	1.4%	0.4%	0.6%	0.2%	0.5%	0.8%
ASSEMBLY	9.5	13.8	5.8	14.6	2.0	16.6
COBOL	71.4	13.8	70.3	59.9	23.4	33.0
COBOL/FORTRAN	2.1	9.4	1.9	2.6	1.0	4.6
FORTRAN	0.5	45.0	3.4	1.8	0.2	4.4
RPG	11.4	0.8	3.5	13.2	1.0	30.8
PL1	0.1	-	0.2	5.3	-	-
NEAT 3/BEST	-	-	-	-	65.5	-
OTHER	3.6	16.8	14.3	2.4	6.4	9.8
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

FIGURE B3

PROGRAMMING LANGUAGES VERSUS MANUFACTURER
(1979)
(U.S. General Purpose Computers)

	Burroughs	CDC	HIS	IBM 360/370	NCR	Univac
BASIC	0.7%	-	0.5%	0.2%	-	0.5%
ASSEMBLY	5.4%	3.7%	1.3%	10.3%	0.1%	14.6%
COBOL	74.4%	24.6%	74.5%	68.8%	31.1%	38.4%
COBOL/FORTRAN	2.0%	13.5%	2.2%	1.8%	0.7%	4.3%
FORTRAN	0.7%	48.5%	2.2%	1.5%	0.2%	3.5%
RPG	10.6%	-	5.0%	4.5%	0.9%	27.1%
PL1	0.1%	-	0.1%	6.4%	-	-
OTHER	6.1%	9.7%	14.2%	6.5%	0.6%	13.7%
NEAT 3/BEST	-	-	-	-	66.4%	-
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

FIGURE B4

such languages suggest that full-scale implementation will not begin until the latter portions of the forecast period, and that implementation levels will not be significant enough to alter projections based on historical patterns.

Figures B2, B3, and B4 provide the basic information for analysis of Federal Government programming language installations. The tables present estimates of the use of various programming languages on computers manufactured by each major general purpose computer manufacturer. These estimates are direct tabulations of information contained on the IDC Computer Installation Data File for 1975, 1977, and 1979, respectively.

Figure B5 presents IDC's estimates of the current distribution of principal programming languages in the Federal Government and of distributions which are reasonably expected by 1985. IDC projected these estimates using a two-step procedure.

1. The use ratios presented in Figures B2, B3, and B4 were weighted to reflect the Federal Government installed base of each manufacturer and combined to generate the 1979 aggregate usage estimate in Figure B5.

2. Trends in programming language usage were calculated for each manufacturer and size class of computer. These trends were based on historical patterns of change in the level of usage and modified as necessary to reflect current IDC thought on long-term forces affecting programming language use.

As noted earlier, these projections assume that programming language technical development will have minimal impact on installations during the prediction period.

PROGRAMMING LANGUAGE AT FEDERAL GOVERNMENT INSTALLATIONS

Language	1979	1985
Basic	0.4%	0.2%
Assembly	9.2%	11.0%
COBOL	57.5%	62.1%
Fortran	8.4%	7.1%
RPG	11.9%	6.0%
PL1	2.2%	3.1%
Other	10.4%	10.5%
Total	100.0%	100.0%

FIGURE B5

Applications

IDC's Computer Installation Data File contains information on the two principal applications for each system on the file. Figure B6 presents the current list of applications included in the file.

In order to facilitate analysis of application patterns, IDC has combined applications into four groups.

1. Business or commercial applications include typical accounting, inventory, accounts payable, and personnel applications.

2. Business or scientific problem solving applications include forecasting, planning, statistical analysis, and cost estimating.

3. Non-Commercial Applications include industrial automation, graphics, and communications control.

4. Office applications include word processing and related functions.

Figure B7 presents the distribution of applications in the IDC computer Installation Data File for 1975, 1977, and 1979. Figure B8 presents IDC's estimate and forecast of Federal Government applications.

APPLICATIONS ON THE IDC COMPUTER INSTALLATION DATA FILE

ADVERTISING	CLAIMS	HEALTH INS	SERVICE BUREAU
BANKING	POLICY WRITING	REVENUE/EXPENSE	BATCH
CHECK PROCESS	PREMIUM BILLING	HOSP SUPPLIES	PROD CONTROL
DEMAND DEPOSIT	REAL ESTATE	CLINICAL RSCH	COMMUNICATIONS
INSTALL LOAN	LAW	LABORATORY	DATA ACQUISITN
LOAN ACCT/ANAL	LIBRARIES	MONITORING	INDUSTRY DP SVC
MORTG LOAN ACCT	PUBLISHING	MATHEMATICS	ORDER ENTRY
PAYROLL ACCT	TYPESETTING	MECHANICAL ENG	TELEPROCESSING
SAVINGS ACCT	SUBSCRIPTIONS	MEDICINE/PSYCH	REMOTE BATCH
SAV CLUB ACCT	WORD PROCESSING	METTALLURGY	MGMT INFO
TRUST ACCT	TEXT EDITING	METEOROLOGY	FACILITY MGMT
COMMERCIAL DP	DIRECT MAIL	MILITARY ENG	MEDIA CONVERSN
TRANSIT CHECK	MILITARY	NUCLEAR ENG	TIME SHARING
CUSTOMER SERV	AF ENGINE/PARTS	PHOTOGRAPHY	RSCH&STATISTICS
EDUCATIONAL	OIL INDUSTRY	PHYSICS	MARKETING
ADMISSIONS	CREDIT CARDS	PSYCHOLOGY	CREDIT CHECKING
REGISTRATION	PUBLIC UTIL	SOCIOLOGY	BILL OF MATL
CPU ASSIST INST	LAW ENFORCEMENT	CPTR AID DESIGN	SALES REPORTING
SCHOLASTIC REC	STEEL INDUSTRY	GEN BUSINESS	DATA ENTRY
CLASS SCHEDULE	CONSTRUCTION	ACCOUNTING	FRONT END PROC
TEACHING	TELEPHONE INDUS	GEN LEDGER	MESSAGE SWITCH
TEST GRADING	TRANSPORTATION	BILL/INVOICES	PERIPH SUPPORT
RESEARCH	RESERVATIONS	BUDGETING	PROG DEV
ADMINISTRATIVE	MISCELLANEOUS	COST ACCT	MERCHANDISING
FINANCE	GEN SCIENCE/ENG	FILE MAINT	HARDWARE DEV
STOCKS + BONDS	AERON/SPACE	FORECASTING	POINT OF SALE
GOVERNMENT	AGRICULTURE	INFO RETRIEVAL	DISTRIBUTION
GOVT ACCT	ARCHITECTURE	INVENTORY	TV/RADIO
GOVT BUDGETS	BIOLOGY	LINEAR PROG	TRAFFIC CONTROL
ELECTIONS	GEOLOGY/MINING	ROSTER	GEN PLANT/PROD
GOVT TAX ACCTG	CIVIL ENG	MANAGEMENT RPTS	LABOR DIST
MOTOR VEHICLES	ECONOMICS	MARKET RESEARCH	NUMERICAL CONT
DRIVER LICENSES	ELECTRICAL ENG	ORDER ACKNOWL	MATERIALS/PARTS
GOVT STAT REPTS	ENVIRON CNTL	ORDER ANALYSIS	ROUTE ACCT
GOVT SUPPLIES	HYDRAULIC ENG	PAYROLL	SHOP SCHEDULE
GOVT UTILITIES	LINGUISTICS	PERSONNEL	CRITICAL PATH
SOC/SEC WELFARE	MARINE ENG	PROD FORECASTS	PROCESS CONTROL
INSURANCE	HOSPITALS	PURCHASE ORDERS	EQUIP TEST
ACTUARIAL RSCH	PATIENT BILLING	SALES ANALYSIS	
AGENCY ACCT	PATIENT RECORDS	GRAPHICS	

FIGURE B6

APPLICATIONS ON U. S. COMPUTER INSTALLATIONS

Application	1975	1977	1979
Commercial	67.5%	64.2%	64.6%
Non-Commercial	18.8%	20.9%	21.0%
Problem Solving	12.8%	14.0%	13.3%
Office	0.9%	0.9%	1.1%
Total	100.0%	100.0%	100.0%

FIGURE B7

PRINCIPAL APPLICATIONS AT FEDERAL GOVERNMENT INSTALLATIONS

Application	1979	1985
Commercial	64.6%	63.0%
Non-Commercial	21.0%	22.0%
Problem Solving	13.3%	13.0%
Office	1.1%	2.0%
Total	100.0%	100.0%

FIGURE B8

Operating Systems

IDC was not able to estimate the operating systems in use in the Federal Government nor estimate future utilization. There are currently shown 160 different operating systems on the IDC Data File. Since operating system offerings are subject to manufacturer discretion, IDC does not forecast future operating system implementation levels. However, IDC does expect several trends in operating system implementation to hold true for both the United States and Federal Government.

1. Manufacturers will be placing major emphasis on development of user-friendly operating systems. Increasing CPU memory will permit increased use of memory for overhead, permitting operating system designers to build more features into the operating system. User-friendly systems, in turn, will permit greater end-user flexibility by reducing the importance of job control language in program development.

2. As memory sizes increase, more operating system code will tend to reside in main memory, rather than on disk, resulting in enhanced system performance.

3. Operating systems in general will feature significantly enhanced security and integrity features, responding to user concerns related to increased system access.

4. Data base and data communications products will be buried in the operating system, closely linking operating systems and utility software.

5. Manufacturers will include more microcode prerequisites in operating systems, leading to stronger ties between vendor operating systems and vendor software.

6. Operating systems will be designed to support multiple CPU environments, reflecting general trends in data processing configurations.

7. Vendors will place greater emphasis on developing procedures to reduce errors in new operating systems. They will also move toward full charges for operating systems, and toward remote operating system support.

These trends represent natural extensions of existing operating system development. However, the actual design of operating systems will be determined by individual vendors.

Section Three

SOFTWARE SPENDING

Introduction

This section presents IDC's estimates of the amounts spent for software in the general computer population, and, by extrapolation, at Federal Government computer sites. Regarding the size of programs, dollar value of software installed, and time and costs involved in software development, IDC conducted a thorough search of all available materials in order to determine these data; however, despite IDC's best efforts in this area, the information available was insufficient to make possible a meaningful analysis. The present section is restricted to an analysis of the dollar amounts spent for software for the year ending December 31, 1979, as well as a breakdown of that spending according to external and internal software expenditures.

Further, data regarding minicomputers and small business computers (Class B and C computers) were insufficient to permit an analysis of software spending in these computer size classes. The present section is restricted to software spending among Class A (mainframe) computers only.

Methodology

The dollar figures for software spending in the present section were derived from IDC's report, Software Spending Analysis (1980). The proportion of general purpose computers installed at Federal Government sites was derived from analysis of IDC's Computer Installation Data File and the GSA inventory. The proportion of Federal Government CPUs to the total CPU population (which was taken from the 1980 General Purpose Computer Census, as published in IDC's publication EDP Industry Report) was then applied to obtain estimates of the proportion of dollars spent for software within the Federal Government. The total value of software spending was then broken down into spending according to the three major software groups -- system, utility, and application software, with figures in each category for both the general computer population and for those systems located at Federal Government sites.

CPUs Installed

Figure Cl provides a breakdown of Class A (general purpose) computers, according to size class, as of yearend 1979. The number of Federal Government computers is also provided, along with the percentage of the total computer population represented by Government systems.

Of particular note is the unusually high incidence of Government computers in size class 7, as compared to the equivalent U.S. population: 15 percent of the U.S. size class 7 CPUs are installed in the Federal Government which is the largest "percent of U.S." amount versus the other size classes. Not surprisingly, these computer sites tend to have the largest software budgets.

The cumulative value of dollars spent for software is presented in Figure C2. These figures (in millions of dollars) represent the amount of money spent for software in the general computer population. The figures for Federal Government installations are presented in Figures C4-C7 inclusive.

GENERAL PURPOSE COMPUTERS INSTALLED
(As of Year-End 1979)
BY SIZE CLASS

Size Class	U.S. Installed Base	Federal Government Installed Base	Gov't CPUs - Percent of U.S.
2	14,810	148	1.0%
3	16,652	531	3.2%
4	10,284	784	7.6%
5	4,891	300	6.1%
6	4,641	402	8.7%
7	1,965	297	15.1%
Total	53,243	2,462	Av. 6.95%

FIGURE C1

As can be seen from Figure C2, the majority of software expenditures are for application software; this is primarily because the range of applications being run requires a greater variety of software; consequently, several systems may be required to perform a task, where one package may suffice for systems and/or utility software requirements. Also of interest is the great extent to which application software is developed internally; as Figure C3 indicates, fully three-fourths of all application software dollars are spent for internal development costs. Also of interest is the forecast that external software expenditures are expected to almost double by the end of 1980, to an estimated figure of $1,450 million; in addition, internal expenditures should also increase to an estimated $6,960 million.

DOLLARS SPENT FOR SOFTWARE
U.S. GENERAL PURPOSE COMPUTERS
By SIZE CLASS
(As of Year-end 1979)
($ Million)

Size	Systems			Utilities			Application			Totals		
Class	Tot.	Int.	Ext.	Tot.	Int.	Ext.	Tot.	Int.	Ext.	Tot.	Int.	Ext.
2	29	8	21	11	2	9	180	146	34	220	156	64
3	47	11	36	30	7	23	353	318	35	430	336	94
4	80	19	61	80	22	58	845	676	169	1,005	717	288
5	112	48	64	37	7	30	596	501	95	745	556	189
6	191	65	126	159	27	132	710	518	192	1,060	610	450
7	567	340	227	283	190	93	1,330	1,144	186	2,180	1,674	506
TOTAL	1,026	491	535	600	255	345	4,014	3,303	711	5,640	4,049	1,591

1. Internal Development Costs

2. External Software Expenditures

Figure C3 presents the percentage of software expenditures for each of the categories identified in Figure C2. As before, these percentages are for the general computer population; figures for Federal Government installations can be found in Figures C4-C7 inclusive.

By applying the percentages of total CPUs that represent CPUs in Federal Government sites against the dollar value of expenditures for software, estimates are obtained for software expenditures at Federal Government sites. These data are presented in Figure C4. The percentage of internal versus external expenditures were assumed to be comparable for both the general population and for Government systems; consequently, the same percentage figures were used in the preparation of these tables.

Figures C5 through C7 provide estimates of the dollar amounts spent and the internal versus external spending distribution at Federal Government computer sites, by size class, for the three major types of software -- system, utility, and application.

Figure C5 presents the estimated expenditures at Government sites for system software. As stated earlier, system software requirements are generally met by a smaller number of software systems than are utilities and applications requirements; this is reflected in the correspondingly smaller dollar amount spent for this type of software. Note that the estimated Government expenditures for system software, as compared to all Government software expenditures, do not differ radically from those when compared with the total U.S. market; overall, the cumulative estimate for Government spending for system software is less than for the total United States, (15 percent versus 18 percent).

Figure C6 presents the estimated expenditures attributable to Federal Government sites for utility software. In this software category, two facets of Government site spending are worthy of special note:

Overall spending for utility software at Government sites is virtually the same as for the

PERCENTAGE OF DOLLARS SPENT FOR SOFTWARE
U.S. GENERAL PURPOSE COMPUTERS
By SIZE CLASS

Size	Systems			Utilities			Application			Totals		
Class	Tot.	Int.	Ext.	Tot.	Int.	Ext.	Tot.	Int.	Ext.	Tot.	Int.	Ext.
2	13%	27%	73%	5%	18%	82%	82%	81%	19%	100%	71%	29%
3	11%	23%	77%	7%	22%	77%	82%	90%	10%	100%	77%	23%
4	8%	24%	76%	8%	27%	73%	84%	80%	20%	100%	71%	29%
5	15%	43%	57%	5%	19%	81%	80%	84%	16%	100%	75%	25%
6	18%	34%	66%	15%	17%	83%	67%	73%	27%	100%	57%	43%
7	26%	60%	40%	13%	67%	33%	61%	86%	14%	100%	77%	23%
TOTAL	18%	48%	52%	11%	43%	57%	71%	75%	25%	100%	72%	28%

1. Internal Development Costs
2. External Software Expenditures

FIGURE C3

ESTIMATED SOFTWARE EXPENDITURES
FEDERAL GOVERMENT COMPUTERS
By SIZE CLASS
($ Millions)

Size Class	U.S. Dollars Spent	Percent of U.S.	Federal Government Dollars Spent	Internal %	Internal $M	External %	External $M
2	$220M	1.0%	$2.2M	71%	$1.6M	29%	$0.6M
3	43M	3.2%	13.8M	77%	10.6M	23%	3.2M
4	1,005M	7.6%	76.4M	71%	54.2M	29%	22.2M
5	745M	6.1%	45.4M	75%	34.0M	25%	11.4M
6	1,060M	8.7%	92.2M	57%	52.6M	43%	39.6M
7	2,180M	15.1%	329.1M	77%	253.5M	23%	75.7M
TOTAL	$5,640M	9.9%	$559.2M	73%	$406.5M	27%	$152.7M

FIGURE C4

ESTIMATED EXPENDITURES FOR SYSTEM SOFTWARE
FEDERAL GOVERNMENT COMPUTERS
By SIZE CLASS

Size Class	U.S. Dollars Spent	Federal Government Percent of U.S.	Dollars Spent	Internal %	Internal $M	External %	External $M
2	$29M	1.0%	$0.3M	27%	$0.1M	73%	$0.2M
3	47M	3.2%	1.5M	23%	0.3M	77%	1.2M
4	80M	7.6%	6.1M	24%	1.5M	76%	4.6M
5	112M	6.1%	6.8M	43%	2.9M	57%	3.9M
6	191M	8.7%	16.6M	34%	5.6M	66%	11.0M
7	567M	15.1%	85.6M	60%	51.4M	40%	34.2M
TOTAL	$1,026M	11.4%	$116.9M	53%	$ 61.8M	47%	$55.1M

FIGURE C5

ESTIMATED SPENDING FOR UTILITY SOFTWARE
FEDERAL GOVERNMENT COMPUTERS
By SIZE CLASS

Size Class	U.S. Dollars Spent	Percent of U.S.	Dollars Spent	Federal Government Internal		External	
				%	$M	%	$M
2	$11M	1.0%	$0.1M	15%	Neg.	85%	$0.1M
3	30M	3.2%	1.0M	22%	$0.2M	78%	0.8M
4	80M	7.6%	6.1M	27%	1.6M	73%	4.5M
5	37M	6.1%	2.3M	20%	0.4M	80%	1.9M
6	159M	8.7%	13.8M	17%	2.3M	83%	11.5M
7	283M	15.1%	42.7M	67%	28.6M	33%	14.1M
TOTAL	$600M	11.0%	$66.0M	50%	$33.2M	50%	$32.8M

FIGURE C6

the total U.S. general purpose computer population.

The extent of internal versus external utility software spending is very close to that of the total United States. The total U.S. internal spending for utility software is about 43 percent of the total, while for the Government it is estimated to be approximately 50 percent. External spending in the Government is estimated to be 50 percent as contrasted with 57 percent for the total United States.

Figure C7 presents estimated Federal Government expenditures for application software. As stated earlier, this software area is the one for which the greatest amount of money is spent, both internally and externally; however, the proportion of internally spent money is greater for application software than for any other type, primarily because the software must often meet particular site or system needs.

The total $376.2M spending for Federal application software represents about 67 percent of all Federal software spending. The U.S. spending for applications software was about 71 percent of the total. Thus, the Federal spending for applications software is quite similar to the U.S. spending pattern. The portion of this figure spent internally, however, exceeds the U.S. internal figure. This indicates that, while the requirement for application software at Government computer sites may be similar to the commercial sector, the degree of customization appears to be greater, explaining the larger percentage of total internal expenditures.

Size Class	U.S. Dollars Spent	Percent of U.S.	Dollar Spent	Federal Government Internal %	Federal Government Internal $M	External %	External $M
2	$180M	1.0%	$1.8M	81%	$1.5M	19%	$0.3M
3	353M	3.2%	11.3M	90%	10.2M	10%	1.1M
4	845M	7.6%	64.2M	80%	51.4M	20%	12.8M
5	596M	6.1%	36.4M	84%	30.6M	16%	5.8M
6	10M	8.7%	61.8M	73%	45.1M	27%	16.7M
7	1,330M	15.1%	200.8M	86%	172.7M	14%	28.1M
TOTAL	$4,014M	9.4%	$376.3M	83%	$311.5M	17%	$64.8M

FIGURE C7

Section Four

SYSTEM DISTRIBUTION BY MODE OF OPERATION

Introduction

This portion of the report focuses on analy[illegible] installation workload by mode of operation and [illegible] application. For the purposes of this [illegible] applications have been grouped as defined in Section Two [illegible] this report. Modes of operation include on-line, batch, [illegible] remote batch.

1. On-line operation involves the use of ter[illegible] and/or related peripheral equipment which pe[illegible] direct operator interaction with the system CPU.

2. Batch operation involves the use of gene[illegible] terminals and/or other peripheral [illegible] submission of jobs which are performed in a [illegible] format, with results provided to the user [illegible] completed.

3. Remote batch operation involves the use [illegible] specialized remote batch terminals which per[illegible] rapid job entry at remote sites, coupled w[illegible] production of reports at those sites.

IDC conducted a detailed search of existing IDC re[illegible] and available literature on systems design [illegible] implementation to develop statistics on system utiliza[illegible] by mode of operation and application. These sear[illegible] indicate that detailed statistics are not availa[illegible] Therefore, IDC has adopted an indirect approach [illegible] estimating utilization rates. In general, this appr[illegible] involves analysis of the distribution of applications [illegible] system characteristics over installations. The[illegible] distribution statistics have been adjusted as appropriate [illegible] generate estimates of system utilization.

Workload by Mode of Operation

IDC has compiled two measures which provide some insight into the distribution of system workload by mode of operation. Figure D1 presents the distribution of systems with terminal controllers by size class. Since controllers are associated with relatively large terminal-based systems, this measure provides some indication of the importance of on-line operations.

Figure D2 presents the distribution of systems with remote batch terminals. While a significant portion of all remote batch jobs will be submitted from terminals which are also capable of operating in an on-line mode, the distribution of remote batch terminals provides a reasonable basis for estimating the importance of remote batch operations.

Figure D3 provides estimates of the distribution of workload by mode of operation. The statistics presented in Figures D1 and D2 were adjusted on the basis of information provided by IDC specialists to reflect the reasonable approximation of workload distribution given in Figure D3. However, these workload estimates are, at best, estimates based on limited information.

DISTRIBUTION OF SYSTEMS WITH TERMINAL CONTROLLERS
1979 FEDERAL GOVERNMENT INSTALLATIONS

Size Class	% With Controllers
2	3.4
3	12.6
4	29.0
5	52.8
6	63.9
7	63.0
Minicomputers	6.9
Others	5.0
Total	17.2

FIGURE D1

DISTRIBUTION OF SYSTEMS WITH REMOTE BATCH TERMINALS
1979 FEDERAL GOVERNMENT INSTALLATIONS

Size Class	% With Controllers
2	6.5
3	10.6
4	7.7
5	8.9
6	8.0
7	7.7
Minicomputers	1.5
Others	2.0
Total	5.3

FIGURE D2

DISTRIBUTION OF SYSTEMS BY WORKLOAD
1979 FEDERAL GOVERNMENT INSTALLATIONS

Size Class	Remote Batch	On-Line	Batch
2	10%	5%	85%
3	20%	25%	55%
4	30%	35%	35%
5	20%	55%	25%
6	15%	70%	15%
7	15%	70%	15%
Minicomputers	5%	10%	85%
Others	5%	10%	85%

FIGURE D3

Workload By Application

Figure D4 repeats IDC's estimates for Federal Government applications based on the figures for the principal applications of systems listed on the IDC Data File. These figures were given in Section Two. Estimates of system workload distribution by application, presented in Figure D5, are based on this distribution. However, the distribution has been adjusted to include some evaluation of the relative effort associated with the different applications.

1. Both commercial and non-commercial applications tend to place greater than average demands upon systems, with many systems dedicated to reporting accounting, sales, and inventory information or to the control applications involved in non-commercial applications.

2. Problem solving and word processing operations should generally be less demanding of system resources. In particular, word processing may often be an application installed to utilize resources not required for other applications.

Thus Figure D5 presents estimates of the percentage of time the system is spending (the system workload) on each application area.

APPLICATION DISTRIBUTION
1979 FEDERAL GOVERNMENT INSTALLATIONS

Application	Frequency
Commercial	64.6%
Non-Commercial	21.0%
Problem Solving	13.3%
Word Processing	2.0%

FIGURE D4

ESTIMATED WORKLOAD DISTRIBUTION
1979 FEDERAL GOVERNMENT INSTALLATIONS

Application	Frequency
Commercial	68%
Non-Commercial	25%
Problem Solving	6%
Word Processing	1%

FIGURE D5

Section Five

DATA BASE MANAGEMENT SYSTEMS

Introduction

This section of the report considers various aspects of the implementation of data base management systems (DBMS) used in Federal Government computer installations. There are five subsections to this analysis of DBMS use:

1. Estimates of the number and dollar value of DBMS used in Federal Government installations.

2. A breakdown of the estimated number of installations for each of the major commercial DBMS packages.

3. Estimates of the number and dollar value of DBMS systems developed in-house in the Federal Government.

4. Projections of DBMS use and growth in installed base through 1985.

Definition of DBMS

It is worthwhile at this point to review what is meant by a data base management system. IDC defines a DBMS as a general purpose, application-independent software package used in association with some form of on-line mass storage to facilitate the entry, storage, processing, sharing, and retrieval of structured data -- that is, data which is either logically or physically interconnected. In this respect, a DBMS differs from file management systems, because the software is data rather than file oriented.

Methodology

Six areas of information were developed in order to determine the data necessary for an analysis of the use of DBMS at Federal Government computer sites. This information included:

1. The number of CPUs installed, according to computer size class.

2. The number of CPUs installed at Federal Government sites.

3. The number of CPUs installed at Federal Government sites, according to computer size class.

4. The total number of DBMS packages installed.

5. The distribution of DBMS packages installed according to computer size class.

6. The average dollar value of major commercial DBMS packages.

To obtain the installed base of DBMS packages in the Federal Government, IDC embarked upon a three-stage research task:

1. IDC estimated the actual number of DBMS installations for the U.S. market. This approach was directed to each major general purpose computer vendor, by size class. Estimates were obtained for each vendor by size class and then aggregated to reflect total U.S. DBMS installations for the total general purpose computer population.

2. IDC then determined the "percent with DBMS" figure for DBMS relative to each vendor's general purpose computer systems within each size class.

3. This "percent with" figure was then applied to the estimated Federal Government installed base of general purpose CPUs by vendor and by size class to generate total estimated DBMS installations for the Federal Government.

This approach also takes into consideration dissimilarities between general purpose computer system distributions in the U.S. market and the Federal Government market.

The dollar value of DBMS installed at Federal Government computer sites was determined by multiplying the Federal DBMS installed base calculated above by the average price of each vendor's specific commercial DBMS package. The dollar value assigned to "other independents" was based upon an overall average of vendor's DBMS offerings, yielding a figure of $62,000.

Estimates regarding the number of internally developed DBMS in the Federal Government were also derived from this three-stage process. The dollar values for internally developed DBMS were determined by multiplying the installed base of in-house-developed systems by the average value of $300,000. The figure of $300,000 was selected as a reasonable figure for self-development costs because an internally developed system is generally the product of customization to meet particular site requirements, and because development costs cannot be spread over multiple installations. Consequently, IDC estimates that the cost of developing such a system is approximately three times the cost of a "high-end" commercial system -- typically about $100,000.

Projections of DBMS installation through 1985 were derived by an analysis of IDC's projections of DBMS growth patterns from past years, and extension of those growth patterns through the target year of 1985. Previous IDC research has found that DBMS implementation is largely determined by the size of the senior computer system installed at a given site. Consequently, DBMS installation growth projections are associated with growth in the number of sites with senior systems of a particular size class. Such growth has been considered in developing the following projections.

<u>CPU Installed Base</u>

Figure E1 presents the installed base of CPUs, according to size class. The general population figures were derived from IDC's estimates contained in the 1980 General Purpose Computer Census and Minicomputer Census, as

U.S. AND FEDERAL GOVERNMENT
CPU INSTALLED BASE
GENERAL PURPOSE & MINICOMPUTERS
(As of yearend 1979)

Size Class	U.S. Installed Base	Federal Government Installed Base
2	14,810	148
3	16,652	531
4	10,284	784
5	4,891	300
6	4,641	402
7	1,965	297
Minicomputers	344,800	7,539

FIGURE E1

published in the IDC publication, EDP Industry Report. The number of Government CPUs was determined from an analysis of IDC´s U.S. Computer Installation Data File and the GSA Equipment Inventory.

DBMS Installed Base

Figure E2 presents IDC´s estimate of DBMS installations in the general computer population, as of yearend 1979. These estimates were derived from several information sources.

1. DBMS installation estimates were obtained from prior IDC research on DBMS installations on a major manufacturer´s systems.

2. DBMS offerings from major independent DBMS vendors were allocated among various manufacturer´s systems using existing IDC information on independent vendors´ installations.

3. DBMS installations on a major manufacturer´s systems were allocated among size classes using existing DBMS distribution information from prior IDC research.

4. DBMS installations on other manufacturers´ systems were allocated among size classes by estimating the DBMS installations for each major vendor, by size class. This approach provided a true indicator of DBMS on other systems since recent findings by IDC indicate that DBMS usage among other vendors can be widely dissimilar to usage of DBMS on a major manufacturer´s systems.

Figure E3 presents the estimated distribution by size class of DBMS use among computer sites in the Federal Government.

U.S. DBMS USE BY SIZE CLASS

Class of Equipment	U.S. Installed Base	Percent With DBMS	Number With DBMS
General Purpose, by Size Class:			
2	14,810	2%E	291
3	16,652	10%	1,632
4	10,284	19%	1,915
5	4,891	35%	1,679
6	4,641	45%	2,047
7	1,965	60%	1,156
Total: General Purpose	53,243	16%	8,720
Minicomputer	344,800	1.1%E	3,840
TOTAL	398,043	3.2%	12,560

FIGURE E2

ESTIMATED DBMS USE BY SIZE CLASS
FEDERAL GOVERNMENT SITES
December, 1979

Class of Equipment	Federal Government Installed Base	Percent With DBMS	Number With DBMS
General Purpose, by Size Class:			
2	148	.7%	1
3	531	6.5%	35
4	784	12.5%	98
5	300	24.3%	73
6	402	43.9%	176
7	297	36.5%	108
Total: General Purpose	2,474	20.2%	491
Minicomputers	7,539	1.1%E	83
TOTAL	10,013	5.8%	574

FIGURE E3

Major Commercial DBMS Packages

IDC conducted a study of major DBMS vendors' products, estimated installations and market shares (based on installation estimates) for the United States and the Federal Government general purpose computers. These estimates were based on previous IDC studies and information from the vendors themselves. These vendors included independent software suppliers and hardware vendors. From the findings of this study IDC estimates that there are over 8400 installations of DBMS in the United States, representing over $230 million in dollar value for yearend 1979. The average purchase price of these systems was approximately $62,000. This average purchase price figure does not include the purchase prices from a few major hardware vendors whose DBMS are not available on a purchase basis. Packages which were only available on a lease basis ranged from $300 to $750 per month.

IDC estimated the number of Federal installations based on the U.S. figures and allowing for differences in the hardware in the Federal Government. They estimated that there were 491 DBMS in the Federal Government representing an installed value of $30M for yearend 1979.

Internally Developed DBMS

Internal development of a DBMS is an option that is taken by relatively few users of DBMS systems, principally because there are less expensive and more convenient ways to implement a DBMS -- namely, the packaged DBMS systems available from a number of hardware and independent vendors. Nevertheless, because of particular site and/or application requirements, some users do choose to develop and implement their own DBMS systems. IDC anticipates that, as commercially available packages prove themselves in the user community, the incidence of internally developed DBMS installations will decline over time.

Estimates for internally developed DBMS installations are presented in Figure E4 for the general computer population - the U.S. market in total - and in Figure E5 for Federal Government sites. The percentages of in-house-developed DBMS for each size class were derived from previous IDC research in the DBMS market; these percentages were then multiplied by the estimated total number of DBMS installed to obtain the data contained in the tables. Information regarding DBMS use at minicomputer sites is scanty, and no published estimates were available for this analysis. IDC estimates that only about 1 percent of minicomputer sites are using DBMS, principally because of the typical applications for minis (networking, data acquisition and control, etc.). For those minicomputer sites that do use DBMS, other IDC research indicates that approximately 14 percent of these systems are developed internally.

INTERNALLY DEVELOPED DBMS
by SIZE CLASS
U.S.

Size Class	Number of DBMS Installed	% Internally Developed	# Internally Developed
2	281 E	6%	17
3	1,578	12%	196
4	1,852	2%	35
5	1,624	5%	74
6	1,981	3%	54
7	1,118	5%	59
Total Mainframe	8,434	5%	435
Minicomputers	3,840	14%	538
TOTAL ALL	12,274	8%	973

FIGURE E4

INTERNALLY DEVELOPED DBMS
FEDERAL GOVERNMENT SITES, BY SIZE CLASS

Size Class	Number DBMS Installed	% Internally Developed	Number Internally Developed
2	1	-0-	-0-
3	35	8.6%	3
4	86	7.0%	6
5	76	7.9%	6
6	184	7.1%	13
7	109	7.3%	8
Total Mainframe	491	7.3%	36
Minicomputer	83	14.5%	12
TOTAL ALL	574	8.4%	48

FIGURE E5

To obtain an estimate of the dollar value of internally developed DBMS installed, the estimates of number of self-developed DBMS were multiplied by $300,000. This figure was determined by IDC to be a reasonable estimate of the cost of developing a DBMS internally because the degree of customization required to produce a DBMS suited to a particular site's requirements is believed to be on the order of three times the price of a typical "high-end" commercial DBMS package. (The figure of $100,000 is representative of the upper end of the commercial DBMS price scale.) For minicomputers, again, there were no data available with which to formulate an estimate of internal development costs; consequently, the same methodology was applied as for mainframe DBMS systems. In the case of minicomputers, however, a search of all available product literature revealed that the upper end of the commercial package price scale is on the order of $35,000. This $35,000 figure, when trebled, yields the rounded estimate of $100,000 for internal development costs for a minicomputer DBMS. This estimate was applied to the IDC estimate of the number of internally developed minicomputer DBMS systems.

The results of this tabulation are presented in Figure E6 for the general computer population and for Federal Government sites.

<u>DBMS Market Projection Through 1985</u>

Figure E7 presents IDC's estimate of the projected growth of DBMS use for the years 1975 to 1985. The estimated growth figures were derived from previous IDC research in the DBMS market.

INTERNALLY DEVELOPED DBMS
INSTALLED VALUE
December 1979 - U.S.

Size Class	Number Installed	Average Cost	Dollar Value Installed
2	17	$300 K	$5.1 M
3	196	"	$58.8 M
4	35	"	$10.5 M
5	74	"	$22.2 M
6	54	"	$16.2 M
7	59	"	$17.7 M
Minicomputers	538	$100 K	$53.8 M
TOTAL	973		$184.3 M

INTERNALLY DEVELOPED DBMS
FEDERAL GOVERNMENT SITES, INSTALLED VALUE

Size Class	Number Installed	Average Cost	Dollar Value Installed
2	-0-	$300 K	-0-
3	3	"	$.9M
4	6	"	$1.8M
5	6	"	$1.8M
6	13	"	$3.9M
7	8	"	$2.4M
Minicomputers	12	$100 K	$1.2M
TOTAL	48		$12.0M

FIGURE E6

GROWTH OF DBMS IMPLEMENTATION
ON GENERAL PURPOSE COMPUTERS, 1975-1985 - U.S.

Year	# DBMS Installed	Percent Growth	# CPUs Installed	% with DBMS
1975	2,550		62,100	4%
		31%		
1976	3,700		59,600	6%
		32%		
1977	5,440		58,200	9%
		23%		
1978	7,060		57,900	12%
		19%		
1979	8,720		53,200	16%
		16%		
1980	10,115		52,800	19%
		14%		
1981	11,530		53,800	21%
		12%		
1982	12,900		54,400	24%
		10%		
1983	14,200		55,400	26%
		8%		
1984	15,350		56,600	27%
		7%		
1985	16,400		57,700	28%

FIGURE E7

Of particular note is the fact that the rate of DBMS implementation slows over time. As indicated earlier, this is a result of market saturation; most of those sites requiring DBMS by 1985 will already have one installed. Further, DBMS implementation is more a factor of the site's size class than of the number of CPUs installed. As a result, growth in the CPU installed base does not automatically indicate a growth in DBMS implementation.

Section Six

CONTRACT SERVICES*

Introduction and Methodology

This section of the report deals with the scope of contract services in the Federal Government. Analyses include a 5 year forecast for seven categories of contract services. In addition, a detailed overview of three of these categories (remote problem solving services, facilities management services, and network services) is presented.

The research employed in this analysis encompassed three areas:

1. A primary data gathering mission was undertaken at the General Services Administration (GSA). Here, the IDC consulting group viewed and analyzed documents outlining the size and vendor participation of contract services in the Federal Government. In addition, personal interviews were conducted with specialists at GSA regarding their own fields of expertise as they related to the contract services under consideration. A perspective on growth trends was also gained.

2. Collection of data to supplement GSA information was accomplished by contacts with other Federal Government agencies, including OMB.

3. In-depth analysis of existing IDC information was performed on the services market and its relationship to that portion which is Federal Government oriented. This research also served as a reconciling factor between IDC data and GSA obtained data.

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* Certain commercial vendors' names are identified in this section by IDC. In no case does such identification imply recommendation or endorsement by the Institute for Computer Sciences and Technology nor the National Bureau of Standards.

Overview of Contract Services

Data processing related contract services in the Federal Government amounted to an estimated $2.3 billion in 1979. These services are expected to grow at an annual compound rate of 15 percent which will amount to some $5.2 billion in dollar volume by 1985.

In broad terms, there are six categories of these services that are performed by contractors:

1. Systems Analysis and Programming Services result from contracts through organizations that offer various types of programming and analyst functions for software. Approximately $470 million or 21 percent of all contract services originated from this segment. This is the largest contributor to contract services as estimated by IDC. By 1985, 16 percent of all contract services, or $837 million will originate from systems analysis and programming services -- an annual compound growth rate of 10 percent.

2. Processing Services are timesharing services offered by both hardware and dedicated services and software vendors. Computing time and networking capabilities are the primary offerings from most of these suppliers. Nearly one half of the activity in the processing services market results over communications lines while applications usage and computing time constitutes the remaining portion. Total processing services in the Federal Government in 1979 amounted to $438 million, or 19 percent of all contract services. By 1985, these services are expected to grow by 11 percent annually, to $796 million.

   2a. Remote problem solving services are a specific type of processing service and represent approximately 29 percent of all timesharing services. Tasks under this category include more sophisticated applications and/or ad hoc computing time for specialized, short-term projects. In 1979, remote problem solving services amounted to some $98 million, or 4 percent of all contract services. This figure will grow at an annual compound rate of 10 percent to $190 million by 1985.

3. Facilities Management Services are tasks that include such services as managing the operation of a data processing facility. These duties are usually performed by services vendors, but not exclusively. Facilities management contracts in the Federal Government amounted to approximately

$300 million, or 13 percent of all contract services in 1979. This figure is expected to grow at just 1.5 percent annually to $327 million by 1985. In addition, FM contracts will drop to only 6 percent of all contract services in the Federal Government by 1985.

4. Network Services include both voice and data communications. IDC estimates that these telecommunications contracts represent $668 million in the Federal Government - approximately 29 percent of the dollar value of all contract services. Network services, overall, should grow by 20 percent annually, which will amount to some $1.9 billion in value by 1985.

5. Maintenance Services are contracts that include upkeep and maintenance of the data processing facility, i.e. maintaining the operational condition of hardware, etc. In 1979, these contracts represented $250 million, or 11 percent of the total contract services in the Federal Government. By 1985, maintenance services will amount to $556 million - a compound annual growth factor of 14 percent.

6. Research and Consulting Services are composed of research studies and specialized, custom, consulting contracts. Contracts of this nature represent some $146 million in dollar value in the Federal Government in 1979 - contributing approximately 6 percent to total contract services. This segment, as estimated by IDC, is the highest growth portion of Federal Government contract services. By 1985, consulting services will grow at an annual rate of 29 percent (to $687 million) where it will contribute an estimated 13 percent to total contract services.

Figure F1 provides the estimated dollar value of contract services in the Federal Government, by type of service, from 1979 through 1985. Figure F2 shows the 1979 and 1985 data in pie chart form to highlight the major changes in contract service.

Of particular interest are the analyses of three categories of contract services: remote problem solving services; facilities management services; and network services. An overview of each of these three services follows.

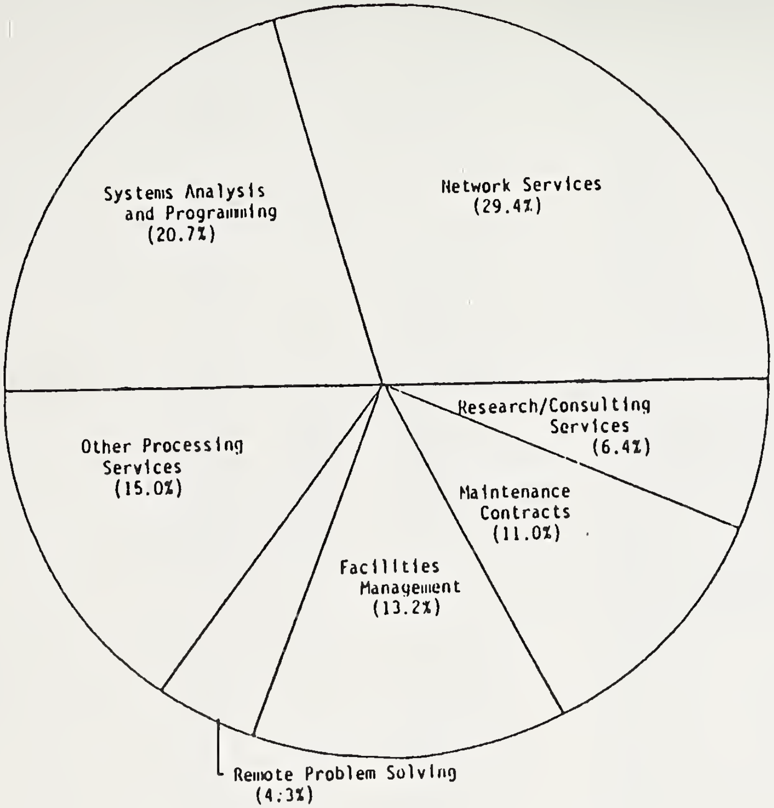
ESTIMATED DOLLAR VALUE OF ADP RELATED CONTRACT SERVICES
IN THE FEDERAL GOVERNMENT BY TYPE OF SERVICE

1979-1985
(Millions)

Contract Service	1979	1980	1981	1982	1983	1984	1985
Network Services (Voice and Data)	$668	$802	$962	$1,154	$1,385	$1,662	$1,994
Systems Analysis and Programming	470	606	646	689	735	784	837
Processing Services (Excluding R/Problem Solving)	340	404	462	495	530	566	606
Remote Problem Solving	98	119	138	151	163	176	190
Facilities Management	300	305	309	314	317	322	327
Maintenance Contracts	250	203	329	375	428	487	556
Research/Consulting Services	146	181	231	303	398	523	687
TOTAL	$2,272	$2,620	$3,077	$3,481	$3,956	$4,520	$5,197

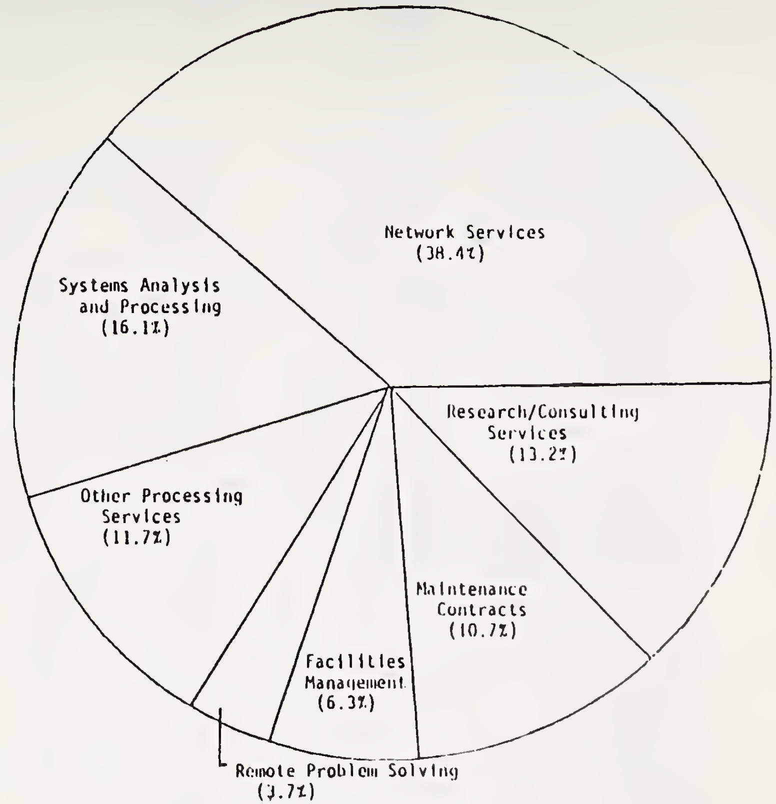
FIGURE F1

FEDERAL ADP RELATED CONTRACT SERVICES: 1979



Total: $2,272 M

FEDERAL ADP RELATED CONTRACT SERVICES: 1985



Total: $5,197 M

FIGURE F2

Remote Problem Solving Services

Remote problem solving services represented a 29 percent portion of the total Federal Government timesharing activities in 1979. These types of contracts originate from large, well established vendors that offer extra computer time and/or sophisticated software applications - usually on an ad hoc basis.

Remote problem services in the Federal Government amounted to $98 million in 1979. The largest supplier was Computer Sciences Corporation with an estimated $43.4 million in contractual activity - 44 percent of the total. Other participants include Tymshare, Boeing, and CDC.

The specific tasks these vendors perform are wide-ranging. Computer Sciences, for example, while specializing in the Federal Government marketplace, offers financial and economic data bases. Also, a significant portion of remote problem solving activities occur through the use of proprietary data bases. In this instance, contractors such as universities and investments establishments supply confidential, specialized data bases such as access to library/bibliographical information and financial records.

Figure F3 outlines the remote problem solving services market for the Federal Government in 1979 and its major contractor participants. IDC believes that this market in the Federal Government will grow at healthy rates over the next 5 years: by 1985, this market should amount to $190 million, representing over 24 percent of all processing services and 4 percent of all Federal Government contract services.

Facilities Management Services

Facilities Management (or "FM") services include tasks such as managing and operating a data processing facility under a contractual arrangement over a stated period of time. Also, supplying personnel and procuring equipment often occurs in an FM contract.

Some of the more typical parameters of a Federal Government FM contract include the following:

1. Data entry tasks such as keypunching, key entry verification, and supply of data entry operators.

ESTIMATED DOLLAR VALUE OF REMOTE PROBLEM SOLVING SERVICES
IN THE FEDERAL GOVERNMENT -- BY CONTRACTOR

1979
(Millions)

Contractor	Dollar Value	Percent
Computer Sciences	$43.4	44.3%
Tymshare	4.0	4.1
Boeing	8.0	8.2
CDC	5.7	5.8
G/E	5.1	5.2
United Computing	2.7	2.8
Others*	29.1	29.6
TOTAL	$98.0	100.0%

*Others Include: On-Line Systems, Interactive Data, Rapidata, Scientific Timesharing, Bowne Information, Martin Marietta, Service Bureau, etc.

FIGURE F3

2. Operational tasks such as managing and staffing a data processing facility. Evaluation of performance, production scheduling, programming and systems analysis, and technical assistance for both hardware and software are also common functions retained under an FM agreement in the Federal Government.

3. Management of personnel and various data base libraries such as tape and disk media are prevalent.

4. System configuration design and implementation commonly form a part of an FM contract. Here, contractors are required to establish proper peripheral placements (i.e. terminals) for optimum functionality.

5. General maintenance of the data processing facility includes traditional up-keep and management of computer operations.

6. Time frames for most FM contracts in the Federal Government run from 2 to 5 years.

It should be noted that many of these functions included in FM contracts also occur separately (i.e. programming and maintenance) under other contractual categories. Those tasks that appear in both categories are treated separately in IDC's dollar value estimates and do not overlap into the facilities management category.

IDC estimates FM contracts in the Federal Government to amount to an estimated $300 million in 1979. This category is expected to grow at low but stable rates - some 1.5 percent annually over 5 years.

The FM market in the private sector is diminishing in popularity with both users and vendors. Users often cannot cost justify the large amount of labor and often lengthy time frame required for a particular task, nor can the vendor justify low profit margins typically associated with large, complex FM contracts. It is usually more beneficial to retain timesharing services for most data processing functions where either one will provide satisfactory results. The Federal Government market, however, represents a healthy target for FM vendors despite the fact that it is growing more slowly than the Federal Government contract service market as a whole. Often the highly complex and/or confidential needs of a particular task eliminate the use of a service bureau and leaves an FM arrangement the only feasible alternative. Despite this low growth rate of 1.5

percent for FM contracts in the Federal Government, it still represents a stable market for participating FM vendors and Government users.

Figure F4 outlines the major Federal Government contractors of FM services in 1979 by dollar value delivered. Computer Sciences again is the leading participant, with a 26.7 percent, market share, capturing an estimated $80.3 million in FM services delivered over the year. By 1985, the total FM market in the Federal Government should reach $327 million.

Network Services

Network services proved to be a difficult category to assess due to problems inherent in defining and then establishing dollar value of telecommunications facilities. Federal Government analysts confirmed this dilemma. IDC, however, was able to approximate the dollar amount of these services and the major carriers participating.

Voice communications represented approximately 56 percent of the total telecommunications contractual dollar activity in 1979 in the Federal Government. The remaining portion - 44 percent - was estimated to be allocated in data transmission. There is, of course, much overlap between voice and data transmission over one carrier (e.g. both voice and data transmission takes place over FTS): IDC's dollar value estimates are based upon factoring out overlapping functions to arrive at a total aggregate value that represents all of network services in the Federal Government.

The defense sector of the Federal Government represents approximately 60 percent of the total dollar value of network services while use of networks in the civil portion is estimated to be 40 percent.

Figure F5 illustrates IDC's estimated mix of network carriers in the Federal Government as of 1979. From a total dollar value of $668 million, over 29 percent originates from Federal-agency-designed systems. WATS and FTS networks follow closely at 23 percent and 21 percent, respectively. Growth rates for all of network services in the Federal Government are quite healthy: some 20 percent per year over the next 5 years. By 1985, these services should reach a total dollar value of $2.0 billion and are expected to contribute over 38 percent to total ADP contract services, as compared to just over 29 percent in 1979.

ESTIMATED DOLLAR VALUE OF FACILITIES MANAGEMENT SERVICES IN THE FEDERAL GOVERNMENT -- BY CONTRACTOR

1979
(Millions)

Contractor	Dollar Value	Percent
Computer Sciences Corp.	$80.3	26.7
System Development Corp.	43.5	14.5
Planning Research Corp.	40.2	13.4
CDC	39.0	13.0
Others*	97.0	32.4
TOTAL	$300.0	100.0%

*Numerous small contractors

FIGURE F4

ESTIMATED DOLLAR VALUE OF NETWORK SERVICES
IN THE FEDERAL GOVERNMENT -- BY CONTRACTOR
(Voice and Data)

1979
(Millions)

Contractor	Dollar Value	Percent
Agency Designed Systems	$197.1	29.5%
WATS (AT&T)	157.1	23.5
FTS(Federal Telecommunications System)	141.7	21.2
Telepak (AT&T and Western Union)	137.6	20.6
Datacom (Western Union)	22.1	3.3
Value Added: (Tymenet, Telenet)	12.7	1.9
TOTAL	$668.3	100.0%

FIGURE F5

Section Seven

SOFTWARE DEVELOPMENT

Introduction

This final section of the report deals with the state of software and software development in 30 Federal Government agencies. This information was obtained via a primary research effort conducted by the IDC Consulting Group in addition to secondary sources. The intent of this section was to establish the accuracy of the data that was estimated in Section Three. An attempt was made to obtain data from the identified agencies and approved ADP installations that would allow confidence intervals to be assigned to the information gathered in Section Three.

IDC was not able to assign confidence intervals to the data in Section Three. The software spending information, obtained in Section Three was not of a complete enough nature to permit realistic comparative analysis with the information gathered for this section. Also, the small sample size and the non-random sample selection utilized in this section places limits on the statistical significance of this section's results. Therefore, software spending projections could not be analyzed. The IDC Consulting Group did, however, link information obtained from this process with internal IDC information and with knowledge of individuals within IDC. By drawing upon this broad arena of knowledge in addition to external sources of data (i.e., leading publications that IDC continually monitors and incorporates in the total IDC body of knowledge) IDC feels that this analysis can provide a reasonable perspective on software development in Federal Government ADP installations.

Methodology

Research design consisted of a careful selection of Federal Government ADP installations. A total of 30 Federal Government IDC "Information Systems Planning Service" sponsors were contacted for this research. Once identified and contacted, each site was personally visited in order to obtain the relevant information.

During the data gathering process, more than one individual at a selected agency was typically required in order to gain insight into software development for that particular site. Often three people were consulted to supplement and/or substantiate the information since one individual rarely had sufficient or complete information.

In several cases, some of the questions could not be answered by the responding agency either through the primary individual contacted or through a follow-up search. This was almost exclusively due to the difficulty obtaining some of the information required.

Some questions could not be answered by responding agencies due to the complexity of the information requested.

1. Internal Federal Government information often was unavailable in the form requested in the work statement.

2. Some agencies are highly decentralized which made it difficult to obtain information relevant to the entire agency. In these agencies, respondents were asked to provide consistent information for all questions. Sites that could only answer questions about the software activity at their immediate location, were asked to provide other information only for the same location.

3. Several ADP sites experienced difficulty in determining the installed value of their software since such statistics are not generated as a part of ongoing operations.

Consequently, IDC made every effort to obtain and verify the validity of all information.

<u>Definitional Review</u>

IDC typically segments the software market by product category and by type of vendor.

A. Product categories are:

    1. <u>System Software</u> is designed to operate through the basic operating system. This software improves the operating capabilities of the hardware system by efficiently routing data flows among machine units

and permits evaluation of the efficiency of systems personnel through systems performance measurement tools.

2. Application Software provides solutions to unique, user-specified problems such as payroll or personnel.

3. Utility Software organizes and manages data resources through data/file managers and sort/merge products; improves program integrity through maintenance and security programs; and increases the productivity of application programmers by performing standard functions.

B. Outside software sources include:

1. Independent packaged software vendors offer previously developed software in an "off the shelf" form to users. Independent packaged software excludes software developed and/or sold by hardware vendors.

2. Hardware vendors also offer software - typically of the systems and utility variety - for their own users.

3. Custom software includes customer-unique systems and programming development, including contract services. Each customer presents the vendor with a unique data processing problem, and development costs are absorbed by individual clients. These services usually involve large, complex systems and/or programs, and development costs are typically high.

C. In-house developed software includes systems developed by users at user sites. ADP installations developing sophisticated proprietary technical products will often prefer to develop their own software for cost justification reasons.

Findings

Figure G1 presents the average dollar value of installed software found in the ADP installations contacted. The installed value of software ranged from $29,000 to $6.7 million. The installed value of applications software was $20,000 to $36 million. The installed value of utilities software was slightly less expensive -- from a low of $10,000 to a high of $11.3 million. Estimates of installed value presented in Figure G1 present respondent estimates of software installations at EDP sites contacted during this study.

IDC regularly estimates total revenues by type of software for U.S.-based software suppliers. These revenue estimates cannot be compared directly to the Government estimates, since the estimates in Figure G1 represent the total dollar value of installed software, while IDC estimates income flows generated by the installed software. However, the relative distribution of the two estimates provides a frame of reference for evaluation of the reasonableness of estimates of the Federal Government software installed base.

Total U.S. revenues attributable to software from outside sources, including independent packaged software houses and hardware vendors, follow a pattern similar to that of the installed value of software at Federal Government sites included in this analysis.

1. Revenues from these sources amounted to over $1.3 billion in 1979 -- with $722 million originating from independent sources.

2. Applications software from independent sources contributed nearly 57 percent to the $722 million.

3. Utilities software generated approximately 31 percent of the independent revenue.

4. System software revenues represented 12 percent of independent revenue.

The relative use of utilities software in the commercial sector is substantially greater than at the Federal Government sites included in the analysis. This can be explained, in part, by respondents' lack of information concerning the installed value of utilities software at their sites.

AVERAGE INSTALLED VALUE OF SOFTWARE IN
SELECTED FEDERAL GOVERNMENT SITES

Software	Average Dollar Value Installed
Systems Software	$2.3m
Applications Software	$20.8m
Utilities Software	$1.6m
TOTAL	$24.7m

FIGURE G1

IDC was able to identify the sources of software installed by agencies included in this analysis. As Figure G2 illustrates, in-house developed software constitutes the major source of software, with 61 percent of the installed base. Respondents indicated that the very nature of their software development -- usually of a proprietary and highly custom nature -- is responsible for this trend. ADP shops engaged in highly scientific or proprietary applications typically find in-house development is the only feasible alternative. This is due to the level of expertise required and the need for familiarity with the on-going phases of tasks at these sites. One agency mentioned that users develop a significant portion of the software in the agency. The users may be high-level chemical or industrial engineers who are also competent programmers in their own right - and therefore able to bring to bear knowledge which would be difficult and costly to obtain fron the commercial sector.

Some installations indicated that they obtain almost all of their software from one or two outside sources. In-house capabilities are linked with the software expertise of outside firms for generation of custom systems. Several sites indicated that virtually all of their installed software is developed in-house, while a minority acquires its software from the commercial sector either in a packaged form or on a custom basis.

AVERAGE DISTRIBUTION OF ORIGIN OF INSTALLED SOFTWARE
IN SELECTED FEDERAL GOVERNMENT SITES

Origin	Amount	Percentage
Purchased Outside:		
Packaged*	$3.5m	14.3%
Custom	$6.2m	24.9%
In-House Development	$15.0m	60.8%
TOTAL	$24.7m	100.0%

*Includes independent ("off the shelf") packaged sources and from hardware vendors.

FIGURE G2

Figures G3 and G4 present average growth trends for installed software in general, and for installed software by source. Based on information supplied by Federal Government sites, IDC estimates that the software with the largest growth per year through 1985 will be applications software. This software is expected to grow in installed value by 16 percent per year. This is followed by systems software and utilities software, with 13 percent and 7 percent growth per year, respectively. Sites contacted during this study projected a broad range of growth rates. Estimated growth rates ranged from zero growth to as much as 100 percent per year for all types of software.

Growth trends for the U.S. independent packaged software market, in terms of supplier revenues, differ significantly from estimated growth rates in installed value at Federal Government sites. IDC estimates that the independent packaged software market in the United States will grow at a compound growth rate of 15 percent per year through 1985. Systems software will grow at 9 percent while applications software will grow at a healthy 15 percent per year through 1985. Utilities software will also grow at a healthy rate through 1985 -- 14 percent per year.

The average growth trend for in-house developed software, in terms of installed value, will be greater than rates for the other two software sources. Growth will be an estimated 19 percent per year through 1985. This reaffirms the present trend toward more dedicated use of in-house capabilities, since agencies prefer to develop their software in-house. Growth of acquisitions from outside sources (both packaged and custom) will be steady, with an average of 12 percent of growth per year through 1985.

AVERAGE GROWTH TRENDS FOR INSTALLED SOFTWARE
IN SELECTED FEDERAL GOVERNMENT SITES

Software	Percent Growth Per Year Through 1985
Systems Software	13.3%
Applications Software	16.1%
Utilities Software	6.9%

FIGURE G3

AVERAGE GROWTH TRENDS OF INSTALLED VALUE
FOR ORIGIN OF INSTALLED SOFTWARE
IN SELECTED FEDERAL GOVERNMENT SITES

Origin	Percent Growth Per Year Through 1985
Purchased Outside:	
Independent Packaged	10.3%
Custom	13.7%
In-House Developed	18.6%

FIGURE G4

Information about the number of programs installed at Federal Government agency sites appears in Figure G5. The data represents the average number of programs installed, by type of program. Applications programs are the largest portion, representing 77 percent of the installed base. The number of applications software programs correlates with the value of installed applications software at Federal Government sites.

AVERAGE NUMBER OF SOFTWARE PROGRAMS INSTALLED
IN SELECTED FEDERAL GOVERNMENT SITES

Program Type	Average Number of Programs Installed
Systems Software Programs	261
Applications Software Programs	1,564
Utilities Software Programs	207
TOTAL	2,032

FIGURE G5

IDC was also able to obtain other software information from Federal Government agencies.

1. An average of 405,000 bytes is required to run an average software program. This amount reflects the maximum amount of memory required to run an average program.

2. An average of over 2,070 lines of code is the size of most programs found at the Federal Government survey sites.

Other, more detailed information was also obtained with regard to the average size of installed programs at ADP installations. This data appears in Figure G6. Most installed programs -- nearly 31 percent -- fall into the "Very Small" range. "Large" and "Medium" program installations follow, with 24 percent and 23 percent of the total, respectively. These figures vary substantially from the findings compiled in Program Quality and Programmer Productivity by T.C. Jones of IBM. Jones's research provides estimates of the distribution of programs by size as measured by lines of code for all industries in the U.S. market. These estimates show that 70 percent of the U.S. population of programs fall into the "Very Small" category versus 31 percent for the Federal Government sites contacted. The largest size variance -- 39 percentage points -- occurs in this size category. Installations of "Small" programs in the ADP sites contacted, however, are parallel to the total U.S. market: 15 percent and 20 percent respectively. While very few programs in the "Medium" and "Large" category are installed in all industries, over 47 percent of the ADP sites contacted have programs installed in this size range. In addition, virtually all of the ADP sites contacted mentioned that it is rare to have programs in use within the "Very Large" range. These Federal Government sites indicated that the greatest portion of their software development does not require such lengthy or complex programs.

Overall, use of medium- to large-scale programs are spread relatively evenly in the ADP sites contacted, while installations of programs in the U.S. market are more heavily accented toward the smaller size ranges.

Size equivalents, in terms of lines of code, are as follows:

Program Size	Lines of Code
Very Small Program	Less than 2,000 lines of code
Small Program	2,000 to 16,000 lines of code
Medium Program	16,001 to 64,000 lines of code
Large Program	64,001 to 512,000 lines of code
Very Large Program	Over 512,000 lines of code

AVERAGE DISTRIBUTION OF SIZE OF INSTALLED SOFTWARE PROGRAMS WORLDWIDE AND IN SELECTED FEDERAL GOVERNMENT SITES

	Percent of Programs Installed	
Program Size	All Industries*	Federal Government
Very Small	70.0%	30.5%
Small	20.0%	15.4%
Medium	6.0%	23.1%
Large	3.0%	24.2%
Very Large	1.0%	6.8%
TOTAL	100.0%	100.0%

*Source: T. C. Jones, Program Quality and Programmer Productivity.

FIGURE G6

Figure G7 presents estimates of the average amount of time spent on developing an average software program within the given size ranges. This data is derived from several sources:

1. Information gathered from Federal Government ADP sites served as a basis for estimating these time allotments for each program size.

2. Estimating techniques were used to supplement information from discussions. Respondents could not provide sufficient information to permit thorough presentation of this data in the "Very Large" category, since few of these Federal Government sites even indicated the presence of such large programs.

In order to derive realistic time estimates for the "Very Large" program size range, IDC combined information gathered from survey sites with other data. This was the only program size range that was estimated in this fashion -- time spent on other program sizes could be estimated without supplemental information. The time estimated to be spent on a program of this magnitude (105 weeks) is considered to be a low but reasonable average. Well over 2 years could be spent on such a task.

Figure G7 also presents the average amount of time spent for all industries, based on the IBM technical report by T.C. Jones. The average amount of time spent in all industries differs significantly from the average time spent in the 30 Federal Government agencies. This, IDC believes, is due to the high incidence of in-house software development that takes place at Federal Government ADP installations and the significant amount of time spent on subsequent maintenance and enhancement of both outside-acquired and in-house developed programs.

AVERAGE TIME SPENT ON SOFTWARE PROGRAMS
IN SELECTED FEDERAL GOVERNMENT SITES
(Survey Data and Statistical Estimates)

Program Size	Average Amount of Time Spent: All Industries*	Average Amount of Time Spent: Federal Government
Very Small	1.8 months	1.9 months
Small	2.9 months	7.4 months
Medium	4.5 months	11.2 months
Large	9.0 months	17.2 months
Very Large	16.0 months	26.3 months

*IBM Technical Report TR 02.764 - January 1977.

FIGURE G7

Federal Government sites also provided information regarding the frequency of use of programming languages used for in-house software development. This data appears in Figure G8.

COBOL is by far the most popular programming language, being used at 30 percent of the Federal Government sites contacted in this study: FORTRAN and PL/1 follow, with 21 percent and 13 percent, respectively. Respondents indicate that COBOL use is expected to increase. When Federal Government data processing shops utilize more than one language, including COBOL, COBOL usage dominates.

In Section Two of this report, IDC was able to obtain information from the U.S. Computer Installation Data File with respect to programming language use at Federal Government ADP installations. According to the IDC Data File, COBOL is the most frequently used of typical programming languages - some 56 percent of the total. On the other hand, Federal Government sites that were contacted indicated that COBOL comprises only 30 percent of the total programming language use. Despite this difference, COBOL is still, by far, the primary programming language used in the Federal Government. RPG use, however, differs substantially in the two estimates. RPG is used 12 percent of the time, according to the IDC Data File, while it is only used 3 percent of the time at the agencies visited. The difference can be explained by the fact that the IDC Data File only lists two programming languages per system - a primary and a secondary. ADP sites contacted, however, mentioned numerous languages in operation that are included in Figure G8. The use of more than two languages will affect the frequency and the apparent mix of programming languages in use when compared to information obtained from the IDC Data File.

TYPICAL PROGRAMMING LANGUAGES USED FOR IN-HOUSE SOFTWARE DEVELOPMENT IN SELECTED FEDERAL GOVERNMENT SITES

Programming Language	Frequency of Mentions Number	Percent
COBOL	27	30.0%
FORTRAN	19	21.2%
PL/1	12	13.3%
Basic	8	8.9%
Assembly	5	5.6%
Assembler	4	4.4%
Pascal	4	4.4%
RPG	3	3.3%
Others*	8	8.9%
TOTAL	90	100.0%

*Others include: APL, ALC, ALGOL, SPS, and MK-IV.

FIGURE G8

IDC also analyzed the phases of work performed for an average software program in Federal Government locations. This analysis traces the development of a typical program from the initial phases of the requirements studies through final operation and maintenance of the program. ADP sites were asked to estimate the dollar expenditure for each function. Time spent is presented as a percentage of the total time allocated for the completion of a typical program. The average time spent on a program, for the purpose of this analysis, is approximately 30 weeks, as indicated by Federal Government sites. The percentage distribution of expenditures per function does not correlate with the percentage distribution of time spent. This is largely due to the use of different personnel skill levels for the various phases. For example, several higher level personnel may be retained to perform detailed design functions. Also, the sites contacted indicate that much time is spent on the detailed design function. This differs from findings of other available research.

Both time allocations and dollar expenditures appear in Figure G9. This figure represents allocations for a single, average, software program.

In many instances, respondents indicated that insufficient time is spent on requirements studies. These agencies feel that this is the crucial step in the program life-cycle, and that work performed in this phase is instrumental in maintaining efficient program development. If more time were spent in this phase, a more productive flow of work would occur and less time would be required for other functions. Substantial time allotment in this phase will also typically preclude getting involved in programs which are abandoned at the middle or end of the development cycle.

Of particular interest is the operations and maintenance phase of the software life cycle. The time and dollars spent on this final function vary significantly. Respondents spend anywhere from a few weeks to several years on the operations and maintenance phase for a functional program. Expenditures range from $2,000 to well over $200,000 over the course of this operation.

Programs are going through constant revision, maintenance, and enhancement, which take substantial time - and therefore money. During a discussion at one ADP installation, individuals mentioned that a program was developed several years ago to perform a specific task. By continually upgrading and performing on-going maintenance to this program, it remains "state of the art."

ANALYSIS OF THE AVERAGE SOFTWARE PROGRAM LIFE CYCLE IN SELECTED FEDERAL GOVERNMENT SITES

Phase Of Program Life Cycle	Percentage Allocation of Time	Average Dollars Spent
Requirements Studies	20.0%	$7,070
Preliminary Design	13.4%	$7,245
Detailed Design	23.3%	$12,820
Coding	23.3%	$6,690
Debugging	10.0%	$4,700
Testing	10.0%	$4,740
TOTAL	100.0%	$43.265

FIGURE G9

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[ ] Document describes a computer program; SF-185, FIPS Software Summary, is attached.

11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here)

This report summarizes the findings of the International Data Corporation (IDC) on the current status of Federal ADP and projects ADP trends in the Federal Government for 1979 through 1985. Hardware areas included are computers and related peripheral equipment such as magnetic tape drives, disk drives, terminals, printers, modems, multiplexers, and word processors. Other areas included are: an analysis of programming languages; analysis of software spending; analysis of installation workload by mode of operation and by application; implementation of data base management systems; scope of contract services in the Federal Government; and the state of software and software development in selected Federal installations.

12. KEY WORDS (Six to twelve entries; alphabetical order; capitalize only proper names; and separate key words by semicolons)

data base management systems; Federal contracts services; Federal Government computers; programming languages; software expenditures; software program life-cycle analysis

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