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A Cost Benefit Analysis of Proposed Federal Input/Output Channel Level Computer Interface Standards

Institute for Computer Sciences and Technology
National Bureau of Standards

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U.S. DEPARTMENT OF COMMERCE
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PREFACE

This analysis has been conducted using the best information available to the NBS Institute for Computer Sciences and Technology. Should additional relevant information be made available at a later time, this analysis may be suitably revised to take that information into account.

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1.0 EXECUTIVE SUMMARY

This report provides a quantitative analysis of the projected Federal cost savings that will accrue through the adoption of proposed Federal input/output (I/O) channel level computer interface standards. The cost savings will result primarily from use of these standards to make possible competitive procurement of computer peripheral equipment that cannot now be procured fully competitively. Cost savings in the procurement of new Federal automatic data processing (ADP) systems as well as in the subsequent augmentation of such systems with additional peripheral equipment are considered.

This analysis concludes (figure 4) that the Federal cost savings will be $9.3 to $13.7 million each year from FY 1980 through FY 1984, resulting in a total net savings for this period of over $55 million (expressed as net present value for 1978 as a base year with a discount rate of 10%).

2.0 INTRODUCTION

This analysis characterizes the magnitude of the major source of projected cost savings that will accrue to the Federal Government through adoption of proposed Federal input/output (I/O) channel level computer interface standards. Three of these standards are being proposed as Federal Information Processing Standards by an announcement in the Federal Register in June 1978. These are the proposed standards for I/O Channel Interface, Channel Level Power Control Interface, and Operational Specifications for Magnetic Tape Subsystems. The Government is also stating its intent to propose a standard for operational specifications for magnetic disk subsystems within the next twelve months. This analysis applies to the expected impact of these four interrelated channel level interface standards as the basis for the interconnection of competitively procured magnetic disk and magnetic tape peripheral subsystems as a part of Federal ADP systems.

Specifically, the analysis addresses the expected cost savings that will result from use of these standards to support the fully competitive procurement of computer magnetic tape and disk peripheral equipment where this is not now possible. Such competitive procurement is expected to satisfy the Government's requirements for peripheral equipment at significantly lower cost. Cost savings both in the procurement of new Federal ADP systems as well as in the subsequent augmentation of these systems with additional peripheral equipment are considered.

The emphasis is on projecting net cost savings at the time of acquisition of computer peripheral equipment. Operational and maintenance costs over the life cycle of the peripheral equipment and consideration of its residual value are not directly addressed. The fully competitive procurement of magnetic tape and disk peripherals through use of these proposed standards will result, in many cases, in the establishment of multi-vendor Federal ADP installations. Based on the best available information, there is no evidence that the operational and maintenance costs for multi-vendor ADP systems differ significantly from those for single vendor systems. This analysis thus assumes that the effects of operational and maintenance costs and equipment residual values do not change in any major way the projected savings calculated in this analysis at the time of computer peripheral acquisition.

An applicable life cycle analysis has been performed by the General Services Administration (GSA) in support of an overall joint NBS and GSA effort to develop and implement effective I/O peripheral interface standards (reference 9). That analysis provides a life cycle comparison of multi-vendor versus single vendor ADP systems. The GSA life cycle cost analysis supports the basic premise that the operating and maintenance costs and the effect of residual value do not significantly detract from the estimated cost savings at the time of acquisition of computer peripheral equipment procured on a fully competitive basis.

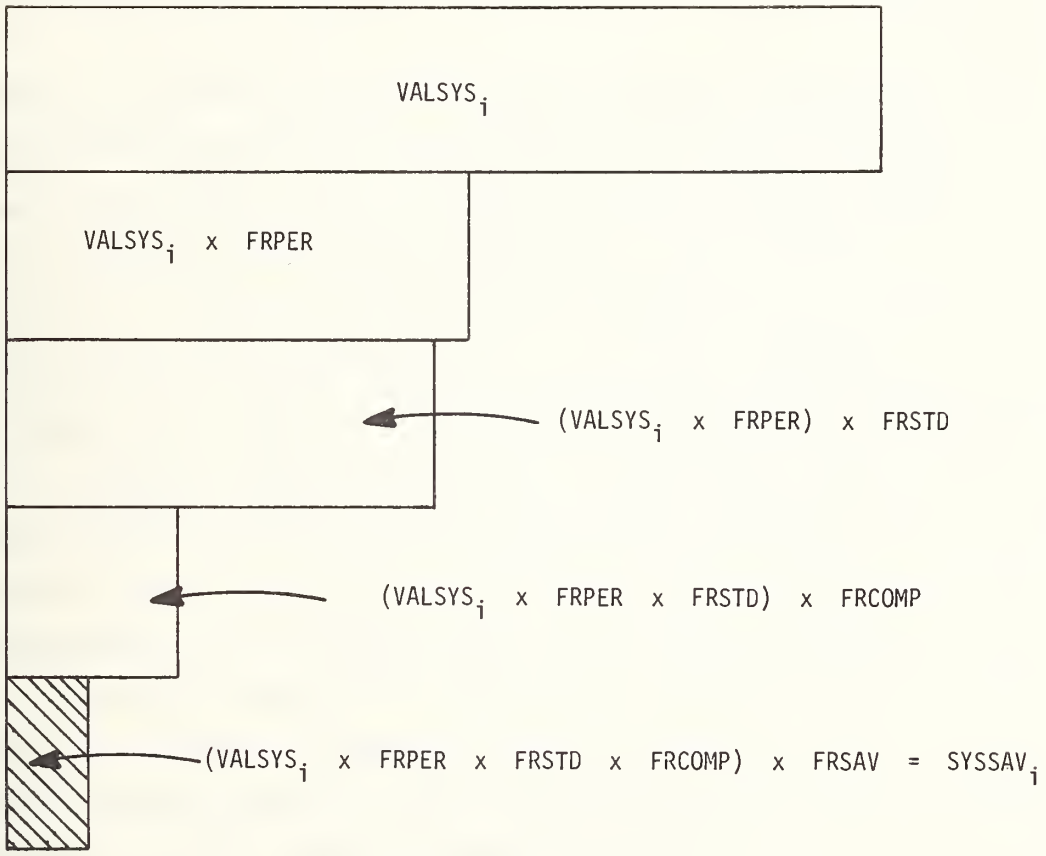
3.0 ANALYSIS

3.1 Methodology

Net Federal cost savings are projected for each fiscal year for which these standards are expected to have a substantial impact. For each year, the cost savings in the procurement of peripherals as a part of new ADP systems are added to the savings during that year through peripheral augmentation of ADP systems. This sum is then reduced by the projected cost to the Government for assuring required compatibility during that year. Each year's net savings are discounted using present value methods to take into account the time value of money.

The calculation of projected savings in ADP system procurement is shown graphically in figure 1. The value of ADP systems estimated to be procured in fiscal year "i" is designated by the variable $VALSYS_i$. The dollar value of computer peripherals estimated to be procured as a part of new ADP systems that year is computed by multiplying $VALSYS_i$ by the fraction by dollar value of Federal ADP systems represented by peripheral equipment (FRPER). Multiplying this value by the fraction by dollar value of peripherals represented by magnetic tape and disk equipment (FRSTD) gives the value of such tape and disk equipment to be procured each year. This value of tape and disk peripheral equipment is multiplied by the fraction by dollar value of peripheral equipment that can not currently be procured fully competitively (FRCOMP). This gives the dollar value of tape and disk peripheral equipment acquired each year that is the principal target for savings through use of the proposed interface standards. Finally, this value is multiplied by the percent savings projected through full competition (FRSAV) to give the projected savings.

The four channel level interface standards being considered provide for full compatibility in the connection of magnetic tape and disk peripheral equipment as a part of ADP systems. Line printers and other peripheral devices are not included. Although the I/O Channel Interface standard is necessary to support line printer interconnection on a fully compatible basis, an operational specification standard for line printers will also be necessary for that class of peripherals. Such a standard is another in the planned family of Federal I/O interface standards.



Graphical Representation of
Projected Gross Annual Savings in Procurement of ADP Systems

Figure 1

It is useful to note that these particular I/O interface standards are anticipated to have the desired cost savings impact only in the procurement of medium and large scale ADP systems and in the procurement of peripherals typically used as a part of such systems. The values for projected ADP system procurement for each year ($VALSYS_i$) have thus been suitably chosen to match those classes of systems for which these standards are applicable.

The cost at the time of procurement that will partially offset these projected cost savings is expected to be primarily part of the cost of adapting computer systems not initially designed to employ interfaces that conform to these standards so that they are in conformance. In this analysis, a conservative approach is taken toward estimating the net cost savings. Thus, the Federal Government is assumed to bear, as a result of the competitive procurement process, all of the costs associated with providing adaptor hardware and software where necessary to make equipment conform to these standards when the Government procures systems that were not initially designed to conform to the standards. A large number of computer system manufacturers already offer all or some of their systems with interfaces that conform to these standards. In competition with these currently conforming systems, some or all of the manufacturers currently offering nonconforming equipment may choose to pass along to the Government none or only a portion of the cost of providing such adaptor hardware and software. In addition, some systems will probably be modified to conform with these standards through substitution of conforming equipment, e.g., channels, in place of non-conforming equipment that is no longer required.

There will be other costs to the Government at the time of procurement associated with the use of these standards to assure full competition in the procurement of computer peripheral equipment. These costs include the evaluation of multiple offers in the competitive selection process and costs associated with verifying that the offered and delivered equipment has interfaces that conform with the interface standards. These costs are estimated to be small compared to the cost of adaptor hardware and software.

3.2 Savings Calculation Model

The discounted net cost savings that will result from these proposed standards are calculated using the model shown in figure 2. Figure 3 provides short definitions for each of the model variables. The Appendix of this report contains a discussion of each independent variable of the model.

Equation (1) of figure 2 is used to calculate the discounted net cost savings by summing the annual savings for each fiscal year ($ANSAV_i$) over the applicable years and applying a discount factor. Parameter FYEAR represents the first fiscal year that the standards are expected to contribute to substantial cost savings, and parameter LYEAR represents the last fiscal year that these standards are expected to contribute to substantial cost savings. The discount rate is represented by parameter "r".

The annual savings, $ANSAV_i$, is given in equation (2) as the sum of the savings that year in ADP system procurement ($SYSSAV_i$) and system augmentation through addition of peripherals ($AUGSAV_i$), and reduced by the cost of adaptor hardware and software ($ADAPTCOST_i$).

The value for each fiscal year of the projected savings in ADP system procurement ($SYSSAV_i$) is computed by multiplying the value of systems to be procured that year ($VALSYS_i$) successively by four fractions, FRPER, FRSTD, FRCOMP and FRSAV as has been discussed in the previous section.

The value of the augmentation savings term ($AUGSAV_i$) in equation (2) is calculated in equation (4) in a manner similar to the successive reductions through multiplication by fractions of equation (3). The dollar volume of magnetic tape and disk peripheral equipment procured to augment Federal ADP systems in each fiscal year ($AUGVAL_i$) is first reduced by multiplying by the fraction by dollar value of that peripheral equipment that cannot currently be procured fully competitively (FRCOMP). This annual value of procured tape and disk equipment for which competition through use of these standards is expected to result in savings is then multiplied by the percent savings projected to accrue through full competition (FRSAV).

$$\text{DISCOUNTED NET COST SAVINGS} = \sum_{i = FYEAR}^{LYEAR} \frac{ANSAV_i}{(1 + r)^{i - 1978}} \quad (1)$$

$$ANSAV_i = SYSSAV_i + AUGSAV_i - ADAPTCOST_i \quad (2)$$

$$SYSSAV_i = VALSYS_i \times FRPER \times FRSTD \times FRCOMP \times FRSAV \quad (3)$$

$$AUGSAV_i = AUGVAL_i \times FRCOMP \times FRSAV \times \frac{i - FYEAR}{SYSLIFE} \quad (4)$$

$$ADAPTCOST_i = NUMSYS_i \times FRNCOMP \times FRADAPT \times NADAPT \times COSTADAPT \quad (5)$$

Savings Calculation Model

Figure 2

$ANSAV_i$:	Federal cost savings in fiscal year i
$SYSSAV_i$:	Savings in procurement of ADP systems in fiscal year i
$AUGSAV_i$:	Savings in peripheral subsystem augmentation and replacement in fiscal year i
$ADAPTCOST_i$:	Cost of adaptors that enable systems to conform to these standards in fiscal year i
FYEAR:	First fiscal year that standards contribute to substantial cost savings
LYEAR:	Last fiscal year that standards contribute to substantial cost savings
r:	Discount rate
$VALSYS_i$:	Federal ADP system procurement costs in fiscal year i
FRPER:	Fraction by dollar value of procured ADP systems represented by peripheral equipment
FRSTD:	Fraction by dollar value of peripherals represented by magnetic tape and disk equipment
FRCOMP:	Fraction by dollar value of peripheral equipment that cannot currently be procured fully competitively
FRSAV:	Percent savings projected through full competition (expressed as a fraction)
$AUGVAL_i$:	Dollar volume of peripheral equipment procured to augment Federal ADP systems in fiscal year i
SYSLIFE:	Expected useful life of Federal ADP systems
$NUMSYS_i$:	Number of ADP systems procured by the Federal Government in fiscal year i
FRNCOMP:	Fraction by number of Federal ADP systems for which peripheral equipment cannot currently be procured fully competitively
FRADAPT:	Fraction by number of ADP systems to be procured competitively through use of these standards and for which adaptor hardware/ software is required
NADAPT:	Average number of adaptors per ADP system for which such adaptors are required
COSTADAPT:	Cost of each adaptor

Short Definitions of Model Variables

Figure 3

The last factor in equation (4) represents a reduction of the augmentation savings to zero during the first year that the standards are in effect, and to linearly increasing amounts each year up to the final year the standard has effect. The increase each year in this factor equals the inverse of the expected useful life of Federal ADP systems (SYSLIFE). The effect of this factor is to gradually increase each year that portion of the Federal inventory for which savings in augmentation will be possible. Essentially all systems will have the capability for competitive peripheral augmentation if the standards are in effect at the end of a period equal to the expected Federal ADP system life. This representation provides a conservative approach toward projecting the savings through augmentation, in that no cost savings are assumed until systems have been procured in conformance with these standards so that their augmentation on a fully competitive basis is guaranteed.

The standards are also applicable in the augmentation of ADP systems that were in the Federal inventory prior to the effective date of these proposed standards, but the additional savings through such application are not included in this model. The degree of competitive peripheral augmentation that will be possible for these systems will be dependent on the commercial availability of adaptor hardware and software for these systems.

Equation (5) is used to calculate the cost of the adaptor hardware and software ($ADAPTCOST_i$) term in equation (2). The cost of adaptors depends upon the number of adaptors that are required to make initially non-conforming ADP systems conform with these standards. The number of such systems projected to be procured in each fiscal year ($NUMSYS_i$) is used as a basis for this calculation. This term represents the cost of adaptors for new ADP systems, and is thus consistent with equation (4), where savings in augmentation are attributed only to the competitive procurement of peripherals for ADP systems that are already in conformance with these standards. The number of systems is reduced in equation (5) by two fractions in a manner similar to the form of equations (3) and (4). The total number of systems projected to be procured each year is multiplied by the fraction of such ADP systems for which peripheral equipment cannot currently be procured fully competitively (FRNCOMP). That product is then multiplied by a fraction representing those ADP systems for which adaptor hardware and software will be required (FRADAPT). Note that in some cases it is expected that manufacturers of currently

non-conforming ADP systems will modify their systems so that they conform to the proposed standards without the need for separately identifiable adaptor hardware or software.

The number of systems represented by the product of the first three factors of equation (5) is then multiplied by the average number of adaptors per ADP system for which such adaptors are required (NADAPT). This product is then multiplied by the estimated cost of each adaptor (COSTADAPT).

3.3 Projected Savings

A computer program that embodies the savings calculation model of figure 2 has been used to calculate the discounted net savings. The Appendix of this report contains a discussion of the values used in this calculation for each of the independent variables of the model. A best estimate has been generated for each parameter, along with likely minimum and maximum values for use in determining the sensitivity of the results to variation in individual parameters.

The results of the savings calculation using the "best estimate" for each independent variable are given in figure 4. Parameter values are shown on the left of figure 5, with the exception of the discount rate r, which has been assigned a value of 0.10, and the systems life, SYSLIFE, which has been assigned a value of eight years.

The columns of figure 4 correspond to the individual terms of equation (2). The rows correspond to each of the five years that these standards are expected to have significant cost savings impact. An additional column headed "Undiscounted Net Savings" that is not explicitly identified in the model has been added to this figure. This column enables one to see the effect of discounting in determining the projected discounted net cost savings of $55.7 million over the five year period.

FISCAL YEAR	GROSS SAVINGS		ADAPTOR COST	UNDISCOUNTED NET SAVINGS	DISCOUNTED NET SAVINGS
	SYSTEM ACQUISITIONS	SUBSYSTEM AUGMENTATION/ REPLACEMENT			
1980	21.4	--	4.8	16.6	13.7
1981	21.4	0.9	4.8	17.5	13.1
1982	16.9	1.9	4.8	14.0	9.6
1983	16.9	2.8	4.8	14.9	9.3
1984	18.9	3.7	4.8	17.8	10.0
FIVE YEAR TOTALS	95.5	9.3	24.0	80.8	55.7

Best Estimate Results (in $ Millions)

Figure 4

PARAMETER				NET DISCOUNTED SAVINGS ($ MILLION)			ELASTICITY
Name	Minimum	Best Estimate	Maximum	Minimum	Best Estimate	Maximum	
FRPER	.50	.56	.6	48.6	55.7	60.4	1.19
FRCOMP	.31	.31	.45	55.7	55.7	88.3	1.30
FRSAV	.22	.4	.5	23.2	55.7	73.8	1.30
FRSTD	.75	.85	.85	47.9	55.7	55.7	1.19
FRADAPT	.33	.9	1	66.2	55.7	53.8	-0.30
NADAPT	2	3	5	61.2	55.7	55.7	-0.30
COSTADAPT	$20K	$30K.	$50K	61.2	55.7	44.6	-0.30
FYEAR	1979	1980	1980	68.6	55.7	55.7	--
LYEAR	1982	1984	1987	36.4	55.7	83.8	--
FRNCOMP	.38	.38	.52	55.7	55.7	49.6	-0.30
AUGVAL	$40M	$60M	$80M	53.8	55.7	57.6	0.104

Sensitivity of Results to Variations in Individual Parameters

Figure 5

3.4 Sensitivity of Projected Net Cost Savings to Individual Parameter Variations

Figure 5 shows the variation in the discounted net cost savings as a function of varying each of the principal independent variables of the model. The $55.7 million best estimate result is reduced under these conditions to as low as $23.2 million with a reduction in parameter FRSAV by a factor of almost two.

The right column of figure 5 shows the elasticity of the projected savings relative to each parameter. This gives a numerical indication of the sensitivity of the projected discounted net cost savings to changes in each independent variable. Elasticities in this list greater than one indicate that a small percentage change in that parameter has a correspondingly larger percentage change in the discounted net cost savings. Parameters FRPER, FRCOMP, FRSAV, and FRSTD, have the greatest individual effect on the results. The other parameters generally have a much smaller effect. Parameters FYEAR and LYEAR are special cases, in that they vary in relatively major steps over a small range. Although the effect of varying these parameters is clearly shown in the minimum and maximum columns of the Net Discounted Savings section of figure 5, computation of elasticity for these parameters does not appear meaningful.

4. CONCLUDING REMARKS

In addition to the major source of savings projected in this analysis through use of these standards to promote competitive procurement of peripheral equipment, additional savings are likely to be accrued. One category of such savings is that expected through more flexible reutilization of peripheral equipment in the Federal inventory. At the present time, reutilization is possible only within the Federal Government's inventory of a particular manufacturer's systems and peripherals for those systems. For example, tape and disk drives that are a part of a large scale system from one manufacturer, and that are no longer needed on the system for which they were procured, may be reused in the augmentation of other similar systems of that manufacturer in the Federal inventory or in the initial configuration of a new system from that manufacturer. These proposed standards will enable the Government to reuse such available tape or disk drives on any medium or large scale Federal ADP system.

The additional reutilization cost savings through increased flexibility in moving peripheral equipment from system to system are difficult to estimate. The General Services Administration projected in May 1977 that the savings from reutilization of ADP equipment in the Federal inventory over the next five years would range from $3.1 million to $4.5 million per year. The additional reutilization savings resulting from these proposed standards would be in addition to the projected savings of $55.7 million in peripheral equipment procurement.

Another category of potential savings is that resulting through assured stabilization over a limited number of years of the interface defined by these proposed standards. This marketplace stablilization relative to Federal Government procurement of computer peripherals should reduce the barriers for both new and current offerers of peripheral equipment that are introduced by potential changes in all manufacturers' peripheral interfaces.

REFERENCES

1. "National Bureau of Standards, I/O Channel Level Interface, Proposed Federal Information Processing Standards," Federal Register, June, 1978.

2. "Draft Proposed American National Standard Specifications for I/O Channel Interface," ANSI Document Number X3T9/600, Rev. 2.

3. "Draft Proposed American National Standard Specifications for Power Control Interface," ANSI Document Number X3T9/666, Rev. 2.

4. "Draft Proposed American National Standard Operational Specifications for Magnetic Tape Subsystems," ANSI Document Number X3T9/780, Rev. 3.

5. "Inventory of Automatic Data Processing Equipment in the U. S. Government," GSA, National Stock No. 7610-00-181-7284, December, 1976.

6. "Study of the Acquisition of Peripheral Equipment for Use with Automatic Data Processing Systems," Comptroller General of the U. S., GAO Report Number B-115369, June, 1969.

7. "Administration of Public Law 89-306, Procurement of ADP Resources by the Federal Government," 38th Report by the House of Representatives Committee on Government Operations and Additional Views, October, 1976.

8. "Computers in the Federal Government: A Compilation of Statistics," NBS Special Publication 500-7, June, 1977.

9. "Government ADP Installations Life Cycle Cost Analysis," Automated Data and Telecommunications Services, GSA, March, 1978.

10. "Remote Terminal Emulation Analysis: Government ADP Procurement Projection," Federal Computer Performance Evaluation and Simulation Center, Report Number NA-510-021-GSA, Task 2, October, 1976.

11. "Assessment of Historical Cost Data Regarding the Effects of Competition on DOD/Military Procurement Costs," J. D. Neate and M. A. Burgess, ARINC Research Corp., November, 1976.

APPENDIX: Parameter Values

A "best estimate" value for each independent variable of the savings calculation model is identified along with a minimum and maximum value for each variable. The rationale for these selected values for each parameter is discussed.

1. FYEAR: First fiscal year that standards contribute to substantial cost savings.

   The first year that these standards can reasonably be expected to have a substantial impact in the Federal Government's procurement of computer peripherals is FY 1979. This is based on approval of the proposed standard in late FY 1978, with an effective date in early FY 1979. It is much more likely that the first substantial cost savings impact will be felt in FY 1980, considering the time scale of Federal procurement solicitations, evaluations, and awards. This value is thus used as the best estimate. This is also consistent with the planned availability of an accompanying operational specifications standard for magnetic disk, necessary to assure full interchangeability of magnetic disk subsystems. Even if a delay occurs in implementation of these standards or development of the disk operational specification standard, the delay should still permit substantial impact in FY 1980. Therefore, a maximum value for the FYEAR parameter is chosen as FY 1980.

2. LYEAR: Last fiscal year that standards contribute to substantial cost savings.

   Considering that these proposed interface standards are employed in several very recently announced systems, including systems not scheduled for delivery until FY 1980, the standard can easily be expected to have substantial cost savings impact through FY 1984, the best estimate value for parameter LYEAR. If the introduction of newer interfaces for systems that are announced over the next few years occurs faster than expected, it may be desirable to significantly change these standards or to rescind them, in which case FY 1982 may be the last year of substantial savings impact.

Especially considering the lifetime of systems that will be installed over the next two years under the provisions of these standards (about eight years), and noting that augmentation of many of those systems over this period will benefit from the provisions of these standards, the standards may continue to have a projected substantial savings impact as late as FY 1987.

3. r: Discount rate.

The net cost savings are reduced using a discount rate that takes into account the time value of money. A rate of 10% (parameter value 0.10) is employed as an approximation to the long run opportunity cost of capital in the private sector. This value is prescribed by the Office of Management and Budget in Circular A-94.

4. $VALSYS_i$: Federal ADP systems procurement cost in fiscal year i.

The Federal ADP system procurement projections employed in this analysis are shown in figure A-1. The data through FY 1983 are taken from the results of an analysis performed for the General Services Administration (GSA) by the Federal Computer Performance Evaluation and Simulation Center (FEDSIM) as a part of a joint GSA/NBS project concerned with the use of remote terminal emulation in the Federal ADP systems procurement process (reference 10). Although the principal intent of that study was to provide a projection of the quantities and costs of teleprocessing systems and services that the Government will procure over the next several years, the data does provide a conservative estimate of the dollar volume of medium and large scale computer systems to be procured by the Federal Government during that period. FEDSIM selected that data to "represent...most medium- to large-scale computer system product lines." These projections are thus good approximations to the systems for which these standards are applicable, generally systems having a fully configured value of over $400K.

This data was initially generated by analysis of Federal agency planning information provided to the Office of Management and Budget in April 1976. Data from the GSA-maintained inventory of Federal ADP equipment was also employed. In addition, FEDSIM interviewed representatives of Federal agencies to review and refine the initial ADP system procurement plan that had been developed for each agency. These projections are for the expected dollar volume of ADP system procurements each year, taking into account each reporting agency's requirements and the cost of meeting those requirements with ADP systems based on technology available in that year.

FISCAL YEAR	VALUE OF SYSTEMS ($ MILLIONS)	NUMBER OF SYSTEMS
1979	244	120
1980	362	157
1981	362	157
1982	287	155
1983	287	155
1984	320	157
1985	326	160
1986	331	163
1987	337	166

Projected ADP Systems Procurement

Figure A-1

These data were actually provided for two year periods. Since no indication was available of the division of projected procurement volume between the two years, equal spending in each of the years, e.g. FY 1980 and FY 1981, is shown in figure A-1. The values in figure A-1 for FY 1984 through FY 1987 were determined by linear regression based on the FEDSIM report values for the earlier period FY 1979 through FY 1983. It should be noted however, that the principal calculation shown in figure 4 is based only on data through FY 1984.

5. FRPER: Fraction by dollar value of procured ADP systems represented by peripheral equipment.

Figure A-2 summarizes relevant data extracted from the GSA-maintained inventory of Federal ADP equipment (reference 5). Line (1) shows the dollar value of systems provided by each of the six specifically identified manufacturers and in the aggregate for the others, giving a total as of June 1976 of $4.414 billion. Line (3) separately identifies the value of peripheral equipment in the Federal inventory, by system manufacturer, and totaling $2.46 billion.

The percent of system inventory value represented by peripheral equipment varies from manufacturer to manufacturer from 41% to 72%. In the aggregate, 56% by dollar value of the entire inventory is represented by peripherals. Examination of similar data for the previous two years also shows a value of approximately 56%. The best estimate value for parameter FRPER is thus taken as 56% (parameter value 0.56).

As reported to NBS by the International Data Corporation, a similar value for the U. S. installed base of ADP equipment is slightly lower, 50%. This value, 50% (parameter value 0.50) is used as the minimum. A value of 60% (parameter value 0.60), representing a similar deviation in the positive direction, is used as a maximum.

		BURROUGHS	CDC	DEC	HIS	IBM	UNIVAC	OTHERS	TOTAL
(1)	Dollar Value of Federal ADP Systems ($ Millions initial cost)	233	727	123	368	1439	582	942	4414
(2)	Manufacturers' Shares of ADP Systems Dollar Value	5%	17%	3%	8%	33%	13%	21%	100%
(3)	Dollar Value of Peripheral Equipment ($ Millions)	168	347	51	196	831	345	524	2462
(4)	Percent of Manufacturer's Inventory by Dollar Value Represented by Peripherals	72%	48%	41%	53%	58%	59%	56%	56%
(5)	Manufacturer's Shares of Peripheral Equipment by Dollar Value	7%	14%	2%	8%	34%	14%	21%	100%

Federal Inventory of Installed Computer Systems (Owned & Leased)

(As of June 30, 1976)

Figure A-2

6. FRCOMP: Fraction by dollar value of peripheral equipment that can not currently be procured fully competitively.

Referring again to figure A-2, multiple sources of supply for peripheral equipment do not currently generally exist for peripherals to be connected as a part of computer systems provided by Burroughs Corporation, Control Data Corporation (CDC), Digital Equipment Corporation (DEC), and Honeywell Information Systems (HIS). The percent of peripheral equipment in the Federal inventory by dollar value represented by these four manufacturers is calculated by adding the first four entries in line (5) of figure A-2, giving a total of 31%.

In general, alternate sources of supply exist for medium and large scale IBM computer systems, principally through use of competitively selected equipment available from requirements contracts negotiated by GSA. Use of these contracts enables Federal agencies to achieve substantial savings in procuring peripherals for IBM and IBM "plug-compatible" computer systems.

Also, although GSA does not have requirements contracts for UNIVAC large scale computers, a number of Federal installations have been successful in competitively procuring magnetic tape and disk peripheral equipment for UNIVAC systems. No calculations were made on the 21% by dollar value of the Federal inventory represented by the "other" category in figure A-2. Thus, the parameter values based on assuring full competition in the procurement of peripherals for Burroughs, CDC, DEC, and HIS systems represent a minimum percentage share by dollar value that will be made fully competitive through use of these standards. Even if these particular manufacturers do not maintain their current Federal market share, the peripherals that are in this portion of the Federal ADP procurement volume are expected to be procured fully competitively as a result of use of these proposed standards. This accounts for a variety of marketplace scenarios, including the possibility that one or more of these companies decide not to market ADP systems conforming to these standards to the Government.

Figure A-3 shows that the summary by dollar value of the Federal inventory represented by these four manufacturers has been stable for three recent fiscal years. Thus, the percent by dollar value of the peripherals in the inventory for these manufacturers can also be assumed to be stable. This leads to a value for FRCOMP, as calculated on the previous page of 31% (parameter value 0.31). The minimum value is also chosen as 0.31, and the maximum of 0.45 reflects the possible more extensive competition for peripherals by including the 14% by dollar value of the Federal inventory represented by UNIVAC peripherals.

7. FRSAV: Percent savings projected through full competition (expressed as a fraction).

The percent savings likely to occur as a result of introducing competition in the procurement of peripheral equipment otherwise available from a single source of supply is indicated by recent GSA experience in the negotiation of requirements contracts for computer peripherals procured on a competitive basis for Government-wide use. A price for peripherals 40% to 50% below the cost of procuring similar equipment from the ADP system supplier at GSA schedule prices has generally been obtained in the past. This represents full competition for particular classes of peripheral devices as opposed to limited negotiation with individual vendors in establishing the GSA schedule prices, which are only slightly discounted below commercial list prices.

In data provided by GSA to NBS in May 1977, an annual savings of over $9.5 million are projected on a "volume" in excess of $19.9 million per year for the next five years based on current annual volumes. That is, the Government will procure for $9.5 million each year on a fully competitive basis those peripherals that would otherwise cost at least $19.9 million procured at negotiated GSA schedule prices from the ADP system supplier.

FISCAL YEAR	BURROUGHS	CDC	DEC	HIS	BUR., CDC, DEC & HIS TOTAL	IBM	UNIVAC	OTHERS
1974	5.3%	17.5%	1.8%	8.5%	33.1%	38.3%	14.2%	14.4%
1975	5.5%	17.4%	2.2%	8.2%	33.5%	35.8%	14.0%	16.7%
1976	5.0%	17.0%	3.0%	8.0%	33.0%	33.0%	13.0%	21.0%

Percentage Share (by Dollar Value) of Federal Inventory

of Selected Manufacturers of Computer Systems

Figure A-3

These data are consistent with the results of a number of studies that have been made of the effect of competition on military procurement costs, including one report that summarizes several previous studies (reference 11). These studies show that significant price reductions result from competition. They show that reductions from 22% to 50% of the unit acquisition price may be realized from competitive procurement, with the bulk of the evidence supporting a figure in the 40% range.

Data reported by the General Accounting Office (GAO), accumulated during the earlier years of availability of alternate sources of supply for ADP equipment (reference 6), shows a purchase savings from alternate sources as compared to system manufacturers of from 17% to 58% for tape drives and from 20% to 29% for disk drives. The report further states that tape drives owned by the Government at that time which initially cost $57 million could then be bought from alternate sources for $31 million, representing a 40% cost savings. Such savings were later capitalized on where the marketplace permitted, for IBM plug compatible peripherals, through the use of GSA requirements contracts. However, no such provision for competitive procurement for all medium and large scale ADP systems has been possible before the availability of the proposed interface standards.

Data reported in the recent GSA life cycle cost analysis (reference 9) show that under the pressure of competition made possible by using the "defacto" interface standard of IBM, not only have substantial savings been accrued in the procurement of peripherals for IBM and IBM plug compatible systems, but IBM has itself significantly lowered its peripheral prices relative to other suppliers. The proposed interface standards are intended to extend these cost savings through competitive peripheral procurement to all magnetic tape and disk peripherals procured for applicable Federal ADP systems.

Based on the above, a best estimate value of 40% (parameter value 0.40) has been chosen for FRSAV. A minimum of 0.22 is employed, based on DOD experience, the early GAO data, and data reported in the recent GSA life cycle cost analysis. A maximum of 0.50 has been chosen, based on past GSA experience in the fully competitive procurement of ADP peripheral equipment of the type that is directly the subject of this analysis.

8. FRSTD: Fraction by dollar value of peripherals represented by magnetic tape and disk equipment

Based on data derived from a recent special search of the GSA-maintained Federal ADP equipment inventory, 85% by dollar value of the peripheral equipment currently in the Federal inventory is represented by magnetic tape and disk peripherals. A value of 0.85 is thus used as both the best estimate and the maximum for FRSTD. A slightly lower value, 0.75, is taken as a minimum. This is a reasonable lower bound on the proportion of the value of peripherals associated with tape and disk equipment if other peripherals do not drop in value as fast as tape and disk over time.

9. $AUGVAL_i$: Dollar volume of magnetic tape and disk peripheral equipment procureo augment Federal ADP systems in fiscal year i.

The $19.9 million augmentation of IBM and IBM plug compatible tape and disk systems on an annual basis through use of the GSA requirements contracts represents approximately 33% by dollar volume of the total Federal inventory annual augmentation. It is reasonable to estimate that the dollar volume of augmentation of the remainder of the inventory is at a similar level, thus giving a best estimate for $AUGVAL_i$ of $60 million. The uncertainty of the best estimate value is represented by a maximum value of $80 million and a minimum of $40 million. Since the augmentation value data that can be extracted from the current data base representing the Federal equipment inventory is limited, these values are used for all fiscal years (all $AUGVAL_i$).

10. SYSLIFE: Expected useful life of Federal ADP systems.

The previously referenced FEDSIM Report (reference 10) provides an estimate of 8 years as the average lifetime of Federal ADP systems. This is generally consistent with data informally available from other sources.

11. $NUMSYS_i$: Number of ADP systems procured by the Federal Government in fiscal year i.

The previously referenced FEDSIM Report (reference 10) provides the data shown in figure A-1 for fiscal years 1979 through FY 1983. The same background information concerning this data as was described in the discussion of $VALSYS_i$ above is applicable here. The values for $NUMSYS_i$ are those in the second column of figure A-1, where the data for fiscal 1984 through fiscal 1987 have been determined by linear regression based on the available data points for earlier years.

12. FRNCOMP: Fraction by number of Federal ADP systems for which peripheral equipment cannot currently be procured fully competitively

Figure A-4 is a chart derived from the GSA-maintained Federal ADP equipment inventory that shows by number of central processing units (CPU's) the same breakdown as was given in figure A-3 by dollar value.

Here, as in the computation of FRCOMP above, those CPU's provided by Burroughs, CDC, DEC, and HIS, totaling 38% by number of the Federal inventory, represent a minimum on a numerical basis of the Federal inventory of the CPU's in the Federal inventory for which these standards will support fully competitive procurement. Note that this percentage has stayed relatively constant during the three years shown in figure A-4. Further, because of the way data is reported in the Federal equipment inventory on both a system and a CPU basis, it is believed that this percentage is also valid as a percentage by number of Federal ADP systems for which the Government can procure peripheral equipment fully competitively. A value of 0.38 has thus been selected as the best estimate for FRNCOMP. It is also selected as the minimum value for this parameter.

Adding the numerical proportion of the inventory represented by UNIVAC to this value, since greater competition in the procurement of peripherals for UNIVAC systems will also be possible, a maximum parameter value of 0.52 is obtained.

FISCAL YEAR	BURROUGHS	CDC	DEC	HIS	BUR., CDC, DEC & HIS TOTAL	IBM	UNIVAC	OTHERS
1974	4.3%	6.8%	17.8%	8.7%	37.6%	17.4%	17.9%	27.1%
1975	3.6%	6.3%	19.6%	8.2%	37.7%	15.3%	15.8%	31.2%
1976	3.1%	5.4%	21.7%	7.8%	38.0%	12.5%	14.0%	35.5%

Percentage Share (by Number of CPU's) of Federal Inventory

of Selected Manufacturers of Computer Systems

Figure A-4

13. FRADAPT: Fraction by number of ADP systems to be procured competitively through use of these standards and for which adaptor hardware/software is required

Assuming that the manufacturers who currently offer systems that are not in conformance with the proposed standards do provide adaptor hardware and software and continue to represent the same fraction of the Federal inventory as they do now, all such systems may require adaptors, and thus a maximum value of parameter FRADAPT of "1" has been chosen.

If this adaptor hardware and software is integrated into some of these systems, if the offerers of these systems choose not to pass along all of the costs of the adaptor hardware and software, or if not all of these offerers choose to provide equipment to the Government, the fraction actually procured that require adaptors will be less. A best estimate parameter value of 0.9 for FRADAPT has been chosen. Should extensive integration of the adaptor hardware and software take place, along with absorption of a significant portion of the cost of such adaptors by currently nonconforming offerers, then a much smaller number of systems will require adaptors, thus leading to a minimum value for parameter FRADAPT of 0.33.

14. NADAPT: Average number of adaptors per ADP system for which such adaptors are required

For many systems, one interface conforming to these standards will be adequate for connection of tape and disk peripherals, since it provides for the attachment of up to 256 peripheral devices. For reliability and I/O throughput purposes, frequently at least two channel interfaces conforming to these standards will be provided. Based on an examination of typical configurations for applicable ADP systems, a best estimate for the average number of adaptors per ADP system for those systems that require adaptors has been selected as 3, with a maximum of 5 and a minimum of 2.

15. COSTADAPT: Cost of each adaptor.

Based on the cost for already produced adaptor hardware and software for two systems, one for a commercially available product and one developed by the Government, a best estimate value of $30K has been selected for parameter COSTADAPT. A value of $50K as a maximum provides an upper limit. It has been demonstrated that an adaptor can be produced for as low as $20K, the minimum value. These data are generally consistent with those informally provided to NBS by other sources as estimates for the cost of adaptor hardware and software for other systems.

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This report summarizes the results of an analysis of the cost savings that are expected to accrue to the Federal Government through use of four proposed Federal input/output channel level computer interface standards. The analysis is based on the best available data, and the results are intended to be a best conservative estimate of the potential Federal Government cost savings that will occur through use of the proposed interface standards to increase competition in the procurement of computer peripheral equipment. The analysis concludes that the Federal Government will accrue cost savings through use of this standard of over $55 million during the five year period beginning in FY 1979.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

Computer systems; computer standards; interface standards; computer peripherals.

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