The Systems Engineering Development
of a
Intelligence Information System

by

Conrad Vance Unciano

Project and Report submitted to the Faculty of

the Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

MASTERS OF SCIENCE

IN

SYSTEMS ENGINEERING

APPROVED:

Ben Blanchard, Chair

Donald Drew

David Hammett

April 1996

Blacksburg, Virginia

Keywords: Information System, Workstation, Server

The Systems Engineering Development
of a Intelligence Information System

by

Conrad Vance Unciano

Dean Benjamin Blanchard, Chairman

Systems Engineering

(ABSTRACT)

The Systems Engineering Development of the Intelligence Information System allows military and customer intelligence agencies to consolidate and eliminate the current deficiencies. The Intelligence Information System's development is through a systematic approach that identifies the key components needed over the system's life time. This development identifies needs and requirements necessary to prevent the problem with the development of poor, inefficient and costly systems. These needs lead to the intelligence system's organization formation. The needs also lead to the intelligence information's requirements and mission creation. The next step in the system development is to create the mission requirements, the operational requirements and the system maintenance concept. The intelligence system's operational and maintenance requirements are further broken down into smaller requirements with functional flow diagrams. These smaller requirements lead to the detail design and development of the intelligence information system. Once the

development of the system begins, an integrated system and test plan ensures the intelligence system's fulfill the mission and customer's needs.

To manage and control the development of the information system, a system engineering plan is created.

The System's Engineering design of the Intelligence System identifies all primary components necessary to develop and maintain the system throughout its lifetime.

Acknowledgments

The Lockheed Martin Technical Development Curriculum, formerly known as the Advanced Courses, is a difficult and demanding program. There are many individuals whom I would like to thank for giving me the chance, the support and the motivation required during these past three years. I would like to thank my father for his support, blessing and wisdom. I want to thank my wife, Diana for her patience and encouragement during the late nights and seemingly endless hours of study and work. I want to thank my son, Brandon Michael, born in January 1996, for keeping me up at all hours of the night so I could work on my project.

Concerning Lockheed Martin, I want to thank Christina Waldorfer and David Hammett for their management, guidance and council. Their professionalism and understanding of the Technical Development Curriculum has equipped me with the skills to be successful. I want to thank Beverly Carpenter for all the behind the scenes work. Her dedication was and is always vital to the program. I want to thank my peers within the Technical Development Curriculum for their wisdom, support and friendship. Without them, I never would have known what LMC programs and businesses existed. I would also like to thank Corporate Headquarters for funding the Technical Development Curriculum. Without the company dedication to equip, support and educate engineers, I would not be writing this report.

I finally would like to thank all the Virginia Tech faculty and staff for their support of the Technical Development Curriculum. The courses were always challenging and fun. Special thanks to Dean Ben Blanchard, Dr. Donald Drew and Loretta Tickle.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. Introduction

1.1 Background Information

The United State's former enemy, Russia, is in disarray. Russia's economy is not stable and the Russian military forces are split and controlled by former communist countries. President Ronald Reagan's priority to dedicate a large amount of money to the US defense was overcome by the Russian economic fall. Because of this, the US Government downsized several defense programs proposed in the eighties. Several costly initiatives are no longer needed. Programs such as the "Star Wars" defense system are being scaled back. Several military bases throughout the country are being closed. In March 1995, the fourth round of military base closings were announced to the public.[1] The Pentagon sent a closure list of 146 military installations to both the Congress and the Independent Defense Base Closure and Realignment Commission.[2] Hundreds of defense contractor employees throughout California have been laid off their jobs. The round four closings proposed by the Pentagon eliminated over 34,000 civilian jobs. The Pentagon expects to save four billion dollars over the next six years and approximately $18.4 billion over the next 20 years.[3] The initial costs associated with the closings and realignment of forces is approximately $3.8 billion dollars. The plan as stated by the Pentagon is to "achieve the levels of readiness and modernization we need within the budget we have.[4]" This downsizing in the US defense has created a need to manage military resources more effectively.

While the need to prepare against an imposing force such as the Russia does not exist, many threats to the US still exist. America's focus is now on smaller third world countries. An example of this focus is given by the US 82nd Airborne Division. The 82nd Airborne Division, based out of Fort Bragg, North Carolina is constantly being deployed throughout the world to keep peace and to respond to hostile threats. The division, part of the Rapid Deployment Force, enters into various hostile countries that have a multitude of terrain and climates. These countries range from the jungles of Nicaragua, to the Iraqi deserts, to the mountains of Bosnia and to island climates such as Grenada. This new focus for the 82nd Airborne causes the need to reevaluate the current Military Intelligence resource.

1.2 Current Military Deficiencies

Admiral Stanley Arthur, the vice commander of naval operations describes the need for tactical intelligence and the modernization of the reconnaissance efforts as a result of Desert Storm. He states that the US military has much to learn about the effective use of intelligence received. "In Desert Storm, you were involved with so many different people flying airplanes in a restricted airspace. Sometimes with the rigidity of the process, you could not turn around real time intelligence into a real time reaction.[5]" The various military intelligence organizations are currently designed and created to gather intelligence about the Soviet Union. The Naval Intelligence, Army Intelligence and Air force Intelligence organizations are responsible for gathering information regarding the USSR's Navy, Army and Air force, respectively. Since the fall of the Soviet Union, these organizations in their current form are obsolete. Several problems have arisen from these organizations. These problems include: redundant work, competition as opposed to synergy, a constantly changing threat, a lack of information sharing, and a lack of preparation time.

1.2.1 Redundant Work

Many of the current intelligence organizations perform redundant work. Different organizations analyze threat information. In many cases, redundancy is necessary. However, budget and workforce reductions cause "turf wars" and mutual distrust between various intelligence agencies. There exists complete hostility between senior military intelligence officials and their Central Intelligence Agency counterparts.[6] These conflicts create a waste of man power, resources and equipment. Many outsiders believe that considerable savings would occur if several intelligence agencies consolidate and reduce the duplication of effort. Redundancy in many intelligence agencies occurs because of strict activity compartmentation. The compartmentation allows information sharing on a "need to know" basis. This compartmentation may have more security benefits; however, a 1980 study estimated that redundant R&D costs were around four billion dollars.[7]

1.2.2 Competition Instead of Synergy

The decrease in the funding for the various military intelligence organizations causes competition between the intelligence organizations. As stated before, a natural alienation occurred between various agencies through compartmentation for security reasons.

However, the reduction in the amount of dollars given to all agencies has caused many antagonistic relationships. These organizations have had to justify their need for more dollars by using their resources to gather more information than other organizations and in some cases withholding information from the various organizations. This competition has led to wasted time, money and effort.

1.2.3 Constantly Changing Threat

The threats to the US have become more diverse since the fall of the Soviet Union. The intelligence collection has become even more complex given the diversity of potential US threats. In a 1993 meeting with the Senate Governmental Affairs Committee, James Woolsey, the Central Intelligence Agency director, described how the need for advanced conventional weapons by Third World countries was triggered by the allied forces dramatic victory over IRAQ in Desert Storm.[8] The demand for improved weapons coupled with the poor economic states of Russia and Ukraine, causes the proliferation of modern weapons to Third World countries hostile to the US.[9] The examples that the director gave include:

1) North Korea is using Egyptian technology to upgrade Scud missiles for sale to the Middle East.[10] 2) Pakistan has an industrial enriching plant that could produce enough high quality uranium to manufacture several nuclear weapons.[11] 3) Israel has a full class of intermediate range nuclear missiles that are capable of hitting targets hundreds of miles away.[12] 4) South Africa has nuclear explosive devices fired from cannons.[13] The diverse threats to the US will continue to pose problems unless the US intelligence modernizes.

2. Conceptual System Design

The information system's conceptual system design includes: the information system background and benefits, the current baseline deficiencies, the information system needs, system operational requirements and system maintenance plan. The background and benefits section discuss the background and benefits for creation of the information system. The need's section discusses the organizations, costs and other information necessary to create the new system from the existing system. The current baseline deficiencies discuss the problems that exist with the current system baseline. The system operational requirements include the information system mission scenarios and performance characteristics. The system maintenance plan includes necessary organizations needed to maintain the information system.

2.1 Background for the Information System

The information system is part of a military effort to consolidate many independent intelligence actions. The system provides a fast and up to date method for the research requisition and process of world activity information, intelligence information, information requests. The system also provides a redundant intelligence information review. The redundant review is important, because lessons learned from the Desert Storm Operation showed a serious flaw in the review of the technical intelligence data gathered there. According to Newsweek, Washington did not fail to anticipate the invasion of troops into Kuwait because of the technical data.[14] In fact, Washington failed to anticipate the invasion because they misunderstood the technical data itself.[15] The US knew that IRAQ massed thousands of Iraqi troops near the Kuwait border. However, the intelligence agencies failed to believe that the invasion was imminent, because of a lack of redundant information review and a breakdown in communication between agencies.

The information system will provide a natural means for review and research. Many military divisions such as the 82nd Airborne Division will benefit from the information system.

2.2 Need

It is necessary to develop and understand the needs that would enable all stakeholders to transition from the current baseline to the improved baseline. The needs identify the current deficiencies with the existing system.

2.2.1 Information Flow

Twelve Sites need to share information sent at 45 Megabits per second. Each site can send or receive information. The information flow is given in Figure 1.

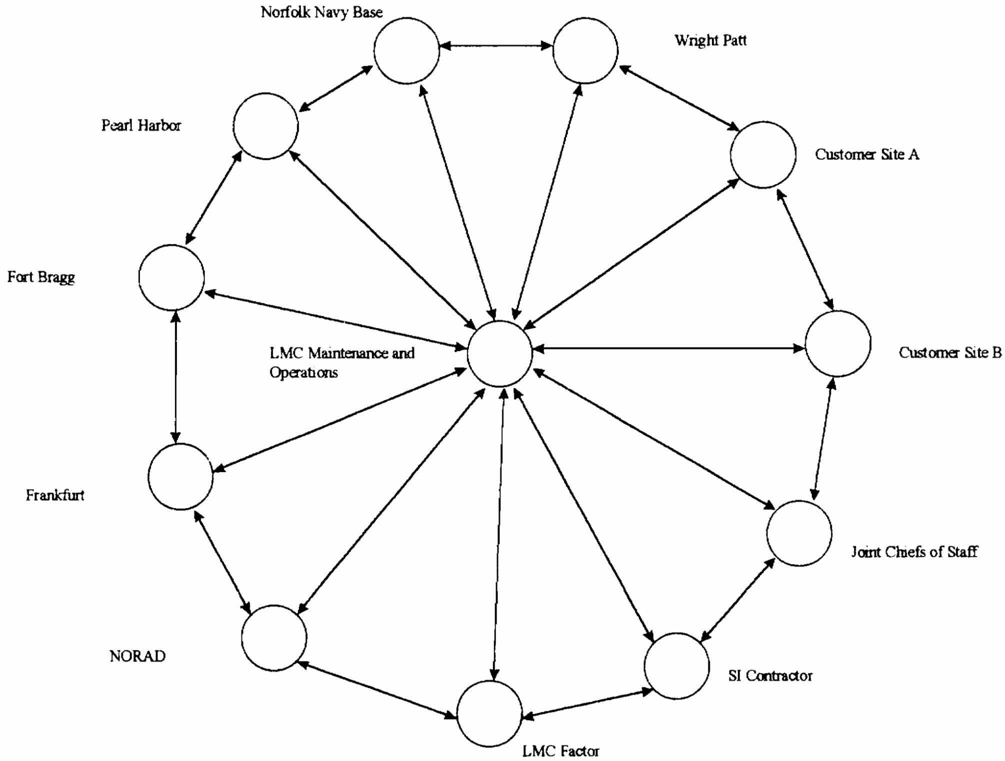

Figure 1: Information Flow

2.2.2 Organization

The current agencies all operate under different and separate organizations. A new organization is necessary with the information system development to facilitate a change in the current intelligence information process. The leaders and primary stakeholders in the development of the information system are the Joint Military Command Headquarters based at the Pentagon and a Government Customer. The Joint Military Command Headquarters is in charge of the military services. The Military's partner, a government customer, operates two sites. The System's Integration, Development Factory and Maintenance & Operations Contractors report to the Joint Chiefs of Staff and the

Government Customer. The Systems Integration Contractor, Lockheed Martin, is responsible for requirements' clarification, customer satisfaction, technical analysis and feasibility analysis for the information system. These requirements, technical and feasibility analysis go to the information system developer, Lockheed Martin, also based in Valley Forge, PA. After the Preliminary Design Review, Critical Design Review and demonstrations are complete, the system maintenance and operations responsibilities are turned over to the Maintenance and Operations Support Contractor, Lockheed Martin, based in Washington, DC.

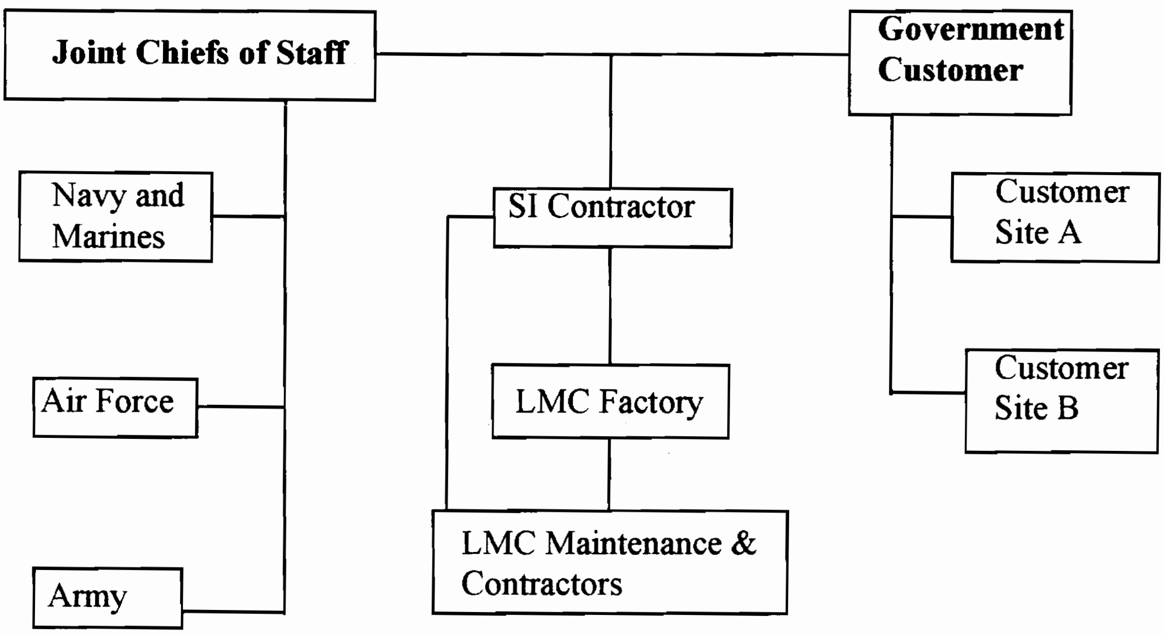

Figure 2: Information System Organization

2.2.3 Participating Sites

The next need is to determine the sites to be part of the system. This is necessary to create a baseline for software and hardware distribution. Therefore, the information system is be used to gather and communicate information between several sites. The site description and location are given in Table 1.

Table 1: Information System Sites

Number	Site	Location
1	Norfolk Navy Base	Norfolk VA
2	Pearl Harbor	Pearl Harbor, HA
3	Fort Bragg	Fort Bragg, NC
4	Frankfurt	Frankfurt, Germany
5	NORAD	NORAD, CO
6	Wright Patt A.F.B.	Wright Patt A.F.B, OH
7	Customer Site A	Unknown
8	Customer Site B	Unknown
9	Joint Chiefs of Staff	Pentagon, Washington, DC
10	SI Contractor – LMC	Valley Forge, PA
11	LMC Factory	Valley Forge, PA
12	LMC Maintenance and Operations	Reston, VA

2.2.4 Contractor Staff

The contractors need to identify their responsibilities and organizations to justify costs and to develop a working relationship with the various customers. Therefore, the Lockheed Martin Contractor Organizations are broken up into three segments:

the Systems Integration, Systems Development and Systems Maintenance and Operations.

2.2.4.1 Systems Integration

The Systems Integration segment of the information system is responsible for the definition, technical analysis and technical feasibility of the Joint Military Command and government customer requirements. The Systems Integration segment determines if the information system meets the government's satisfaction over the project life time. The segment also verifies the contractor's requirement fulfillment and warns the government against possible cost overruns, technical difficulties, missed deadlines and other problems that might occur from the development to the retirement of the system.

2.2.4.2 Information System Development

The Lockheed Development Contractor is responsible for information system development given the customer's requirements and needs. The development contractor consists of network, systems and software developers. The systems developers acquire the system hardware and equipment. The network developers are responsible for the creation of the network between the various sites. The software developers are responsible for meeting the user requirements for handling, storage and processing of information. Once the development of the information system is complete the development contractor segment phases.

2.2.4.3 Information Systems Maintenance and Organization

The maintenance and operations for the information system are the responsibility of the Lockheed Martin Corporation. This contractor is responsible for ensuring that the system runs 24 hours a day, 365 days a year. Over the lifetime of the information system, several different employees maintain the system and verify that it is up 99.5% of the time. This percentage includes unscheduled outages. As stated before, the maintenance and operations group checks to see if the software processing the information meets customer satisfaction also. The groups responsible for this are: Configuration Management, Software Maintenance, Help Desk, Build, Systems Engineering, Database Administrators, system Administration and Network Engineers.

Configuration Management Group

This group is responsible technical problem accountability, investigation and modification. A tool used to an investigate problem is the Problem Report. The Problem Report contains all technical problems, investigations and modifications. The Problem Report (PR) describes a problem with the software, hardware or system. This report investigation by either software, hardware or system engineers and programmers provides a solution or modification. Furthermore, the problem report gets a priority, modification or closure status with the Engineering Review Boards (ERB) approval. The Problem Report helps to verify that the contractors and government are meeting each other's expectations. The software engineering group and the Engineering Review Boards track and discuss each Problem Report. Additionally, the engineer's group and Engineering Review Boards track a problem from the problem's discovery to the problem's closure. The Configuration Management group is responsible for ordering and presenting Problem Reports to the software engineering groups and the Engineering Review Boards. The Configuration Management group is also responsible for maintaining the software fixes and coordination of the fixes with the Build Group organization.

Software Maintenance

The software maintenance organization is responsible for problem verification, investigation and modification. The software maintenance organization's composition into different units based on the information system software components or computer software configuration items (CSCIs). Each part of the information software has a particular function for processing the system information. The software maintenance's organization formation is due to those functions.

Help Desk

The help desk group is responsible for assisting and helping government and military information system users. The help desk fields problems with the system's execution speed, software question and/or hardware questions. The help desk subsequently assists the users or passes the questions on to the various groups such as: network engineering, software maintenance, database administration, or systems engineering. If necessary, the Help Desk writes Problem Reports against the system for the users. The help desk is available 24 hours a day since the system is available 24 hours a day.

Build Group

The build group is responsible for the software modifications builds and distributions to the various sites. The build group works with the configuration management group in coordination of the software installations. It is important for the build group to understand the impacts of the software installations. This is because the time it takes for compilation and the building of software depends on the number of programs, header files and other software functions. Furthermore, many software installations could directly affect the user's ability to work on the system. Thus, it is the responsibility of the build group to install and build software with the least amount of impacts to both the users and customers.

Systems Engineering

The systems engineering group observes and investigates problems due to a decrease in system speed or an improper system configuration. The systems engineering group is also responsible for ensuring that the system is optimized and utilized at peak efficiency. The system engineering group performs studies and understands the peak and minimum usage on the information system. The group uses metrics and the configuration management system to track problems.

Database Administrators

The database administrators (DBAs) are responsible for maintaining the information in the databases for the system. The database administrators seek to optimize the performance of the database by creating multiple keys and subsets of databases and tables. The administrators copy operation information into test databases for software maintenance. Besides the system database maintenance, the DBAs also maintain the configuration management (CM) database. There are many cases in which the CM database needs: updates with the latest data, records deleted, incorrect information field modifications, etc.

System Administration

The systems administration group is responsible for assisting users with system problems. These problems include: server crashes, computer reboots, log on creation and printer restarts. The systems administration group also assists in aiding users in questions regarding the operating system, lost files and other system issues. The systems administration group works hand in hand with performance groups such as the networks and systems engineering to determine the best possible performance for the information system.

Network Engineering

The network engineering group is responsible for ensuring that the information system network is working correctly. The network group handles items such as: downed links between sites and system slowness. Furthermore, the network group assists in the creation of new sites and the installation of cable and router connections. The network group also seeks to improve the network configurations based on the increase and or decrease in the number of users at a particular site.

2.2.5 Products Produced and Shared

The information system must provide information products that assist the user community in the accomplishment of their missions. The products include: configuration management, information system software, system software, training software, presentation and business software.

2.2.5.1 Configuration Management Products

Technical Investigations

The various engineers, who work on problems ranging from software to networks and perform technical investigations on the system, must input their findings into a configuration management tool. The investigations are a part of the problem reports generated against the system. Any modification authorization information is also part of the technical investigation. This is due to fact that engineer submitting a fix to the software must have their software built by the modification authorization.

Modification Authorizations

The engineers that fix problems with the information system need to submit a modification authorization to include the modified software into the system. The modification authorization needs to include information such as: to and from directories of where the software is, the associated problem report, the impacts to the system and a before and after modification number. The before and after number allows the modification authorization's builds to the software baseline in the correct order and to ensure that no problems occur. Once the fixes go into the baseline, verification and tests ensure the problem no longer exists.

Requests For Change

After the system creation, the user community may request for additional features and functions for the information system. These features and functions need to have additional funding approval from the regular customers since the additional features are not part of the original required software delivered into the system. The request for change includes a thorough description of the enhancement and a time estimate of how long it would take with the staff hours to implement the enhancement.

Problem Reports

The users create Problem Reports when part of the information system does not meet requirements or is not functioning properly. The problem report includes a detailed discrepancy write up, the location, functions used and if applicable the time the problem occurred. The Engineering Review Boards review each problem report to ensure that it is a valid problem and not a user error. The problem report changes status as it travels from creation to closure. The status includes: new, awaiting technical investigation, awaiting engineering review board, awaiting build, verification and closure.

2.2.5.2 Information System Software

The different deficiencies identified as needs for the government customers, along with the system software upgrade are discussed in greater detail in the Software deficiencies section.

2.2.5.3 System Software

Some of the system software used in the information system are electronic mail and log in information software. Most of these products are commercial off the shelf. It is important to keep track of conversations and important reference information. The electronic mail aids in this feature. The log in information and security depends on the type of platform and operating system used. Thus, commercial off the shelf software tracks and adds a user's log in and information.

2.2.5.4 Training Software

The information system effectiveness depends on how well the users are able to accomplish their missions. Therefore, it is important to have training software that allows users to be productive, informed and knowledgeable regarding the features, functions and capabilities of the system. Effective training software includes extensive help resource and several macros that include demonstrations.

2.2.5.5 Presentation and Business Software

The intelligence information within the system needs to be effectively communicated to the military and government contractors. Thus, the presentation and business software used includes spreadsheet, time management and word processor. Commercial off the shelf products such as Microsoft office or Word Perfect office could suffice depending on the type of platform used for the information system. A capability to display information simultaneously between several sites is another affective way of presenting data.

2.2.6 System Information

The system information stored on several databases within the system can create items such as: reports, milestones, graphics, schedules, plans, test data, training procedures, software descriptions, requirements, and configuration management information.

2.2.6.1 Databases

Almost all the data used in the information system resides in databases. These databases provide a centralized location for the various users to process and research information on a particular country, terrain, and other important facts. A distributed database allows for information sharing and higher reliability. There is no single point failure because all the information resides in different locations.

2.2.6.2 Reports

The information system prints out intelligence information reports based on the needs of the customer. These reports could include: profiles, query outputs, world fact information, weather information, configuration management information such as problem reports, modification authorizations and request for changes.

2.2.6.3 Milestones

The information system also keeps information about key dates. These include: software installations, hardware installations, software versions and updates, test activities and demonstrations.

2.2.6.4 Graphics

The information system will have to display graphics regarding different countries, terrain's and climates for the researchers gathering intelligence data on possible hostile threats to the US. Additionally, part of the user interface may have windows that require additional graphics to aid in the understanding and ease of use in manipulation of key system functions.

2.2.6.5 Plans

The information system should contain information regarding planning of activities. The plans include requirement's checks, installation, intelligence agency consolidation, development, maintenance and operations.

2.2.6.6 Test Data

There are several instances where the software engineers and testers need to have test data to verify particular functionality and requirements met the customer's satisfaction. The test data is also useful in the training of new users of the information system.

2.2.6.7 Training Procedures

The training procedures help the information system users understand the system capabilities and functions. Furthermore, the training procedures could be a reference for users in case they forget or do not understand certain functionality. The training procedures also assist everyone from testers to developers in understanding the user needs and how the information system software should work.

2.2.6.8 Software Descriptions

The software descriptions aid the developers in understanding the requirements and software capabilities and uses. The software descriptions contain the listings of the different computer software components (CSCs) and the computer software component items (CSCIs). Furthermore, the software descriptions aid the new software engineer or software programmer in understanding the system.

2.2.6.9 Requirements

The System Integrators, Customers and Developers help create the information system requirements. The customers define their needs and wants to the contractors. The system engineering method also helps create requirements. Further requirements discussion is in Section 2.5.

2.2.6.10 Configuration Management Information

The configuration management system contains the information regarding previous software, system and hardware problems. It also contains information about items used to correct the discrepancies. This information assists the engineers in understanding previous problems and solutions.

2.2.6.11 File Formats

The information system's primary file formats cover programming, databases, graphics, plans, test data, training procedures and software descriptions. These formats include: .csh (UNIX C shell), .syb (SYBASE Sequential Query Language), .c (C Language format), .obj (C Language Objects Format), TAR (UNIX format), .sh (UNIX Korne Shell), ASCII, .bbn (BBN Slate file format).

2.3 Deficiencies

To appreciate the information system benefits, one must understand the current existing process deficiencies. The current process that exists today for the military intelligence system is obsolete. Several problems exist that waste money, time and energy. These deficiencies include hardware, software and support. The sections discuss each functional deficiency and a plausible improvement or upgrade.

2.3.1 Hardware deficiencies

There are several hardware deficiencies that prevent the different military agencies from effectively functioning together. These include the lack of: communication between segments, specialized servers and workstations, reliable systems, high security communications equipment and a real time capability.

2.3.1.1 Communication Between Segments

The current two way communications among all twelve military, contractor and customer sites does cannot handle large site to site information exchanges. The sites all have independent systems. The various site configurations consist primarily of independent mainframe computer(s) and user terminals. The existing systems cannot communicate information between different sites and distant locations. Currently, large information amounts such as: data, graphics, and video images exist. The current systems could not handle this information without poor user response times. Since speed and reliability are necessary, high speed communications lines, such as a T1 or a T3, are necessary. The various sites connect by way of the T3 lines, while the various workstations within the sites connect with the T1 lines as shown in Table 1.

Table 2: Communication Link Speeds

Connection	**Type**	**Speed**
Site to Site	T3 data line	45 Megabits/second
Workstation to Server and Server to Workstation	T1 data line	1.544 Megabits/second

2.3.1.2 Computer Resources

The customer, military and contractor sites do not have the computer resources for real time information processing needed for site to site connectivity. The current site systems at the various locations lack equipment and design for distributed information sharing. The information exists on a mainframe that is accessible only by user terminals. The primary equipment necessary for distributed information processing are servers and workstations. The servers and workstations handle multiple users and are able to store, retrieve and send up to 10 Terabits of information (the estimated total information amount of all the sites, including new data). It is also important to have machines that could process the information at high speeds or else the users could have unacceptable 30 to 60 second delays in going from display screen to display screen. Note: Most user's prefer one to two second delays in processing functions. The mainframe terminals and most personal computers do not have the necessary processing capability. However, network workstations such as the Intergraph and the SUN workstations can handle information transmission across the high speed communication links.

2.3.1.3 Efficient Systems

The current site systems do not have the efficiency that exists with distributed systems. This inefficiency is costly because computer upkeep, maintenance and support are expensive. The current site configurations consist of a primary mainframe and a secondary backup mainframe. The primary computer handles all job computing while the secondary backup computer waits until a problem with the primary occurs. This is a poor utilization of computer resources because the backup mainframe is a standby and standby computers are not used frequently. A distributed system uses all the system servers and workstations for information processing and has a built in backup capability. For example, if a problem occurs with a server, the System Administration personnel powers down the problem server. The personnel then routes the data through other servers. The operators do not need to switch to a backup system. The other servers simply process more data and handle more of the loads.

2.3.1.4 High Resolution Graphics

The current user terminals and monitors at the various sites cannot process high resolution graphics. The sites have monochrome mainframe terminals that display simplistic menu systems. Current mapping tools enable 3-D graphical views of terrain and climates. The various user's want to see this type of mapping to gather better information. Therefore, there exists a need to display maps with granularity of 1000 to 1 million pixels.

2.3.1.5 Multiple Tasks

The current hardware configurations do not give the user multiple-task capability. The mainframe terminals run with the IBM TSO (Time Sharing Option). The time sharing option shares computer resources with other users and waits for available resources before proceeding. Most modern systems allow multiple-task capability. For example, a user running a large information query can simultaneously read electronic mail or create a document. This features enable the users to be more productive.

2.3.2 Software deficiencies

The effective use of information is not possible without high quality software to process the information and meet the user requirements. The software deficiencies that exist among the twelve sites include: configuration management, database, user and software security, feasibility, graphics, network monitoring, test tools, monitoring, nomination, process management, requirements, tasking, user assisted queries and user friendliness.

2.3.2.1 Configuration Management Software

The different sites do not have united configuration management software and cannot keep a consistent software baseline across all locations. It is very important to maintain strict control over the software developed and maintained. The sites have different configuration management systems. The systems do not and cannot handle distributed site maintenance. The distributed configuration management software tracks problems, fixes, and enhancements through the CM tools. These tools include: the problem report, the modification authorization and the request for change. The configuration management software should be able to track fixes at their various stages before going into the operation stage. From the engineers local fix area to the operational baseline, the configuration management software tracks the different versions of software and distributes them to the various sites. The current software does not have this capability. Besides this, the software has the capability of removing a bad software module from the operational baseline in case of major failure. This ensures the highest reliability for the software.

2.3.2.2 Databases

The existing software databases have the following deficiencies: users cannot query databases from different sites, the database fields and information formats differ, and inconsistent site to site database information. Therefore, there is no information sharing between the different sites. In a distributed system, the information storage ensures that a common area exists for users to run queries, add information, perform searches and other research activities. The current total information size for the different sites is approximately 10 Terabits. Therefore, it is important to have a huge database or databases that can store and archive at least 10 Terabits of information, including graphics, video and voice information. Not only must the database be huge, the software that manipulates database information must be flexible, yet allow strict limitations on the data inputs. This is necessary to keep data integrity and optimum performance. Tools such as limit checking, field screening and checking keep data integrity. Furthermore, the information in the databases needs to have identical field lengths and sizes to have consistent data or else the software cannot process all the information. The current data formats that exist in the databases are integer, real, ASCII, and BOOLEAN. Thus, the databases would also have to support these formats.

2.3.2.3 Software Security

The existing software security systems cannot protect a distributed information system. Currently, each site has its software security procedure for its internal users and systems. However, the security personnel do not have software that can update and change user log ins and user profiles at different locations. Should the users decide to connect the sites, the current software could not handle the security requirements. It is important to have software that protects against hostile users who would like to access information that they should not across a distributed network. The current software cannot detect delayed or intercepted information data packets used for a distributed system. Furthermore, the software throughout the distributed system must: limit the number of times a user can attempt to log into a system and create a system password for the user. (Note: a system generated password forces users to have passwords that are harder for intruders to figure out.) Furthermore, the system should force the user to change their password at set intervals. This is necessary to keep the information on the system from being stolen by spies.

2.3.2.4 Feasibility Software

The existing system cannot support user requests or requirements from different locations or sites. Once the sites connect, the users from different military intelligence services analyze and perform research on various threats. A distributed system has many diverse user information requests. Thus, it is important that the software determines if the user's requirement is feasible. For example, a user requirement that is too large or minute is ineffective. Therefore, a feasibility software function enables the users to understand the potential and limits on the system.

2.3.2.5 Graphics Software

The current software cannot process large data amounts for high resolution mapping and graphics. The current software design is for mainframe terminals that cannot support basic personal computer monitor resolutions such as 1280 X 960 pixels. Currently, the customers do not have country mapping information. This is unfortunate, because the data exists and is necessary to produce the best intelligence reports. However, the current systems cannot process the information. Thus, it is important to have software that can display complex maps and terrain images. The current software cannot support resolutions ranging from 1000 to 1 million pixels. This is necessary for persons who want to know about the maps that contain a country's terrain, climate(s) and weather.

The software at the different locations also lacks a good user interface. The current site software does not have descriptive menu options nor consistent functionality.

Furthermore, the current user interfaces are hard to use and learn. If the current diverse interfaces were replaced with a single graphical interface, these problems would be limited.

A graphical user interface has extensive graphic requirements for items such as windows, icons and message displays. These make the software easy to use and learn by providing error or help messages, and pictorial icons that display functionality and help windows.

2.3.2.6 Network Monitoring Software

The existing software cannot monitor nor detect downed communication links, downed servers and software problems at different locations and sites. Any attempt to connect data links between sites without network monitoring software could cause problems. If a network problem occurred, one could not easily determine where the problem exists or what the problem is. It is important to ensure that the network works efficiently. Therefore, network monitoring software needs to check if the communication links between the sites are up and functioning properly and that the servers are up and able to handle communications and routing if necessary. The network monitoring software also checks if the databases are up and tools such as the File Transfer Protocol (FTP) work

2.3.2.7 Test Tools

The software engineers do not have a consistent set of test tools to verify the software processes the correct information. Items such as software debuggers are unavailable at all sites. The debuggers ensure the software operates correctly. It helps the engineer determine problems and allows fixes in a relatively short amount of time. To debug a program, the programmers and engineers currently have to use print and write statements to output the variable contents. This is inefficient and causes large money, time and resource waste. The debuggers are unavailable because the information systems at the various sites are written in software languages no longer supported by the vendors. Thus, improved diagnostic tools, compilers and upgrades are not available.

2.3.2.8 Monitoring Software

The system cannot track a user request from another location. It also cannot determine the status of a task or information request. Therefore, the users do not know the task or information they will receive nor the time the information will arrive. To solve this problem, monitoring software needs to be created. When a user puts in a requirement, task request or information request, monitoring software enables the user to track his request from the input time to the receive time. Users could put in a request for the number of ships that will arrive at the port of Sudan for the next three days. Their request could then be processed based on priority and resources available.

2.3.2.9 Nomination Software

The existing software does not support a multiple site user request for information. This is necessary if the sites are to be connected. To solve this problem, nomination software is created to input a user's request for information regarding a particular event. The user's nomination is then processed based on available resources, priority of the nomination and customer needs. The nomination software performs limit checking on the various information fields to verify that information enters the databases correctly.

2.3.2.10 Process Management Software

The software at the sites cannot determine if software processes running at other sites are functioning and operating correctly. Should a user query at one location affect a query at another location, the software would not know and the software engineers could not determine the error. To solve this problem, process management software needs to be developed. The process management software monitors primary processes to ensure that the system functions properly. The software attempts to restart processes if they abend and terminate. Furthermore, the software journals the amount of times a process crashes and restarts. If a process fails a certain number of times, the software sends a message to the user to let them know that a particular function is not working correctly. Another feature of the software is the ability to start jobs at specified times. These include backups, database cleanups and journals.

2.3.2.11 Tasking Software

The current software does not process multiple site resource requests. The software also does not have a priority scheme for handling multiple user requests. Once the sites are connected, the users task the available resources. Currently, the agencies only task their resources. To solve this problem, tasking software needs to be created. The tasking software is used to instruct various resources to gather information for a particular nomination or requirement. The users can place a task request into a particular agency for information. That agency then commands their resources to fulfill the request. Tasking software like many of the other items can be based on priorities and other different types of actions. Tasking software verifies that all the available resources use is efficient with the fewest costs incurred.

2.3.2.12 User Assisted Queries

The current information systems at the different sites are not linked. Therefore, a user cannot determine what information exists at another military or customer site. There needs to be a way to perform queries on the system to ensure the users can find out as much information on the database as possible. The user assisted queries can aid users in performing their research regarding a particular country, threat or current data on a particular terrain. The user assisted queries would be part of common set of databases that all the military agencies could use.

2.3.2.13 User Friendliness

The current systems are highly complex and are difficult to use. The current user interfaces consist of blank command lines for data input and menu options full of jargon. It is not only important to have software that accomplishes it mission. It is also important to have software that users enjoy to work on and can perform a variety of tasks. Items such as graphical interfaces ensure that individuals can learn the functions quickly and can accomplish their requirements faster. Furthermore, items such as help screens can ensure that people can spend more time paying attention to work and less time trying to figure out how the software works.

2.3.3 Support Deficiencies

Support deficiencies prevent the system improvements and hinder maintenance. These deficiencies include electronic mail, vendor support, support personnel, distributed site capability, business software and documentation.

2.3.3.1 Electronic Mail

The current sites do not have capability to send user to user information. Programmers and engineers at different locations cannot send software code modification instructions to each other. Users cannot send soft copy documents to each other. A way to solve this problem would be to use electronic mail. Electronic mail is a tool for collecting and sending documents, commands and reference material through the computer. This information sharing would enhance teamwork and communication.

2.3.3.2 Vendor Support

The current software languages at the various sites are no longer supported by the vendors. The FORTRAN IV language and CLIST (Command List Languages) used for the current systems are no longer supported by IBM, the original support vendor. Thus, the software cannot easily perform modern functions typical of a third generation language. For example, the FORTRAN IV language does not have a CASE condition for decision making. Programmers have to create twice as much code to accomplish a similar task. This makes the software more complex and harder to maintain. Without vendor support, the maintenance costs are higher.

2.3.3.3 Support Personnel

The existing systems are so old that no new engineers or programmers want to support the system. Many colleges and universities teach modern software languages and techniques on state of the art hardware. Young engineers working on these modern systems have skills that are in demand. An engineer working on the old system would not have the experience or skill development necessary for marketability. Therefore, the contractors and customers have to pay higher amounts of money to keep the current support work force.

2.3.3.4 Distributed Site Capability

The current mainframe operating system cannot support distributed software and hardware. The current operating systems only support mainframe to terminal access capability. The operating system cannot support information packet processing, remote hardware access and file sharing.

2.3.3.5 Business Production Software

The users cannot produce spreadsheets, documents and presentations on the current information systems. The hardware cannot run spreadsheets, documents and presentations. Furthermore, users cannot view business products or reports created in different locations. Therefore, the users are not as productive and informed as the could be.

2.3.3.6 Documentation

Since the vendors no longer support the current system computer languages, FORTRAN IV and CLISTS, modern documentation on the language capabilities and functionality does not exist. The available documentation is hard to read, is written poorly and is full of jargon that is difficult to understand. Thus, system maintenance is difficult and hard for new personnel.

2.4 Benefits of the Information System

The information system provides several benefits. These include: better communication between the military services, consolidation of military intelligence activities, up to date information and the development of synergistic relationships.

2.4.1 Better Communication Between the Military Services

The United States Military Services demand the need for communication. During Desert Storm, better communication between the US services regarding troop movements could have prevented the loss of life from "friendly fire." The information system enables better communication between the services and provides up to date information. For example, A T3 communications line, connected between US military sites, enables the sites to send information back and forth at speeds up to 45 Megabits per second. This communication will provide for enhanced teamwork, a better utilization of the military services during various operations. The information system provides two-way point to point communications between all the participating sites at an almost real time speed.

2.4.2 Consolidation of Military Intelligence Activities

Due to the shrinking defense budgets and military downsizing, it is important to consolidate the actions between the services to prevent unnecessary redundant activities. Since the information system will provide a means for information sharing, the military services will be able to consolidate their individual activities. Before engaging on an intelligence mission, the various services perform research on the information system to determine if other organizations meet their requirements or needs. The information system, once developed, has a storage capacity of 10 Terabits. Any important information can be stored on the system.

2.4.3 Up to Date Information

The diverse threat to the US from many third world nations has changed the role of various military organizations. It is important to have up to date information about the various hostile threats to prepare the various military services for that threat. Currently, US military forces are in Bosnia. These forces deal with cold climates and temperatures. It is important for the lives of our soldiers to have up to date information about the Bosnia, Serbia and Croatian troop deployments, weather information, etc. The information system will provide units such as the 82nd Airborne division information to act and prepare against the various hostile threats. The ability for military sites to communicate data at rates of up to 45 Megabits per second allows for fast information retrieval. The storage capacity of 10 Terabits allows the users to input up to date information.

2.4.4 Development of Synergistic Relationships

The enhanced communication between the services, military intelligence activity consolidation and the use of up to date information does not exist because there is no synergistic relationship between the services. The military services and will have to develop a trust between each other and be willing to share as much information as possible. The information system provides a centralized storage area for the hostile threat information. Users can access information from the 10 Terabit distributed database. This action provides redundant information analysis by the military agencies. The redundancy insures the best reports and actions for the military services. Important points missed by an intelligence service could be found by another intelligence service. This prevents hostile intent miscalculation in third would country such as Iraq.

2.5 System Operational Requirements

2.5.1 System Operational concept

The systems operation concept is used to help identify the operational requirements for the information system. The concept includes the: mission definition, performance and physical parameters, use requirements, operational deployment, the operational life cycle, effectiveness factors and the environment.

2.5.1.1 Mission definition

The information system's prime mission is to provide a system that can store, retrieve and process vital information regarding possible threats to the US. The users can add information regarding dangerous threats to the US. The users can research current information on various countries. The users can have meetings, create reports and have other agencies concur about the different information that is given them. The users can task another agency or resource for information about another country.

Information Storage Scenario

The information storage scenario includes: data or information from an external source, data input screens, data download, data parsing and data storage.

<u>External Information Access</u>

The information system connects to different external sources. These include external computers, couriers, and operators. The information system retrieves information through external computer transmission. This allows the various agencies to send data to the system from the various resources. The information system retrieves information from couriers. A courier brings a computer tape or disk to input into the system. The information system can retrieve information from an operator. An operator can physically key in data into the system for the various users.

Data Input Screens

Once the data goes to the system through an external source, the system or operators verify the correct data input screens appear before the information enters into the system. These input screens include a connection to external computer screen, operator screens and a computer tape or disk input screen.

Data Download

The information system downloads the information into the system. Should information exchange be from computer to computer, data buffers slow down the amount of data entering the system. The software divides the information into appropriate segments. The courier data download from a tape or disk includes the computer reading the data and then parsing it. The operator data download includes keying in the information directly into the system.

Data Parsing

Once the data downloads into the system the system then parses the information for storage into a database. In a computer to computer scenario, software programs parse the data before it goes into to the database. Similar actions occur for a computer tape and disk parsing. The operator's information separates through the data input screens. The data input screens have fields for the information. Subsequently an information save step protects the data entered into the computer.

Data Storage

Once the data parse occurs, the software stores the information within the database. If a computer to computer or data tape/disk exchange was used, the data is stored via programs into the system after it is parsed. If operators input data through the keyboard into the system, they can then save the data via the software save options available. An example could be a save button.

Information Research Scenario

The information research scenario includes user log in, database queries, database sorts and data output.

User Log In

The system users get into the system by entering their user identification and their user password. They then access the database by selecting a particular software function from a user screen. The distributed databases exist throughout the system and are available for multiple users. The security software determines the user type accessing the information from the system. For example, given a specific software profile, a user may only have permission to access information from the navy and army. All other information would be off limits. Using the example, the information from the air force is not part of the user's "need to know." So, the user is not be able to get air force information.

Database Queries

Once the user's profile and database privilege establishment occurs, the user can then perform queries on the information. The queries are based on a city, country, time, date and keyword search. The user can input a range or limited search parameter set for particular information.

Database Sorts

To improve the speed at which the user can access information, the software may perform sorts so that the data is easily understood by the users. Furthermore, the software may perform sorts to optimize the system performance. The user can select a primary and secondary key field by which a sort could be done. An optimization sort performed by the software allows faster access time for data retrieval.

Data Output

Once the data sort completes, the information is shared by several means. The data can be printed to the user's terminal. The user can then read the information and decide to take further action. Another data output form is a hard copy report. The user can print out the information in an appropriate designed format. Data output can even be sent to another site via electronic mail.

Business Productivity Scenario

The business productivity scenario includes the user's ability to communicate the information from the system. This scenario includes report generation, briefing preparation, document creation and meetings.

Report Generation

The users generate reports from the system that they can use for gathering information about a particular country or threat. The users first gather the information from the tools such as user query and electronic mail. They can then generate the appropriate reports. The reports could be in a hard copy or soft copy format. Later on, the reports could form the basis for a document or briefing.

Briefing Preparation

A briefing or presentation information is created through the reports or query information. The reports are then sent to other interested readers. The briefer creates the presentation using software such as MS Power Point or HARVARD graphics. The meeting presentation enables intelligence personnel to generate opinions and responses.

Documentation Creation

Instead of a briefing presentation, the user can prepare a report or document for various users stating an opinion and/or technical data. The documents are saved or sent on to higher officials for analysis and review. Like the presentation, the document can be used for meetings with other individuals.

Meetings

Once a presentation or document is prepared, various individuals can get together for a meeting. The presentation or documents can be hard copy or soft copy based on the type of meeting taking place. A meeting between sites can use computers to simultaneously present slides across various sites. The documents are shared across all the sites so that a user at one location can print out a document created at a different location.

Resource Tasking Scenario

The resource tasking scenario includes the user's performing a feasibility analysis, nomination request, resource tasking and overall monitoring.

Feasibility Analysis

Information not available to the user can be requested with the use of the feasibility analysis function. The feasibility analysis software determines if the user's request for information is feasible. The feasibility analysis is based on several factors, these include the priority of the information, the available resources and whether other reports have provided the necessary information. If the request is within reason and is based on a high priority, the user can make a nomination request.

Nomination Request

A nomination request is part of several requests placed by various users. The requests are combined into a group to determine how to use the available resources. The resources can be anything from a weather satellite, to fighter aircraft, or ground troop scouts. These resources are then tasked to gather information for a nomination request.

Resource Tasking

The resource tasking system function calls upon available resources to gather information for a particular agency. The resources are given various orders through the nomination request software and gather information about a particular country or force. Once the information is gathered, it is then sent back to system for processing. From the time the information request is made, to the time the information is sent back, the user can monitor the progress of their request using the monitoring function.

Overall Monitoring

The overall monitoring function is done by the users to check on status of their requests for information. In many cases, the information must pass through several check layers to be processed. Given the resource type, the check could include a: priority, resource availability, weather or other important factors. A request rejection based on the various checks allows efficient resource utilization.

2.5.1.2 Performance and physical parameters

The main performance and physical information system parameters are: Transfer Rate, Workstation and Server Processing Speeds, Capacity, Data Types, File Formats, Hardware Size and Weight, Operational Availability and Error Detection.

Transfer Rate

It is important to have distributed information processed and sent to users at different locations without having poor data rates. Therefore, the communication's links between the various sites and the site server to site workstations have the following performance characteristics: 1)The information passed between the sites shall travel at a speed of 45 Megabits per second. 2)The information passed between the site servers to the site workstations shall travel at a speed of 1.544 Megabits per second. These speeds are based on the data given in Table 2: Communication Link Speeds.

Workstations and Servers

The Information workstations and servers must be able to process the 10 Terabits of information at acceptable speeds. Therefore, the workstations and servers have the following processing requirements:

- The Information System Servers shall consist of a minimum of four 100 Megahertz hyper-SPARC chips.
- The Information System Servers shall have a minimum of 124 Megabits of Random Access Memory.
- The Information System Workstations shall contain a 85 Megahertz micro-SPARC II processor or better.
- The Information System Workstations shall have a minimum screen size of 20 inches and a minimum resolution of 960 by 1280 pixels.
- The Information System Workstations have a minimum of 64 Megabits of Random Access Memory.

Capacity

Since the total data size is 10 terabits, each workstation and server has specific storage requirements:

- The Information System Servers shall have a combined minimum storage capacity of 10 Terabits. Note: Tape drives and disk cartridge systems are part of the server configurations.

- The Information System Workstations have a combined minimum storage capacity of three Gigabits.

Data Types

The information system shall process several software data types. These include: Real, Integer, Boolean and String.

System Formats

The System Formats are discussed in greater detail in the File Formats section

Hardware Size and Weight

The Information System Monitor's have a screen size of 20 inches are weight approximately 30 pounds.

The Information System Workstations and Servers have a size of 4 by 25 by 25 inches and weigh approximately 20 to 40 pounds.

Operational Availability

The Information System has an availability of 85% for scheduled outages and a 99.5% availability for unscheduled outages.

Error Detection

The Information system shall detect and correct at least 99.95% of the bit error caused from transmission between sites and between servers and workstations.

2.5.1.3 Use requirements

The information system operates 24 hours a day throughout the year. The peak system usage occurs at each site between the hours of 9:00 to 11:00 a.m. and from 1:00 p.m. to

3:00 p.m. Since the different sites have different time zones, the total system impact increases the peak system usage for a longer period than four hours. A maximum number of 1800 users can use the system at different times of the day. The maximum system performance parameter peaks occur during the 9:00 to 11:00 a.m. and 1:00 p.m. to 3:00 p.m. periods. To minimize impacts to all the system users, at midnight, the local system is brought down for backup, scheduled system maintenance and configuration system tests. In this way, other sites that are not in this time range do not get impacted so that system availability is at its highest. The required system availability for the system is 99.5%.

2.5.1.4 Operational deployment

The operational deployment of the twelve site installations is done in three phases. The first phase includes the System Integration site, development factory site and systems operations and maintenance site. The second stage includes the installation of the Joint Chiefs of Staff site and the Customer Site A. The final stage for operational deployment includes all the remaining sites. The table below discusses the installation stages as well as the equipment and support infrastructure necessary. Each site installation has three phases, the hardware installation, communication link installation and the software installation.

Table 3: Operational Deployment

Site	Description	No. of Users	Hardware No. & Software Units	Time to Operational (years)	Phase
10	SI Contractor	25	76	1	1
11	LMC Factory	200	441	1	1
12	LMC Maintenance & Operations Center	300	649	2	1
9	Joint Chiefs of Staff	150	325	3	2
7	Customer Site A	150	325	3	2
8	Customer Site B	50	102	3	2
1	Norfolk Navy Base	30	87	5	3
2	Pearl Harbor	30	87	5	3
3	Fort Bragg	75	178	5	3
4	Frankfurt	50	127	5	3
6	Wright Patt AFB	50	127	5	3
	Totals:	1110	2524		

2.5.1.5 Operational life cycle

The anticipated time that the information system will be in use is 20 years. The total software units and hardware numbers are expected to be around 2700 annually. This includes units that are in the shop for maintenance and upgrades. The LMC factory is expected to decrease in size to around 25 employees once the system is operational for five years. The SI and Maintenance & Operations Contractor, LMC, maintains and operates the system over it's 20 year life time. Given the system effectiveness, the information system effectiveness could increase the site number and users. The expected increase in size for both LMC SI and Maintenance & OPS personnel is 5% per site.

2.5.1.6 Effectiveness factors

The effectiveness factors for the information system include: system cost, operational availability, dependability, logistic support, failure times, system support, software, system, hardware and user satisfaction

System Cost

The System Integration Contractor determines the system cost effectiveness factor. The SI contractor ensures that the LMC Maintenance and Operations Center keep detailed logs regarding actions, Software Metrics, Hardware Metrics and effective Configuration Management. The SI contractor uses these tools to ensure that the costs for maintenance and operations are as low as possible during the project lifetime. The SI contractor, Military and Government Customers reward or punish the LMC Maintenance and Operations Center for poor cost effectiveness.

Operational Availability and Dependability

The operational availability is 99.5% for unscheduled outages. The dependability effectiveness measurement includes the failure times, logistic support, software, system and hardware effectiveness factors. All these different factors combine to form the system dependability and reliability.

Logistic Support

The number of Operations & Maintenance personnel determines the logistic support effectiveness. Should a large attrition rate occur for the maintenance facility, the overall availability and dependability are affected. The responsiveness of the external hardware and COTS software package vendors is also extremely important. Several problems with the hardware and software could be beyond the general intermediate maintenance support. For example, a configuration glitch might be due to an operating system problem. This problem type goes to the depot maintenance vendor for a new software patch.

Failure Times

The mean time between maintenance (MTBM) for the information system will be 24 hours. The MTBM measures the times in which the system is down for six hours or more. The scheduled maintenance downtime is 6 hours. Daily maintenance including database archive, system diagnostics and software synchronization lasts between 2 to 4 hours. These jobs run at specific sites and times when no users are on the system; preferably 12:00 midnight. The mean time between failure shall be 2520 hours per site.

System Support

The effectiveness of the system support depends on how well the user training works and how fast the users can get answers to the system, software and hardware questions. The amount of documentation and information help available is also important. The system users go to a training class that lasts for two workdays or 16 hours.

Software

The software effectiveness factors include the: software complexity, Problem Report numbers, maintenance ease and documentation. The cyclometric complexity checkers determine software complexity by checking for multiple nesting and looping functions that can create complex software. A Software Engineering Institute's study correlates software complexity with high failure rates. The problem report numbers correspond to the Computer Software Component Item's failure and reliability. The maintenance ease is the ability of another software engineer or programmer to understand and fix the software. The documentation lists the software functions so that another engineer can learn the software component's purpose and workings.

System

The system effectiveness factor is dependent on the system performance and response times, MTBF and MTBM. The system performance shall not exceed the performance parameters listed in the Performance and physical parameters section. The Technical Performance Measure section lists the MTBM and MTBF factors.

Hardware

Like the system effectiveness, the hardware effectiveness factor is dependent on the hardware performance and response times, MTBF, MTBM and Mean Downtime. The hardware shall not exceed the performance parameters listed in the Performance and physical parameters section. The Technical Performance Measure section lists the MTBF and MTBM and Mean Downtime factors.

User Satisfaction

The user satisfaction is dependent on almost all the previously described factors. The other factors are part of the overall makeup that leads to user satisfaction with the system and high profit and award fees for the contractor.

2.5.1.7 Environment

The information system and all associated equipment and personnel work in a climate controlled rooms. The humidity and temperature regulation ensures the best conditions for the equipment and personnel operation.

2.6 System Maintenance Concept

The information system maintenance concept provides the system maintenance, support and operation details. It describes the levels of maintenance support, the responsibilities of the maintenance support, the maintenance general repair policies, logistic support elements, effectiveness criteria, and the maintenance environment.

2.6.1 Levels of Maintenance Support

The information system maintenance levels are as follows: organizational, intermediate, and depot. The organizational maintenance occurs at the various information system sites. The intermediate maintenance occurs at the LMC Maintenance and Operations Center. The depot level of maintenance occurs at the LMC factory and the various vendor locations. Each level consists of the scheduled and unscheduled maintenance actions as well as the support factors involved.

2.6.1.1 Scheduled Maintenance

The scheduled maintenance tasks are periodic tasks done to keep the system operating at peak efficiency, to prevent performance and reliability problems while increasing user and customer confidence. Scheduled maintenance involves anything from user log in creation to a site shutdown depending on the type of maintenance action involved.

2.6.1.2 Unscheduled Maintenance

The unscheduled maintenance tasks occur when a system part or component fails and the system maintenance is not at an acceptable operational level. The unscheduled maintenance tasks require immediate attention to minimize the impact caused by the unscheduled activity.

2.6.1.3 Support Factors

The support factors include the necessary facilities, hardware, software, supplies and diagnostic tools available to the maintenance personnel in the support of the scheduled and unscheduled maintenance activities.

2.6.2 Basic Responsibilities of Support

The maintenance organization can best utilize personnel, minimize maintenance and training costs by defining the roles and responsibilities of each level. These responsibilities clearly define the tasks and roles for the organizational, intermediate and depot maintenance groups.

2.6.2.1 Organizational maintenance

Personnel with no extensive technical knowledge or training perform the organizational maintenance at each site. Only a small set of responsibilities exists for scheduled and unscheduled outages. The organizational maintenance staff supports the system 24 hours a day, 365 days a year. The staff works at all twelve sites. The descriptions below contain a detailed but not exhaustive list of the maintenance actions performed.

Table 4: Organizational Maintenance

Activity	Staff Level	Skill Level	Responsibilities
System Operations & Administration	3-4	low-moderate	• Initial user creation and removal (log on, passwords, profiles, etc.) • System diagnostics and checkups • Site level backups • Emergency response procedure execution • Problem Report Generation • System startups and shutdowns • Basic user support and help
Hardware	3-4	low-moderate	• Hardware installation and removal • Diagnostics and checkouts
Logistics	1	low	• User supply maintenance • Equipment inventory • Inventory supply reports

2.6.2.2 Intermediate maintenance

The LMC Maintenance and Operations Site performs the intermediate maintenance tasks. The intermediate level maintenance requires personnel with extensive knowledge, experience and training regarding the hardware, software and system. The organizational staff works a standard 40 to 50 hour week. Many problems require monitoring and review by the configuration management tools. The descriptions below contain a detailed but not exhaustive list of the maintenance actions performed.

Table 5: Intermediate Maintenance

Activity	**Staff Level**	**Skill Level**	**Responsibilities**
Software Engineering	90-100	moderate to high	• Technical Investigations • Modification Authorizations • Problem Report resolution • Software modifications • Integration, checkout and test • COTS software integration
System Administration	10-15	moderate to high	• COTS software integration • System programming • Network administration • System performance problems • Technical Investigations • Modification Authorizations • Problem Report resolution
Hardware	10-15	moderate to high	• Hardware diagnostics • Hardware repair and maintenance • Technical Investigations • Modification Authorizations • Problem Report resolution
Database	3-4	moderate to high	• Database maintenance • Database setup and configuration • Database performance and reliability
Logistics	1	moderate to high	• Software Upgrades and Integration • Hardware Upgrades and Integration • Vendor Supplies

2.6.2.3 Depot Maintenance

The LMC Factory and various vendor locations perform depot maintenance. Like the intermediate level maintenance, the depot requires personnel with extensive knowledge, experience and training regarding the hardware, software and system. The organizational staff works a standard 40 to 50 hour week. Like the intermediate level, problems require monitoring and review by the configuration management tools. The descriptions below contain a detailed but not exhaustive list of the maintenance actions performed.

Table 6: Depot Maintenance

Activity	Staff Level	Skill Level	Responsibilities
System Engineering	1	high	• System development and configuration • Performance monitoring and evaluation • Problem report resolution • Technical Investigations • Modification Authorizations
Vendor Support	Varies	high	• Hardware, Software, Networks and COTS problem resolution • System Integration • Hardware, Software, Network and COTS patches. • Hardware, Software, Networks and COTS upgrades and performance resolution
Software Engineering	2-5	high	• Software Optimization and Speed performance • Software upgrades and integration • Integration, Checkout and Test • Problem Report resolution • Modification Authorization • Technical Investigations
Logistics	1	high	• Budget Allocation • Subcontractor and Vendor Supplies, Cost and Support • Equipment inventory management • Inventory supply management

2.6.3 General Repair Policies

The repair at all levels are usually initiated via a problem report or request for change. This enables the configuration management to keep the system operating at a high level with the least amount of errors. Furthermore, should an error occur, the configuration management team could remove the problem and replace it with a previous version or existing equipment.

2.6.4 Logistic Support Elements

To support systems, software and hardware modifications, a small network configuration consisting of hardware, software and communications lines is needed. This network is necessary to mimic the operational system with most of the performance and system functionality. The small configuration consists of a couple of servers, mini-database and a few network connections. The software programmers and engineers could then test their fixes for an extended time before placing them into the operational baseline.

2.6.5 Effectiveness Requirements

The maintenance effectiveness factors are based on the number of Problem Reports that are active and the Modification Authorization rate per programmer submitted. The user satisfaction is another key requirement for maintenance.

2.6.6 Maintenance Environment

The maintenance environments are all in office type climates have a temperature of 70 degrees and 85% humidity. They consist of offices with several workstations, phones, desks, chairs, etc.

2.7 Life Cycle Costs

Considering the identified baseline deficiencies, initial cost estimates of 335 million dollars for the network configuration, hardware and software development are necessary. Furthermore, the contractors have determined the annual costs to be between 85 million and 114 million dollars a year for the next five years. These annual cost estimates include the organizational, intermediate and depot level maintenance requirements and support requirements as described in the System Maintenance Concept. The future cost due to inflation and possible software, hardware and network upgrades is 8.5% annually. According to the customer, the estimated saving due to the agency consolidation is approximately $750 million dollars over the next 20 years. These savings include: the obsolete hardware and software removal, the agency's reorganization and personnel reallocations. The initial cost breakdown structure is given in Figure 3. The cost areas to consider are research and development, implementation, operations and maintenance, and retirement and disposal costs. The detailed cost for the information system life cycle is given in the Detailed Design Section.

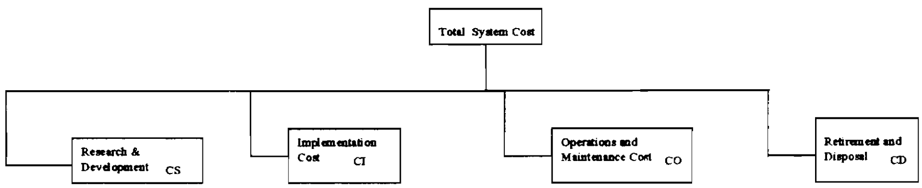

Figure 3: Initial Cost Breakdown Structure

2.8 Integrated System Test and Evaluation

The integrated system test and evaluation plan creation occurs during the conceptual design of the information system. This allows the customers and contractors to identify the methodology for testing the system and to identify the types of testing required over the live of the system.

2.9 Technical Performance Measures

The customers and contractors define the initial technical performance measures during the conceptual design phase. The technical performance measures discuss and describe design related factors necessary to evaluate the system and its components. The technical performance measure target values are given in the Detailed Design section.

2.10 Production Engineering

The contractors and customers also consider the potential for growth during the conceptual design phase. The information system initial configuration contains twelve sites. The customers and contractors incorporate production engineering in case the initial configuration grows to include more customer locations and military sites.

3. Preliminary System Design

The next step in the information system design is the Preliminary System Design phase. This design phase includes the: system functional analysis, allocation of requirements, and life cycle costs calculations.[16] These methods are part of top-down approach to the information system development.

3.1 System Functional Analysis

The system functional analysis method describes the typical functions performed during the information system creation, operation, maintenance and retirement. This ensures the requirement's definition, exploration and/or modification through an iterative process. That is, to support the intelligence information processing between the various sites and customers.

3.1.1 Functional Flow Diagrams

The functional flow diagrams help map structure system requirements to the mission functions performed during the information system operation. The diagrams depict the design requirements, the system organization and functional interfaces.[17] Each function is further broken down into sub-functions. These sub-functions are then broken down to ensure that all the system requirements and needs are developed and that the proper resources are acquired to fulfill the needs.[18]

3.1.2 Operational Functions

The operational functions include the entire system activities. Each function illustrates a step used to accomplish the overall mission. The function flow diagrams used in this section are meant to illustrate the functional analysis and are not meant to be complete. Figure 4 illustrates the top level development.

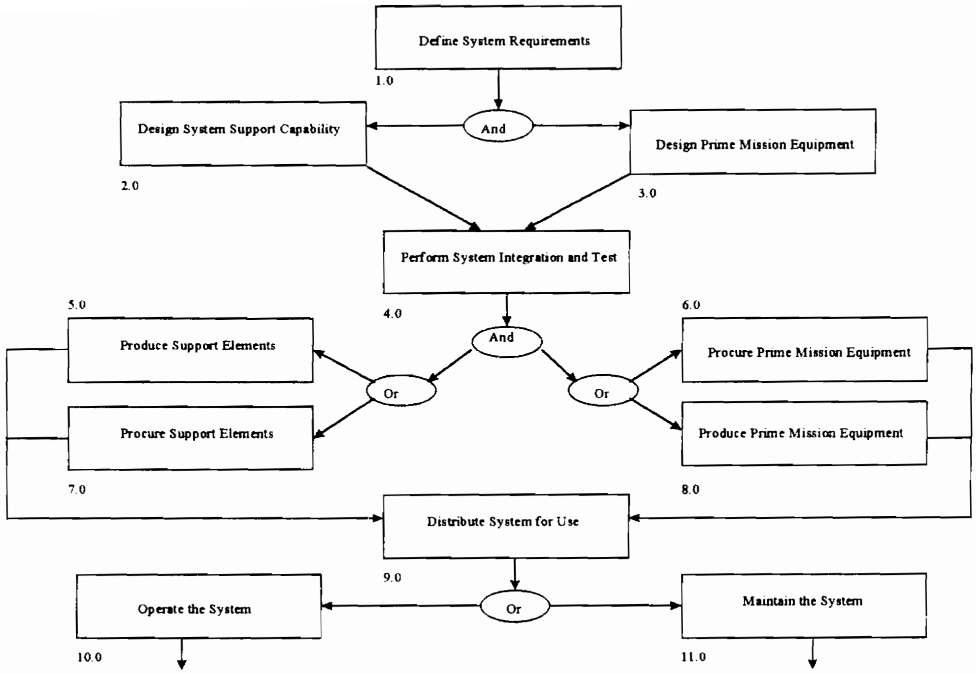

Figure 4: Top Level Function Development[19]

The top level function development initial function is the System Requirements definition. Once the requirements are defined, the prime mission equipment and system support capabilities are designed. The prime mission equipment design includes the development of the information system network, software and hardware acquisition. The system support capacity includes the development of the operations and maintenance centers. The sites include the organizational maintenance. The operations and maintenance site includes the intermediate maintenance center as well as the support staff. Once the support capacity and the prime mission equipment is designed. The System Integration and Test functions are performed. The next steps are to procure or produce support elements and to procure and produce prime mission equipment. The information system is then distributed to the various sites. Once everything is distributed to the sites, the users can operate the system and maintain the system. Figure 5 illustrates the second level.

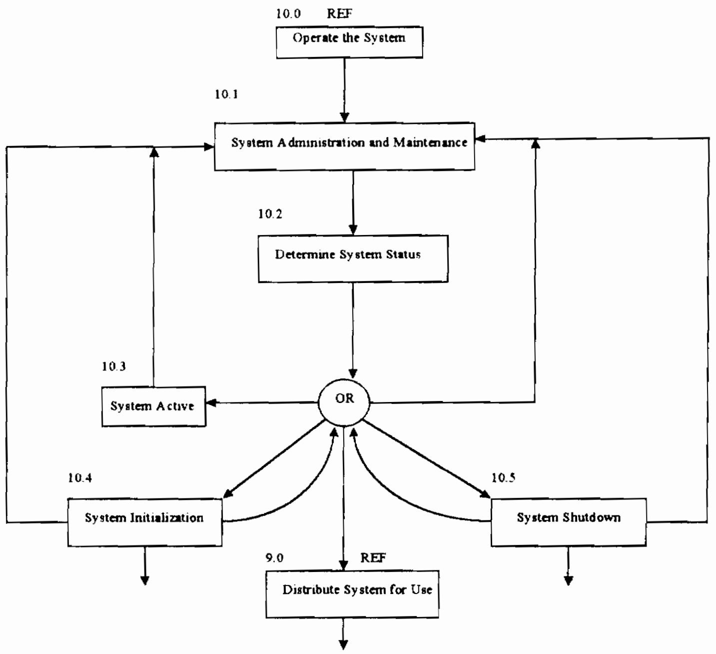

Figure 5:Operate the System – 10.0

Figure 5 starts with the System Administration and Maintenance. The System Administration and Maintenance group determines the system status to ensure that database, communications and network is operating. Once the status is known, the system administrators determine if the system is active. They check the database server, communications monitor, process monitor, network monitor and performance monitor. This ensures the information system can perform its mission. If the system is not active, the system administrators can perform a system initialization. The system initialization starts the site workstation servers, the site servers and communication links. Another option would be to perform a system shutdown. The system administrators can take down system segments to ensure that all hardware and software are brought down in an orderly fashion. This includes the links to the sites and the links between the servers and the workstations. Figure 6 is a further breakdown of the operational function flow.

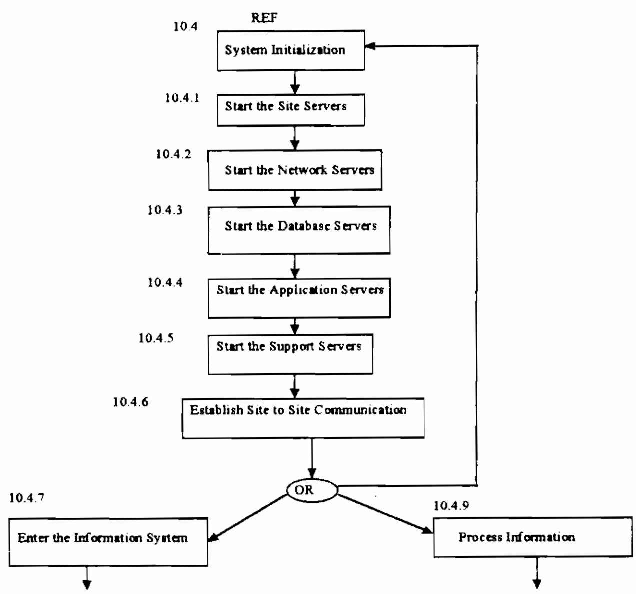

Figure 6: System Initialization -- 10.4

The information system initialization starts at each site. The System Maintenance and Administration personnel contact each other at the different sites and each site starts their site servers. The site servers establish communication and run processes with the workstations. Once the site servers start up, the network servers get started. These servers establish connectivity with all the sites. The next step is to start the database servers. The database servers start the databases and process database information. The application servers start up after the database start up completes. These servers are primarily responsible for processing the information application software. The support servers are the primary machines used for maintenance and testing activities. Towards the end of the system initialization, a test of the site to site communications ensures the information processes run throughout the network. Finally, the workstations enable the users to enter the information system. Once the servers process the information, the system administration and maintenance personnel move on to other tasks. Figure 7 is an example of the user log in functional flow.

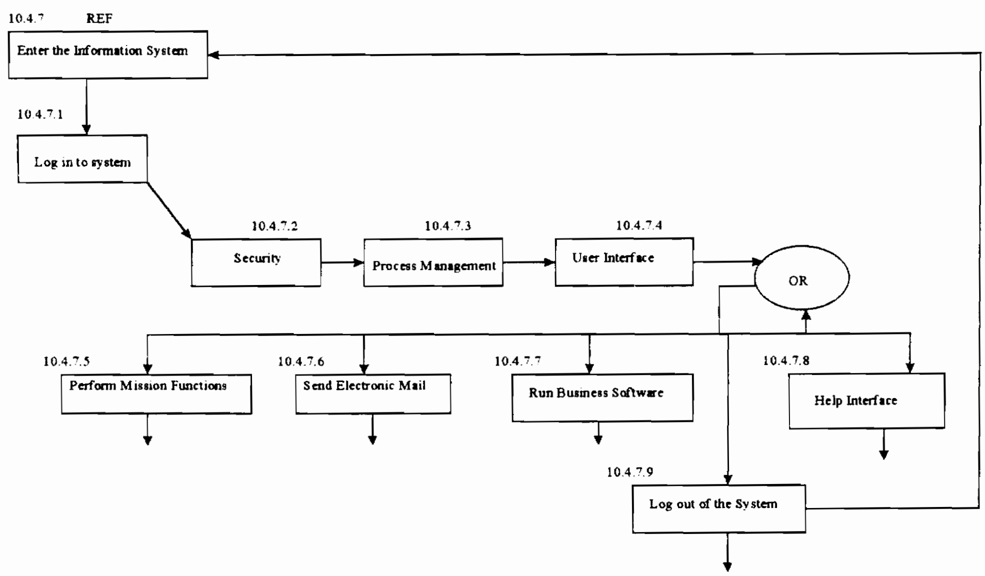

Figure 7: Enter the Information System -- 10.4.7

The users enter the information system by entering their password to log in to the system. The security software determines who the user is, their profile and other information. The user's profile establishes their credentials: privileges, responsibilities, phone number, and site location. This information limits the number of mission functions that the user can perform. The process management software then ensures that the database is running, the communication links are up and the application software is running. Once the process management software determines everything is running, the user interface displays. The users can then view or send electronic mail, run business software, get help on the information system, perform mission functions and log out of the system. Figure 8 is an example of the mission functions available during the operational function flow.

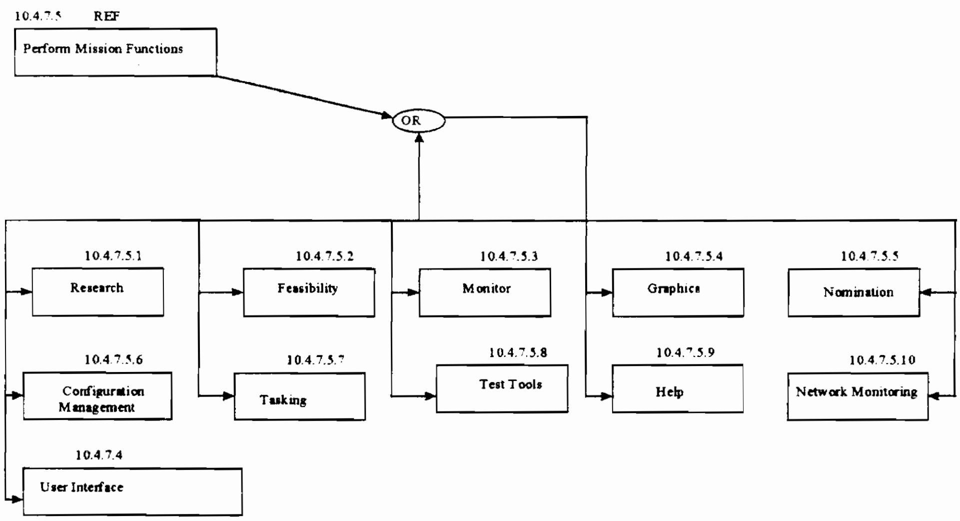

Figure 8: Perform Mission Functions -- 10.4.7.5

From the user interface, the user's can perform mission functions. They can perform queries for research, monitor their requests, check the feasibility of their request, run mapping graphics and place a nomination request for information. Additionally, the user's write problem reports on a configuration management machine or task a resource.

They also run test tools to look into problems, run topic help and/or determine the network status.

3.1.3 Maintenance Functions

Once the information system sites communicate and the distribution is complete, the operations and maintenance facility work begins. The operations and maintenance staff ensures that the problems and the discrepancies that exist with the information system are reviewed, prioritized and assigned to the correct organizations. Again, the function flow diagrams used in this section are meant to illustrate the functional analysis and are not meant to be complete. Figure 9 is a example of the maintenance functional flow.

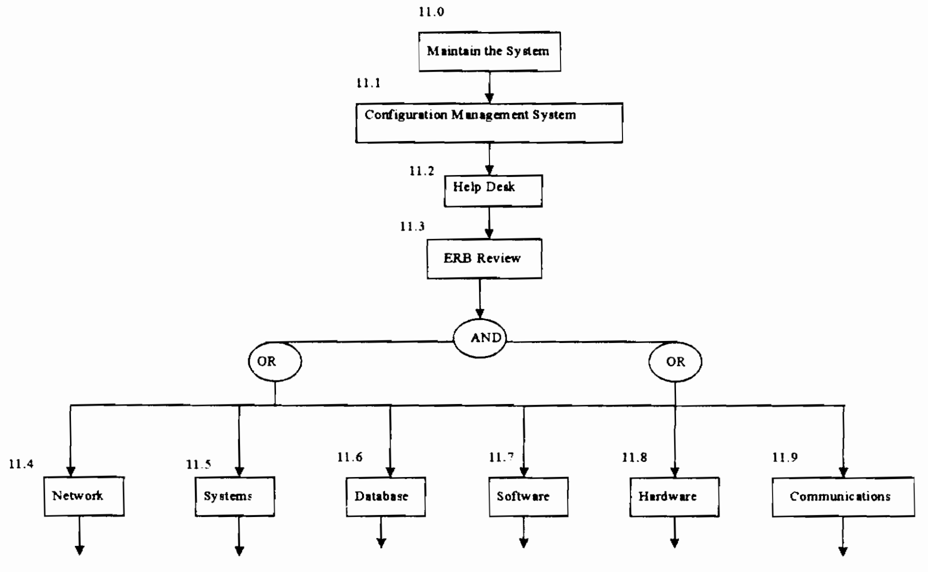

Figure 9: Maintenance -- 11.0

In the maintenance function flow, all problems, discrepancies and inconsistencies with the information system go into the configuration management databases. These problems include: performance, requirements, customer satisfaction, hardware, software and network deficiencies. The help desk reviews the configuration management system to check for the problem reports. Next, the help desk adds their comments regarding the problems. Should the problems be user error, the help desk closes the problem report and then contacts the user. If a real problem does exist, the help desk contacts the users to determine the proper criticality.

The problem report review by the Engineering Review Board is the next step. The customer representatives, systems integration and maintenance & operations members discuss the problem and assign it the correct maintenance organization. These organizations include: network, systems, database, software, hardware and communications.

The functional packaging for this project is not necessary. No combined or self contained packages are necessary for the information system. This is due to the following reasons:

- The information system is distributed. All products and information are shared.
- The hardware, software, systems and network needs all form a natural functional package.
- The information system constantly changes. Software modifications distributions to the system occur once every two weeks. The network configuration optimum performance checks occur once a week.

3.2 Requirements Allocation

The information system naturally forms functional packages used for the requirements allocation. The top level requirements allocations are shown in Figure 10: Hierarchy of System Components. This figure is not exhaustive. It illustrates how the operational and maintenance requirements can be grouped and allocated together. The facility allocation block contains the maintenance and operational requirements associated with the sites. An example of the facility requirements is the humidity and temperature requirements. The software allocation block includes the user interface, business software and mission software. These blocks can be further broken down.

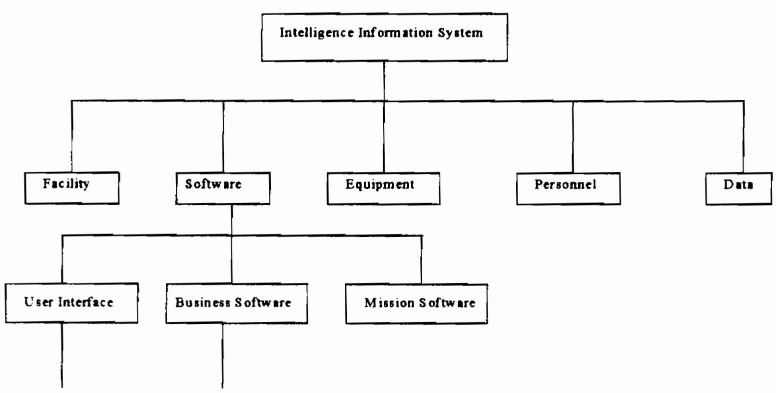

Figure 10: Hierarchy of System Components

From the hierarchy of system components, the system is broken further down to the system sub-component level. Table 7 depicts some of the requirements broken down into further components and functions.

Table 7: Requirements Allocation

Tech. Performance Measures	Facility	Software	Equipment	Personnel	Data
Availability	24 hours	24 hours	24 hours	24 hours	24 hours
Reliability	-	85%	99.50%	-	99.90%
Maintainability	99%	99%	95%	-	100%
Accuracy	-	99.50%	99.50%	-	99.50%
Speed	-	-		-	-
CPUs			400 MHz		
Links			45 MB/sec		
Capacity		500 GB			10 TB
Sites (heads)	1000				
Servers			10 TB		
Workstations			3 GB		
Throughput	-	-	-	-	-
Site to Site			45 MB/sec		
Server to Workstation			1.5 MB/sec		
Weight	-	-			-
Servers			20 lbs.		
Workstations			40 lbs.		
Size	-	-	2' by 2' by 4'		-
Volume	-	-	40 users/min		-
MTBM	-	30 hours	120 hours	-	-
Training Time	-	48 hours	120 hours	240 hours	-
Mean Downtime	-	15 minutes	1.5 hours	-	-

3.3 Life Cycle Cost

The cost of implementing the Intelligence information system is given in Figure 9. The Cost Breakdown Structure for the intelligence information system consists of four primary costs. The four primary costs include: Research and Development, Implementation, Operations & Maintenance and Retirement & Disposal. The customers and contractors limit the anticipated costs to five years. This is due to congressional requirements and the customer's desire to have the flexibility to retire the system, re-bid the contract or request improvements after four years of operations.

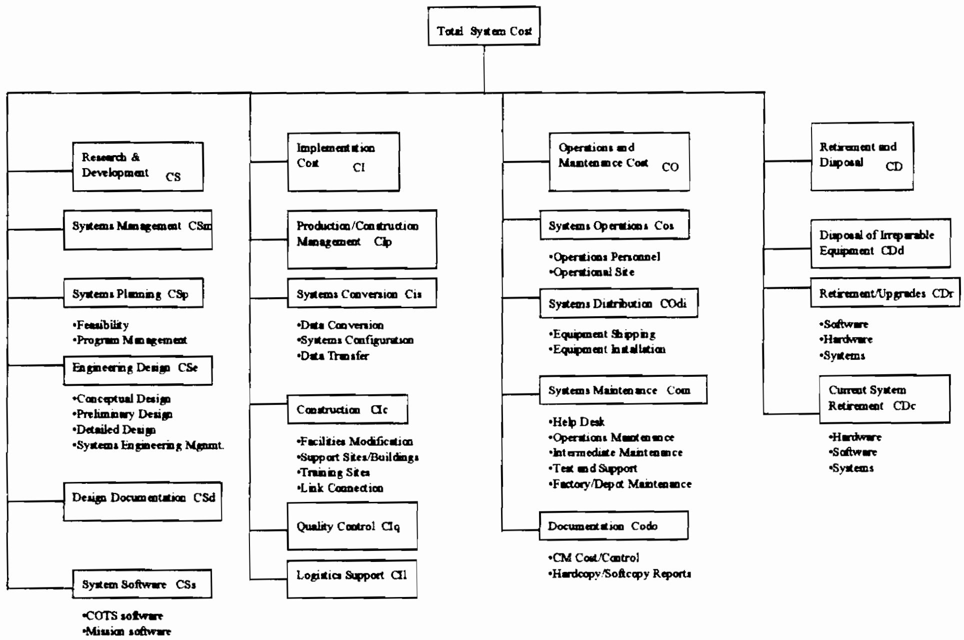

Figure 11: Cost Breakdown Structure

3.3.1 Research and Development Costs

The Research and Development costs include: Systems Management, Systems Planning, Engineering Design, Design Documentation and System Software. The Systems Management cost includes the costs associated with creating a Systems Engineering Management Plan and the costs associated with the management of the system. The Systems Planning Costs includes the feasibility analysis costs and the program management costs. The Engineering Design costs include the expenses associated with the systems engineering development of the system. The Design Documentation cost includes the expenses necessary to document the hardware, software and system development plans, implementation, research and development. The Systems Software costs include the costs for research and development of Mission Software and Commercial Off the Shelf software used in the system. All costs for Research and Development occur during the first year. The Research and Development Costs are given in Table 8.

Table 8: Research and Development Costs

Research & Dev.	Symbol	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Systems Mngmt.	Csm	1.50E+06	0	0	0	0	1.50E+06
Systems Planning	Csp	2.50E+05	0	0	0	0	2.50E+05
Engineering Design	Cse	3.00E+07	0	0	0	0	3.00E+07
Design Doc.	Csd	2.50E+05	0	0	0	0	2.50E+05
System Software	Csc	1.50E+07	0	0	0	0	1.50E+07
Totals (Dollars)	**Cs**	**4.70E+07**	**0**	**0**	**0**	**0**	**4.70E+07**

3.3.2 Implementation Costs

The Implementation costs include: Production/Construction Management, Systems Conversion, Construction, Quality Control and Logistics Support. The Production/Construction Management includes the costs associated with the management implementation of the system. The Systems Conversion cost includes the costs necessary to consolidate the independent systems and transfer associated data into the system. The Construction costs include the expenses necessary to install the information system at the sites. The Quality Control costs include the costs associated with configuration management, audits, demonstrations and reviews necessary to maintain quality over the system. The Logistics Support costs include the expenses associated with support for the system. All costs for Implementation occur during the first year. The Implementation Costs are given in Table 9.

Table 9: Implementation Costs

Implementation	Symbol	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Product./Construct.	Cip	5.00E+05	0	0	0	0	5.00E+05
Systems Conversion	Cis	4.75E+06	0	0	0	0	4.75E+06
Construction	Cic	1.00E+07	0	0	0	0	1.00E+07
Quality Control	Ciq	7.50E+05	0	0	0	0	7.50E+05
Logistics Support	Cil	2.00E+07	0	0	0	0	2.00E+07
Totals (Dollars)	**Ci**	**3.60E+07**	**0**	**0**	**0**	**0**	**3.60E+07**

3.3.3 Operations and Maintenance Costs

The Operations and Maintenance Costs include: Systems Operations, Systems Distribution, Systems Maintenance and Documentation. The Systems Operations Costs include the costs necessary to operate the system 24 hours per day throughout the year. The Systems Operations costs estimates are 50 million dollars per year once the system becomes operational. The Systems Distribution costs include the costs associated with the distribution of hardware, software and systems equipment to the sites. The Systems Distribution Costs estimates are 2.5 million dollars for initial system distribution and 200 thousand dollars per year for the distribution of system modifications. The Systems Maintenance Cost includes the costs associated with the Help Desk, the Maintenance levels, the test and the support equipment. The System Maintenance Costs estimates are 30 million dollars per year once the system becomes operational. The Documentation costs include the costs for the configuration management documentation and the mission reports. The Documentation costs estimates are 500 thousand dollars in initial costs plus

100 thousand dollars per year once the system becomes operational. The interest due to depreciation and inflation is 8.5% per year. The Operations and Maintenance Costs are given in Table 10.

Table 10: Operations and Maintenance Costs

Operations & Maint.	Symbol	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Systems Operations	Cos	0	5.43E+07	5.89E+07	6.39E+07	6.93E+07	2.46E+08
Systems Distribution	Codi	2.50E+06	2.17E+05	2.35E+05	2.55E+05	2.77E+05	3.49E+06
Systems Maint.	Com	0	3.26E+07	3.53E+07	3.83E+07	4.16E+07	1.48E+08
Documentation	Codo	5.00E+05	1.09E+05	1.18E+05	1.28E+05	1.39E+05	9.93E+05
Totals (Dollars)	**Co**	**3.00E+06**	**8.71E+07**	**9.45E+07**	**1.03E+08**	**1.11E+08**	**3.99E+08**

3.3.4 Retirement and Disposal Costs

The Retirement and Disposal Costs include: Disposal of Irreparable Equipment, Retirement/Upgrades and Current System Retirement. The Disposal of Irreparable Equipment costs includes the disposal of irreparable equipment and the destruction of equipment used for processing classified data. The expected cost for the Disposal of Irreparable Equipment is one million dollars four years after the system becomes operational. The Retirement/Upgrades costs include the hardware, software and system retirement, upgrades and software patches. The retirement and upgrades costs are 1.5 million dollars in the second and fourth year after the system becomes operational. The Current System Retirement costs include the costs associated with the retirement of the existing intelligence systems. The cost to retire the existing systems is 250 million dollars. The interest due to depreciation and inflation is 8.5% per year. The Retirement and Disposal Costs are given in Table 11.

Table 11: Retirement and Disposal Costs

Retiremnt/Disp.	Symbol	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Disp. of Irrep. Eqmt.	Cdd	0	0	0	0	1.00E+06	1.00E+06
Retirement/Upgrades	Cdr	0	0	1.77E+06	0	2.08E+06	3.84E+06
Curr. Sys. Retiremnt	Cdc	2.50E+08	0	0	0	0	2.50E+08
Totals (Dollars)	**Cd**	**2.50E+08**	**0**	**1.77E+06**	**0**	**3.08E+06**	**2.55E+08**

3.3.5 Total System Costs

The total system costs for a five year duration is given in Table 12.

Table 12: Total System Costs

Total Cost	Symbol	Year 1	Year 2	Year 3	Year 4	Year 5	Totals
Research and Dev.	Cs	4.70E+07	0	0	0	0	4.70E+07
Implementation	Ci	3.60E+07	0	0	47,000,000	0	8.30E+07
Operations & Maint.	Co	3.00E+06	8.71E+07	9.45E+07	1.03E+08	1.11E+08	3.99E+08
Retirement/Disp.	Cd	2.50E+08	0.00E+00	1.77E+06	0.00E+00	3.08E+06	2.55E+08
Totals (Dollars)		**3.36E+08**	**8.71E+07**	**9.63E+07**	**1.50E+08**	**1.14E+08**	**7.83E+08**

4. Detail Design and Development

4.1 Detail Design Requirements

The system objectives and elements are found from the operational requirements and maintenance concept discussed previously. The design criteria necessary for the detail design requirements include: functional design, reliability design, maintainability design, human factors design and logistics design

4.1.1 Functional Design

The information system technical performance measures are the basis for the system evaluation. The primary mission is to provide users with information critical to the US. The technical performance measures are described in the Technical Performance Measures section.

4.1.2 Reliability Design

The information system's design includes reliability as a primary concern. Therefore, a distributed system design is an important system feature. A distributed system contains built in backup capability and redundancy. There are no single point failures that can bring the entire system down. For example, a mainframe system with connected terminals fails if a mainframe problem occurs. On the other hand, a distributed system continues to function should a failure in a server occur. The primary definitions of reliability for the system include: satisfactory performance and time. The satisfactory performance criteria is based on the Technical Performance Measures. The time based reliability criteria is another information system reliability measure. The technical performance criteria used is the Mean Time Between Failure and the Mean Downtime. Additionally, the reliability analysis, Failure Mode Effect and Criticality Analysis, Metrics and Formal & Customer design reviews are done for reliability design.

4.1.2.1 Reliability Analysis

Reliability analysis is an important technique to improve system maintenance. The block diagram determines the process and actions performance. The block diagram analysis follows. The block check by representatives from all the stakeholders helps best procedures establishment and inefficient procedure or process elimination. The worst case scenarios generation is performed with the block diagram analysis also. The procedures and plans creation assists the worst case scenario impact reduction. Since the information system is a user based system, the high usage analysis with the maximum user numbers is performed to determine the impact to the overall system performance. The procedures and plans creation also assists in the high usage impacts.

4.1.2.2 Failure Mode Effect and Criticality Analysis

Failure Mode Effect and Criticality Analysis (FMECA) is a technique to identify potential critical failures. This is important because equipment criticality is not always associated with price. An inexpensive video computer board might cause a critical failure while an expensive server does not.

4.1.2.3 Formal Design and Customer Reviews

Formal design and customer reviews are done from the information system design through the information system activation. A preliminary design review (PDR) is an initial review done by the development contractor, systems integrator and the military & customer representatives. This review includes the development contractor's initial design and proposal to meet the customer requirements. The next system review is the critical design review (CDR), this review is conducted once a small information segment is complete. The development contractor demonstrates system functionality and actions to ensure the system design meets the customer satisfaction. The final review is the customer acceptance review (CAR). All stakeholders attend the review. The development contractor demonstrates a limited system to the customers. The customers then decide if the system is acceptable or unacceptable. Should the system be acceptable, funding continues to the development contractor until the system is complete. If the system is unacceptable, the funding stops, the contract is put up for bid and all work done by the development contractor is given to the customers.

4.1.2.4 Metrics

Metrics are an important factor for continual analysis of the MTBF and MTBM numbers. The configuration management system data entered into the system enables the systems integration, maintenance and operations contractors to get an accurate number for the mean time between failure and the mean time between maintenance. Additional numbers include the time it takes to get a problem fixed, the time it takes a problem fix verification, etc.

4.1.3 Maintainability Design

Maintenance Planning is important to the information system design. The methods and tools used in ensuring high maintainability include: maintainability requirements, configuration management, maintenance requirements, maintainability analysis and maintainability prediction & assessment.

4.1.3.1 Maintainability Requirements

The maintainability requirements for the sub-system levels are another key maintainability task for optimum user satisfaction. The maintenance and operations centers divides the maintenance team into smaller teams assigned to a specific sub-system. The sub-system teams assign and set maintainability goals that correspond to the overall system requirement. For example, a software system requirement is "High quality software that accomplishes the mission." A subsystem requirement is "Low Software Engineering Institute's complexity rating." The software complexity rating is a rating system developed by the Software Engineering Institute based in Carnegie Mellon University.[20] It states that a software complexity is directly proportional to the amount of software errors.[21]

4.1.3.2 Configuration Management

The configuration management of problems is a key technique and practice for the information system maintainability. The configuration management system tracks any problem, perceived or legitimate. This system receives the information system stakeholders input and impact concerns from the time the system is developed to the time it retires. As stated before, the systems integration, military, customer organization and maintenance & operations representatives check all problem reports to assign them priority and tracking code. Thus, the system maintenance staff concentrates on the highest priority problems.

4.1.3.3 Maintenance Metrics

Maintenance metrics are a necessary part for system maintainability. Software metrics aid in the reduction of maintenance time. For example, a tool developed by the Software Engineering Institute called a cyclometric complexity checker is used to reduce errors.[22] This tool is used to check software complexity. As stated before, correlation between high complexity and high errors necessitate the checker's use. The software modules with high complexity are redesigned to reduce maintenance time and errors. Additional metrics include lines of code, number of errors per computer component, and number of errors per 100 lines of code.

4.1.4 Human Factors Design

Human factors analysis is another important design factor. The anthropometric, human sensory and physiological factor are all considered in the system design. Almost all functions performed on the information system are from an office setting. From mission functions to maintenance, most actions are performed at a desk with a workstation and computer terminal.

4.1.4.1 Anthropometric Factors

The primary anthropometric concerns are with the office desks and chairs. The desks and chairs should include ergonomic designs to prevent stress and fatigue to the information system personnel. The chairs should be adjustable so a person sitting in the chair can have there heels touch the floor. The chairs should also have back and shoulder support to prevent poor posture and fatigue. Wheels enable the users to move or slide around to different parts of their desks. The desk height thirty-eight inches is acceptable. An adjustable keyboard shelf that is about thirty to thirty-two inches reduces wrist and hand fatigue. The terminal height should enable the users to look directly into the center of the screen without having to look up or down. This reduces the eye strain.

4.1.4.2 Human Sensory Factors

The human sensory factors concerning the information system are vision and noise. The computer terminal's position is at the eye level. It also has a resolution of .28 mm. This prevents eye strain and fatigue. Furthermore, the sites should have adequate lighting for reading and viewing printed material. This reduces eye strain caused by poor lighting. The office colors should allow light to reflect and brighten the room. Most offices have light tans, off-white or light blue colored walls and office furniture. The facility rooms with computer hardware need adequate cooling. In most cases environmental temperature control occurs with fans and cooling units that generate large amounts of noise. The individuals working within these locations should have adequate hearing protection devices to ensure that no damage to hearing occurs.

4.1.4.3 Physiological Factors

The Physiological factors affecting the information system are the temperature and humidity. As stated before, most information system functions occur in an office setting.

Therefore, the office temperature and humidity technical performance measures help eliminate problems associated with temperature and humidity concerns. Most modern offices include environmental control systems that keep offices at a set temperature and humidity. In most cases, temperatures in the 60 to 65 degree range are not necessary. Most offices run at 72 to 78 degrees. Unfortunately, hardware rooms where the computers reside need to run temperatures of 60 to 65 degrees. Consequently, the hardware workers within the rooms need education regarding the long term affects due to a colder environment. Some affects include muscle numbness and increased fatigue.

4.1.5 Error Analysis

The objective in the information system design is to reduce as much human error in the daily information system operation and maintenance activities. The Failure Mode Effect Criticality Analysis is necessary to understand the impacts due to failures associated with operations and maintenance procedure errors, test errors improper software or hardware distribution and inadequate training.

4.1.5.1 Operation and Maintenance Procedure Errors

The operation and maintenance procedure errors directly affect the system. The inability to detect and fix problems associated with software modifications increase the downtime and recovery times. Therefore, it is important that procedures for incorrect software removal, defective hardware removal and network reroute have no errors, are easy to understand and reduce human errors. The error analysis determines the impacts caused by the improper fulfillment of procedure steps.

4.1.5.2 Test Errors

Incorrect test data or improper testing is a major concern for the customer. The failure to fully test modifications made to the system could mean the loss of data, functionality and time. A modification made to correct a certain problem may introduce another problem into the system. Thus, it is important to not only test the modification, but it is important to test several functions to ensure that the changes made did not affect current functionality. Functionality impacts occur if the verification is done with incorrect data. Since databases store information, it is important to have data that match the operation database formats, size and length.

4.1.5.3 Improper Software And Hardware Distribution

The inability to distribute software or hardware to the sites affects mission functionality. Should the build group send software modifications to certain sites and not to others, the sites may not communicate or process information correctly. For example, a database modification made to certain sites and not to others may cause different data formats. These different data formats could cause software to send correct information to certain sites and erroneous information to other sites.

4.1.5.4 Inadequate Training

The analysis enables planning for possible problems and impacts associated with user error. The users could perform incorrect or incomplete reports because information gathered from the system was incomplete. A user error caused by the improper running of queries could lead to incorrect decisions. These decisions, given the critical nature of the information, may jeopardize lives and equipment. The US may miss an invasion similar to the Iraqi invasion of Kuwait.

4.1.6 Safety Analysis

The safety analysis is similar to error analysis. However, it is focuses on the prevention of accidents and the reduction of hazards. The improper lifting of hardware, failure to maintain proper environmental conditions, improper hardware use, improper appliance use are all dangerous and could lead to accidents. The hazardous material disposal of items such as toner cartridges, is another necessary requirement. The offices and computer rooms contain electrical and fire hazards. Therefore, special "Dead-Man" switches and special fire extinguisher in the rooms throughout all the sites are also necessary.

4.1.7 Logistics Design

The logistic support planning includes the information systems distribution, maintenance, and system support and products. The logistics support plan includes: quantitative and qualitative logistic system requirements, functional analysis and sub-system allocation, logistic support analysis, new logistic support element design, early procurement and acquisition for logistic support elements and formal design reviews.

4.1.7.1 Logistic System Requirements

The logistics system requirement basis is from the mission profiles and maintenance concept. The stakeholders understanding the mission and maintenance requirements gives the maintenance and operations contractor the ability to create and justify the site hardware, software and system support requirements. The site locations and existing support services assist in fulfilling the logistic system requirements.

4.1.7.2 Logistics Allocation

The logistics allocation to the sub-system level is part of the design used to maintain and operate the information system. The maintenance analysis allows the stakeholders to understand the tools and equipment necessary to keep the system functioning. The information system runs on computers and network lines. Therefore, vendor support and availability is necessary. The maintenance plan includes three levels, operational, intermediate and depot levels. The operational maintenance at the sites primarily calls primarily for spare servers and boards in case a part should fail. The system is redundant. Thus, it is not necessary to include hardware and communications inventories at the sites. At the intermediate level, the sub-system maintenance work occurs at the maintenance and operations facility. The intermediate levels includes a test network. This network allows the engineers to test and verify software, hardware and system modifications. The depot level or vendor support maintains the necessary hardware, software and system inventories. The equipment goes to the vendor sites for modification.

4.1.7.3 Logistics Support Analysis

Functional analysis done for the operational and maintenance functions allows the logistics support analysis. The logistics support analysis identifies the equipment and hardware the maintenance and operations personnel use in the daily, weekly and yearly activities. The technical performance measure target values adjust the support requirements and analysis done. For example, a mean downtime target value could justify the need for backup support server inventories.

4.1.7.4 New Logistics Support Element Design

As the system matures, more information sites, hardware, software and system upgrades could affect the logistics requirements, allocation and analysis. Therefore, the ongoing functional analysis verifies existing support and/or new logistic support. This could include but is not limited to: upgrades, new sites, different vendors, suppliers, test and support equipment.

4.1.7.5 Logistic Procurement and Acquisition

The logistic procurement and acquisition plan for the information system is necessary to ensure the logistic requirements are met at the different sites. Sites located in other countries could have different procurement needs than the sites located domestically. For example, the site located in Germany may not have any vendor facilities near by. Therefore, the site may have to keep a supply warehouse in case maintenance needs to be performed.

4.1.7.6 Formal Design Review

The formal design reviews assist in the identification logistic strategies and importance. The preliminary design adjustment may be necessary given the maintenance and operational needs. The maintenance and operations lead to logistic support issues that could impact cost and time.

4.1.8 Production Engineering Design

The information system initial configuration contains twelve sites. The customers and contractors incorporate production engineering in case the initial configuration grows to include more customer locations and military sites. Furthermore, production engineering ensures the best costs during the information system production.

4.1.9 Social Acceptability Design

The social acceptability design for the information system is, as the title describes, to allow society to accept the information system. Many systems produce harmful products that pollute or are dangerous to the environment. Fortunately, the information system does not generate any hazardous by-products. In fact, most modern computer equipment contains low power energy saving features. The low power settings prevent over heating and reduce the need for energy. Another benefit of the system is that there are limited ways that a person could get hurt. A possible area of concern is electrical shock. An exposed electrical wire from a computer and a person spilling a liquid on a computer are examples of electrical hazards.

4.2 Technical Performance Measures

The primary Technical Performance Measures are defined in Table 13: Technical Performance Measures and Values. The measures discuss and describe design related factors, that are applied to evaluate the system and its components.

Table 13: Technical Performance Measures and Values

Tech. Performance Measures	Value
Availability	24 hours/day all Year long
Reliability	99.50%
Maintainability	100%
Facilities	99%
Software	99%
Equipment	95%
Data	100%
Accuracy (S/W, H/W, Data)	99.50%
Speed	400 Mhz/sec Servers; 85 Mhz/sec Workstations
Capacity	10 Terabits
Throughput	45 Megabits/sec
Weight	40 pounds/Workstation; 20 pounds/server
Size	8' by 8' by 8'
Volume	40 users/second
MTBM	24 hours overall, 30 hours for software; 120 hours networks and hardware
Training Time	48 hours
Mean Maintenance Downtime	1.5 hours
Site to Site Speed	45 Megabits/sec
Server to Workstation Speed	1.5 Megabits/sec
Environment Humidity	<85%
Environment Temp.	65-78 degrees
Max Number of Users.	1200
Software response time	2 seconds
Software Language	Third Generation
Database Type	Distributed

Research & Development Cost ($)	4.70E+07
Implementation Cost ($)	3.60E+07
Operations & Maintenance Cost ($)	3.99E+08
Retirement/Disposal Cost ($)	2.55+08

5. Integrated System Test and Evaluation

5.1 Testing Methodology and Overview

The testing methodology and overview includes the test plans and the test guidelines for the information system. The information system includes four types of testing that are used throughout the different phases. These tests occur in conjunction with customer review to gain the customer acceptance necessary to complete and finish the project. The test plan includes the personnel types necessary to ensure all functionality within the system gains customer satisfaction and accomplishes the overall mission. The test plan is part of the system life cycle and is integral to a system engineering design. It is important that the personnel performing tests have a clear understanding of the customer needs, the mission and the operational, system and maintenance requirements.

5.2 Types of Testing

As stated before, the test plan includes specific testing types to verify the mission, operational and maintenance requirements. Each test type occurs in conjunction with the system life cycle. The test types and system life cycle are shown in Figure 12.

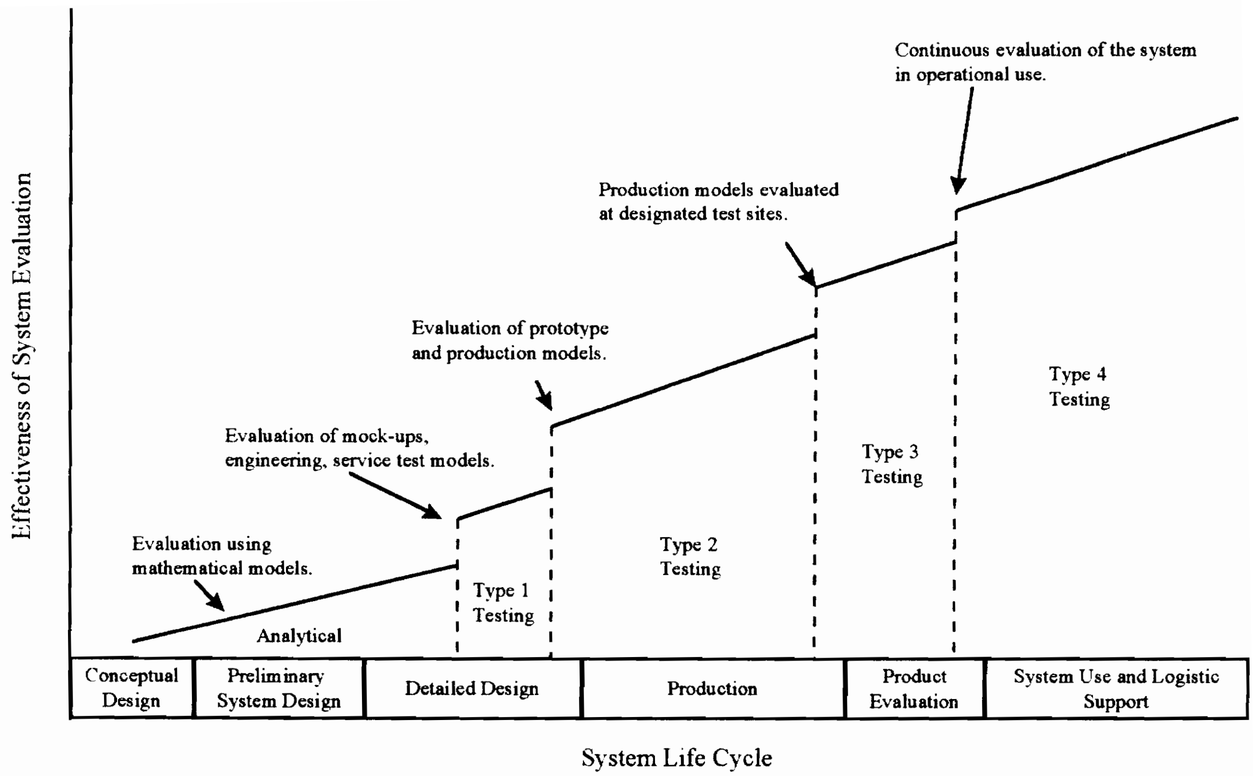

Figure 12: System Evaluation Stages During the Life Cycle[23]

5.2.1 Type 1 Testing

The Type 1 Testing is done during the information system detail design. The purpose of this testing is to verify system performance and system characteristics. The tests are done to verify that hardware and software performs as expected. The tests also verify some operational and logistic support actions. For example, a performance parameter such as 100 data records sorts per minute is checked. The support tests might include the removal of a server and subsequent network reroutes. From the type 1 tests, slight modifications can be made to the information system design to gain the most performance or support use with the lowest cost.

5.2.2 Type 2 Testing

The Type 2 Testing is done towards the end of the detail design and the start of the information system production and construction. The testing is more extensive than the type 1 testing. A formal test program for the information system is created to verify operational and maintenance requirements in different areas of the information system. The type two testing includes. Performance tests, Human Factors/Safety Tests, Reliability Tests, Maintenance Tests, Support Equipment Tests, Technical Data Verification and Software Verifications.

5.2.2.1 Performance Tests

The performance tests run on the information system to verify that information can be shared between the sites. Since the information system has a distributed database, the system's capability to send, sort and receive information is critical to mission success.

5.2.2.2 Human Factors/Safety Tests

The Human Factors/Safety Tests verify that a safe environment exists for personnel. The personnel must work in a safe setting that takes into account the anthropometric, physiological, psychological and human sensory factors. A safety test verifies that no hazards such as exposed wires, flammable liquids, etc., exist.

5.2.2.3 Reliability Tests

The information system reliability tests verify technical performance measures, such as mean time between failure, mean time between maintenance, mean down time are known and are within the specified target value. Once the reliability factors are learned through testing, adjustments to the system can be made.

5.2.2.4 Maintenance Tests

The maintenance tests verify the logistic maintenance support requirements. The three levels of maintenance are tested to establish clear lines of responsibility. The operational maintenance, intermediate maintenance and depot maintenance groups run formal tests to check if any support or personnel requirements need adjustment for the maintenance organization.

5.2.2.5 Support Equipment Tests

The support equipment tests are similar to the maintenance tests except, that the support equipment is checked to ensure that the maintenance organization can perform its mission. At the sites, the system administration workstations are tested to verify organizational maintenance requirements. At the maintenance and operations site, the test network is used to verify support requirements. The depot level maintenance is also checked to ensure mission capability.

5.2.2.6 Technical Data Verification

The technical data verification tests ensure the information passed between the sites is valid and correct. No data should be lost in transition and procedures for archive and backup capability need to be checked as well.

5.2.2.7 Software Verification

The software mission requirements are verified and checked. The database and information sharing demonstrations for the customer are done to ensure they meet with customer satisfaction.

5.2.3 Type 3 Testing

The Type 3 Testing begins during the end of the production and construction phase and the start of the product evaluation phase. The tests verify operational and logistic support requirements. Demonstrations conducted at the sites by operations and maintenance personnel who run realistic mission scenarios ensures customer confidence. The testing also is done to determine if the customer accepts the information design or the design goes to another contractor. If the tests meet mission and customer requirements, refinements and/or enhancements are defined and given to the customer.

5.2.4 Type 4 Testing

The Type 4 Testing is performed when the system is in use and logistic support mechanisms exist. The testing involved are the information system sites. The information system performance limits are found and checked with Type 4 testing. For example, every available workstation has a user run mission functionality. From this, performance parameters can be measured and the impact of having the maximum number of users is found. These tests may cause changes to the mission plans and operations. The tests last anywhere from 24 hours to 120 hours. A greater understanding of the logistic and support requirements is gained and demonstrated to the customer.

6. SYSTEM ENGINEERING MANAGEMENT PLAN (SEMP)

The Systems Engineering Management Plan enables the intelligence information system development, operations and maintenance to be managed with orderly and detailed methods. The next sections illustrate the topics necessary to complete the plan. Each section contains a brief summary of some topics discussed in Sections 1 through 5, plus additional items such as a Work Breakdown Structure and a Project Schedule. The SEMP for the intelligence information system demonstrates topics a management team needs given a development task. The SEMP given in this report is not a complete and exhaustive plan. It lacks an indepth analysis and justification for each section. It also lacks the Systems Engineering scheduling techniques such as a PERT (program evaluation and review technique) or a CPM (critical path methods).

6.1 Technical Program Planning and Control

6.1.1 Program Requirements

The need has been identified for intelligence information management between the different military, customer and contractor sites located throughout the world. The current government systems cannot share information with multiple sites and have difficulties in keeping current with up to date information. Furthermore, the current information systems located at the sites cannot send electronic mail, run business software and task other military agency components. This has resulted in incorrect decision making based on inaccurate information and delays in preparation for our military forces. The systems engineering activity enables the government to consolidate many intelligence activities. Obsolete hardware, software and systems that are no longer supported by the vendors can be replaced with modern equipment to allow information sharing, better decision making, improved response times, and longer preparation times. The intelligence information management difficulties have caused the need for a well engineered information system.

6.1.2 Organization

The Maintenance and Operations contractor is responsible for the management, planning, procurement, development of the information system. The customers that include the Joint Chiefs of Staff and government customer. These customers provide direction to the Systems Integrators. The Maintenance and Operations contractor will work with the

Systems Integration contractor (SI) to ensure that the customers' needs are fully addressed and met. The military intelligence agencies fall under the responsibility of the Joint Chiefs of Staff while the Customer is responsible for their agencies. The Maintenance and Operations provides the operations, maintenance and support organizations, lines of responsibility and reporting calls regarding all stakeholders.

6.1.3 Supplier or Subcontractor Requirements

The Maintenance and Operations contractor with the help of the Systems Integration contractor will manage and direct all vendors and other support organizations to ensure that they fulfill customer needs and meet the mission requirements.

6.1.4 Program Interfaces

The Systems Integration will be the primary responsible entity that ensures that the Information System development contractor, maintenance and operations contractor military agencies and customer agencies interface properly and communicate needs and requirements for mission success.

6.1.5 Work Breakdown Structure

The Intelligence Information System Work Breakdown Structure (WBS) is given in Figure 13.

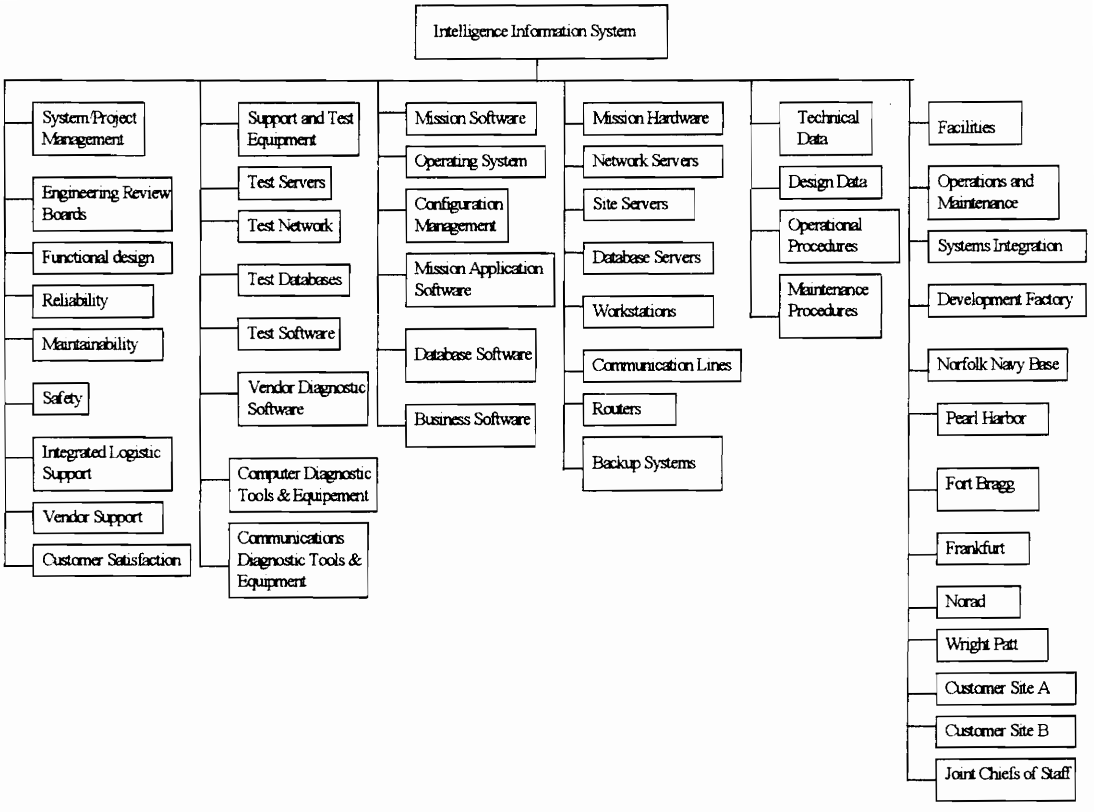

Figure 13: Work Breakdown Structure

6.1.6 Schedule

The Intelligence Information System schedule is given in Figure 14.

Tasks			Oct-96	Dec-96	Mar-97	Jul-97	Oct-97	Dec-97
Needs analysis/feasibility analysis			XXXXXXXXX					
Operational Requirements				XXXXXXXXXXXXX				
Maintenance Concept					XXXXXXX			
System Engineering Management					XXX			
Conceptual Design Review					XXXXXX			
Functional Analysis						XXXXXXX		
Preliminary Design						XXXXXXXXXXXX		
Detail Design						XXX		
Customer Acceptance Review							XX	
Equipment Procurement							XX	
Software Development							XXXXXXXXXXXXXXX	
Network Installation							XXXXXXXXXXXXXX	
Final Demonstrations								XXXXX XX

Figure 14: Intelligence Information System Schedule

6.1.7 Technical Performance Measures

The Intelligence Information System Technical Performance Measures are validated by the Maintenance and Operations contractor to ensure the information system processes information between the military, contractor and customer sites and that the software, hardware and system functions, performance and features meet the customer's satisfaction.

6.1.8 Cost Estimating and Reporting

The Allocation of the Requirements Table and Life Cycle Cost sections contain detailed estimates of the Intelligence Information System costs down to the Maintenance and

Operations, Systems Integration, Military and Customer site level cost. The budget and cost expenditures are handled by each of the different sites. The Joint Chiefs of Staff, Customer, Systems Integration, Maintenance and Operations and all relevant stakeholders annually review the budget to determine if costs were met or exceeded. If necessary, segments of the information system can be placed up for bid by the customers.

6.1.9 Program Monitoring and Control

On a daily basis, video and teleconferencing engineering review boards (ERB) and sub engineering review boards (SUBERB) meet with representatives from the Military, Customer Organization, Maintenance and Operations and Systems Integration. This ensures that the mission problems, system monitoring and system control are addressed for the customer needs and requirements. The representatives discuss and review Problem Reports, Modification Authorizations, Requests for Change and other items that affect mission performance.

6.1.10 Risk Management

On a daily basis, video and teleconferencing engineering review boards (ERB)s and sub-engineering review boards (SUBERB)s meet with representatives from the Military, Customer Organization, Maintenance and Operations and Systems Integration. This ensures the early problem detection regarding technical performance measures and system performance. Delivery schedules, support and maintenance requirement definition occur as well. Furthermore, the budgeted cost versus actual cost discrepancy review occurs on a monthly and annual basis. The information system configuration management system tracks discrepancies and resolutions.

6.2 System Engineering Process

6.2.1 Need Identification

The need for intelligence information management between the different military, customer and contractor sites is necessary to ensure mission success. The current government systems cannot share information with multiple sites and have difficulties in keeping current with up to date information. The systems engineering process helps define the requirements necessary to develop, maintain and operate the information system. This involves the allocation of encrypted data links between the Maintenance & Operations, military and contractor sites. Furthermore, software, hardware and systems computing resource procurement, installation and maintenance at the Program Maintenance and Operations, SI, Military and Customer Contractors sites must occur. The different sites come on line at random times when different demos and tests run.

6.2.2 Feasibility Analysis

The intelligence information system feasibility development occurs with the use of current software packages, third generation languages and sound network capabilities. The techniques and methods available for installing the network currently exist. Therefore, no thorough and indepth analysis is necessary. Furthermore, the military installations, customer installations and contractor facilities are in existence, so no additional costs due to site construction exist. The major risks associated with the project are getting the sites prepared for the information system installation. Raised floors, secure conduits and environment change installations at the sites ensures that the communications lines, cables and hardware are protected. All the sites will use identical servers, workstations and configurations. This enables easier maintenance at the organizational, intermediate and depot levels. The configuration management group uses distribution software to synchronize all site with the identical software enhancements and modifications. Thus, the risks associated with incorrect software versions are minimized.

6.2.3 Operational Requirements

The information system operation requirements are determined by the need to consolidate obsolete intelligence agencies, the need for more teamwork and the need for information sharing. Additionally, current deficiencies in the processes, software, hardware and networks are addressed to highlight the information system needs. The system upgrades are discussed from a functional perspective. Once this is done, the operational requirements are created. The Systems Integration contractor works with the military and customer organizations to ensure satisfaction and mission requirements are met. The technical performance measures and other customer defined effectiveness factors associated with the operational requirements are verified during the customer demonstrations, acceptance review and tests.

6.2.4 System Maintenance Concept

The system maintenance concept is based on the determination of the levels of maintenance support. The defined levels of maintenance support for the information system is the organizational, intermediate and depot levels. The organizational maintenance is performed at the various sites. The intermediate maintenance is performed at the information system operations and maintenance facility. The depot level of maintenance is performed at the hardware, software and network vendor sites. The responsibilities for the organizational, intermediate and depot maintenance levels are determined. The general repair policies are discussed with the main stakeholders. The support logistics, maintenance effectiveness factors and maintenance environments are discussed with the main stakeholders to ensure a complete maintenance concept is defined.

6.2.5 Functional Analysis

The information system functional analysis is done with the use of functional flow diagrams. These diagrams portray the step by step actions done during the daily operations. From the development of the system to the retirement of the system, the functional flow diagrams illustrate the relationships between the information system personnel, hardware, software and network. This is done to ensure that all possible needs and requirements for personnel, hardware, software and network equipment are determined. Additionally, the functions are grouped to create the best maintenance support organization. The two types of functional flow diagrams used in the information system are the operational and maintenance flow diagrams. The operational flow diagrams illustrate the functions and actions performed during the information system operation. The maintenance flow diagrams illustrate the actions performed during system maintenance and repair.

6.2.6 Requirements Allocation

The information system is broken down in to sub systems given the functional flow diagrams. The system hierarchy depicts the sub-systems and allocation based on the functional analysis. The requirement's analysis demonstrates requirement fulfillment to the sub-system level. The information system qualitative and quantitative requirements affect the information system design requirements. The requirements include MTBF, MTBM, FMECA, Human Factors, Mean Downtime and Customer Satisfaction.

6.2.7 System Test and Evaluation

The testing methodology and overview includes test plans and test guidelines for the information system. The information system includes four types of testing that are used throughout the different phases. These tests are part of done in conjunction with customer review to gain the customer acceptance necessary to complete and finish the project. The test plan includes the personnel types necessary to ensure all functionality within the system gain customer satisfaction and accomplishes the overall mission.

6.2.7.1 Type 1 Testing

The Type 1 Testing is done during the information system detail design. The purpose of this testing is to verify system performance and system characteristics. The tests are done to verify that hardware and software perform as expected. The tests also verify some operational and logistic support actions.

6.2.7.2 Type 2 Testing

The Type 2 Testing is done towards the end of the detail design and the start of the information system production and construction. The testing is more extensive than the type 1 testing. A formal test program for the information system is created to verify operational and maintenance requirements in different areas of the information system. The test plan includes:

- Performance Tests
- Human Factors/Safety Tests
- Reliability Tests
- Maintenance Tests
- Support equipment tests
- Technical data verification
- Software verification

6.2.7.3 Type 3 Testing

The Type 3 Testing begins during the end of the production and construction phase and the start of the product evaluation phase. The tests verify operational and logistic support requirements. Demonstrations are conducted at the sites by operations and maintenance personnel who run realistic mission scenarios.

6.2.7.4 Type 4 Testing

The Type 4 Testing is performed when the system is in use and logistic support mechanisms exist. Testing involves are the information system sites. The information system performance limits are found and checked with Type 4 testing.

6.3 Engineering Specialty Integration

6.3.1 Reliability Engineering

The information system operational life is 20 years. Operational availability and reliability is at least 99.5%. The MTBM is determined from the metrics gathered from the maintenance and operations group. The metrics contain information on the network, hardware, software and communications. The reliability plan for the information system includes:

- Qualitative and Quantitative Reliability requirements based on the information system operational requirements and the maintenance concept.
- Reliability requirements allocation to the information system sub-system level.

- Configuration Management.
- Reliability analysis to include Information System block diagrams, worst-case scenarios and high system usage analysis.
- Failure mode, effect and criticality analysis (FMECA).
- Formal design and customer reviews.
- Metrics collection, analysis and corrective action.

6.3.2 Maintainability Engineering

Maintenance Planning is important to the information system design. The maintainability requirements for the sub-system levels is a key maintainability task for optimum user satisfaction. The configuration management of problems is a technique and practice for the information system maintainability. Maintenance metrics are also a necessary part for system maintainability. With the System's Engineering process, the following issues are addressed:

- Maintainability quantitative and qualitative requirements for the system.
- Allocation of maintainability requirements to the subsystem level.
- Design techniques and practices.
- Maintainability analysis
- Maintainability predictions and assessment.
- Formal design reviews
- Metric collection, analysis and corrective action.

6.3.3 Human Factors Engineering

Human Factors analysis is an important design factor. The system design considers the anthropometric, human sensory, physiological and psychological factors. Most information system functions are performed in an office setting. The mission functions to maintenance work is performed at a desk with a workstation and computer terminal. Therefore, the primary anthropometric concerns deal with the office desks and chairs. Recommendations include ergonomic designs to prevent stress and fatigue to the information system personnel. The human sensory factors important to the information system is vision and noise. The Physiological factors affecting the information system are the temperature and humidity.

6.3.4 Error Engineering

The objective in the information system design is to reduce as much human error in the daily information system operation and maintenance activities. The operation and maintenance procedure errors directly impact the system. Incorrect test data or improper testing is a major concern for the customer. The inability to distribute software or hardware to the sites impacts mission functionality. The analysis enables planning for possible problems and impacts associated with user error.

6.3.5 Safety Engineering

The safety analysis is similar to error analysis but is associated with the prevention of accident and the reduction of hazards. The improper lifting of hardware, failure to maintain proper environmental conditions, improper hardware use, improper appliance use are hazardous and could lead to accidents. Hazardous support materials such as copy toner cartridges must be disposed of properly. The offices and computer rooms contain electrical and fire hazards. Therefore, special "Dead-Man" switches and special fire extinguisher are located throughout all the sites.

6.3.6 Logistics Engineering

The logistic support planning includes the information systems distribution, maintenance, and system support and products. The logistics system requirements basis is from the mission profiles and maintenance concept. The logistics allocation to the sub-system level is part of the design used to maintain and operate the information system. Functional analysis done for the operational and maintenance functions allows the logistics support analysis. As the system matures, more information sites, hardware, software and system upgrades could impact the logistics requirements, allocation and analysis. The logistic procurement and acquisition plan for the information system is necessary given the site locations. The formal design reviews assist in the identification of logistic strategies and importance. Regarding the systems engineering process, the logistics support plan will includes:

- Definition of system operational requirements and the system maintenance concept.

- Quantitative and qualitative logistic design requirements for the system.
- Functional analysis and the allocation of logistic requirements to the subsystem level and beyond as appropriate.
- Logistic support analysis
- Design of new logistic support elements as required.
- Formal design reviews
- Early procurement and acquisition of selected logistic support elements.
- Test and evaluation of logistic support elements.

6.3.7 Production Engineering

The information system initial configuration contains twelve sites. The customers and contractors incorporate production engineering in case the initial configuration grows to include more customer locations and military sites. Furthermore, production engineering ensures the best costs during the information system production.

6.3.8 Social Acceptability Engineering

Social acceptability engineering ensures the system will be acceptable by society. Every attempt is made to reduce pollution and risks to society. A possible hazard is electrical shock. Fortunately, safety and social acceptability go hand in hand when designing the information system.

7. Future Recommendations

The system engineering process is continually evolving. Some future recommendations to consider when developing a system include:

- Activity Based Costing. This costing enables all major stakeholders to understand the cost associated with performing a system function.
- Traceability Requirements.
- Rapid Prototyping and possible simulation. This allows the major stakeholders to identify the technical performance measures early.
- Failure Mode Effect and Criticality Analysis in the Conceptual Design Phase. This allows the major stakeholders to understand critical areas within the system early.

8. Conclusion

The need for intelligence information is vital. The weapons, hostility and economic conditions of third world countries increase the need for timely up to date information. Unfortunately, the defense cutbacks and downsizing due to budget constraints have caused a need for military intelligence consolidation and optimization. The current military organization's deficiencies: redundant work, competition and a constantly changing threat have caused the need to create an intelligence information system. The information system enables military and customer intelligence sites to communicate and share information. This reduces redundancy, provides the agencies with up to date information, and creates a synergistic relationship between the various intelligence groups.

The current intelligence systems do not support the capability for site to site communication. The systems primarily run off mainframe computers with user terminals. These systems do not support graphics, communication and or business COTS software needed to reorganize the current intelligence groups.

The use of System Engineering principles ensures the mission, operational, maintenance and support requirement identification and accountability. The conceptual design phase identifies the current deficiencies, the needs and benefits from the information system. The preliminary design phase enables a functional analysis of the operational and maintenance functions to ensure the design requirements are as complete as possible. The detail design and development phase verify that the reliability, maintainability, human factors, error analysis, safety analysis and logistics support requirements are complete. During the life time of the project, integrated tests and evaluations allow users to understand the limits of the system. To aid the stakeholders in the management of the system, a system's engineering management plan helps to ensure the project direction until the system completion.

REFERENCE

Blanchard, Benjamin S. and Fabrychky, Wolter J. Systems Engineering and Analysis, Second Edition. Prentice Hall: New Jersey, 1990.

Schwartz, Mischa. Telecommunication Networks. Addison Wesley Publishing Company: Massachusetts, 1987.

Stallings, William. Local and Metropolitan Networks. Macmillan Publishing Company: New York, 1993.

ENDNOTES

[1] Casper Weinberger, "Base Closings, Round 4", Forbes, March 27,1995.

[2] Casper Weinberger, "Base Closings, Round 4", Forbes, March 27,1995.

[3]John Morrocco, "Air Force to Trim, Not Close Depots", Aviation Week and Space Technology, March 1995.

[4] Casper Weinberger, "Base Closings, Round 4", Forbes, March 27,1995.

[5]John Morrocco, "Air Force to Trim, Not Close Depots", Aviation Week and Space Technology, March 1995.

[6] "Consolidate U.S. Intelligence Operations", Aviation Week and Space Technology, November 28, 1994

[7] "Consolidate U.S. Intelligence Operations", Aviation Week and Space Technology, November 28, 1994

[8] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993.

[9] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993

[10] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993

[11] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993

[12] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993

[13] David Fulghum, "CIA Chief Paints Bleak Threat Picture", Aviation Week and Space Technology, March 1, 1993

[14] Mark Whitaker, "Avoiding the Next Crisis", Newsweek, March 11, 1991.

[15] Mark Whitaker, "Avoiding the Next Crisis", Newsweek, March 11, 1991.

[16] Ben Blanchard, Wolter Fabrycky; Systems Engineering and Analysis. Prentice Hall, Englewood Cliff, New Jersey, Second Edition, 1990.
[17] Ben Blanchard, Wolter Fabrycky; Systems Engineering and Analysis. Prentice Hall, Englewood Cliff, New Jersey, Second Edition, 1990.

[18] Ben Blanchard, Wolter Fabrycky; Systems Engineering and Analysis. Prentice Hall, Englewood Cliff, New Jersey, Second Edition, 1990.

[19] Ben Blanchard, Wolter Fabrycky; Systems Engineering and Analysis. Prentice Hall, Englewood Cliff, New Jersey, Second Edition, 1990.

[20] Software Engineering Institute, Carnegie Mellon University.

[21] Software Engineering Institute, Carnegie Mellon University.

[22] Software Engineering Institute, Carnegie Mellon University.

[23] Ben Blanchard, Wolter Fabrycky; Systems Engineering and Analysis. Prentice Hall, Englewood Cliff, New Jersey, Second Edition, 1990.

VITA

Conrad Vance Unciano was born on March 22, 1967 in Honolulu, Hawaii. He is the son of a career military officer. Conrad has lived in several locations throughout the United States and the World. The locations included: Germany, Texas, Colorado, Hawaii, and Virginia. In 1985, Conrad's father retired from the Army to work for the Federal government. Conrad subsequently attended George Mason University where he received a Bachelors of Science in Electrical Engineering and a two year Cooperative Education job as a computer programmer with the Air Force at the Pentagon, Washington DC. Upon graduation in 1991, Conrad was hired by the Lockheed Martin Corporation where he currently works as a Senior Software Engineer. In 1993, Conrad was accepted into the Advanced Education Program, a Lockheed Martin engineering development program affiliated with the Virginia Polytechnic and State University. Conrad has a wife, Diana and a newborn son, Brandon.