United States General Accounting Office

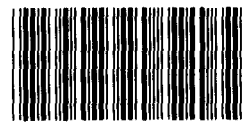
GAO

Report to the Chairman, Subcommittee on Transportation and Related Agencies, Committee on Appropriations, House of Representatives

May 1990

FAA PROCUREMENT

Major Data-Processing Contract Should Not Be Awarded



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GAO

United States
General Accounting Office
Washington, D.C. 20548

Information Management and
Technology Division

B-234903

May 25, 1990

The Honorable William Lehman
Chairman, Subcommittee on Transportation
and Related Agencies
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

This report responds to your request that we review the Federal Aviation Administration's Computer Resources Nucleus project. It presents our analysis, conclusions, and recommendations regarding the project. In March 1989, we reported on the project's objectives, cost estimates, and implementation approach.

As arranged with your office, unless you publicly release its contents earlier, we plan no further distribution of this report until June 15, 1990. At that time, we will send copies of the report to the Secretary of Transportation; the Administrator, Federal Aviation Administration; the Director, Office of Management and Budget; the Administrator of General Services; interested congressional committees; and other interested parties.

This work was performed under the direction of JayEtta Hecker, Director, Resources, Community, and Economic Development Information Systems, who can be reached at (202) 275-9675. Other major contributors are listed in the appendix.

Sincerely yours,

Ralph V. Carlone

Ralph V. Carlone
Assistant Comptroller General

Executive Summary

Purpose

In February 1989, the Federal Aviation Administration (FAA) issued a request for proposals for its largest and most complex general-purpose data-processing acquisition to date: the Computer Resources Nucleus (CORN) project. This project is intended to meet the agency's general-purpose data-processing needs for 10 years and provide options for supporting the processing needs of other parts of the Department of Transportation at an estimated cost of $1.5 billion. At the request of the Chairman of the Subcommittee on Transportation and Related Agencies, House Committee on Appropriations, GAO reviewed FAA's assessments of its data-processing problems and future needs used to justify CORN, its methodology for validating vendors' proposals, and its planning and preparation for converting current applications' software.

Background

Currently, FAA's 12 in-house "Common System" computer facilities provide general-purpose data processing for mission and administrative areas such as airport and aviation activity (excluding real-time air traffic control), aviation safety, national airspace facilities, and financial, materiel, and human resources. Agency officials maintain that the Common System is not meeting FAA's current processing needs because of capacity and response time problems, and that it is not possible or desirable to meet long-term needs by upgrading this system.

To resolve these problems, FAA developed the CORN project, under which a contractor would provide data processing on a fee-for-service basis for up to 10 years from computer facilities owned, operated, and maintained by the contractor. The Common System would be closed down once current applications systems are moved to the new system. In addition to meeting FAA's anticipated needs, the project includes options for providing service to other elements of the Department of Transportation. FAA estimates that the contract, scheduled to be awarded in the summer of 1990, has a value of $1.5 billion.

Results in Brief

The CORN project has not been properly justified and planned, and contains major unresolved problems. FAA's claims about the causes of perceived problems with its current system are poorly supported, as are its projection of future needs, leading to fundamental doubts about the project's justification. In addition, the agency's methodology for evaluating technical and cost aspects of vendor proposals is seriously flawed, a problem that could have cost ramifications. Further, FAA's estimates of the cost of converting software to CORN and the amount of agency support needed for the conversion are unreliable. The estimated time frame

for the conversion has already doubled, from 18 months to 3 years, leading to more cost growth. Finally, the conversion itself will not result in better management information.

Principal Findings

FAA's Justification for CORN Is Unsubstantiated

In documents and briefings provided to the Congress and the Department of Transportation, FAA has repeatedly cited Common System capacity and response time problems as key justifications for CORN. However, FAA is unable to provide support for these perceived problems because it lacks a central capacity and performance management program to gather and analyze data on system-wide utilization and response times. GAO's own analysis of available system monitoring data shows no evidence of computer processor capacity conditions that would cause response time problems, indicating that perceived response time problems may not be solved by procuring more computer processing capacity through CORN. FAA itself has not determined the specific causes of such problems.

FAA also justifies CORN on the grounds that its future general-purpose data-processing needs will increase at a rate of 30 percent per year over 10 years, resulting in a system about 1300 percent larger than the current one. However, GAO found that this estimate is based on sparse data, raising doubts about whether such extremely steep growth will occur.

Project's Validation Methodology Is Flawed

FAA needs meaningful and accurate information to evaluate the most effective way of meeting agency requirements. However, one key FAA method used in validating the vendors' CORN proposals is deficient because the sample work load to be used is extremely small and unrepresentative of the agency's total work load. In addition, the performance information on the current system that FAA provided to the vendors to assist them in developing their proposed solutions was incomplete. Failure to accurately validate vendors' proposed solutions could have cost ramifications throughout the life of the contract.

Major Problems Loom Over CORN Conversion

Converting computer application software to run on a new system is a costly, disruptive task that requires careful preparation. FAA's efforts to plan for the CORN conversion have been marred by its unreliable initial

inventory of applications to be converted, calling into question the basic accuracy of the conversion cost estimate of $74.5 million. The number of applications to be converted has varied from 500 to 200, while estimates of the amount of code to be converted have varied from 18 million to 10 million lines. More seriously, the conversion cost estimate is incomplete because the potentially substantial costs of rectifying problems with the applications' documentation were not included. FAA, nevertheless, continues to use this incomplete estimate in CORN budget information provided to the Congress.

FAA states that it will need to provide 85 employee-years of staff support to assist the CORN contractor in converting current applications to the new system. However, the basis for this estimate is questionable because it is not grounded in a review of each individual application to take into account the specific characteristics, complexities, or problems associated with converting each one. In addition, FAA has not determined the extent to which staff actually will be available to support each conversion. The estimated time frame for conversion has doubled from 18 months to 3 years, resulting in additional costs, since the current Common System is to run in parallel with CORN during the conversion. These parallel costs for a 3-year conversion period could be as much as $105 million. This cost is not part of the CORN project cost estimates.

Further, the agency has stipulated that the application code is to be converted without functional change to the applications. As a result, the conversion will not enhance the application code, improve its efficiency, or result in better information. In addition, FAA has done no analysis to determine whether specific applications are worth converting at all. Existing problems, such as poor response time, that are associated with FAA's information practices and computer applications may simply be transferred to CORN, at considerable expense.

Recommendations

GAO recommends that the Secretary of Transportation direct that the CORN contract not be awarded. In addition, GAO recommends that the Secretary direct the FAA Administrator to ensure that future procurements of this type and magnitude be properly justified and planned.

Agency Comments

Department of Transportation and FAA officials state that CORN should be assessed on its planned benefits—such as enabling FAA to better manage its information resources, provide quality services as needed, and perform its mandated missions. Although expressing general agreement

with the facts presented in GAO's report, they believe that GAO has judged CORN on grounds that are not fundamental to its purpose and not material in the larger context. They maintain that CORN has been sufficiently planned and justified to warrant its award. GAO maintains that its findings deal with problems and deficiencies that are fundamental to the project's scope and implementation and, consequently, support the conclusion that the contract should not be awarded.

In response to GAO's recommendation not to award CORN, the FAA Administrator has ordered an independent review of the project. The House Committee on Appropriations has directed the Department and FAA not to award the CORN contract until (1) the Committee reviews the results of GAO's report and FAA's written response to it and (2) FAA and Department officials subsequently discuss the project with the Committee to resolve any outstanding concerns.

Contents

Abbreviations

CORN	Computer Resources Nucleus
DOT	Department of Transportation
FAA	Federal Aviation Administration
GAO	General Accounting Office
IMTEC	Information Management and Technology Division

Introduction

On February 27, 1989, the Federal Aviation Administration (FAA) issued a request for proposals for its largest and most complex general-purpose data-processing acquisition to date: the Computer Resources Nucleus (CORN) project. CORN is intended to meet the agency's general-purpose data-processing needs for up to 10 years in the following mission and program areas:

- airport and aviation activity;
- air traffic control and airspace (excluding real-time air-traffic control systems);
- aviation safety;
- national airspace system facilities;
- financial, materiel, and human resources; and
- management support.

FAA currently supports these areas with its own in-house, general-purpose data-processing resources called the "Common System." The Common System is made up of one International Business Machines 3084 computer and 22 Data General MV/15000 computers distributed among 12 agency facilities: headquarters, 9 regional offices, and 2 centers. The major hardware components of this system were installed and upgraded during the 1980s.

In March 1989, we issued a report that provided information about the CORN project's objectives, cost estimates, and implementation approach.[1] The report highlighted the tenfold increase in estimated project cost—from $148 million to $1.5 billion—that occurred as the project evolved between 1986 and 1987.

How FAA Hopes CORN Will Meet Its Needs

In project documents supporting the need for CORN, project officials maintain that the agency's current general-purpose data-processing needs are not being met by the Common System. Specifically, they assert the capacity of the Common System is saturated, causing average response times of 4 seconds that result in substantial loss of staff productivity. They estimate that FAA's general-purpose data-processing needs will grow at a rate of 30 percent per year over the next 10 years. They argue that this growth rate far exceeds any feasible timetable for expanding the Common System because of the agency's lengthy procurement process. Finally, they maintain that it is not desirable to upgrade

[1]Computer Procurement: FAA's $1.5-Billion Computer Resources Nucleus Project (GAO/IMTEC-89-44FS, Mar. 31, 1989).

the current Common System because it is a hodge-podge of widely varying equipment that is inefficient and wasteful of critical staff and funding resources.

CORN project officials have concluded that in order to meet FAA's projected growth in data-processing needs over the next decade, the agency must free itself from the administrative and technical burdens involved in acquiring, managing, and operating its own general-purpose computer facilities. Consequently, under the CORN approach, FAA plans to procure data-processing services from a contractor and close down its Common System operations. The work of FAA's information systems staff would shift from managing an in-house system to helping agency users meet their information resource needs.

The CORN approach calls for FAA to define its general-purpose data-processing needs for the next 10 years. On the basis of this information, the contractor—not FAA—determines the computer configuration most appropriate and cost-effective for meeting these projected needs. The contractor is to provide, operate, and maintain the new system, which is to be located in at least two contractor-provided facilities that communicate with each other and with FAA centers, regions, and offices, as well as other Department of Transportation locations. The contractor is to provide the agency with specified levels of data-processing services on a fee-for-service basis.

In addition, the contractor is to convert the current Common System applications' software and data to the new system on a fixed-price basis; prepare full documentation for the converted applications; provide technical staffing, support, and training to agency users of the system; select and manage subcontractors; and implement system upgrades.

Project officials maintain the CORN approach will allow the agency to easily order increasing levels of data-processing service over the next 10 years just as if it were a basic utility, such as electrical service. System users, however, will be required to internally budget and pay for their use of CORN, something they do not do in obtaining data-processing from the Common System. Consequently, the amount of service that FAA program offices would receive under CORN would depend on their ability to pay for it. On a broader level, project officials maintain that CORN will promote data-processing standardization, and data integration and integrity.

Optional Levels of Service

CORN includes options for processing applications other than those currently run on the Common System. These additional applications include FAA data-processing requirements that are not part of the Common System, as well as data-processing needs of other elements of the Department of Transportation, such as the Coast Guard, the Federal Highway Administration, and the Federal Railroad Administration. Detailed requirements, feasibility, and cost/benefit studies have not been done for the optional levels of service. Instead, they are to be done before implementing these options.

Project Length, Estimated Cost, and Status

The CORN contract is expected to cover an initial 5-year implementation period, followed by five 1-year renewals. FAA estimates the total contract value to be about $1.5 billion: $876 million to meet FAA processing requirements, and $619 million to meet optional data-processing requirements.

The Secretary of Transportation designated CORN as a major systems acquisition in September 1987. The project was reviewed by the Transportation Systems Acquisition Review Council and approved by the Deputy Secretary of Transportation in January 1989. FAA issued the CORN request for proposals on February 27, 1989. Vendors' cost and technical proposals were due by August 30, 1989. FAA is currently reviewing the proposal material submitted and anticipates that the CORN contract will be awarded in the summer of 1990. However, in the House Committee on Appropriations report supporting the fiscal year 1990 appropriations bill for the Department of Transportation, FAA and the Department were directed to defer awarding the CORN contract until (1) the Committee reviews the results of our evaluation of CORN and a written FAA response to our report and (2) FAA and Department officials subsequently discuss the project with the Committee to resolve any outstanding concerns.

Regardless of the future of CORN, FAA plans to upgrade the mainframe portion of the Common System. The existing contract for the minicomputer portion of the system already has provisions for implementing upgrades.

Objectives, Scope, and Methodology

At the request of the Chairman, House Committee on Appropriations, Subcommittee on Transportation and Related Agencies, we reviewed FAA's proposed procurement of the CORN system. As agreed with the Chairman's office, our objectives were to

- determine the adequacy of FAA's assessment of its current and future data-processing needs,
- determine the adequacy of FAA's methodology for validating the vendors' proposed solutions for meeting agency data-processing requirements, and
- determine the adequacy of FAA's preparation and planning for the conversion of current applications to the CORN system.

To determine the adequacy of FAA's assessment of its current data-processing problems and future needs, we met with officials at the Department of Transportation and FAA to discuss CORN's development, goals, objectives, estimated cost, implementation approach, and management. We also reviewed key documents—such as the CORN requirements analysis, feasibility study, mission need statement, project charter, request for proposals, and draft implementation plan—used by FAA and the Department of Transportation to review and approve the CORN approach. We analyzed Common System performance monitoring tapes to determine the extent of capacity and response time problems, and reviewed other data on the system's performance. We visited FAA's Mike Monroney Aeronautical Center, where about half of the agency's general-purpose data processing is performed, to discuss system performance issues and review performance data.

To determine the appropriateness of FAA's validation methodology, we reviewed the rationale for the chosen approach and the method by which it is to be implemented, met with officials of the General Services Administration's Federal Systems Integration and Management Center to discuss their independent assessment of the approach, and considered applicable federal regulations.

To assess the adequacy of preparation and planning for the CORN conversion, we reviewed the project's 1987 conversion study, the original and revised CORN documentation package, the methodology for estimating agency resources needed to support the conversion, and the management plan for implementing the conversion. We discussed the conversion with officials at the General Services Administration's Federal Software Management Support Center, FAA program offices, the CORN project office, and the Department of Transportation's Office of the Inspector General.

We performed our work at the Department of Transportation, FAA, the General Services Administration in Washington, D.C.; the Federal Systems Integration and Management Center, the Federal Software Management Support Center in Falls Church, Virginia; and at FAA's Mike Monroney Aeronautical Center in Oklahoma City, Oklahoma.

Our review, performed from January 1989 to April 1990, was conducted according to generally accepted government auditing standards. We obtained the views of Department of Transportation and FAA officials on this report and have incorporated them where appropriate.

CORN Has Not Been Justified

While the concept of CORN—to contract for data-processing services from a vendor—may be acceptable, key justifications for the CORN project are not properly supported, raising fundamental questions about the rationale for the project. In promoting CORN, project officials maintained that Common System users were receiving inadequate response times because the system was "at capacity" or "saturated." However, we found no evidence proving that perceived response time problems are being caused by a lack of processor capacity or would be solved by CORN. FAA has virtually no data on response times indicating the frequency, magnitude, and cause of such problems. Project officials also maintain that the agency's data-processing needs will increase faster than its ability to upgrade the current system. However, the data and methodology used by FAA to make its growth projections are inadequate, raising further doubts about the necessity for the CORN approach.

CORN Is Intended to Solve Perceived Chronic System Problems

Project officials have repeatedly maintained that FAA needs CORN because the current Common System does not adequately meet the agency's needs and because the level of service provided by the system is continuously degrading. Specifically, they maintain that the Common System is "saturated" and that current capacity must be increased by 150 percent to achieve required service levels. The officials also claim that the system's response time is inadequate, averaging 4 seconds and causing a productivity loss of $37.5 million a year. In addition, they maintain that the agency's general-purpose data-processing needs will grow at a compounded rate of 30 percent per year, over the next 10 years.

These justifications have been continually stressed in documents and briefings used to explain why CORN is needed. For example, the system is described as "repeatedly saturated" in a February 1989 "Project CORN Basic Facts" briefing document. The draft CORN implementation plan provided to the Department of Transportation in April 1989 stated that the current system has reached its saturation level, suppressing service to FAA personnel. The system was also described as "saturated" in a September 1989 briefing document prepared for the FAA Administrator. Earlier project documents and briefings used to justify CORN also asserted that the Common System was "overloaded," "at capacity," or "saturated." Briefings given to the Congress and to us have also stressed that lack of computer capacity is causing inadequate response times and impairing staff productivity.

FAA Lacks Data on Current System Performance

Project officials were unable to provide us with adequate support for their assertions about capacity and response time problems because FAA lacks a central capacity and performance management program for the Common System. Such a program is important to ensure maximum use of existing resources and adequate capacity for growth. Not only is capacity and performance management a commonly-accepted business practice, but the Federal Information Resources Management Regulation Part 201-30 requires agencies to perform capacity management activities in planning, acquiring, and using computer resources.

An effective capacity management and performance monitoring program needs to address both performance management and capacity planning. Performance management involves analyzing the performance of computer systems to determine how resources are currently utilized and how such utilization can be improved. Capacity planning assists in forecasting computer resource requirements to ensure that enough capacity exists when needed.

While data are captured and analyzed on several components of the Common System, officials at both FAA and the Department of Transportation stated that there is no central capacity management program for the Common System that captures and analyzes Common System utilization and response time data on a systemwide basis. According to project officials, instead of having a central program, each of the 12 facilities is responsible for independently conducting capacity planning.

We found, however, that the lack of a central capacity and performance management program has resulted in inadequate data on the system's utilization and response times. Very little data on utilization and response times is available for the minicomputer portion of the system. Performance monitoring is much more in evidence for the mainframe portion of the system. But even there, project officials could not provide us with critical performance information, especially on response times, that is key to justifying the need for CORN. Consequently, the officials were unable to provide support for the key assertion that response time problems were caused by insufficient capacity and therefore could be solved by abandoning the current system and moving to CORN—a capacity-oriented approach.

Project officials state that the current mixture of mainframe and minicomputers does not lend itself to centralized capacity management, and that it is difficult to monitor the minicomputers' performance. They

claim that CORN will create an environment that will allow FAA to have centralized capacity management.

Limited Data Available on Response Time Problems

Project officials claim that insufficient processor capacity is causing the Common System to provide users with poor response times, averaging 4 seconds, resulting in annual productivity losses of $37.5 million. They calculated that by reducing response time to a maximum of 2 seconds, CORN would allow FAA to realize cost-avoidance savings of $375 million over 10 years due to improved productivity.

Project officials, however, could not provide support either for their assertion that the Common System's average response time is 4 seconds or for their assertion that perceived response time problems are caused by a lack of Common System processor capacity. Information resource staff responsible for the operation of the mainframe system stated that they had not collected overall response time data during the last 2 years because of the architecture of the agency's telecommunications system.[1] Further, no quantifiable data were provided to support the assertion that the average response time on the minicomputer systems is 4 seconds.

Since project officials were unable to provide us with performance monitoring data to support their assertions that the 12 Common System facilities are at capacity and were the cause of poor response time, we independently analyzed the limited processor utilization data that were available. Specifically, we analyzed July 1989 and January 1990 utilization data from the system's mainframe facility, which processes about 44 percent of the work load; and utilization data from February through May 1987 for 4 of the 12 minicomputer facilities that process the remaining 56 percent.[2]

For high-priority interactive work loads,[3] the July 1989 data showed that the mainframe processor was at or below 59 percent utilization for

[1]Officials responsible for the operation of FAA's mainframe stated that they have decided to start collecting very limited response time data. The telecommunications lines being monitored represent 2.5 percent of the mainframe users.

[2]The 1989 and 1990 data were provided at our request. The minicomputer utilization data from February through May 1987 are the most recent data collected by FAA on these machines.

[3]High priority interactive work loads include those applications programs that require on-line processing and are considered most critical to FAA.

99 percent of the time between 7 a.m. and 7 p.m. on nonholiday weekdays. Similarly, the January 1990 data showed the mainframe was at or below 67 percent utilization for 99 percent of the same hours for the same type of work load. It is highly unlikely that these levels of processor utilization would cause poor response times.

Our analysis of utilization levels for the minicomputer portion of the Common System yielded similar results. Based on the available data, the mean prime-time (8 a.m. to 4 p.m. on nonholiday weekdays) utilization was between 16 and 25 percent for all of the selected sites except for one facility, the Aviation Standards National Field Office, where it was 45 percent.[4] Since 1987, when these data on the minicomputers were collected, FAA has upgraded all of its minicomputers. The upgraded machines have over 3.5 times the processing power of the old ones, according to industry specifications. Although FAA does not regularly collect utilization data from the minicomputer facilities, the available chargeback reports provide data on total processor utilization at each data-processing facility. Using extrapolations of the 1987 data and 1989 chargeback reports, we estimate that prime-time, processor utilization was at or below 65 percent 99 percent of the time between 8 a.m. and 4 p.m. on nonholiday weekdays for 7 of the 8 facilities analyzed.[5] It is highly unlikely that processor utilization at these levels is the cause of response time problems.

Given the absence of direct measurements of response time, we analyzed the interactive, time-sharing option subsystem of the mainframe and found response times of less than 1 second.[6] Agency officials said that the time-sharing option subsystem is not heavily used and that response time problems occurred in other subsystems, namely their data base management system and communications handlers. However, agency officials were unable to provide us with data documenting the existence of poor response times in these subsystems. Moreover, we observed that the data base management system and the communications handlers are

[4]Although used in the CORN requirements analysis, these data are sparse and incomplete. During the 4-month monitoring period, the selected sites had gaps in their utilization data ranging from about 1 to 3 months.

[5]Chargeback reports are generated monthly by FAA and distributed to each of its data-processing facilities for information purposes only. No charges are collected. The reports contain information describing the total resources (i.e., central processor unit time, memory, tape storage, etc.) used by each facility and the dollar amount the facility would be billed for the use of those resources. Our analysis of prime-time utilization is based on the extrapolation of data from these reports.

[6]The time-sharing option subsystem is an option of the International Business Machines 3084 operating system that allows users to interactively share computer time and resources.

assigned a higher processing priority than the time-sharing option subsystem. Therefore, if the lower priority time-sharing subsystem was not suffering from poor response time resulting from a saturated processor, it is unlikely that these other higher priority systems were suffering in that way either.

Perceived Slow Response Times May Be Caused by Other Problems

The absence of data on the response times does not, of course, mean that response time problems do not exist. Common System users have complained about slow response times. However, as our analysis of the system's available utilization data and processing power indicates, response time problems do not appear to be caused by insufficient processor capacity.

Other factors that may be causing FAA's response time problems include the following:

- Inefficiencies in the design of application programs may cause processing delays that prevent the current system or the proposed CORN system from providing a 2-second response time.
- Contention for peripheral devices (e.g., disk and tape drives) may cause processing delays.
- The communication system linking users to the Common System may be causing delays. An official at the mainframe facility believes that response time problems may be caused by FAA's Administrative Data Transmission Network communications system. CORN requires 2-second response time within the contractor's facility, not at the users' terminals. As a result, delays due to telecommunications problems or the input devices, such as microcomputers, will not be corrected by CORN. Project officials have asserted, without support, that CORN and the agency's switch to the new FTS 2000 telecommunications system will eliminate current response time problems.
- Inefficient management of current system resources may be causing delays. For example, the mainframe system contains an operating system module that is designed to optimize the tradeoff between throughput and response time. In order to do this, the module must be given control over which batch jobs are allowed in the computer's memory and when they are allowed in. FAA is denying this control to the module by not allowing many batch jobs to be initiated during prime-time hours. As a result, we identified instances where jobs took only minutes to complete and utilized only hundredths of a second of processor time, yet waited hours before they were initiated. One of the worst

cases identified was a job that unnecessarily waited 80 hours to be initiated. Once initiated, this job was completed in 12 minutes and used only 0.06 seconds of processor time.

10-Year Growth Projection Is Based on Sparse, Inadequate Data

Project officials constructed a 10-year growth projection to estimate the data-processing resources required to meet FAA's needs throughout the life of the project. Their projection is comprised of four components:

- current demand, the measurable demand that existing application programs place on data-processing facilities;
- latent demand, the difference between the measured demand and the demand that would be exerted on a computer system if an acceptable level of service were available;
- projected mission growth, the increase in the demand for data-processing resources resulting from the agency's additional use of automated systems to meet future mission needs; and
- new demand, the demand that planned or developing application programs will exert on the system when they are implemented.

According to FAA estimates, these four growth components, when combined, result in a projected growth rate of 30 percent per year compounded annually. Over 10 years, this amounts to demand growing by about 1300 percent.

Making long-range data-processing growth projections is inherently difficult. To make accurate growth projections, it is essential to have a complete and thorough understanding of a system's historical utilization patterns, current demands, and the effect that future applications and changes in the operating environment will have on the system. However, FAA lacks the data to assess current demand, latent demand, and mission growth.

FAA's current demand estimate is flawed because it is based on incomplete and inadequate processor-utilization data. The minicomputer data used by FAA only covered a 4-month time frame from 4 of the agency's 12 minicomputer facilities, and these data had gaps of 1 to 3 months. Project officials stated that the missing data resulted from periods when the monitoring system used to extract utilization data from the system was not operating. The incompleteness of the minicomputer utilization data prevents FAA from accurately identifying daily, weekly, or monthly levels of processor utilization for more than half the Common System's processing. The lack of complete data and the short measurement period

make it difficult for FAA to obtain a clear understanding of the demands currently placed on the Common System.

The latent demand estimate is based on the increase in demand that project officials say was observed after two upgrades to the mainframe. Project officials, however, could not provide any utilization data documenting this increase. Moreover, the officials could not furnish any data that provide a basis for measuring the amount of latent demand in the other half of the Common System—its minicomputer systems. Consequently, the latent demand estimate is based partially on speculation, rather than on quantifiable data.

FAA's estimate of projected mission growth is also flawed. To make a reliable forecast of this growth over the 10-year life of the contract, the agency needs (1) complete and accurate historical data on system utilization, and (2) an in-depth understanding of the projected changes in agency operations that will affect FAA's general-purpose data-processing resources.

As previously discussed, FAA has a limited amount of historical utilization data. These limited data do not provide a sound basis for making an adequate 10-year growth projection. To compensate for the lack of historical utilization data, FAA officials relied on their knowledge of past growth in the agency's data-processing facilities to validate their growth projections. Project officials stated that, on the basis of their knowledge of central processing units obtained over the past 10 years, their projections for the next 10 years appear to be accurate.[7]

Regarding projected changes in agency operations, government and industry experts recommend that growth projections be tied to natural forecasting units[8] and thus be based on real-world actions. However, project officials did not use natural forecasting units as part of the growth analysis. As a result, the growth projections are not tied to any factor that would cause the 30-percent annual growth rate to slow down or plateau at any point during the 10-year life of CORN. FAA's projection

[7]Project officials stated that the data-processing industry will experience a similar growth pattern over the next 10 years as has been calculated for the CORN project. When we asked project officials for the support for this statement, they said that the statement was based on a single magazine article.

[8]A natural forecasting unit is a functionally-oriented unit of measure of the work that system users perform. For a financial institution, for example, natural forecasting units would include loan applications processed, credit reports prepared, and checks processed.

methodology simply continues to compound the 30-percent growth rate year after year.

Optional Levels of Service Based on Unsupported Assumptions

Embedded in the growth projections are data-processing requirements for applications that are not processed on the Common System. These include some additional FAA applications, as well as applications used by other elements of the Department of Transportation such as the Coast Guard, the Federal Highway Administration, and the Federal Railroad Administration. Currently these applications are processed on dedicated hardware, time-sharing systems, or outside FAA. Levels of service are included in CORN to accommodate these additional applications on an optional basis. These levels of service account for approximately 40 percent of the estimated $1.5 billion value of the CORN contract. No detailed requirements, feasibility, or cost/benefit studies were done for the optional levels of service portion of the procurement. Sizing for these levels of service was based on the assumption that the growth rate, acquisition schedule, and the ratio of peripheral devices to the central processing unit would be identical to that of the Common System's requirements.

The Importance of Accurate System Sizing

FAA's growth methodology results in extremely large annual leaps in the system's size and capabilities, especially after the first few years of CORN. By the tenth and final year of the CORN contract, the projected growth rate results in a system almost 1300 percent the size of the current one. Growth of this magnitude would, for example, result in a system capable of providing 390,000 hours of system access time per calendar day and producing over 15 million printed pages of output per calendar day in the final year of the CORN contract. A system of this magnitude would provide 32.5 hours of access per person per day for 12,000 users. Similarly high growth is projected for system input/output transfers, number of tape reels used, gigabytes of disk storage, and central processor use. However, project officials have not addressed basic issues that are naturally associated with growth of this speed and magnitude, such as (1) determining how the 30-percent level of growth correlates with expected increases in the number of system users over the next decade, or (2) determining whether FAA's and the Department's activities would in fact require the production of over 15 million pages of output every day of the year.

The larger and more demanding a computer growth requirement is, the lower the number of vendors available to meet the requirement. A procurement as large as CORN can only be handled by the largest computer companies. If the 1300-percent growth requirement is in fact too high, then it may have unnecessarily precluded other vendors from competing. In addition, vendors must design solutions and attempt to cover the costs for a system that can handle a potential work load of this size. Therefore, the per-unit cost can be expected to be high for lower levels of usage.

CORN Evaluation Methodology Is Faulty

In a procurement as large and costly as CORN, it is critical for FAA to have meaningful and accurate information for evaluating the most effective solution for meeting agency requirements over the contract's 10-year period. However, a key element of FAA's methodology for validating the vendors' proposed solutions—an operational capability demonstration—is deficient in two ways. First, information that FAA provided to the vendors to assist them in developing their proposals was incomplete. Second, the sample work load that FAA developed for use in the demonstration is extremely small and unrepresentative of the Common System's total work load. As a result, the demonstration will not provide adequate data for accurately evaluating the vendors' proposals and their proposed charges for data-processing service. This deficiency could have cost ramifications throughout the life of the contract.

Performance and Capability Validation Are Critical for Large Acquisitions

Performance and capability validation techniques are important to agencies that are acquiring a large amount of data processing equipment or services. Performance and capability validation helps to reduce the risks of acquiring insufficient or excessive capacity, inadequate functional capability, and uneconomical capability.

Federal Information Resources Management Regulation 201-30.013-3 stipulates that the selection of performance evaluation techniques shall be commensurate with the programmatic risks of inappropriate or insufficient data-processing capacity. Present and forecasted data-processing work loads, anticipated system life costs, validation costs to the government and offerors, and objectiveness and fairness in the acquisition process are factors to be considered.

The most precise performance validation technique is benchmark testing. A benchmark is a set of computer programs and associated data tailored to represent a particular work load. A benchmark test is a user-witnessed demonstration on a vendor's proposed computer system done to validate system performance or cost. Benchmark tests are used to assess how a vendor's system will process the work load (e.g., processing speed, resource consumption) and to compare the performance of several systems.

FAA's Validation Strategy Will Not Adequately Test the Proposed Systems

Under the validation methodology developed by FAA, vendors will be required to perform an agency-designed operational capability demonstration in which they will process a portion of the agency's work load on a subset of their proposed systems. The makeup of this sample work load is critical to the thoroughness and adequacy of the demonstration because it will exercise the vendors' billing algorithms, which will be the basis for charging the government for the services provided.[1] The demonstration is intended to aid FAA in determining how well the vendors' proposed solutions will meet the agency's projected requirements.

Problems Cited by Independent Review

Problems with FAA's demonstration were originally cited by the General Services Administration's Federal Systems Integration and Management Center, which was asked by FAA to perform an independent review of a draft of the CORN request for proposals.[2] In its September 1988 report to the agency, the Center raised methodological issues regarding the demonstration, stating that the agency's demonstration methodology would not accurately validate the cost of processing the agency's work load on a vendor's proposed system. The Center stressed that it is crucial for the agency to accurately validate its work load in terms of the billing units proposed by each vendor. According to the Center, an error in validating the number of billing units required to process FAA's work load could have "staggering cost consequences over the 10-year contract life." The Center stated that the only reliable method for performing this validation is through the use of a "government-furnished benchmark." We discussed FAA's validation methodology as it appears in the final draft of the CORN request for proposals with Center officials. The officials said that they would prefer that FAA use a more rigorous test, which would include a larger, more representative sample of the agency's work load.

Data and Validation Problems Remain

In our own review of FAA's proposed validation methodology, we found that serious problems remain in its approach. One basic problem is that the data supplied by FAA to the vendor community to aid them in sizing a system capable of meeting the agency's general-purpose data-processing needs for the 10-year life of the contract are flawed. The agency supplied performance data for its mainframe system on magnetic tape.

[1]The actual algorithms designed by each vendor will be extremely complex, including dozens of pricing elements with complicated relationships among them. Properly exercising these algorithms is critically important to understanding the utilization costs of the resources being offered.

[2]The Center was established in 1972 to assist federal agencies in acquiring, managing, and using information systems and technology. It provides agencies with a wide range of technical and contractual assistance on a cost-reimbursable basis.

However, portions of the data needed to accurately model FAA's current system were either unusable or missing from the tapes, making it impossible for the vendors to obtain information on such things as disk drive activity.

In addition, information needed to identify the characteristics of batch and on-line application systems[3] and transaction volumes was not provided. Consequently, vendors would have to make assumptions about key characteristics of the current mainframe system in order to perform their modeling.

Another problem with FAA's approach is that the sample work load to be used in the demonstration does not represent the Common System's work load. According to FAA, the Common System's current work load is made up of almost 290 application systems, both batch and on-line, totaling nearly 15 million lines of code. However, the sample work load to be used in the demonstration is made up of only 12,000 lines of code from parts of two application systems.

Project officials admit that the application subsystems to be used in the demonstration are only "slivers" of the Common System's total work load and are not representative. Nevertheless, they maintain that these subsystems are typical examples of the types of applications that are processed in FAA's current data-processing environment because they have qualitative attributes found in many of the agency's applications. For example, according to project officials, the programs both use a high-level programming language and data base management systems. In addition, one application is processed at a minicomputer facility, while the other is processed at the mainframe facility.

Officials also maintain that a more rigorous validation methodology would be hard to develop and more costly to both the agency and vendors because of the difficulty in defining and constructing a larger, representative work load.

We recognize that the two subsystems chosen for the demonstration have attributes similar to other types of Common System programs. However, because of their small size and level of activity, they cannot provide FAA with a realistic view of the resource utilization cost per transaction or cost data resulting from work loads of increasing size. As

[3]A batch system processes one group of transactions entirely before processing the next group. On-line refers to users' ability to access and interact with a computer via a terminal.

a result, the demonstration would not provide FAA with adequate data to evaluate vendors' proposals and their proposed charges for data-processing service.

Major Uncertainties Loom Over Conversion

The General Services Administration's Federal Software Management Support Center starkly characterizes software conversion[1] as "labor intensive, management intensive, machine-resource intensive, and deadline intensive. In short, it has all of the wrong attributes for a successful enterprise, and many problems will arise." Because of the extremely large size of the CORN conversion—nearly 290 software applications made up of over 14.8 million lines of code—and the fact that FAA staff will need to assist the contractor in the effort, the conversion will be costly, disruptive, and time-consuming. Unfortunately, FAA has not adequately prepared for the conversion, resulting in major outstanding problems and uncertainties. Specifically:

- The conversion could cost substantially more than the current $74.5-million estimate because it is based on an unreliable inventory of applications and excludes the cost of fixing major documentation deficiencies.
- Project officials state that 85 employee-years of agency staff support will be needed for the conversion. This figure, however, does not include all the conversion tasks and is not based on a review of each individual application to determine the amount of conversion support needed. More significantly, the availability of agency staff to support the conversion will not be determined until after the CORN contract is awarded.
- The estimated time needed for the conversion has doubled from 18 months to 3 years. The Common System will continue to operate until the conversion is complete, at a potential 3-year cost of $105 million. This cost will need to be funded in addition to CORN.
- The conversion will not correct problems in the applications, which may be causing inefficient processing of data, nor will it improve the agency's information structures.

Conversion Cost Estimate Is Unreliable

Project officials estimate that the conversion will cost $74.5 million.[2] An essential step in making such an estimate is preparing and validating the inventory of applications software and files to be converted. The $74.5-million estimate is based on project officials' initial attempt in 1987 to establish an inventory of applications to be converted. This effort did

[1]Software conversion is the transformation, without functional change, of computer programs and data to permit their use on replacement data-processing equipment.

[2]The complexity and cost of the conversion will vary with the type of hardware being proposed by a vendor. The project team developed cost estimates for several hardware scenarios—ranging from $10.6 million for a replacement system fully compatible with the current system, to $125 million for a completely noncompatible replacement system. The $74.5-million figure consistently used in budget documents corresponds to the estimate for converting to an International Business Machines-compatible system. This estimate does not include the cost of converting other FAA or Department of Transportation applications as part of CORN's optional levels of service.

not succeed in establishing reliable results, and therefore the cost estimate remains questionable.

Between 1987 and 1989, estimates of the number of applications that need to be converted ranged between about 200 and 500, while estimates of the lines of applications code to be converted varied from about 10 million to 18 million. Project officials maintain that the variance in the count of applications to be converted is largely a result of different ways in which they grouped related applications. They have no explanation for the changes in the corresponding line counts, however. As late as February 1989 project officials conceded in a CORN "basic facts" briefing document that the conversion will not be easy because "FAA's knowledge of what currently exists to be converted is far from perfect."

This uncertainty over the applications inventory reached a critical point shortly after the request for proposals was issued in February 1989. FAA received vendor complaints that the CORN documentation package—which was supposed to include current code for all applications to be converted—was confusing, incomplete, and did not provide an adequate basis for making a firm, fixed-price offer.[3] In April 1989 FAA informed prospective offerors that the documentation package "is being revised to include the information needed to fix price the effort." FAA analysts subsequently reviewed the documentation package and found that it contained obsolete versions of applications, along with applications no longer in use. In addition, some applications systems were listed for conversion in the CORN request for proposals, but had no code included in the documentation package. Project officials concluded that the materials provided by its staff for this package "were not sufficiently accurate." They subsequently characterized the documentation package as a first attempt to gather code for the vendors' use in preparing proposals for CORN. They maintain that the initial documentation package provided information "to enable offerors to analyze FAA's source code to appreciate the scope of the conversion effort."

Between February and August 1989, the conversion count continued to vary from 204 applications to 247 to 279, while the line count changed from 12.8 million to nearly 14.8 million (with an interim estimate of 10

[3]An FAA fraud hotline complaint triggered a review of the issue by the Department of Transportation's Office of the Inspector General. The resulting report is scheduled for release later this year.

million lines done between these two line counts). The revised documentation package and related amendment to the request for proposals, listing 279 applications with nearly 14.8 million lines of code, was issued only 3 weeks before vendor proposals were due in August 1989. According to an FAA memorandum, the revised package still had missing and incorrectly labeled components. Project officials issued another revision in February 1990 that raised the number of applications to 289 and increased the line count to slightly more than 14.8 million. Continued changes in the documentation package between the time of expected contract award and the actual conversions could drive up conversion costs by triggering cost-adjustment provisions specified in the request for proposals.

The conversion cost estimate is also unreliable because project officials did not include an estimate of the cost of enhancing or updating out-of-date applications' documentation—such as system, program, and users' manuals—or creating such documentation where none exists. Providing new documentation for all converted applications, except for functional requirements, is required of the contractor under CORN. These documentation costs could be substantial because project officials estimate that the documentation is, on average, only about 60 percent current and complete.

Project officials originally told us that the additional costs of fixing documentation deficiencies would be offset by an anticipated decrease in the number of lines to be converted as a result of revising the applications inventory. When the new inventory did not result in the anticipated reduction, project officials speculated that the additional documentation would probably add less than 10 percent to the $74.5-million conversion cost estimate. Officials now maintain that they have developed a new cost estimate, for use during review of vendors' proposals, that includes the documentation costs. For planning and budgeting purposes, however, FAA is continuing to use the original $74.5-million estimate and continues to submit this figure to the Congress in CORN budget information.

Staff Support for Conversion Inadequately Determined

FAA information systems staff and program office staff will need to support the conversion by helping the contractor understand the functionalities of the applications being converted, assisting in resolving technical issues and documentation problems, and reviewing the converted systems prior to accepting them. In presenting the project to the Department of Transportation for approval, FAA committed itself to a series of actions that it termed "critical to the success of CORN."

Among these actions, FAA stated that it planned to "establish an estimate of FAA/DOT [Department of Transportation] staffing resources required and their availability for each [application] system conversion prior to contract negotiations." We found, however, that project officials developed only aggregated estimates of the amount of agency employee-years needed for the conversion and have not determined the extent to which agency staff with appropriate skills will be available to support the conversion.

Estimated Amount of Employee-Years Is Poorly Supported

Project officials state that a total of 85 employee-years of staff support will be needed to assist in the conversion, excluding employee training.[4] However, this figure is not based on a review of each individual application to take into account the specific characteristics, complexities, condition of documentation, or other problems associated with converting each one. Instead, project officials developed a formula based on general assumptions about the amount of time needed to perform typical conversion tasks and the number of lines of code involved. They told us that they lumped the mainframe-based applications into one group and applied this formula to the aggregate, and used the same procedure for the minicomputer-based applications. Project officials were unable to provide us with documentation showing the basis for their general assumptions or how they carried out their calculations.

FAA initially informed the Department of Transportation that the conversion would require 45 employee-years of FAA staff support.[5] Project

[4]Project officials have identified the need for an additional 5 employee-years to train agency staff in using the CORN system. This estimate is very soft, however. Project officials informed the Department of Transportation that "the numbers of employees involved in the application systems operation varies too much from application system to application system to make a meaningful estimate for conversion/transition." They maintain that a firm estimate cannot be made until after contract award.

[5]The 45 employee-year estimate is cited in a project milestone chart provided by FAA to the Department of Transportation in April 1989 in response to the Department's request for additional information on project planning.

officials said that this number was a typographical error, since the estimate they had actually calculated was 85 employee-years. The 85 employee-year estimate is used in the CORN request for proposals and remains current. However, this estimate does not include the staff time needed to prepare the conversion packages to be provided to the contractor for each application. Project officials estimate that this task will require about 28 employee years.

Project officials maintain that their employee-year estimate cannot be refined until after the CORN contract is awarded, since the amount of staff resources needed will depend to a large degree on how compatible the current applications software is with the contractor's system. They are nevertheless confident that they have a "pretty solid feel" for the amount of employee-years needed for the conversion. In the CORN request for proposals, they stipulated that vendors bidding on the contract must develop preliminary conversion plans that require no more than 85 FAA employee-years of support (42 years for the mainframe applications and 43 years for the minicomputer applications). Project officials acknowledge, though, that this does not preclude FAA from providing a higher level of support, if necessary. For example, they said that if funding for the conversion is constrained, some of the contractor's conversion work could be shifted to agency staff.

FAA Staff Availability Remains Undetermined

Along with estimating the number of employee-years needed to support the conversion, it is necessary to determine the extent to which agency employees with the needed skills can actually be made available from their regular work to support the additional work involved in the conversion. As noted, FAA's promise to determine staff availability for each application conversion prior to contract negotiations has not been carried out. Project officials told us in March 1990 that they were in the process of beginning to determine staff availability. They maintain, however, that this activity cannot be made final until after the contract is awarded and the contractor's conversion plan is completed. This leaves unresolved the crucial issue of the extent to which appropriate FAA staff will actually be available to support the conversion. A senior information resources management official acknowledged that the conversion work load would put a heavy burden on the staff, but said that the agency would find a way of working through it.

If staff are not available to the extent needed to support the conversion, agency offices may need to turn to other contractors for help. For example, officials in FAA's Human Resource Information Division said that

they do not have enough staff to maintain the current personnel management system while supporting the complex task of reengineering the system for CORN. Consequently, they have requested $2.3 million in contract help for the conversion to CORN. The manager of the payroll system expressed similar concern about the lack of staff to support the conversion. Other program offices responsible for several less complex applications may need similar contract help in coping with their aggregate conversion work load.

Project officials acknowledge that FAA is planning to support the CORN contractor by using a combination of agency personnel and assistance from additional contractors. They have determined that the agency's information services staff will need to rely more heavily on their current contractors, and have asked FAA to provide $1.2 million a year during the 3-year conversion period for this purpose. However, the extent and cost of additional contractor help needed by FAA program offices remains undetermined.

Project officials said that they are currently developing a preliminary conversion schedule that will propose the sequence for converting the applications and apportion the 85 employee-year estimate to individual applications. The officials said that prior to contract award, they will ask the staff designated to manage the conversion to comment on the plan. They said that they would not send the plan to the program offices, although the offices would be heavily involved in the conversion. Since this plan is to be used in contract negotiations, project officials maintain that it is procurement-sensitive and not for general release. The plan originally was to be made final in August 1989, but was still being reviewed internally when we completed our audit work in April 1990.

Estimated Conversion Time Frame Has Doubled

The amount of time estimated to complete the conversion has repeatedly escalated. Project officials originally assumed that the conversion would take 18 months, which is the estimate found in the conversion study and various documents leading to the project's approval by the Department of Transportation in January 1989. They said that this 18-month schedule was an optimum estimate based on advice from several contractors. However, FAA program offices maintained that they could not meet this estimate because they lacked the requisite staff and other resources needed to satisfy CORN's requirements while concurrently performing their regular duties. Consequently, project officials increased their estimate to 24 months and then to 30 months. The officials said that this 30-

month estimate was judgmental, based on discussions with agency information systems staff. By November 1989, project officials had raised the estimated time frame to 3 years, citing budgeting concerns that could further slow the pace of the conversion.

Conversion delays will have cost consequences. Project documents repeatedly state that the Common System will remain fully operational in parallel with CORN until all of the system's applications are successfully converted. Project officials estimate that it costs $35 million a year to operate the Common System (excluding an additional $14 million a year in personnel, space, and supply costs that would not be avoided by moving to CORN). The conversion time frame delay from 18 months to 3 years could result in additional parallel operations costs of $105 million. The officials noted that the cost of parallel operations might be reduced by phasing out portions of the Common System before the conversion is completed, depending on the conversion plan agreed to by FAA and the contractor.[6] In any event, the parallel operations costs will be substantial and would have to be funded in addition to CORN contract costs.

Conversion Will Not Result in Better Information

One of FAA's goals is to create automated systems that provide the staff with better information for managing their programs. The CORN justification documents stress this goal by pointing out the agency's desire to integrate data into more useful information structures to improve management policymaking and decisionmaking. Project officials claim that the diversity of hardware in the current system inhibits meeting this goal, while CORN would promote it.

For all of its expense, however, the CORN conversion in itself will not move FAA toward this goal. Although the conversion would move the applications and data bases onto a new hardware environment, it would not improve the applications themselves or integrate the data bases because of the way the conversion is structured. Project officials insist that existing applications and data bases be converted so that they are functionally equivalent to the original applications.[7] That is to say, the same inputs to both the original and converted applications are to produce identical outputs. Vendors were informed that enhancement of the

[6]Some applications processed on the Common System, such as office automation applications, are not part of the CORN conversion. They, too, will need to be moved off of the Common System—mainly to microcomputers—before the system can be closed down.

[7]Two exceptions are the Consolidated Personnel Management Information System and the Aeronautical Information System, which are to be put onto a modern commercial data base management system.

application code for purposes of increased functionality, presentation improvement, or performance improvement are neither encouraged nor desired. The conversion will result in information being provided in the same way it is now. The officials said that they adopted this approach in order to be able to determine whether the conversion was carried out successfully.

Project officials have not determined whether all of the applications identified for conversion are worth converting. Following contract award, but prior to ordering the conversion of a particular application, the FAA office responsible for the application is supposed to determine whether there is a continued need for it. Software problems with the applications are to be corrected after they have been converted. The officials maintain that correcting any such problems is the responsibility of the agency staff in charge of the applications and is outside the scope of CORN, which was never intended to be a software development contract. This includes correcting errors in the applications, enhancing their functionality, or providing new functional requirements documentation—all of which are tasks not required of the contractor under CORN. Thus, if the current software is inefficient and causing poor response times, the possibility exists that the converted software will still be inefficient, and CORN will not achieve one of its primary benefits—improved response time.

Conclusions and Recommendations

A project of CORN's magnitude, both in terms of cost and effect on operations, requires careful preparation and well-supported technical analysis. CORN envisions a total commitment: the project is meant to completely replace the current system, not merely to augment it, by transferring FAA's general-purpose data processing to one vendor for up to 10 years. The project's viability depends heavily on FAA's ability to understand its current system, define problems and their causes, forecast future needs for a decade, adequately evaluate vendor-proposed systems, and adequately plan for conversion to the new system. To date FAA has not demonstrated satisfactory performance in these areas. Consequently, it is not ready to proceed with awarding the CORN contract.

CORN is, in essence, a request to the vendor community for a comprehensive technical solution to FAA's long-term data-processing problems and needs. While the concept of contracting for data-processing services support may be acceptable, FAA has not adequately defined, measured, and analyzed its current technical problems and needs. Most notably, FAA has not adequately documented response time problems, nor defined the causes of perceived response time problems with its current system. Its assertion that these problems exist and are caused by the lack of processor capacity is not supported by available data. By not establishing a central capacity management program for the Common System's 12 facilities, FAA has done a poor job of tracking Common System utilization, monitoring the system's performance, optimizing the use of its current resources, and identifying the causes of perceived response time and performance problems. Because FAA has not identified the cause of response time problems in the current system, it cannot be assumed that CORN will eliminate these problems. Without improved response times, CORN will not achieve one of its major objectives.

Since past and current performance data are an indispensable element with which to build projections of future growth, FAA is not able to make a reasonable projection of its anticipated growth in general-purpose data processing over 10 years. Its projected growth rate of 30 percent per year compounded for 10 years is based on inadequate data and oversimplified analysis of the agency's work load. The methodology does not take into account any factors that would cause this rate of growth to change over the contract period, especially in the later years when the cumulative effect of the 30 percent growth leads to extremely large annual jumps in system capacity—eventually reaching a point where the system would be 1300 percent larger than the current one. Further, project officials know even less about the future processing growth of other elements of the Department of Transportation. They have simply

assumed a similar 30-percent annual growth rate and increased CORN's estimated contract value by about 40 percent to accommodate it.

Although FAA and the Department are not obliged to order all of the service built into CORN, vendors must develop a proposed system capable of accommodating this high rate of growth. And they must develop fixed prices for levels of service that such a system would provide over 10 years. FAA, however, has not provided vendors with key information on the performance of the current system that they should have in order to properly develop a proposal to meet FAA's projected needs. In the absence of such information, vendors have to make assumptions about crucial characteristics of FAA's current system in order to model their proposed solutions to the agency's needs as specified in the request for proposals.

FAA should have meaningful and accurate information with which to evaluate the most effective solution for meeting the agency's projected needs. One of FAA's critical evaluation tools for doing this—the agency-designed operational capability demonstration—is seriously deficient. The sample work load used in the demonstration is extremely small and not representative of the agency's work load. As a result, the demonstration will not provide adequate data for accurately evaluating the vendors' proposals. This problem, coupled with FAA's failure to provide the vendors with adequate data with which to model a new system, could have cost ramifications throughout the life of the contract.

A critical hurdle for implementing CORN is the conversion of Common System applications. Project officials have not adequately prepared for the conversion, as evidenced by the long-standing confusion over the inventory of applications to be converted to CORN. The officials have also not provided agency management and the Congress with reliable information on the funding, staff resources, and time frames of the conversion. The conversion cost estimate of $74.5 million, used for project approval and budget requests, is unreliable and incomplete. The project officials' assertion that the conversion will require 85 employee-years is broadly estimated on a aggregate basis. Most critically, staff availability to support the conversion will not be determined until after contract award, when the agency's staff will be confronted with the necessity of working through the conversion some way or another.

As for time frames, CORN passed through the justification and approval process on the unsupported assumption that the conversion would involve a quick, 18-month effort. The time frame was lengthened to 3

years after the project was approved, when reactions from agency staff made clear the unreasonableness of the project officials' original estimate. The conversion inherently has a high risk for schedule delays because of its extremely large size, as underscored by the fact that the original time frame has already doubled before any conversion work has begun. Delays in the conversion would further increase the cost of running the current system in parallel with CORN during the transition period. For the current 3-year time frame, these costs could run as high as $105 million.

Finally, the conversion approach chosen by FAA will not result in improvements to the applications or their data bases. Problems currently found in them would be transferred to the new system at considerable cost.

Recommendations to the Secretary of Transportation

Because the CORN acquisition has not been adequately justified or planned and has major unresolved problems, we recommend that the Secretary of Transportation direct that the CORN contract not be awarded. In addition, we recommend that the Secretary direct the Administrator, FAA, to ensure that future procurements of this type and magnitude are properly justified and planned prior to contract award. Specifically, the Administrator must ensure that the following is done prior to proceeding with a comprehensive procurement similar to CORN:

- Existing system deficiencies need to be accurately and completely identified and a solution needs to be designed that addresses these deficiencies. Direct, periodic, systemwide monitoring, accomplished through the implementation of a computer capacity and performance management program for FAA's general-purpose systems, should be used to determine the presence, extent, and causes of performance problems—such as poor response times.
- Evaluation of vendors' proposals should involve the use of a representative work load sample.
- Planning for conversion should include an accurate inventory of the existing applications, an assessment of their continued need, and complete estimates of the cost and employee-years needed to support the conversion, including the extent to which qualified staff are available.

Agency Comments

Department of Transportation and FAA officials stress that CORN is a new way of doing business and of making data-processing services available to the agency's program offices during the 1990s. Accordingly, they

maintain CORN should be assessed on its planned benefits—such as enabling FAA to better manage its information resources, provide quality services as needed, and perform its mandated missions. Although expressing general agreement with the facts presented in our report, they disagree with the conclusions. They maintain that the report has not considered CORN's planned benefits and has judged the project on grounds that are not fundamental to its purpose and not material in the larger context. They maintain that CORN is sufficiently planned and justified to warrant its award. We maintain that our findings deal with problems and deficiencies that are fundamental to the project's scope and implementation and, consequently, support the conclusion that the contract should not be awarded.

After receiving our draft report for comment, the FAA Administrator decided to order an independent review of CORN to determine if it should proceed as planned. The House Committee on Appropriations has directed the Department and FAA not to award the CORN contract until (1) the Committee reviews the results of our report and FAA's written response to it and (2) FAA and Department officials subsequently discuss the project with the Committee to resolve any outstanding concerns.

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