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Economic Analysis for the Integrated Booking System (IBS)

L. F. Truett
V. V. Wheeler

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ORNL/TM-11910

Energy Division

ECONOMIC ANALYSIS FOR THE INTEGRATED BOOKING SYSTEM (IBS)

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August 1991

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EXECUTIVE SUMMARY

This document provides an analysis of costs associated with the design, development, deployment, and maintenance of the Military Traffic Management Command's (MTMC's) proposed Integrated Booking System (IBS). IBS will provide MTMC International Traffic (MTIT) with computer support for booking unit and nonunit cargo in both peacetime and wartime. IBS will be fielded worldwide to provide a consistent mechanism for accomplishing the objectives of managing and monitoring international surface cargo movements. Through its decision-support module, IBS will provide efficient nonunit booking aids. The database will provide tracking and querying capabilities. It is assumed that readers of this document are familiar with the proposed concept of and functional requirements for IBS that are stated in the IBS Functional Description (FD), provided to MTIT on July 2, 1991.

Included in this Economic Analysis (EA) are:

- a brief discussion of the existing methods and procedures used by MTIT for performing booking operations,
- a statement of the objectives of the proposed Automated Information System (AIS),
- a discussion of the scope of the requirements for a system to replace current methodologies and fulfill the booking requirements,
- assumptions and constraints that may affect implementation of the proposed system,
- descriptions of four alternative strategies for fulfilling the objectives of the proposed AIS,
- a comparative analysis of the four alternatives,
- tables (Sect. 4) containing draft cost estimates for each alternative based on a ten-year system life cycle,
- a brief discussion of risks, and
- a recommendation based on the comparison of the four alternatives.

The four design strategies for accomplishing the mission of the proposed IBS are listed below:

- Alternative 1 - Maintain the "status quo."
- Alternative 2 - Modify the current systems and methodologies [Mechanized Export Traffic System II (METS II), Automated System for Processing Unit Requirements (ASPUR), and various other manual and automated procedures].
- Alternative 3 - Develop IBS with a client/server architecture.
- Alternative 4 - Develop IBS on a midrange mainframe computer with terminal access.

The IBS Architectural Analysis has been completed. Based on consideration of the benefits (as analyzed at this point in time) gained from meeting the functional specifications, neither Alternative 1 nor Alternative 2 is a feasible solution. Both Alternative 3 and Alternative 4 offer clear operational benefits over Alternatives 1 and 2. However, the IBS Architectural Analysis concludes that Alternative 3 is the preferred alternative based on fulfilling the functional requirements of the proposed IBS.[1]

Alternative 1 costs through FY04 are estimated at a total of $11,461,000. Alternative 2 costs are estimated at a total of $11,821,000. Alternative 3 costs are estimated at a total of $10,690,500. Alternative 4 costs are estimated at a total of $10,622,900. Thus, maintaining the current systems (Alternative 1), even with enhancements (Alternative 2), is not cost-effective.

Because Alternative 3, the client/server architecture, is the choice of the IBS Architectural Analysis and because it is a cost-effective alternative, Alternative 3 is recommended as the preferred alternative both from a benefits and from a cost perspective.

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[1]There is a technological advantage of using Alternative 3 over Alternative 4 from the perspective of using "new" rather than "old" technology. In addition, when an analysis of Outside the Continental United States (OCONUS) requirements (especially sizing) is completed, it is believed that a much reduced platform will be required at OCONUS sites. Alternative 3 lends itself to downsizing much better than does Alternative 4. Thus, on a worldwide basis, it is believed that Alternative 3 is the preferred alternative.

When choosing the design strategy for the proposed IBS, MTIT must consider state-of-the-art technological capabilities. AUTOSTRAD 2000 encourages flexibility of design to support both centralized and distributed processing. This forward-looking vision must not be ignored just to accommodate current knowledge of hardware and software techniques and technology. Through innovative design and planning for IBS, MTMC can build a computer system for the present which will be usable well into the future.

ABSTRACT

The Military Traffic Management Command's proposed Integrated Booking System (IBS) will provide automation support for movement of international surface cargo. IBS will operate during peacetime and wartime to book unit and nonunit cargo. This Economic Analysis (EA) provides draft cost estimates over a 10-year life cycle for four alternative strategies. The EA considered costs only for implementation and operation in the Continental United States although IBS will be implemented worldwide.

Through the year 2004, costs for Alternative 1, maintain the status quo, are estimated at a total of $11,461,000. Costs for Alternative 2, modify the current systems, are estimated at $11,821,000. Costs for Alternative 3, develop IBS with a client/server architecture, are estimated at $10,690,500. Costs for Alternative 4, develop IBS on a midrange mainframe computer with terminal access, are estimated at $10,622,900.

Alternatives 3 and 4 are preferred from a technological and operational viewpoint as well as from a cost perspective. Alternative 3 provides additional benefits over Alternative 4 because of its downsizing capabilities. Thus, Alternative 3 is the recommended course of action.

1. INTRODUCTION

1.1 PURPOSE OF THE ECONOMIC ANALYSIS

This Economic Analysis (EA) for the Military Traffic Management Command's (MTMC's) proposed Integrated Booking System (IBS) provides:

- a brief discussion of the existing methods and procedures used by MTMC International Traffic (MTIT) for performing booking operations,
- a statement of the objectives of the proposed automated information system (AIS),
- a discussion of the scope of the requirements for a system to replace current methodologies and fulfill the booking requirements,
- assumptions and constraints that may affect implementation of the proposed system,
- descriptions of four alternative strategies for fulfilling the objectives of the proposed AIS,
- a comparative analysis of the four alternatives,
- tables (Sect. 4) containing draft cost estimates for each alternative based on a ten-year system life cycle,
- a brief discussion of risks, and
- a recommendation based on the comparison of the four alternatives.

After the first draft of this EA was produced in March 1991, Oak Ridge National Laboratory (ORNL) conducted an architectural analysis for IBS. Based on the results of that analysis, this version of the EA has been modified to include additional emphasis on the recommended architectural platform. This version of the EA also addresses MTMC

comments on the draft EA. MTMC will continue to update and revise this EA as part of the life-cycle management (LCM) documentation for IBS.

This document describes four design strategies for accomplishing the mission of the proposed IBS:

- Alternative 1 - Maintain the "status quo."
- Alternative 2 - Modify the current systems and methodologies [Mechanized Export Traffic System II (METS II), Automated System for Processing Unit Requirements (ASPUR), and various other manual and automated procedures].
- Alternative 3 - Develop IBS with a client/server architecture.
- Alternative 4 - Develop IBS on a midrange mainframe computer with terminal access.

Cost tables are provided in Sect. 4 on each of the four alternatives. These tables can be modified over time to reflect changing requirements and/or economic conditions. Some costs have been estimated at this time because the cost elements are not clearly defined in terms of final configuration and usage.

Eventually IBS will be fielded worldwide; however, this EA includes costs only as they pertain to Continental United States (CONUS) sites. Alternatives 1 and 2 (the status quo and modification of the status quo) are described in terms of existing CONUS hardware and software. This EA should be considered incomplete until after it is expanded to include Outside the Continental United States (OCONUS) development. Although it may be assumed that OCONUS implementation will involve two or three regionally located sites with hardware requirements approximating or less than those of the Western Area Command (AC), other investment and operational costs cannot be estimated without a requirements analysis.

1.2 OBJECTIVES OF THE PROPOSED SYSTEM

MTMC executes its traffic management mission by managing and monitoring peacetime cargo movements; responding to inquiries for cargo status; reporting the status of wartime unit and nonunit cargo movements; monitoring the performance of ocean carriers, shippers, and traffic managers; and analyzing the transportation pipeline to ensure the efficient and economical expenditure of transportation funds. MTMC is also the single manager within the Department of Defense (DOD) for origin-to-final-destination management of intermodal containers.

Current procedures for accomplishing this mission are briefly described in Sect. 1.3. These systems and procedures have several shortfalls. IBS can correct these deficiencies and provide MTIT with a tool to accomplish its mission more efficiently. The primary objectives of IBS are discussed below. [Specific operational, performance, and functional objectives are listed in detail in the IBS Functional Description (FD), provided to MTIT in July 1991.]

1. The primary objective of IBS is to provide a single, worldwide, automated booking system to support MTIT's cargo management mission.

2. IBS will provide booking for both unit and nonunit cargo in an efficient and timely manner. Existing automated functional requirements of ASPUR and METS II will be incorporated into IBS.

3. IBS will be used for both peacetime and wartime operations.

4. IBS will follow MTMC directives for open-systems architectural design.

5. IBS must interface with current and proposed systems within the MTMC Directorates of MTIT, Inland Traffic (MTIN), and Strategic Plans and Mobility (MTPL), as well as with systems outside MTMC. IBS will collect, process, and output data. IBS data transfers with external systems will be both automated and manual.

6. It is proposed that IBS will share data with a corporate database, which will be accessible by other MTMC automated systems. This shared data environment will

tie booking to documentation (e.g., manifesting), provide international visibility, and aid in tracking shipment status information from origin to destination.

7. IBS must receive data from classified systems in order to book wartime cargo movements. To efficiently conduct booking operations in a consistent manner in both peacetime and wartime conditions, IBS must be an unclassified system. Declassification of data will occur before the data are entered into IBS. For further explanation of this declassification procedure, see Sect. 2 of this EA, item No. 11, and also the IBS FD, Sect. 6.2.3.2.

1.3 EXISTING METHODS AND PROCEDURES

Currently the CONUS booking mission for deploying units (used during exercises and contingencies) is supported by ASPUR, and the CONUS mission for booking peacetime nonunit cargo is supported by METS II. There is no automated system for booking wartime nonunit cargo, although it is assumed that METS II would be used in time of war as much as possible. Both METS II and ASPUR operate at the CONUS ACs. There is no interface between the two systems, however. Therefore, if a global conflict erupted, no automated system exists for comparing unit and nonunit resource utilization for international cargo.

There is currently no standard automated system to support the OCONUS booking mission. The only automated booking aid overseas is the Department of the Army Standard Port System - Enhanced (DASPS-E), which is a system for port management and cargo documentation.

Cargo status data for peacetime operations exist in a number of separately maintained data systems. These include a variety of shipper and carrier systems, MTMC booking systems, and cargo documentation systems. Getting information on all of the events that occur between the initiation of a request for booking of a shipment and delivery to final destination requires accessing each of the separate systems. No specific provisions exist for cargo tracking during wartime. [Although the Joint Operation Planning and Execution

System (JOPES) purportedly tracks the cargo, an efficient method for updating JOPES has not been developed because of the problems associated with interfacing unclassified systems with the classified JOPES.]

Ocean Cargo Clearance Authorities (OCCAs) and Ocean Cargo Booking Offices (OCBOs) are located throughout the world to provide effective and economical movement of cargo within the ocean segment of the Defense Transportation System (DTS). The OCCA or OCBO controls the movement of Department of Defense (DOD) cargo by providing routing, port selection, and booking with the appropriate carrier. Also, the OCCA administers the Military Sealift Command (MSC) container agreements and contracts with commercial ocean carriers for the export and import of DTS cargo.

For exercises and wartime operations, the Emergency Operation Center (EOC) becomes the central traffic management interface with ocean terminals and MSC. MTMC EOC staff is formed from the services and from MTMC personnel from the Directorates of MTIT, MTPL, and MTIN. MTMC EOCs are located at MTMC Headquarters (HQMTMC) and at the ACs. Communication between EOCs is accomplished via secure lines, through Worldwide Military Command and Control System (WWMCCS) terminals over the WWMCCS Intercomputer Network (WIN) or through secure Automatic Digital Network (AUTODIN) transfers. Currently no direct automated interface exists between MTMC booking offices and agencies that make projections of cargo volume or movement requirements.

1.4 SCOPE OF THE PROPOSED SYSTEM

IBS will be a lead execution system of the DTS for international surface cargo in both peacetime and wartime. Consistent procedures will ensure that the workforce can move efficiently from peacetime to wartime operations. IBS must also satisfy the MTMC mission to execute the strategy developed in deliberate planning for international surface cargo. In addition, IBS will be responsible for booking nonunit cargo during contingencies. Thus,

IBS will provide a single automated system during wartime for viewing both unit and nonunit international cargo requests.

IBS must conform to the MTMC guidelines for an open-systems architecture. The ultimate goal of IBS is to provide international cargo booking for both unit and nonunit movements during peacetime and wartime. IBS will replace aging systems and integrate automated and manual procedures. Good human-computer interface design will be incorporated into the system during its development.

Although this EA addresses IBS only at CONUS sites, IBS will eventually be fielded at both CONUS and OCONUS sites. IBS capabilities will enhance visibility of the booking process.

1.4.1 Background

MTMC has a worldwide responsibility to provide traffic management for international surface cargo movements. The IBS Mission Elements Needs Statement (MENS) was published in mid-1989. MTMC assigned ORNL responsibility for development of a proof-of-concept IBS prototype (IBS-P). The IBS-P identified required functionality, interfacing systems, potential problems, and operational objectives. ORNL was also tasked with producing five documents relating to the prototype system (Database Description, End-Users Handbook, User Interface Guidelines, Test Plan, and Implementation Plan). These reports can be refined into LCM documents for the target IBS. Production of this EA and the IBS FD was also part of the ORNL tasking.

1.4.2 Summary of Improvements

The current methods for booking cargo have several shortfalls. For example, multiple systems are maintained for performing similar functions. This duplicative effort increases

maintenance and training costs and reduces flexibility. In addition, some of the current systems are nearing obsolescence. Users are becoming more aware of state-of-the-art computer capabilities and are demanding additional and more powerful automation, including on-line access and visibility of the total booking arena.

IBS will provide the following improvements to the existing methods for booking.

- IBS will provide a single system for booking unit moves for exercises and contingencies.
- IBS will provide a decision-support system for use with "standard" nonunit booking requests which will aid the booking technician in booking typical cargo movements.
- IBS will be sized for wartime booking operations and will provide an efficient solution to the need, during wartime, for nonunit cargo movements.
- Because IBS will be the booking system used during both peacetime and wartime, proficiency in its use during a contingency (for both nonunit and unit moves) will already be developed.
- The IBS peacetime algorithm for choosing a low-cost carrier is different from the wartime algorithm for choosing a carrier to meet the required delivery date; however, this difference will be transparent to the IBS operator.
- Through the use of consistent user interfaces, system flexibility, and state-of-the-art technology, the booking business will be conducted more efficiently.
- IBS will eventually be provided to both CONUS and OCONUS sites; currently the OCONUS sites have no automated booking aides.
- Because IBS will be a worldwide system that contains booking information for international surface cargo movements, the capabilities of and timeliness of acquiring movement status data will be greatly enhanced.
- Because IBS is a critical part of the DTS, the system must be efficient and reliable, and the data must be correct. IBS will be designed for on-line transaction processing, Thus, performance will be optimized for rapid response times, and tight controls on data integrity can be maintained.

Based on previous experience, a cost savings resulting from the development of IBS can be anticipated. The value of this savings is estimated as 0.1% of the total transportation costs for containers and breakbulk shipments. Annual transportation costs for container shipments are estimated at $500 million and for breakbulk at $125 million for a total annual transportation bill of $625 million. Thus the total savings can be estimated at $625,000 annually, which would accrue to the Navy Industrial Fund. Although this is a significant savings, it is not included in the cost tables in Sect. 4, since they are representative of MTMC costs for MTMC systems.

1.4.3 Summary of Impacts

At the AC, the OCCA operates during peacetime to book nonunit cargo moves, and the Terminals Division operates during exercises and contingencies to book unit cargo moves. It is anticipated that IBS computer equipment will exist in both environments and that the current responsibilities of each office will continue. In addition, the OCCAs will be responsible for using IBS to book nonunit cargo during wartime as well as peacetime operations.

Because of increased automation capabilities, the Terminals Division should not have the need to rekey declassified information from JOPES into an unclassified system. This impact should result in more efficient operations for booking unit moves.

Prior to and during implementation, METS II and ASPUR will continue to function at their current level of effort. They will be maintained in a status quo without enhancements until IBS is implemented. At the time that IBS becomes operational, three options exist:

1. Continue to operate METS II and ASPUR until all bookings already existing in the two CONUS systems are complete (for METS II, approximately 90 days) in parallel with the operation of IBS, which will be accepting all new requests. IBS will not track bookings that were in place in METS II prior to IBS initiation, and

no historical booking data will be loaded into IBS. ASPUR will complete booking for any exercises underway at the time of IBS implementation.

2. Load all active METS II data into IBS as soon as IBS comes on-line. This procedure has the advantage of identifying any problems in volume processing early in IBS's existence while METS II would still be available for processing the bookings if necessary. A major disadvantage is the necessity for development of an interface tool to transfer data for METS II to IBS. ASPUR functionality would be implemented at the time of the first scheduled exercise after IBS implementation.

3. If IBS is implemented during a contingency, both METS II and ASPUR data should be immediately loaded on IBS. If any problems arise, both METS II and ASPUR would be available as backup systems.

Prior to development, the staff responsible for developing and maintaining IBS [MTMC Information Management (MTIM) at the Eastern AC] will need training in the programming languages. The greatest impact during the development period will be on these developers at the Eastern AC, because personnel will continue to maintain METS II and ASPUR at the same time that they are developing the programs for IBS.

Prior to implementation, training will be required for IBS users. Detailed training will be required for the system, database, data, and network administrators. During the initial training period, some personnel may need to be cross-trained to handle on-going work while others are being trained in use of the new system.

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1.6 TERMS AND ABBREVIATIONS

AC	Area Command
ACI	Automated Carrier Interface
ADD	Army Data Dictionary
AIS	Automated Information System
ASCII	American Standard Code for Information Interchange
ASPUR	Automated System for Processing Unit Requirements
AUTODIN	Automatic Digital Network
CMB	Cargo Management Branch
CONUS	Continental United States
DASPS-E	Department of the Army Standard Port System-Enhanced
DEC	Digital Equipment Corporation
DDN	Defense Data Network
DLSS	Defense Logistics Standards System

DOD	Department of Defense
DOE	Department of Energy
DTS	Defense Transportation System
EA	Economic Analysis
ECC	Error Correction Code
EOC	Emergency Operation Center
ETR	Export Traffic Release
ETRR	Export Traffic Release Request
FD	Functional Description
FORSCOM	U.S. Army Forces Command
FTE	Full-time Equivalent
FY	Fiscal Year
GB	Gigabyte
HQMTMC	MTMC Headquarters in Washington D.C.
IBS	Integrated Booking System
IBS-P	Integrated Booking System Prototype
IPC	Interpersonal Computer (Sun workstation)
IV&V	Independent Verification and Validation
JOPES	Joint Operation Planning and Execution System
LAN	Local Area Network
LCM	Life Cycle Management
MAD	Master Address Directory
MB	Megabyte
MENS	Mission Element Needs Statement
METS II	Mechanized Export Traffic System II
MFLOPS	Million Floating Point Operations per Second
MHz	Megahertz
MIPS	Million Instructions per Second
MSC	Military Sealift Command
MTMC	Military Traffic Management Command
MTIM	Information Management (MTMC Directorate)
MTIN	Inland Traffic (MTMC Directorate)
MTIT	International Traffic (MTMC Directorate)
MTPL	Strategic Plans and Mobility (MTMC Directorate)
O&M	Operations and Maintenance
OCBO	Ocean Cargo Booking Offices
OCCA	Ocean Cargo Clearance Authority
OCONUS	Outside the Continental United States
ORNL	Oak Ridge National Laboratory
PC	Personal Computer
R&D	Research and Development
RAM	Random Access Memory
RDBMS	Relational Database Management System
RISC	Reduced Instruction Set Computing
SAS	Statistical Analysis System
SCSI	Small Computer System Interface

SMSCRC	Standard Multiuser Small Computer Requirements Contract
SQL	Structured Query Language
TACOS	The Automated Container Offering System
TC ACCIS	Transportation Coordinator's Automated Command Control Information System
TCP/IP	Transmission Control Protocol/Internet Protocol
VAN	Value-Added Network
VGA	Video Graphics Adapter
VUPS	VAX Unit of Performance
WIN	WWMCCS Intercomputer Network
WPS	Worldwide Port System
WWMCCS	Worldwide Military Command and Control System
4GL	Fourth-Generation Language

2. ASSUMPTIONS AND CONSTRAINTS

The following assumptions and constraints can affect the costs and/or benefits (e.g., functionality, timeliness) of IBS.

1. A specific automation base for MTMC is stated in the AUTOSTRAD 2000 Plan. IBS will conform to the guidelines provided for hardware, software, and telecommunications.

2. IBS will be both a decision-support system and an operations support (on-line transaction processing) system.

3. ORNL designed a proof-of-concept prototype of the overall system, costs of which are included under the Research and Development (R&D) cost category. Activities included prototyping the system and preparing certain LCM documents. Because the prototype hardware and software environment is inadequate for the target IBS, the prototype will not be ported to the operational environment. Although the programming logic and system structure of the prototype will be useful to IBS programmers, all code will be rewritten. Thus, costs for total code production and implementation of IBS are included in this EA.

4. IBS will include a relational database management system (RDBMS) with a set of information management and analysis tools. Ada will be combined with a fourth-generation language (4GL) for programming of applications. Some modules may be written in an object-oriented language, probably C++. Additional programming packages, possibly including one for graphics output and one for statistical analysis, may be required. These costs, insofar as they have been determined, are included in this EA.

5. For the purposes of determining costs for this EA, it is assumed that, in CONUS, the IBS system, including a complete suite of hardware, software, and telecommunications, will reside at two sites: Eastern AC and Western AC. (See Sect. 3 for a discussion of this decision.) If during further examination of the requirements of IBS it is determined that a single site is sufficient, then costs must be recomputed. The determination of the final design and siting will affect the costs of the system.

6. IBS will be developed by MTIM-Development personnel at MTMC Eastern AC. An average rate of $3,000 per person-month for programmers, analysts, and management personnel is used for estimation of these development costs (Alternatives 2-4). Actual costs (FY91 dollars) are used (Alternative 1-4) for personnel costs to maintain the current systems.

7. The new system must interface with various existing or planned systems, as well as with organizations that have no automated interfaces. Shippers, requesters, carriers, MTMC systems, theater automated systems, the military services, and MSC need to interact with IBS. These interfaces and accompanying conversion tables, as far as they are part of IBS program code, are included in the costs of IBS. The hardware and telecommunications costs for remote users will not be costed to IBS.

8. Existing external interfacing systems will not need redesign or data/database changes; any changes to these systems which affect IBS will be communicated to the IBS designers and developers at the earliest possible time. Maintenance costs for IBS include costs for expected configuration changes.

9. A shared data environment may be used to provide a solution to MTIT's requirement for tying booking to manifesting through automated system interfaces. This corporate database, or a comparable solution, will be available for

use by IBS when needed. Costs for the design and maintenance of this shared data environment are not included in the costs for development of IBS.

10. The data dictionary for IBS will conform, insofar as is possible, to the Defense Logistics Standards Systems (DLSS) Dictionary and the Army Data Dictionary (ADD). Because these standards will be used in the initial design of IBS, no additional costs (e.g., for retrofit or redesign) are expected to result from this design requirement.

11. Any conflicts related to security issues, such as receiving data from and transmitting data to classified systems from the unclassified environment of IBS, will be resolved in a timely manner that will not hinder the development and effective operation of IBS. The procedure that has been proposed for accomplishing this declassification is as follows: (1) download data from JOPES to a stand-alone personal computer (PC) in a secure area, (2) delete or mask fields that cause the data to be classified as secret/top secret, (3) certify the data as declassified, (4) load the unclassified data onto removable electronic media (disk or tape), and (5) transport the disk or tape to the IBS area and load the data into the IBS database. Costs for hardware and/or software programs required to implement security measures are included in this EA.

12. None of the IBS hardware will require a TEMPEST configuration. IBS will be an unclassified system.

13. Any conflicts relating to database/data access and usage that could affect the integrity of the database/data and/or the sensitivity of information on unit moves will be resolved in the implementation of appropriate hardware and software components. Associated costs are included in this EA.

14. At the Eastern AC, no more than 50 individuals will be logged into IBS at any one time conducting nonunit movement booking operations; no more than four

individuals will be logged on at any one time conducting unit booking operations; and no more than 30 users will be remotely logged on transmitting files and/or querying the database. Therefore, a maximum of 84 users can be logged on concurrently. Selection of the hardware must consider these sizing requirements.

15. At the Western AC, no more than 18 individuals will be logged on at any one time conducting nonunit movement booking operations; no more than two individuals will be logged on at any one time conducting unit booking operations; and no more than 20 users will be remotely logged on transmitting files and/or querying the database. Therefore, a maximum of 40 users can be logged on concurrently. Selection of the hardware must consider these sizing requirements.

16. The system must meet the needs of a range of MTIT users including management, bookers, personnel from Terminals Division, requesters, shippers, carriers, planners, data administration staff, and maintenance and modification staff. There will be four types of IBS user access: (1) users who are conducting the booking business, (2) users who are transmitting data to or from the system or are changing data values, (3) users who are querying the database but not changing the data, and (4) individuals who are maintaining/modifying the system. Hardware and software requirements for each of these categories of users are addressed separately in this EA.

17. Shippers and requesters will communicate with IBS through dial-up telephone lines. MTMC sites will communicate via local area networks (LANs), value-added networks (VANs), or the Defense Data Network (DDN). Communication costs are addressed in this EA.

18. The capability for tying documentation to booking will be severely limited until both the Worldwide Port System (WPS) and IBS are installed and operational worldwide. This capability is a definite cost benefit of IBS development; however, its specific effect cannot be measured because of uncertainties surrounding the

development and implementation timeframe of the two systems and the possible use of a shared data environment. (A "best guess" estimate of the savings in transportation costs that would result from IBS implementation is given in Sect. 1.4.2.)

19. IBS will require dedicated system, database, network, and data administration staff at each RDBMS site.

20. Costs for implementing IBS OCONUS are not included in this document; however, this cost must be analyzed prior to considering the IBS cost analysis complete. This is a critical cost omission, and MTIT is aware of the omission.

21. The costing time period is by fiscal year (FY). Operation and maintenance (O&M) costs after implementation will be equally distributed over the useful lifetime (ten years).

22. The R&D for IBS will be completed by the end of April 1991; the target system design period began in July 1991; programming will begin in October 1991 (FY92); deployment will begin in FY93; deployment will be completed at Eastern AC and Western AC by the end of FY94. The target hardware and software for Eastern AC will be purchased in FY92; and the target hardware and software for Western AC will be purchased in FY93.

23. Costs prior to FY91 are actual costs; costs for FY91 and post-FY91 are in FY91 dollars.

24. The system design will be flexible enough to allow it to evolve to meet the changing needs of the MTIT organization. This flexibility is a cost benefit but cannot be quantified for this EA.

25. Computer technology is rapidly changing, especially in the areas of hardware, multilevel security, and data communications. These changes may result in additional costs or reduced costs for IBS. Technology trends are not projected in this EA.

26. The decision-support module, used to find the low-cost carrier, is being developed through a prototyping effort entitled The Automated Container Offering System (TACOS). TACOS will be fully functional and available for incorporation into IBS (including program code, hard-copy documentation, and hardware platform requirements) when needed for conversion to the IBS development language. Costs for development and testing of the TACOS prototype and for porting TACOS to the target operational language are not included in this EA. Costs for linking this module to the IBS framework and for maintenance and modification of this module are included in this EA.

27. Before a final architectural platform is chosen, a study should be conducted to ascertain hardware and software constraints in the OCONUS environment. These costs are not included in this EA.

3. DEFINITION OF ALTERNATIVES

Four alternative strategies have been examined as possible approaches for accomplishing the objectives of IBS as listed in Sect. 1.2. These alternatives, which are discussed in Sects. 3.1-3.4, are as follows:

- Alternative 1: Maintain the status quo,
- Alternative 2: Modify the current systems and methodologies,
- Alternative 3: Develop IBS with a client/server architecture, and
- Alternative 4: Develop IBS on a midrange mainframe computer with terminal access.

Certain characteristics must be adhered to if a new system is developed. These include AUTOSTRAD 2000 guidance and DOD and MTMC directives to provide an open-systems architecture with an RDBMS, to use Ada and/or a 4GL, and to ensure general interoperability.

The configurations of Alternatives 1-4 are based on the assumption that in CONUS similar hardware, software, and telecommunications capability will exist at each of the two proposed sites (although the total number of individual workstations/PCs/terminals may be less at Western AC). Two arguments exist for this design decision: first, backup is automatically provided (although at reduced performance because of the increased workload) during downtime or in case of massive destruction of one of the sites; second, the similar environment ensures that each AC has a highly responsive system but that personnel at each site have access to the other system, if needed, for booking purposes. A potential hardware configuration is listed in each alternative presented below. A hardware platform of equivalent or greater power, capacity, and response could be substituted. Costs, given in Sect. 4, represent the configuration required for both CONUS ACs. It

should be noted that the design of IBS will ensure that log-ins from individuals at remote sites (HQMTMC, shippers, ports, etc.) will not require special hardware. It is assumed that these individuals will have access to automated equipment such as PCs and modems; thus, there is no cost to IBS for any of this remote hardware. Programs on the proposed AIS telecommunications server will ensure appropriate access and use of IBS; costs of these programs will be included in the costs of IBS development.[1]

An alternative design (for the configurations given in Alternatives 3 and 4) would be to install a larger capacity, more powerful central computer (or series of linked computers) at Eastern AC on which the data for both ACs would be stored. This computer (or computers) and database would be maintained by Eastern AC personnel. A centrally managed database has both advantages and disadvantages. This option needs to be examined further before a final decision is made on sizing.

3.1 ALTERNATIVE 1 - MAINTAIN THE STATUS QUO

A brief overview of the current booking systems and methodologies is given in Sect. 1.3. In CONUS, ASPUR aids in booking unit moves, and peacetime nonunit booking is handled by METS II. In addition to automated interfaces [e.g., with commercial carriers through the Automated Carrier Interface (ACI), with some requesters and shippers for transmitting Export Traffic Release Requests (ETRRs) and Export Traffic Releases (ETRs) online, and with the Transportation Coordinator Automated Command Control Information System (TC ACCIS)], many data transfers are handled in a semi-automated manner [e.g., computer tape in ASCII format from U.S. Army Forces Command (FORSCOM)] or manually [e.g., with MSC, MTIN, JOPES, some shippers and requesters who cannot provide automated data exchange, foreign flag ships, and ports]. No interface

[1]The assumption is made that the hardware and software available at these remote sites is very basic (i.e., there is no access to a mouse, color, or windows) and that the hardware/software at the database server must allow for this very limited type of access.

exists between METS II and ASPUR. METS II and ASPUR operate only in CONUS and move cargo from CONUS to OCONUS.

ASPUR runs on a VAX 11/780 at the Eastern AC and on a VAX 8250 at the Western AC. Implemented at the MTMC Eastern AC in 1984 and at the Western AC in 1989, ASPUR has never been fully operational in terms of its original concept, primarily because of a failure to establish a common data element key between JOPES files and FORSCOM files. Therefore, much of the effort expended to book unit moves is handled by downloading JOPES data and entering pertinent information into a spreadsheet on a stand-alone IBM-compatible computer to perform analysis unsupported by ASPUR. Because the information must be considered "SENSITIVE" (although unclassified), information exchanges are via secure AUTODIN lines. No automated interfaces exist. Data from FORSCOM resides in ASPUR, and the ASPUR data are manually compared with the JOPES data by personnel in the Terminals Division. Essentially the same procedures are followed for peacetime exercises and wartime unit moves. Terminals with communication links to the ACs VAX computers are located in the computer room, the EOC, and in MTIN and MTIT offices. Communications with MSC are handled by courier.

At the ACs, METS II runs on a Honeywell Level 6 computer. METS II was implemented in 1984 at the Eastern and Western ACs. The program has been modified as needed to provide additional features. Each AC owns one Honeywell Level 6 computer. In addition, the Eastern AC has a backup Honeywell Level 6. The Western AC has 16 terminals in the OCCA; the Eastern AC has 34 PCs and/or terminals in the OCCA. Additional PCs are located in the MTIT systems area for management access. Requests and releases are transmitted by dial-in access, via AUTODIN, or by phone. The ACI is used to communicate offers and replies with the carriers who have ACI connectivity. The phone, facsimile, or mail may be used. (In the future, it is expected that carriers will be required to use ACI to do business with MTMC.)

The greatest percentage of traffic management requests within MTMC are requests for booking of nonunit peacetime cargo. Approximately 4,000-6,000 peacetime nonunit

requests are booked each month at the Eastern AC. At the Western AC, approximately 2800 nonunit requests are booked each month. Of all nonunit cargo moves, about 90% are booked with commercial carriers using MSC rates; very few MSC ships are used for nonunit cargo. About 1% is booked to foreign flag vessels. Also, the Western AC provides Government-Bill-of-Lading support for Hawaii and Guam (commercial ships, commercial tariff). In contrast, 90-100% of unit moves are handled by MSC-controlled ships.

Alternative 1 would maintain the current systems with no major revisions or upgrades. The only modifications to the status quo would be minor revisions required to maintain the current operational capability. The status quo option fails to meet the objectives listed in Sect. 1.2 for the proposed AIS.

Continuation of the status quo has several disadvantages that must be addressed if this alternative is chosen. First, it should be noted that METS II has reached the saturation point for adding new users. Although MTMC is stressing that users should dial directly into METS II for uploading files (rather than using AUTODIN), there are no additional user slots available. In addition, METS II has been judged inadequate for use in Europe. Finally, TACOS, a decision-support system which is currently being used at Eastern AC to aid with booking nonunit cargo, is unusable at the Western AC.

3.2 ALTERNATIVE 2 – MODIFY THE CURRENT SYSTEMS AND METHODOLOGIES

The current systems (METS II and ASPUR) for conducting MTIT business operations in CONUS are described in Sect. 3.1. This alternative would continue to use the current hardware, operating systems, telecommunications, and system software. However, in order to attempt to fulfill the objectives of the proposed AIS (Sect. 1.2), major modifications would be necessary. Modifications that would be required <u>at a minimum</u> if the current systems were to be enhanced to the point that they could meet the objectives of IBS would be the following:

Mod. 1. Combine the METS II and ASPUR databases.

Mod. 2. Upgrade existing hardware to a level that will support all of the current ASPUR and METS II functionality in a state-of-the-art, maintainable, upgradable configuration.

Mod. 3. Implement the combined METS II/ASPUR system OCONUS and provide worldwide interconnectivity.

Mod. 4. Provide a single consistent user interface for unit and nonunit, peacetime and wartime, CONUS and OCONUS procedures.

Mod. 5. Provide automated interfaces with shippers, requesters, MSC, MTIN, FORSCOM, the to-be-developed WPS, and the possible corporate database. Design and implement a semi-automated interface (air-gapped) with JOPES and possibly with MSC.

Mod. 6. Provide sufficient system protection to ensure that the sensitivity of unit moves data will not be jeopardized.

Mod. 7. Develop and implement a workable policy for automatically comparing JOPES data with DTS data.

Mod. 8. Incorporate a decision-support module to aid the user in determining a best carrier for nonunit cargo.

Mod. 9. Add functionality for booking nonunit wartime resupply.

Mod.10. Support Cargo Management Branch (CMB) functions through automated procedures.

Each of the above requirements for modification has been studied for technological feasibility and reasonability. The results of this analysis are listed below; each numbered comment corresponds to the similarly numbered modification listed above.

Comment 1: METS II programs are written primarily in COBOL; ASPUR is programmed in COBOL and Oracle. METS II uses flat files for data storage, and ASPUR uses the Oracle RDBMS. It would be more efficient and more productive in the long-term to design a new relational database structure than to attempt to combine these two databases and reprogram both systems to accommodate the combined database. Therefore, this modification cannot reasonably be met if METS II and ASPUR programs and databases remain in their current design status.

Comment 2: Neither the Honeywell Level 6 nor the VAX 11/780 is considered state-of-the-art technology. To upgrade the computers to the desired level is not wise either from a technological or an economical viewpoint considering current advances in computer hardware technologies. Therefore, this modification cannot reasonably be met if METS II and ASPUR hardware platforms remain in their current configurations.

Comment 3: Implementation of OCONUS combined METS II and ASPUR system (if it were feasible) would require purchase of additional hardware, implementation at the OCONUS sites, and training. Because this EA concentrates on CONUS costs, costs of this modification are not considered in this EA.

Comment 4: Because of the failure of Modifications 1 and 2, this requirement also cannot reasonably be met.

Comment 5: This modification is possible. The cost is estimated and included in this EA. (See also Sect. 3 for costs that are not included.)

Comment 6: This modification is possible, and an estimate of the cost has been included.

Comment 7: This modification is possible, and an estimate of the cost has been included.

Comment 8: This modification is possible, and an estimate of the cost has been included.

Comment 9: This modification is possible, and an estimate of the cost has been included.

Comment 10: This modification is possible, and an estimate of the cost has been included.

It is important to note that the first, second, and fourth modifications listed as requirements in order for this alternative to meet the objectives of IRS are neither technologically nor economically wise (as stated in Comment 1 for Mod. 1, above). Costs for implementation of this alternative without Modifications 1, 2, and 4 have been estimated; these costs are included in Sect. 4. However, it must be stressed that this alternative fails to meet the minimum requirements of the objectives for IBS.

3.3 ALTERNATIVE 3 – DEVELOP IBS WITH A CLIENT/SERVER ARCHITECTURE

A configuration that should be capable of fulfilling all functional, operational, and performance requirements for IBS is the client/server architecture. The basic configuration is to link one or more minicomputers (or powerful workstations) as database servers and attach multiple small workstations (or responsive PCs). The RDBMS (and the data) would reside on the server; most applications processing would occur on the individual workstations.

A potential DRAFT hardware configuration used for cost estimation is listed below. Configurations based on specific vendors are given in Appendix A. Estimated costs for this potential configuration are given in Sect. 4.

3.3.1 Hardware Environment

- Server -- minicomputer/workstation (must be upgradable; may need to link multiple server components or add additional processing boards to provide optimum performance)
    - 25 MHz [24 million instructions per second (MIPS)] system board (minimum capability)
    - 32-bit processor
    - Floating point coprocessor
    - 64 megabytes (MB) of memory
    - Nonremovable hard disk drives for a total of at least 1 gigabyte (GB) of formatted storage
    - Small Computer System Interface (SCSI) cartridge tape drives for a total of at least 1 GB of backup storage capacity
    - SCSI host adapter card
    - Monitor and keyboard (workstation) or system console (minicomputer)
    - 16 serial ports and controllers
    - Power supply and cables
    - Communication boards
    - Unlimited users license
    - Warranty
    - Documentation

- Workstation -- 80386 (minimum) or Reduced Instruction Set Computing (RISC) microprocessor [at Eastern AC, 54 separate workstations are required; they will operate on two separate LANs; at Western AC, 20 separate workstations on two LANs are required][2]
  - Video graphics adapter (VGA) high-resolution graphics color monitor (14 or 16 inch)
  - Serial mouse and driver
  - 101-key enhanced keyboard
  - 16 MB of random access memory (RAM)
  - 25 MHz processing speed
  - 160 MB SCSI hard disk drive
  - 1.2 MB floppy disk drive
  - Ethernet cables

- Boards and/or external devices to complete the following networking requirements
  - DDN X.25 network
  - IEEE 802.3 LAN
  - RS-232C dial-in ports

- Laser printer for complex or extra high-quality printing requirements [three printers required at each AC (a total of six): one for the OCCA, one for the Terminals Division, and one for MTIT management]
  - High-resolution, low-speed (300 x 300 dots per inch; 8 pp/min)
  - Supports complex graphics and multiple user-selectable fonts

- Laser printer for fast page printing (at Eastern AC, a total of eight printers are required: five for the OCCA, one for the Terminals Division, and two for MTIM in the systems management area; at Western AC, a total of four printers are required: two for the OCCA, one for the Terminals Division, and one for systems management)[3]
  - High-quality, high-speed (300 x 300 dots per inch; 24 pp/min)
  - Five type fonts and multiple pitches

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[2]One LAN would be used in the OCCA for conducting nonunit resupply bookings; one would be located in the Terminals Division for booking unit moves.

[3]It is assumed that, if printers are needed at sites with whom automated interfaces are desired, such as MTIN or MSC, these organizations will purchase the appropriate hardware.

3.3.2 Support Software Environment

The following commercial software is proposed for use with the generic hardware platform listed above. The following list is based on the use of Ingres RDBMS and associated tools.[4] A software environment of equivalent capability and with equivalent features could be substituted for the Ingres RDBMS and applications software:

- UNIX operating system (or UNIX clone)

- Ingres RDBMS (v. 6.3) with the following tools
  - Ingres/Windows 4GL (development tool for X-windows environment)
  - Ingres Application by Forms (ABF) (a 4GL for non-windows development; required for programming certain forms that will be used by dial-in users)
  - Ingres Net (needed to provide the client/server environment)
  - Ingres Star (not yet available; however, will be required if a distributed database is designed; projected delivery date is end of calendar year 1991)
  - Ingres Knowledge Management (for storing business rules and database triggers)
  - Ingres Object Management (for adding user-defined data types)[5]

- C compiler or C++ compiler (to be used for programming the decision support module). (Prior to a final decision on the software, designers will ensure that the programming software for the decision support module has interfacing capability to the 4GL being considered.)

- Statistical analysis package (not yet available; the SAS[6]

Institute is currently developing an interface with Ingres RDBMS for the Statistical Analysis System (SAS).

- Ingres Embedded SQL (Structured Query Language) Ada compiler

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[4]Ingres is the RDBMS recommended by the IBS Architectural Analysis. Some of the Ingres tools reside on the server (e.g., Ingres Application by Forms) and some on the client (e.g., Ingres/Windows 4GL).

[5]This tool may not be necessary if no unique data types (e.g., latitude and longitude) are identified as needed in IBS.

[6]SAS is the title of the statistical analysis software produced by SAS Institute, Inc., Box 8000, Cary, NC 27511.

- Communications software
  - Transmission Control Protocol/Internet Protocol (TCP/IP) interface package
  - software to permit file sharing
  - software to permit a workstation or PC to handle communications

It is proposed that the application software be developed primarily in Ingres with some modules possibly being written in Ada. The Ingres RDBMS has interfaces with C. It is not definitely determined how TACOS will be reprogrammed in IBS; however, if C++ is used, it can probably be accessed through the C interface.

It is possible that a different RDBMS and applications development programming languages could be used. Indeed, other RDBMSs (e.g., Sybase, Oracle, and Informix) each have specific advantages and disadvantages with respect to the requirements of IBS. These different features are addressed in the IBS Architectural Analysis.

3.4 ALTERNATIVE 4 -- DEVELOP IBS ON A MIDRANGE MAINFRAME COMPUTER WITH TERMINAL ACCESS

With the extensive increase in workstation technology, including capacity and capability, the use of the mainframe computer as the only computing solution has decreased. For IBS, however, the mainframe is a possible configuration and has several advantages. This alternative is <u>not</u> equivalent to Alternative 3. The RDBMS, all data, all applications programming tools, and all system programs would reside on the mainframe computer. Access would be via a terminal or a microcomputer/workstation emulating a terminal. All processing would occur on the mainframe.

The hardware architecture described below is for Digital Equipment Corporation (DEC) VAX family. Because ASPUR runs on a VAX-11/780, some MTIM personnel at Eastern AC are familiar with the hardware and, thus, could be expected to require minimal training costs if another VAX were used. It should be noted that comparable

configurations from other vendors should be investigated for performance and price comparisons.

The IBS Architectural Analysis did not recommend this platform; therefore, a comparison of various software and hardware vendors was not undertaken for this option. If MTMC determines that this architecture is the preferred alternative, however, then additional RDBMS and hardware vendors should be contacted for cost and technology comparisons. [For example, two of the hardware vendors (Pyramid and Sequent) who submitted configuration/cost information for the client/server architecture could compete quite well in this arena.] In addition, although "Oracle on a VAX" has the advantage of being a platform that is familiar to some of the development staff, it is not necessarily the best combination of software and hardware for this alternative, should this alternative be chosen.

3.4.1 Hardware Environment

- Midrange mainframe computer -- VAX 4000 Model 300[7] (one VAX 4000 should be sufficient and costs in this EA are based on purchase of one VAX 4000 for each site; however, should expansion be necessary, data availability and processing speed can be increased through dual-hosting)
  - KA670 system module with CPU, two on-board DSSI adapters, and one on-board Ethernet controller
  - 32 MB Error Correction Code (ECC) memory[8]
  - 8 VAX units of performance (VUPs);[9] CMOS technology

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[7]This computer has a one-year product warranty.

[8]On the Vax 4000 Model 300, memory is expandable to 128 MB in 32-MB increments; also storage capacity is expandable to 28 GB. It should be noted that Alternative 3 costing is for a 64 MB memory configuration.

[9]The VUP is measured relative to the performance of the VAX-11/780 (VUP = 1). The VUP measurement is <u>not</u> equivalent to the MIPS measurement; however, because the average performance of the VAX 11/780 is close to 1 MIPS, for the purposes of this EA, they can be considered approximately equal.

- Integrated and removable storage elements to provide 2.8 GB of disk capacity[10]
- Floating-point accelerator
- 32-bit processor
- VMS file and application server and VMS cluster software license

- System console, DEC VT420

- Any terminal or existing PC may be adapted and attached to the Ethernet LAN. A possible configuration if new or additional equipment is to be purchased for IBS is the configuration of a workstation given in Sect. 3.3.1.

- Networking devices (boards and/or external units) must be added to complete the following networking requirements:
    - DDN X.25 network
    - IEEE 802.3 LAN
    - RS-232C dial-in ports

- The printers described in Sect. 3.3.1 are appropriate for this configuration.

3.4.2 Support Software Environment

The following commercial software is proposed for use with the hardware listed above. A 4GL software environment of equivalent capability and with equivalent features could be substituted for Oracle and the applications software.[11] Oracle was chosen as the RDBMS for this configuration because some MTIM personnel at Eastern AC have familiarity with the Oracle family of products on the VAX hardware. The DEC product Rdb could be chosen as the RDBMS for this particular hardware configuration because it is part of the

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[10]The costing for this configuration (Sect. 4) is based on 2.8 GB disk storage capacity. Alternative 3 costing is based on 1-GB storage capacity. These configurations and cost figures were provided by vendors based on IBS functional and operational requirements provided to the vendors.

[11]In the Draft EA, costs for the Oracle RDBMS were obtained as explained in the text. The IBS Architectural Analysis recommended the use of Ingres with a client/server configuration (Alternative 3). Because the Alternative 4 configuration was not recommended, a cost comparison of the Ingres RDBMS with this configuration was not obtained.

DEC purchase package at no additional cost. However, this choice of Rdb should be carefully examined prior to a final decision.

- VAX VMS operating system

- Oracle RDBMS (an unlimited user license) with
  - Oracle RDBMS Transaction Processing Option
  - Oracle SQL* Forms
  - Oracle SQL* Plus
  - Oracle SQL* Report Writer
  - Oracle SQL* Net
  - Oracle SQL* Menu

- C compiler or C++ compiler (to be used for programming the decision support module. Prior to a final decision on the software, designers will ensure that the programming software for the decision support module has interfacing capability to the 4GL being considered.)

- VMS DECwindows (features windowing and graphics capabilities based on X-Windows)

- Statistical analysis package

- VAXELN Ada

- Communications software
  - TCP/IP interface package
  - software to permit file sharing
  - software to permit a workstation or PC to handle communications

The application software is proposed to be developed primarily in Oracle, Ada, and in C (or C++).

4. COMPARATIVE ANALYSIS OF ALTERNATIVES

The four strategies that have been examined as possible approaches for accomplishing the objectives of IBS are compared in this section. The alternatives are examined in terms of ability to meet mission objectives (i.e., benefits) and in terms of actual costs. The alternatives considered are (1) to maintain the status quo, (2) to modify the current systems and methodologies, (3) to develop IBS with a client/server architecture, and (4) to develop IBS on a midrange mainframe computer with terminal access.

4.1 BENEFITS

4.1.1 Alternative 1

Alternative 1 does not meet the objectives of IBS. Maintaining the status quo implies maintaining multiple systems (rather than a single system), both in CONUS and, especially, in OCONUS. Maintaining the status quo implies that, during wartime, unless METS II can be used (i.e., cargo movement rates can be determined), no system exists for booking nonunit cargo.

Another reason for eliminating this alternative from consideration is the current condition of METS II operations. The Honeywell Level 6 (METS II hardware) is not a state-of-the-art computer;[12] the number of possible users who can log into METS II has reached the saturation point; METS II is inadequate for European operations; TACOS is unusable at

[12]Although warranties for both the Honeywell Level 6 and the VAX 11-780 are still available from the vendors, neither machine is currently being marketed.

the Western AC; and the amount of downtime caused by telecommunications, hardware, and software problems for METS II and the ACI is excessive.

The only benefit to this alternative is that nothing new needs to be developed or learned (if this can be called a "benefit"). If Alternative 1 is chosen, the current processes and procedures would continue to be used for booking cargo. However, if global warfare should occur, dependence on METS II and ASPUR could be a severe handicap because of the inadequacies of the current systems.

When METS II and/or the ACI goes down and the system or some integral part of it experiences downtime, three specific groups are impacted. According to information supplied by the Western AC, the following types and numbers of personnel are involved. [Obviously, at Eastern AC, similar groups (though larger numbers of personnel) are impacted if METS II and/or the ACI goes down.]

> International Traffic: 16 booking technicians and 7 other individuals in supervisory or management positions;
>
> Information Management: 3-7 individuals who are programmers, system analysts, computer operations personnel, or communications and maintenance personnel;
>
> Cargo Shippers/Customers: any individual who inputs data directly to the METS II system.

It has been stated that downtime on the current systems is especially costly because all booking ceases and all personnel are negatively impacted to some degree. If the system is down for more than one day, there is a negative impact on ocean carriers and cargo delivery dates. Downtime may require booking technicians to work overtime, which increases costs.

4.1.2 Alternative 2

Significant modification of the current systems would be required to meet the objectives of IBS. Minimum modifications required are listed in Sect. 3.2. Of these ten modifications, the first, second, and fourth cannot reasonably be met. Thus, Alternative 2 is not a feasible alternative because it does not meet the primary objective of IBS -- to develop a system with consistent procedures for booking both unit and nonunit cargo movements during peacetime and wartime.

The only benefit of Alternative 2 is that personnel who use and operate these systems to conduct booking operations (MTIT) and personnel who maintain the systems (MTIM) are familiar with the current hardware, software, and telecommunications. However, with respect to maintenance of METS II and/or ACI, it must be noted that the problems itemized in Sect. 4.1.1 concerning downtime and system inadequacies must also be considered deficiencies for this alternative.

4.1.3 Alternative 3

Alternative 3 can meet all of the objectives of IBS. Because it provides an entirely new platform, all functional, operational, and performance requirements can be designed into the system.

An IBS Architectural Analysis has been completed. This analysis indicates that Alternative 3 provides adequate processing speed, that an appropriate RDBMS, 4GL, and hardware/telecommunications platform can be assimilated, and that all other MTMC requirements (e.g., open systems design) can be incorporated.

This alternative has the special benefit of being easily expandable and down-scalable. It is also state-of-the-art technology.

4.1.4 Alternative 4

This alternative meets the objectives of IBS. Because it provides an entirely new platform, all functional, operational, and performance requirements can be designed into the system. It must be noted, however, that during the architectural analysis, this alternative was examined and discarded in favor of Alternative 3.

This alternative has the benefit of being "old" technology, which is tried and tested. The hardware platform for which costs have been assessed is familiar already to some personnel at Eastern AC in MTIM-Development, the individuals responsible for system development. In addition, if the VAX family of computers is selected, expansion is not difficult.

This alternative has the disadvantage of a central processor that may be too slow. The VAX 4000 has a processing speed of 8 VUPS (essentially equivalent to 8 MIPS), which is very slow in comparison with the newer workstation technology.

The operating system on the VAX 4000 is VMS, rather than UNIX. Thus, it does not fulfill the open-system requirement.

4.2 COSTS

The analysis of the IBS costs is structured into the following categories: R&D, Investment (or procurement and implementation), and O&M. All costs in Tables 4.1-4.4 are given in thousands of dollars.

The R&D costs are identical for all four alternatives because the IBS R&D costs were expended to identify the system requirements of an IBS that would fulfill all mission objectives. During this phase, no costs are listed for project initiation and management because all costs were absorbed in HQMTMC overhead. No specific MTIT management

costs for IBS were tracked by MTIT. The $80,000 listed for concept development was the cost of the MENS.

Tables 4.1-4.4 represent CONUS costs only. This EA is incomplete without inclusion of OCONUS implementation.

It should be noted that the spreadsheet is designed to show fiscal year costs for pre-FY91, FY91, FY92, FY93, FY94, and FY95-FY04. All costs for FY91-FY04 are given in FY91 dollars. It is assumed that, for FY95-FY04, all O&M costs will be spread equally over the ten-year lifetime of IBS. Thus, for the FY95-FY04 column, divide the total amount by ten to arrive at the costs for a single fiscal year. Except for Alternatives 1 and 2, which figure O&M personnel costs on an actual FY91 rate, all personnel costs are figured at a rate of $3,000/person-month. This rate is an average of the current payrates for MTIM personnel who would be developing the proposed AIS.

4.2.1 Alternative 1

Table 4.1 presents costs (in thousands of dollars) for this alternative. Under the R&D category, all costs are sunk costs by the end of FY91. An explanation of the R&D costs is given at the beginning of Sect. 4.2.

No costs are given under the Investment Costs category because this alternative is strictly maintenance of current systems and methodologies (i.e., O&M costs). Note that no pre-FY91 costs for development and maintenance of METS II and ASPUR are listed.

Under the O&M category, costs for maintenance of METS II and ASPUR application programs, commercial software products required for METS II and ASPUR, and all hardware are based on FY91 costs. All O&M costs for METS II and ASPUR (maintenance of applications programs, supplies, commercial software maintenance contracts, hardware maintenance contracts, etc.) were supplied by the Eastern AC.

Table 4.1. ALTERNATIVE 1: MAINTAIN THE STATUS QUO

A. GENERAL INFORMATION

Submitting Organization	MTMC International Traffic
System Objective	A single worldwide booking system for unit/nonunit moves during peace and war
POC Name/Phone	Bob Porter / (703) 756-1627

TASK	Pre-FY91	FY91	FY92	FY93	FY94	FY95-FY04	Total ($1000)
B. RESEARCH & DEVELOPMENT							
Project Initiation	0	0	0	0	0	0	0
Concept Development	80	0	0	0	0	0	80
Prototype Develop/Demo	188.5	180.2	0	0	0	0	368.7
Initial LCM Documents	60.6	35.9	0	0	0	0	96.5
SUBTOTAL	329.1	216.1	0	0	0	0	545.2
C. INVESTMENT COSTS							
Project Oversight	*	0	0	0	0	0	0
System Design	*	0	0	0	0	0	0
System Development	*	0	0	0	0	0	0
System Testing	*	0	0	0	0	0	0
IV&V	*	0	0	0	0	0	0
HW Procure/Install	*	0	0	0	0	0	0
Commercial SW Proc/Inst	*	0	0	0	0	0	0
Telecom Proc/Inst	*	0	0	0	0	0	0
Training	*	0	0	0	0	0	0
Other One-time Costs	*	0	0	0	0	0	0
LCM Documentation	*	0	0	0	0	0	0
Facilities Preparation	*	0	0	0	0	0	0
SUBTOTAL	*	0	0	0	0	0	0
D. OPERATIONS & MAINTENANCE							
System Management	*	101.4	101.4	101.4	101.4	1014	1419.6
System Operations/Support	*	319.6	319.6	319.6	319.6	3196	4474.4
Supplies	*	28.7	28.7	28.7	28.7	287	401.8
Configuration Management	*	0	0	0	0	0	0
Maintenance: Commercial SW	*	8.5	8.5	8.5	8.5	85	119
Maintenance: HW	*	231.2	231.2	231.2	231.2	2312	3236.8
Training	*	28.3	28.3	28.3	28.3	283	396.2
Quality Control	*	10.2	10.2	10.2	10.2	102	142.8
Security	*	45.6	45.6	45.6	45.6	456	638.4
Technology Enhancements	*	0	0	0	0	0	0
LCM Maintenance	*	0	0	0	0	0	0
Other O&M Costs	*	6.2	6.2	6.2	6.2	62	86.8
SUBTOTAL	*	779.7	779.7	779.7	779.7	7797	10915.8
TOTAL SYSTEM COSTS--ALT 1 (in thousands of dollars)	329.1	995.8	779.7	779.7	779.7	7797	11461

*Costs for development and maintenance of current systems prior to FY91 not included.

Under the O&M category, personnel costs (i.e., the costs for subcategories of system management, system operations and support, quality control, and security) are based on a percentage of time of current personnel assigned to maintenance of ASPUR and METS II. The following ranks of personnel are involved: GS-13 -- one part-time; GS-12 -- one full-time and one part-time; GS-11 -- three full-time and two part-time; GS-10 -- six part-time; GS-7 -- six full-time. This is a total of about 13.5 full-time equivalents (FTEs).

O&M supplies include disk packs, tapes, console/printer ribbons, and printer paper. Commercial software maintenance costs are those for maintenance of Oracle (the RDBMS used by ASPUR). Annual hardware maintenance costs are as follows: $21,512 for VAX support, $205,817 for Honeywell Level 6 support, and $3,840 for telephone lines. The training cost includes the training that is necessary for maintenance of the current systems (e.g., cross-training in Oracle for METS II operators). The category "other O&M costs" includes costs for maintenance of the Easylink mailbox and Telink hotline.

Under the O&M category, several cost categories are notably empty: for example, there are no configuration management, technology enhancements, or LCM maintenance costs for current systems. Because configuration management and documentation LCM are not formally established programs for METS II and ASPUR, no costs are associated with these tasks.

4.2.2 Alternative 2

Table 4.2 presents costs (in thousands of dollars) for this alternative. Under the R&D category, all costs are sunk costs by the end of FY91. An explanation of the R&D costs is given at the beginning of Sect. 4.2.

Table 4.2. ALTERNATIVE 2: MODIFY THE CURRENT SYSTEMS AND METHODOLOGIES

A. GENERAL INFORMATION

Submitting Organization	MTMC International Traffic
System Objective	A single worldwide booking system for unit/nonunit moves during peace and war
POC Name/Phone	Bob Porter / (703) 756-1627

TASK	Pre-FY91	FY91	FY92	FY93	FY94	FY95-FY04	Total ($1000)
B. RESEARCH & DEVELOPMENT							
Project Initiation	0	0	0	0	0	0	0
Concept Development	80	0	0	0	0	0	80
Prototype Develop/Demo	188.5	180.2	0	0	0	0	368.7
Initial LCM Documents	60.6	35.9	0	0	0	0	96.5
SUBTOTAL	329.1	216.1	0	0	0	0	545.2
C. INVESTMENT COSTS							
Project Oversight	*	0	18	18	18	0	54
System Design	*	0	18	18	0	0	36
System Development	*	0	36	36	54	0	126
System Testing	*	0	18	18	18	0	54
IV&V	*	0	0	0	0	0	0
HW Procure/Install	*	0	0	0	0	0	0
Commercial SW Proc/Inst	*	0	0	0	0	0	0
Telecom Proc/Inst	*	0	5	5	5	0	15
Training	*	0	30	30	15	0	75
Other One-time Costs	*	0	0	0	0	0	0
LCM Documentation	*	0	0	0	0	0	0
Facilities Preparation	*	0	0	0	0	0	0
SUBTOTAL	*	0	125	125	110	0	360
D. OPERATIONS & MAINTENANCE							
System Management	*	101.4	101.4	101.4	101.4	1014	1419.6
System Operations/Support	*	319.6	319.6	319.6	319.6	3196	4474.4
Supplies	*	28.7	28.7	28.7	28.7	287	401.8
Configuration Management	*	0	0	0	0	0	0
Maintenance: Commercial SW	*	8.5	8.5	8.5	8.5	85	119
Maintenance: HW	*	231.2	231.2	231.2	231.2	2312	3236.8
Training	*	28.3	28.3	28.3	28.3	283	396.2
Quality Control	*	10.2	10.2	10.2	10.2	102	142.8
Security	*	45.6	45.6	45.6	45.6	456	638.4
Technology Enhancements	*	0	0	0	0	0	0
LCM Maintenance	*	0	0	0	0	0	0
Other O&M Costs	*	6.2	6.2	6.2	6.2	62	86.8
SUBTOTAL	*	779.7	779.7	779.7	779.7	7797	10915.8
TOTAL SYSTEM COSTS--ALT 2 (in thousands of dollars)	329.1	995.8	904.7	904.7	889.7	7797	11821

*Costs for development and maintenance of current systems prior to FY91 not included.

Under the Investment Costs category, system management, design, development, and testing costs have been estimated to include the functionality listed below. The average cost per person-month is assumed to be $3,000. In addition to normal system maintenance of METS II and ASPUR (the cost of which is included in O&M cost category), it is assumed that one analyst working half-time to provide project oversight and two full-time programmer/analysts (for design, development, and testing) could complete the following tasks by FY94 (begun in FY92).

- automated interfaces with shippers, requesters, MSC, MTIN, FORSCOM, WPS, and a semiautomated interface with JOPES and MSC,
- additional system protection for sensitive unit moves data; a workable policy for automatically comparing JOPES data with DTS data,
- a decision-support module to aid the user in determining a best carrier for nonunit cargo,
- functionality for booking nonunit wartime resupply, and
- automation of CMB functionality.

There are no hardware and commercial software costs because no new hardware/software will be purchased. Costs of maintaining the existing hardware, software, and application programs are covered by current programs (see O&M category). Telecommunications costs are for additional mailboxes to be added to the current system (if possible). Training costs are for programmers to be trained in an object-oriented language in order to reprogram TACOS so that it interfaces with METS II.

No analysis of other investment costs has been conducted. The above listing of required system modifications might require some additional costs for commercial software, hardware, and telecommunications. This potential cost has not been addressed in this EA. It is assumed that any additional one-time costs that would occur cannot be anticipated, that no additional LCM documentation is required (because this is an already existing system), and that facility preparation is not required.

All other costs are O&M costs. The explanation for these costs as given in Sect. 4.2.1 is also applicable here. These costs are identical for Alternatives 1 and 2.

4.2.3 Alternative 3

Table 4.3 presents costs (in thousands of dollars) for this alternative. Under the R&D category, all costs are sunk costs by the end of FY91. An explanation of the R&D costs is given at the beginning of Sect. 4.2.

Under the Investment Costs category, personnel costs for project oversight and system design, development, and testing were estimated by assuming that seven programmer-analysts and one project manager will work full-time at an average rate of $3,000/person-month. FY costs are based on the following assumptions: system design will begin in early July 1991 (last quarter of FY91); development will begin in October 1991 (FY92); implementation and testing will begin in April 1993 at Eastern AC and in October 1993 at Western AC; and deployment will be complete by September 1994 (FY94). It is assumed that the Independent Validation and Verification (IV&V) costs will be $187,200. This amount is determined by multiplying the total system design, development, and testing costs by 20%. IV&V activities will be costed in FY93 and FY94.

The IBS Architectural Analysis indicated that the choice of hardware should <u>not</u> be determined until after the RDBMS had been chosen. Application software changes relatively slowly; however, hardware technology changes rapidly. At this time, both DEC and Sun (as well as other hardware vendors) have announced new client/server hardware platforms that would fulfill the IBS requirements. Investment costs for hardware are based on costs for a Sun hardware platform because Sun vendors provided a lower cost estimate than DEC (see Table A.1 in Appendix A).

Table 4.3. ALTERNATIVE 3: DEVELOP WITH A CLIENT/SERVER ARCHITECTURE

A. GENERAL INFORMATION

Submitting Organization	MTMC International Traffic
System Objective	A single worldwide booking system for unit/nonunit moves during peace and war
POC Name/Phone	Bob Porter / (703) 756-1627

TASK	Pre-FY91	FY91	FY92	FY93	FY94	FY95-FY04	TOTAL ($1000)
B. RESEARCH & DEVELOPMENT							
Project Initiation	0	0	0	0	0	0	0
Concept Development	80	0	0	0	0	0	80
Prototype Develop/Demo	188.5	180.2	0	0	0	0	368.7
Initial LCM Documents	60.6	35.9	0	0	0	0	96.5
SUBTOTAL	329.1	216.1	0	0	0	0	545.2
C. INVESTMENT COSTS							
Project Oversight	0	9	36	36	36	0	117
System Design	0	63	152	100	50	0	365
System Development	0	0	100	100	150	0	350
System Testing	0	0	0	52	52	0	104
IV&V	0	0	0	93.6	93.6	0	187.2
HW Procure/Install	0	0	624.9	268.1	20	200	1113
Commercial SW Proc/Inst	0	0	175.5	87.8	0	0	263.3
Telecom Proc/Inst	0	0	10	20	20	0	50
Training	0	28.3	45	30	30	0	133.3
Other One-time Costs	0	0	5	10	10	0	25
LCM Documentation	0	0	60	60	60	0	180
Facilities Preparation	0	0	10	30	20	0	60
SUBTOTAL	0	100.3	1218.4	887.5	541.6	200	2947.8
D. OPERATIONS & MAINTENANCE							
System Management	*	101.4	101.4	0	36	360	598.8
System Operations/Support	*	319.6	319.6	0	162	1620	2421.2
Supplies	*	28.7	28.7	28.7	28.7	287	401.8
Configuration Management	*	0	0	40	40	400	480
Maintenance: Commercial SW	*	8.5	45.7	55.8	55.8	558	723.8
Maintenance: HW	*	231.2	259.4	49.5	53.6	536	1129.7
Training	*	28.3	28.3	15	15	150	236.6
Quality Control	*	10.2	10.2	10.2	10.2	102	142.8
Security	*	45.6	45.6	45.6	45.6	456	638.4
Technology Enhancements	*	0	0	10	10	100	120
LCM Maintenance	*	0	4	4	4	100	112
Other O&M Costs	*	6.2	6.2	15	15	150	192.4
SUBTOTAL	*	779.7	849.1	273.8	475.9	4819	7197.5
TOTAL SYSTEM COSTS--ALT 3 (in thousands of dollars)	329.1	1096.1	2067.5	1161.3	1017.5	5019	10690.5

*Costs for development and maintenance of current systems prior to FY91 not included.

It is assumed that all hardware for Eastern AC will be purchased and installed early in FY92 and will be used as the development and operational hardware. It is also assumed that all hardware for Western AC will be purchased and installed early in FY93. (These assumptions should be corrected when a valid IBS Implementation Plan is determined.) In addition to the computers, the cost of a total of 12 high-speed and six high-quality laser printers (total number for both sites) has been added (costs of $39,600 for Eastern AC and $22,800 for Western AC; see Appendix A, Table A.2). Thus, investment costs for hardware as listed in Table 4.3 were derived as follows: FY92 (Eastern AC) -- Sun computer system (see Table A.1) at $585,300 plus printers (Table A.2) at $39,500 for a total of $624,900; FY93 (Western AC) -- Sun computer system at $245,300 plus printers at $22,800 for a total of $268,100. Additional hardware upgrades (not including normal supplies or maintenance; see O&M category) for Eastern AC and Western AC are assumed to be $20,000 per year ($10,000/site).

The estimated cost for off-the-shelf software for the RDBMS and applications development is based on the cost of using Ingres RDBMS and tools. Cost estimates of each Ingres toolset are listed separately in Appendix A, Table A.3. It is assumed that installation of this software will be completed at Eastern AC in FY92 and at Western AC in FY93. Other RDBMSs (Sybase, Oracle, Informix, FoxPro, and Recital) were also considered by ORNL during the IBS Architectural Analysis; however, the top recommendation was Ingres. The cost of this RDBMS and applications software for FY92 (Eastern AC) is $175,500. The cost for FY93 (cost for implementation at the Western AC) is half the cost for FY92 ($87,800) because the number of users is about half that of Eastern AC.

Costs for telecommunications are based on purchase and installation of ethernet cables ($300 per workstation) and other telecommunication peripherals. The training cost includes those costs incurred for training of programmers (FY91-FY92) in the new RDBMS and 4GL, the object-oriented language, and Ada. Training for the database administrator, data administrator, system administrator, and network administrator for Eastern AC are also included (FY92). End users will be trained in FY93 and FY94. This

cost is estimated by assuming that 40 persons in the OCCA at the Eastern AC will be trained in use of the application software. IBS training will be conducted onsite and will last for one week. Figured at $750/person week, the total cost in personnel time is $30,000 (FY93). At Western AC, 20 end users in the OCCA, plus the database administrator, data administrator, and system administrator will be trained (FY94). Other one-time costs and facilities preparation cover setting up and/or upgrading phone lines and facility cabling.

The costs of preparing LCM documentation are estimated on the assumption that four new documents (Maintenance Manual, Computer Operation Manual, Training Manual, and System/Subsystem Specifications) must be prepared. It is assumed that these documents will cost about $30,000 each to develop (a total of $120,000). These costs are spread equally over FY92-FY94. Documentation prepared for the prototype IBS (Database Description, End User Handbook, User Interface Guidelines, Implementation Plan, and Test Plan) will need to be revised in terms of the target system. It is estimated that an additional $60,000 (total for all five documents) will be required to update these documents; this cost is distributed equally over FY92-FY94. Maintenance of other documentation (this EA and the FD), which was written during the R&D phase, is addressed under the O&M category.

Under the O&M category, costs for maintenance of the current systems are included for FY91 and FY92. It is projected that deployment of the proposed AIS will begin in FY93 at the Eastern AC and will be completed at both ACs by the end of FY94. No O&M costs for maintenance of METS II and ASPUR are included for FY93 and FY94 because it is assumed that a minimum of personnel effort will be expended on these systems, that the hardware and software maintenance contracts will be allowed to lapse, and that effort will be primarily directed toward the new AIS. It should be noted that O&M costs in FY92 for commercial software and hardware include maintenance costs for the proposed system (software, $37,200; hardware, $28,200) as well as for ASPUR and METS II (software, $8,500; hardware $231,200).

In the O&M category, it is assumed that one full-time system manager is required. The estimate on the cost of system operation and support is figured on the following rule-of-thumb. In a networked RDBMS environment, system management and administration functions require one FTE per ten workstations. If IBS has 54 workstations at Eastern AC and 20 at Western AC, this requires 5.5 FTEs at Eastern AC (beginning in FY94) and two at Western AC (beginning in FY95) at a rate of $3,000 per person-month.

Supplies include printer paper, ink cartridges, and storage media (e.g., floppy diskettes, tapes). This cost is estimated at $28,700/year (based on the current costs for supplies). Configuration management is estimated to cost $40,000 annually for activities of the Configuration Management Board. These activities include establishment of policy and procedures for change control, board meetings, and record keeping.

It is assumed that the maintenance agreement on the commercial software is that provided by Ingres Corporation (see Table A.3 in Appendix A).

Hardware maintenance costs are estimated on the basis of the following assumptions. Hardware will be installed during the first quarter of the fiscal year and will be under installation warranty for three months. Thus, if the annual hardware warranty equals 6% of the total hardware cost, nine months of FY92 warranty coverage at Eastern AC equals $28,200. During FY93, Eastern AC coverage (for 12 months) equals $37,500 and Western AC (nine months) equals $12,000, for a total at both sites of $49,500. Both sites would pay full coverage in FY94 ($37,500 + $16,100 = $53,600). These figures are based on the Sun Corporation estimated maintenance costs. However, it MUST be stressed that many organizations do not pay for hardware maintenance on PCs and workstations. This EA HAS included this cost; however, if only the server is covered under a hardware maintenance contract, then the costs would be greatly reduced.

Training costs are basic requirements for cross-training of system operations and support personnel. Quality control and security costs are figured on the current requirements (see

Tables 4.1 and 4.2). Technology enhancement costs are typical for ensuring that state-of-the-art enhancements (e.g., network, communications, hardware) are added as needed.

LCM documents will need to be updated annually. These documents include, at a minimum, the FD, EA, Maintenance Manual, Computer Operation Manual, and System/Subsystem Specifications. It is assumed that these revisions will cost about $10,000 per year beginning in FY95. Costs for updating the FD and EA for FY92-FY94 are estimated at $4,000 per year.

Other O&M costs are estimated at $15,000 per year. These costs include telecommunications upgrades, circuit costs, and other unforeseen maintenance costs.

4.2.4 Alternative 4

Table 4.4 presents costs (in thousands of dollars) for this alternative. Under the R&D category, all costs are sunk costs by the end of FY91. An explanation of the R&D costs is given at the beginning of Sect. 4.2.

Under the Investment Costs category, it is assumed that project oversight and system design, development, and testing costs are the same as those for Alternative 3. IV&V costs are determined as for Alternative 3.

All investment costs for hardware and software are included in FY92 (Eastern AC) and FY93 (Western AC). Hardware procurement and installation are based on the purchase at the Eastern AC of one VAX 4000, Model 300, midrange computer at $100,000, eight workstations for development purposes at $11,800 each (total of $94,400), and 54 high-resolution, graphics PCs (286s or 386s) to be used for terminal access at $2,500 each ($135,000). In addition, eight high-speed printers and three high-quality printers are added into the costs of hardware ($39,600 total). This is a total of $369,000 for hardware. At Western AC, one VAX 4000, Model 300, midrange computer at $100,000, no workstations

Table 4.4. ALTERNATIVE 4: DEVELOP ON MIDRANGE MAINFRAME COMPUTER WITH TERMINAL ACCESS

A. GENERAL INFORMATION

Submitting Organization	MTMC International Traffic
System Objective	A single worldwide booking system for unit/nonunit moves during peace and war
POC Name/Phone	Bob Porter / (703) 756-1627

TASK	Pre-FY91	FY91	FY92	FY93	FY94	FY95-04	TOTAL ($1000)
B. RESEARCH & DEVELOPMENT							
Project Initiation	0	0	0	0	0	0	0
Concept Development	80	0	0	0	0	0	80
Prototype Develop/Demo	188.5	180.2	0	0	0	0	368.7
Initial LCM Documents	60.6	35.9	0	0	0	0	96.5
SUBTOTAL	329.1	216.1	0	0	0	0	545.2
C. INVESTMENT COSTS							
Project Oversight	0	9	36	36	36	0	117
System Design	0	63	152	100	50	0	365
System Development	0	0	100	100	150	0	350
System Testing	0	0	0	52	52	0	104
IV&V	0	0	0	93.6	93.6	0	187.2
HW Procure/Install	0	0	369	172.8	20	200	761.8
Commercial SW Proc/Inst	0	0	115	115	0	0	230
Telecom Proc/Inst	0	0	20	30	30	0	80
Training	0	28.3	45	30	30	0	133.3
Other One-time Costs	0	0	5	10	10	0	25
LCM Documentation	0	0	60	60	60	0	180
Facilities Preparation	0	0	25	35	25	0	85
SUBTOTAL	0	100.3	927	834.4	556.6	200	2618.3
D. OPERATIONS & MAINTENANCE							
System Management	*	101.4	101.4	0	36	360	598.8
System Operations/Support	*	319.6	319.6	0	252	2520	3411.2
Supplies	*	28.7	28.7	28.7	28.7	287	401.8
Configuration Management	*	0	0	40	40	400	480
Maintenance: Commercial SW	*	8.5	8.5	17.3	34.5	345	413.8
Maintenance: HW	*	231.2	240.6	16.4	19	204.4	711.6
Training	*	28.3	28.3	15	15	150	236.6
Quality Control	*	10.2	10.2	10.2	10.2	102	142.8
Security	*	45.6	45.6	45.6	45.6	456	638.4
Technology Enhancements	*	0	0	10	10	100	120
LCM Maintenance	*	0	4	4	4	100	112
Other O&M Costs	*	6.2	6.2	15	15	150	192.4
SUBTOTAL	*	779.7	793.1	202.2	510	5174.4	7459.4
TOTAL SYSTEM COSTS--ALT 4 (in thousands of dollars)	329.1	1096.1	1720.1	1036.6	1066.6	5374.4	10622.9

*Costs for development and maintenance of current systems prior to FY91 not included.

(because all development activities will be conducted on workstations purchased for use at Eastern AC), and 20 PCs at $2,500 each ($50,000), plus printers ($22,800) comes to a total of $172,800. Additional hardware upgrades (not including normal supplies or maintenance; see O&M category) for the Eastern AC and Western AC are assumed to be $20,000 per year ($10,000/site).

The costs of commercial software are based on the use of Oracle (GSA pricing) and associated tools to reside on the mainframe computer. All processing will be done on the mainframe computer. An alternative RDBMS is Rdb, which is VAX-supplied. Use of Rdb should be carefully examined. Neither the feasibility of use nor the cost of software (Ada, C++, etc.) to interface with Rdb has been determined.

The costs for telecommunication processing and installation are slightly higher ($30,000) for Alternative 4 than for Alternative 3 (the client/server architecture). Costs for training, quality control, technology enhancements, other one-time costs, and LCM documentation are as described in Sect. 4.2.3. Costs for facilities preparation are higher than those for Alternative 3 because of increased requirements for the mainframe (e.g., raised flooring, cooling).

Under the O&M category, costs for maintenance of the current systems are included for FY91 and FY92. It is projected that deployment of the proposed AIS will begin in FY93 at the Eastern AC and will be completed at both ACs by the end of FY94. No O&M costs for maintenance of METS II and ASPUR are included for FY93 and FY94 because it is assumed that a minimum of personnel effort will be expended on these systems, that the hardware and software maintenance contracts will be allowed to lapse, and that effort will be primarily directed toward the new AIS. It should be noted that O&M costs for hardware in FY92 include costs for the proposed system ($9,400) as well as for ASPUR and METS II ($231,200).

Under the O&M category, system management and operation and support costs are figured on the basis of needing eight full-time personnel for maintenance of mainframe

software technology (at $3,000/person-month). Costs for supplies and configuration management are as described in Sect. 4.2.3. The software maintenance estimate is based on the general practice of using 15% of the purchase price each year for software maintenance costs. This estimate is based on the use of Oracle as the RDBMS. If Rdb is used rather than Oracle, the software maintenance is significantly less. (A cost estimate provided by DEC for a software maintenance contract for Rdb and C for both sites equals $97,900 through FY04.) Hardware maintenance costs for a maintenance contract for the VAX 4000 only would cost $72,000 beginning in FY93 and continuing through FY04. Costs for PC maintenance are included because hardware maintenance costs for Alternative 3 provided costs for maintenance of workstations; normally a maintenance contract is not obtained for PCs. Costs for PC maintenance are $9,400/year at Eastern AC and $5,000/year at Western AC. Training, quality control, security, technology enhancements, LCM maintenance, and other O&M costs are as described for Alternative 3.

4.3 COST/BENEFIT COMPARISON

Costs for Alternative 1 through FY04 are estimated at a total of $11,461,000. Alternative 2 costs are estimated at a total of $11,821,000. Alternative 3 costs are estimated at a total of $10,690,500. Alternative 4 costs are estimated at a total of $10,622,900. Thus, Alternatives 3 and 4 are less costly over the ten-year life cycle than Alternatives 1 and 2.

It should be noted that Alternatives 1 and 2 cannot meet the objectives of the proposed AIS and thus cannot benefit MTMC through improved functionality. Therefore, MTMC must next consider Alternatives 3 and 4, both of which fulfill the objectives of the proposed system. Alternative 3 is chosen over Alternative 4 in terms of being state-of-the-art technology, scalable (both up and down), and more operationally effective in terms of response time and modern technology.

Thus, maintaining the current systems in a status quo (Alternative 1) and maintaining the current systems with enhancements (Alternative 2) are neither beneficial nor cost-effective alternatives. Both Alternatives 3 and 4 can meet the objectives. Because Alternative 3, the client/server architecture, is the choice of the IBS Architectural Analysis (see reference in Sect. 1.5) and because it is a cost-effective alternative, Alternative 3 is the alternative of choice both from a benefits and from a cost perspective. Thus, ORNL recommends that MTMC build the proposed system using Alternative 3.

5. OTHER CONSIDERATIONS

5.1 ADVANCES IN TECHNOLOGY

Computer technology is changing rapidly. As hardware technology advances, mainframe technology decreases in importance and popularity. Workstation processors of today can outperform mainframes of only a few years ago. Advances in RISC technology continue.

Recent world conditions have proved how important advanced computing methods can be for moving materiel. Thus, the importance of obtaining and maintaining a system that is upgradable, downscalable, transportable to "alien" sites (e.g., Saudi Arabia), user friendly for field personnel, and very flexible is critical. New technological advances in the areas of data communications and multilevel security are being announced with every issue of hardware/telecommunications journals. Standards for open systems are being developed and vendors are conforming.

Finally, it must be noted that ensuring data quality in IBS is especially important because of the diversity of input sources and mechanisms and because of the impacts that poor quality data can have on cargo movement -- from initial request through billing. An RDBMS with built-in quality control mechanisms is highly desirable. Because of its RDBMS features, Sybase was a close contender with Ingres for being the RDBMS of choice in the IBS Architectural Analysis. Sybase lost out primarily because of the poor user interface and lack of front-end tools available. Coupled with a User Interface Management System, Sybase might provide an excellent alternative to Ingres at approximately the same cost.

5.2 UNCERTAINTY AND RISKS

For Alternatives 1 and 2, a technological risk exists in attempting to maintain the Honeywell and VAX systems until FY04. It should be noted that the average lifetime for mainframe computers is normally 15 to 25 years; therefore, the Honeywell Level 6 and the VAX 11/780 will be reaching their upper limit of maintainability by FY04. Thus, the assumption that these two mainframe computers will continue to function adequately has some risk involved.

There is also a risk in attempting to modify the two current systems (METS II and ASPUR) to add required enhancements such as booking for wartime resupply. Also, because the hardware platforms are no longer sold, it would be impossible to provide operational capability of these two systems for OCONUS sites using the same hardware/software configurations. The capability of the current systems (even if modification and maintenance were not issues) to perform if a major worldwide contingency occurred is highly doubtful.

It should be recalled that no hardware/software costs have been added into this analysis for OCONUS deployment.

In the selection of an architectural platform for IBS, vendor stability and reputation should be considered. The RDBMS vendor community has been in a state of upheaval, with layoffs, takeovers, and the entry of new products into the market.

IBS faces a special risk in the area of interoperability with multiple systems. To minimize risk and provide maximum upgradability as hardware improves, an open system design that can support X-Windows is highly recommended. X-Windows applications provide a consistent user interface, even in a network of widely mixed computers.

Another risk exists when "mixing" hardware and software types to get the best cost package from government purchasing contracts. Therefore, although this EA is based on

the selection of a specific RDBMS (Ingres) and a specific hardware platform (Sun), ORNL recommends that the hardware platform be reconsidered if a different RDBMS is chosen in order to ensure that the hardware and software working together provide optimal performance. Also, if a hardware platform is selected that mixes vendors (e.g., a server from Pyramid and client workstations from Sun), then the purchasing organization needs to verify who is providing maintenance for the integrated portions of the system in order to ensure that all components work together effectively.

Current technological advances in the RDBMS area should be considered. For example, object-oriented programming and object-oriented database design are new methods which build on and enhance the relational database philosophy. AUTOSTRAD 2000 encourages flexibility of design to support both centralized and distributed processing. This forward-looking vision must not be ignored just to accommodate current knowledge of hardware and software techniques and technology. With IBS, MTIT, through innovative design and planning, can build a computer system for the present which will be usable well into the future.

5.3 SENSITIVITY ANALYSIS

A formal sensitivity analysis on the specific architecture recommended by ORNL has not been performed. ORNL recommends that MTMC definitely choose an RDBMS and hardware platform and then conduct a sensitivity analysis. In addition, the conditions and requirements of OCONUS should be considered.

APPENDIX A. ALTERNATIVE 3 CONFIGURATIONS FROM SPECIFIC VENDORS

Several vendor-specific hardware and software configurations and cost estimates are listed in this appendix. The cost estimate in Sect. 4.2.3 (Table 4.3) of this EA is based on the preferred configuration of software (Ingres) and hardware (Sun). That is, Ingres is the RDBMS recommended by the IBS Architectural Analysis, which also recommended a choice of server/workstation platforms -- that is, either Digital Equipment Corporation (DEC) or Sun. A cost analysis indicated that the Sun platform provides a cost savings. It should be noted that costs included in the tables below are estimates based on purchases within a certain time frame; these price quotations were obtained by ORNL in preparation of this EA. Actual cost figures would probably differ from these estimates. In addition, these lists must be considered draft configurations because they do not necessarily include all small but essential parts.

A.1 SOFTWARE

Ingres

The following listing of Ingres software is suitable for loading onto many different platforms. Ingres is the preferred RDBMS as determined by the ORNL Architectural Analysis. The Ingres RDBMS and toolset listed below, when used on either the DEC or Sun configuration listed in Sect. A.2, fulfill the requirements for IBS.

Server machine (licensed for 96 users)[1]

Ingres BASE (includes NET and a Protocol)
Ingres ABF
Ingres Knowledge Management
Ingres Object Management

Ingres STAR (available by the end of calendar year 91)

Client machine (licensed for 48-64 users)[2]

Embedded C
Embedded Ada
Ingres/Windows 4GL (both the development and the runtime versions)
NET and protocol (communication tools)

Sybase

In the IBS Architectural Analysis, the Sybase RDBMS was a strong contender because of its many strengths. The following Sybase tools are proposed for use with Sun hardware. Sybase was chosen as the RDBMS for this particular hardware configuration because of a better performance rating; that is, this configuration running Sybase processes 59 transactions per second while it processes 40 transactions per second running Oracle.

- Sybase RDBMS with
  - Sybase Application Productivity Tool (APT),
  - Report Writer

- C compiler or C++ compiler (to be used for programming the decision support module; see Sect. 3.3.2). (Prior to a final decision on the software, designers will ensure that the programming software for the decision support module has hooks to the 4GL being considered.)

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[1]The number of licensed users who can be logged in to the server concurrently can be increased in increments of 16 with slightly higher fees.

[2]These client machines are for users at the ACs.

- OpenWindows 2.0 plus a graphical user interface (possibly a third-party User Interface Management System; see IBS Architectural Analysis for a specific discussion on these tools)

- Ada compiler (It is possible that Ada may not be required.)

- Communications software
  - TCP/IP WIN/3B Interface Package
  - software to permit file sharing
  - software to permit a workstation or personal computer to handle communications

The application software is proposed to be developed primarily in Sybase and in C (or C++) with some modules possibly being written in Ada.

A.2 HARDWARE

Draft configurations and cost estimates were obtained on three hardware platforms for the client/server architecture of Alternative 3.

AT&T Minicomputer and Workstations

This environment is taken from the SMSCRC (see reference in Sect. 1.5). The specific 80386 workstation configuration given in the list below was prepared by AT&T as part of the costing statement (Table A.1). It is expected that this configuration may not be sufficiently powerful to run IBS.

- Minicomputer -- AT&T 3B2/600G (two or more linked to provide optimum performance)
  - 24 MHz system board
  - 32-bit processor
  - Floating point coprocessor
  - 64 MB RAM

- Three 5.25-in. nonremovable 327-MB hard disk drives for a total of 981 MB of formatted storage
- 125 MB SCSI cartridge tape drive
- One 155 MB medium-capacity removable disk storage device
- 720 kB floppy disk
- SCSI host adapter card

- System console, one AT&T 605 business communications terminal

- Workstation -- 80386 microprocessor[3]
  - VGA high-resolution graphics color monitor (14 inch)
  - Serial mouse and driver
  - 101-key enhanced keyboard
  - 2 MB RAM (may require more memory)
  - 16 MHz (or possibly greater) processing speed
  - 80 MB SCSI hard disk drive
  - 1.2 MB floppy disk drive

- Boards and/or external units to complete the following networking requirements
  - DDN X.25 network
  - IEEE 802.3 LAN
  - RS-232C dial-in ports

- UNIX System V, Release 3.2.2.0 operating system

AT&T Laser Printers

- Laser printer for complex or extra high-quality printing requirements (three printers required at each site: one for the OCCA, one for the Terminals Division, and one for MTIT management)
  - High-resolution, low-speed (300 x 300 dots per inch; 8 pp/min)
  - Supports complex graphics and multiple user-selectable fonts

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[3]It is assumed that 54 new workstations will be purchased for the Eastern AC and that 20 will be purchased for the Western AC. It is assumed that, at each site, these workstations will operate from two separate LANs. One LAN will be located in the OCCA for conducting nonunit resupply bookings (50 workstations at Eastern AC; 18 at Western AC); one will be located in the Terminals Division (four workstations at Eastern AC; two workstations at Western AC) for booking unit moves.

- Laser printer for fast page printing (at Eastern AC, a total of eight printers required: five for the OCCA, one for the Terminals Division, and two for MTIM in the systems management area; at Western AC, a total of four printers required: two for the OCCA, one for the Terminals Division, and one for systems personnel)[4]
    - High-quality, high-speed (300 x 300 dots per inch; 24 pp/min)
    - Five type fonts and multiple pitches

Sun Workstation[5]

The following configuration is based on the capabilities of a single SPARCstation-2 Desktop Workstation as the database server. The SPARCstation Interpersonal Computer (IPC) is the workstation chosen as the client machine for use by individual booking technicians.

- Sun SPARCstation-2 Desktop Workstation
    - 40 MHz CMOS SPARC integer unit for 28.5-MIPS performance
    - 32 MB memory (expandable)
    - 19-in. color monitor
    - I/O cache for fast I/O throughput
    - 1.3 GB SCSI disk and 2.3 GB tape
    - 150 MB 1/4-in. SCSI tape drive
    - 424 MB disk
    - 1.44 MB diskette
    - 644 MB CD ROM
    - SCSI host adapter card
    - Usage license for unlimited number of users
    - Two controllers (to support 16 additional serial ports)
    - Documentation, keyboard, mouse

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[4]It is assumed that, if printers are needed at sites with whom automated interfaces are desired, such as MTIN or MSC, these organizations will purchase the appropriate hardware.

[5]ORNL analysts were unable to obtain a copy of the AFCAC 308 procurement that went to Sun.

- SPARCstation IPC Workstation
  - High-resolution graphics color monitor (16 inch)
  - Serial mouse and driver
  - 101-key enhanced keyboard
  - 8 MB main memory with 64-kB write-through cache[6]
  - 25 MHz processing speed (15.8-MIPS performance)
  - 25 MHz SPARC floating-point processor
  - 207 MB internal SCSI hard disk drive
  - SCSI, Ethernet, two serial, and audio input/output port
  - 1.44 MB 3.5-inch floppy drive
  - Documentation

- Sun OS (operating system; BSD UNIX)

The SPARCstation IPC is connected via ethernet to the server through a common network port. To accommodate users dialing in from remote sites, two additional boards are required which allow serial access (16 concurrent dial-in users).

DEC Specifications

DEC offers a family of computers that provides a similar client/server configuration. The following configuration is based on the latest RISC technology.

- DECsystem 5000, model 200 server
  - 25 MHz (24 MIPS)
  - 16 MB RAM
  - 332 MB disk
  - 665 MB disk
  - 64 kB cache
  - SCSI disk controller
  - Floating-point processor
  - Usage license for unlimited number of users
  - One-year product foundation warranty
  - Installation by DEC

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[6]This memory capacity should probably be increased to 16 MB.

- DECstation 5000, model 120 client workstation
  - 25 MHz
  - 16 MB RAM
  - 121 MB 3.5-in. disk
  - One-year product foundation warranty
  - Keyboard, mouse
  - 16-in. color monitor

- ULTRIX operating system (DEC's UNIX variant)

A.3 Draft Cost Estimates

A draft cost comparison (Table A.1) was made on each of the hardware configurations given in Section A.2. Table A.2 lists costs of the two types of printers recommended. Table A.3 presents costs for Ingres RDBMS and tools over two potential hardware platforms (DEC and Sun).

Tables A.4 and A.5 show configurations and costs of Sequent and Pyramid hardware platforms. Pyramid Technology and Sequent Computer Systems Inc. provided configurations only on the server portion of Alternative 3. These computer platforms might be appropriate for the Alternative 4 architecture, should that alternative be chosen.

Names and phone numbers of all vendor representatives contacted by ORNL are given in Sect. 1.5.

Table A.1. Cost comparison of Alternative 3 vendor-specific hardware configurations

Cost item	Cost of item	No. units	Subtotal	Total
		AT&T configuration:		
Eastern AC				
3B2/600G mini	$62,000	2	$124,000	
Materials*	6,000	2	12,000	
Workstation	8,000	54	432,000	
Western AC				
3B2/600G mini	62,000	1	62,000	
Materials*	6,000	1	6,000	
Workstation	8,000	20	160,000	
			TOTAL	$796,000
		Sun configuration:		
Eastern AC				
SPARCstation 2	$26,000	1	$26,000	
Materials*	19,300	1	19,300	
Workstation	10,000	54	540,000	
Western AC				
SPARCstation 2	26,000	1	26,000	
Materials*	19,300	1	19,300	
Workstation	10,000	20	200,000	
			TOTAL	$830,600
		DEC configuration:		
Eastern AC				
DECsystem 5000	$36,500†	1	$36,500	
DECstation 5000	11,800	54	637,200	
Western AC				
DECsystem 5000	36,500	1	36,500	
DECstation 5000	11,800	20	236,000	
			TOTAL	$946,200

*Operating system, vendor-supplied software, site operating license for unlimited number of users, network license, extra disk/tape drives, and/or documentation.

†Costs include DEC installation fees on the server. Additional disk drives (1-GB and 665-MB for DEC server), if needed, cost $10,300.

Note: these figures are based on vendor-supplied documentation and have not been checked by a vendor representative for additional costs and/or discounts. They must be considered as DRAFT figures and supplied only to suggest typical costs for this particular client/server configuration (Alternative 3).

Table A.2. Costs of printers*

Cost item	Cost of item	No. units	Subtotal	Total
Eastern AC				
High-quality laser printer	2,000	3	6,000	
High-speed laser printer	4,200	8	33,600	
			TOTAL	$39,600
Western AC				
High-quality laser printer	2,000	3	6,000	
High-speed laser printer	4,200	4	16,800	
			TOTAL	$22,800

*Costs are based on AT&T SMSCRC contract

Table A.3. Cost comparison of Ingres on two hardware platforms (DEC and Sun), the Alternative 3 architecture

	License	Support*
Server -- license for 80-96 concurrent users		
Ingres BASE	$61,425	$12,759
Applications by Forms	21,498	4,466
Knowledge and Object Management	36,855	7,656
Ingres STAR†	18,429	3,828
Client -- license for 48-64 concurrent users‡		
Embedded C	6,581	1,367
Embedded Ada	6,581	1,367
Windows 4GL	15,356	3,190
NET	6,581	1,367
Protocol	2,194	1,185
TOTAL	$175,500	$37,185

*Support includes telephone support, software updates, maintenance, and a "1-800" dial-in support system.

†STAR is recommended by the IBS Architectural Analysis; however, this product will not be available until the end of calendar year 1991. Because price quotations are already available, they are included in the cost analysis.

‡Another tool set for the client, "Tools," is available for the client if the Window application will be performing character-based Ingres functions, such Ingres/Query (QBF) or Ingres/Reports (Report Writer and RBF). Price is $13,163 with annual support at $2,734. Although character-based functions will be required for dial-in users who may not have access to the features provided by Ingres/Windows 4GL, these capabilities for dial-in users are provided by programs provided through the Application-by-Forms package on the server. ORNL does not believe that the "Tools" package is needed for the workstation environment located on the LANs at Eastern and Western ACs.

Note: These numbers represent costs for Ingres at Eastern AC, the largest site. Costs for installation of Ingres at Western AC is figured at half of that for Eastern AC. Cost, therefore, for Ingres software at Western AC is $87,800. Support for Western AC would be $18,600 annually.

Table A.4. Configuration and cost estimates for Sequent Computer Systems Inc.

- S2000/200 1 Model D -- 80486 CPU
  - 25 MHz processor
  - 40 MB and 1250-MB disks
  - 512 kB Cache per CPU
  - 40 MB memory
  - 1250 MB SCSI disk
  - 1/4-in. cartridge tape drive
  - Sequent system console and warranty
  - Ethernet controller board and cables
  - TCP/IP and LAN boards, tapes, and documentation
  - 16-line terminal controller
  - License for unlimited number of users
  - Windows
- DYNIX operating system (Sequent's UNIX variant)

Total cost, including installation, is $102,480.

Note: The installation charge ($2,035) is waived when hardware maintenance and software support services are contracted for at the time of system purchase. Annual system service charges would be $13,980.

Table A.5. Configuration and cost estimates for Pyramid Technology

- MIS 2/1 T Model 8649T*
  - MIServer Turbo CPU
  - 32 MB RAM
  - Two 663 MB SCSI disks
  - 320 MB cartridge tape
  - 16-port serial ports
  - Documentation, power supply, cables
  - 90-day warranty†
  - OSx operating system (unlimited users)
  - System console, cables

Total cost is $93,373

*The Pyramid T series has two processors. A smaller version for Western AC with only one processor would cost $50,000-60,000.

†Maintenance costs are about $800/month on GSA.

Note: Pyramid recommends addition of another CPU board ($41,000) and additional memory (64 MB at $49,400 or 128 MB at $95,000) to fulfill the requirements of 84 concurrent users at Eastern AC.

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