Life Cycle Management Concepts for Air Force Computer Resources

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Abstract

The increasingly pervasive and vital use of computers throughout the Air Force and the Department of Defense has been the impetus of an evolution of life cycle management concepts for computer resources. This paper briefly discusses the necessity and classifications of computers and then describes computer life cycle management in terms of resource management.

Key Words and Phrases

Computer Resource Management, Computer Resource Life Cycles, Life Cycle Management Concepts.

I. Introduction

During the past fifteen years the use of computers has continued to expand into all defense systems. We have reached the point where every job is, in one way or the other, impacted by computers. In most cases, Air Force managers are using computer systems or they are managing personnel who are using or operating computer equipment (hardware). The purpose of this paper is to summarize the Air Force's life cycle management concepts of computer systems. First, a brief discussion on the importance of computer systems, then the classifications of computer systems are discussed followed by a discussion of the life cycle management concepts associated with each class. In conclusion, management of the two classifications of computers is contrasted.

II. Importance of Computers

There are many types of systems (intelligence, personnel, command and control, telecommunications, aircraft, missiles, payroll accounting, etc.) within the Air Force. Computer systems are normally either components of a larger system such as the F-15 or separate supporting subsystems such as the military personnel data processing systems. Whatever their duties, Air Force personnel use computers in some way daily. According to Walter Beam, Deputy for Advanced Technology to the Assistant Secretary of the Air Force for Research, Development, and Logistics, the number of functions of a system accomplished by computers is growing at a prodigious rate. As the role of com-

puters has increased so has their criticality in terms of cost and performance reliability.[1] DOD expends over \$3 billion annually on just weapon system software, not to mention software for data processing systems. The Air Force spends approximately four percent of its budget on computer software for weapon systems.[2] There is no doubt that the reliability of our defense systems (such as the F-15 and Cruise Missile) depends, in most cases, on the reliability of computer systems. Thus, the importance of computer systems (hardware and software) is obvious.

III. ADP Classifications

Because of the diverse requirements of systems that utilize computers and the complex management problems associated with acquiring and developing computer resources for these systems, DOD has divided computer systems into two basic classifications--Embedded Computer Systems (ECS) and Automatic Data Processing Systems (ADPS). An ECS is embedded within and integral to weapons, communications, command and control, intelligence, and air and defense systems. ECSs are used to monitor system performance on the C-5A, guide a missile toward some target, and monitor aircraft engines in flight. An ADPS is a type of computer system used to support administrative or management information systems. Examples of ADPSs are: Base Level Data Automation, Space and Missile Test System, Reconnaissance Intelligence System, and Satellite Control Support System. The life cycle management concepts of ECSs and ADPSs are similar but different. The rest of this paper provides a brief overview of these concepts.

IV. Life Cycle Concepts

There are different directives and chains of command that manage the life cycle of each class--ECS and ADPS. DOD Directive 5100.40 governs the DOD Automatic Data Processing (ADP) Program. This program establishes the policy for the management and control of the development, acquisition, deployment, and support of Automatic Data Processing Systems (ADPSs). The Assistant Secretary of Defense (Comptroller) administers the DOD ADP program.[3] The Air Force 300-series of regulations and manuals implement the DOD ADP program within the Air Force. DOD Directive 5000.29 establishes policy for the management and control of ECSs

during the development, acquisition, deployment and support of major defense systems.[4] A Management Steering Committee for Embedded Computer Resources (MSC-ECR) oversees the DOD ECS program and coordinates and integrates the ECS program into the normal defense system acquisition process. The MSC-ECR reports directly to the Deputy Secretary of Defense. The Air Force 800-series of regulations and manuals implements the DOD ECS program within the Air Force.

A requirement to use computer resources, regardless of the class, must be documented as a result of a thorough system analysis. Requirements for computer resources originate in a number of ways. Normally, the requirements for computer resources evolve from overall system requirements as a result of applying system engineering disciplines. When computers are to be utilized as part of the overall solution to a system requirement, specific regulations and procedures must be followed.

ADPS requirements are examined thoroughly to determine if a computer is the proper means to satisfy the requirement.[5] Once an analysis of all alternatives/solutions has been made and it has been decided that an ADP solution is the best approach, the result of this analysis is documented in a Data Automation Requirement (DAR). The DAR is jointly prepared by the appropriate functional area and data automation personnel. The appropriate functional area authority will sign the DAR. The DAR must be approved by the ADP program single manager or the USAF ADPS manager, or the HQ USAF Director of Computer Resources, before any ADPS can be procured.[5]

ECS requirements originate in a number of ways. They may originate, for example, in master plans of commands or organizations or as a result of specific mission or functional analysis studies. Computer resource requirements may also originate as a result of system development efforts which are undertaken in response to a validated Statement of Need, also known as a Required Operational Capability (ROC).[6]

Regardless of how the requirement for computer resources is documented, i.e., DAR or ROC, a Data Project Directive (DPD) or Program Management Directive (PMD) will be used to provide management direction for satisfying the approved requirement. A DPD authorizes the use of ADP computer resources. A PMD authorizes the use of embedded computer resources in major defense systems. Once authority is given to use a computer to satisfy a specific requirement, configuration management (CM) procedures are used to manage the acquisition and maintenance of both hardware and software items throughout their life cycle.[7] CM applies to both ECSs and ADPSs.[8] The following paragraphs discuss the life cycle phases of ECSs and ADPSs, respectively.

ECS Life Cycle

The weapon system acquisition process provides a basis for the life cycle management phases for an ECS.[9] The life cycle consists of five major phases with three Defense Systems Acquisition Review Council (DSARC) reviews. The order of these phases along with the reviews is concept formulation, DSARC I, validation, DSARC II, full scale development, DSARC III, production, and deployment.[1]

Concept formulation is the initial planning phase. Technical, military and economic bases are established through comprehensive feasibility studies, experimental development, and concept evaluation. The objective of this phase is refining proposed solutions or developing alternative concepts to meet an operational capability such as software to monitor an engine during flight. Proposed solutions are refined using feasibility assessments, estimates (cost and schedule, intelligence, logistics, etc.), tradeoffs, and other logical analysis such as top down techniques. The major document resulting from this phase is the initial system specification which documents total system requirements. It documents software requirements as well as relevant design and technology constraints. Also, it contains a superficial definition of essential interfaces between all computer and communications equipment, and personnel. This document is normally referred to in the Decision Coordinating Paper (DCP).[10] Normally, this information is derived from system engineering studies of required functions.[9]

During the DSARC I review phase the DCP is reviewed for completeness and relevance to DOD needs. With assistance from the Management Steering Committee on Embedded Computer Resources (MSC-ECR) and the Cost Analysis Improvement Group (CAIG), DSARC will approve or disapprove the DCP.[11] Results are reported to the Secretary of Defense for his approval. If approval is granted, the validation phase is entered.[4]

The validation or advanced development phase is the period in which major system characteristics are refined through studies, system engineering, and preliminary equipment and computer program development, test and evaluation. The objective is to validate the choice of alternatives and determining whether or not to proceed into the next phase. For computer resources, the major definitive documents resulting from this phase are the authenticated system specification, the preliminary development specifications containing system functional requirements for computer programs and equipment, and the initial Computer Resources Integrated Support Plan (CRISP). The initial preparation and coordination of the CRISP are accomplished as soon as possible to permit the program manager to accommodate appropriate CRISP provisions in the full-scale development contracts.[9]

During the DSARC II review phase, the DSARC reviews the DCP for completeness and accuracy. The CAIG and MSC-ECR groups assist in this review. Results are reported directly to the Secretary of Defense. The DCP is updated subsequently and the development phase is started.[10]

During the full scale development phase, the system, equipment, computer programs, facilities, personnel subsystems, training, and the principal items necessary for support are designed, fabricated, tested and evaluated. These include a system which closely approximates the production item, the documentation necessary to enter the production phase, and the test results which demonstrate that the system to be produced will meet the stated performance requirements.

The development specifications are finalized and authenticated. Authentication of any development specification establishes the allocated baseline. Preliminary design reviews (PDRs) are held for computer resource items and computer program items to review the preliminary design against the respective authenticated development specification. Formal engineering change control procedures are used to prepare, propose, review, approve, implement, and record engineering changes to the allocated baseline.[9]

Design of a computer resource item begins following acceptance of a PDR for the item. This activity produces engineering documentation such as flow-charts, input and output specifications, and test plans. For computer programs, design specification includes documentation of logical flows, functional sequences and relations, formats, constraints, and the data base. This documentation is reviewed by software engineering personnel prior to the Critical Design Review (CDR). The CDR assures that the recommended design satisfies the requirements of the development specification. Specified portions of the draft product specifications are reviewed at the CDR. The CDR identifies specific portions of the product specification which will be released for coding and testing.[9]

Development, test and evaluation, and initial operational test and evaluation are conducted. Testing of computer programs (configuration items) is performed according to formal test plans initially submitted in preliminary draft form for review at CDR, and finalized prior to the start of testing. These activities normally proceed in such a way that testing of selected program functions begins early during development and proceeds through successively detailed levels of assembly to the point where the complete computer program is tested.[9]

During the DSARC III review phase, the DSARC, with assistance from CAIG and MSC-ECR, reviews the updated DCP and reports the results to the Secretary of Defense for his approval. The DCP is updated to reflect all the decisions and changes up to this point in the life cycle of the system.

The production phase is the period from production approval until the last system item is delivered and accepted. The objective is to produce and deliver supportable systems to the using command(s). Functional and physical configuration audits are performed on all configuration items. Provisions are made in contracts and follow-on support arrangements to maintain the currency of the equipment/computer program configuration and associated documentation in accordance with standards. Failure to properly consider these provisions may result in support complications, obsolete documentation, and costly "modernization" programs. The supporting and using service commands continue to program for resources necessary to support the computer programs throughout the deployment phase.[9]

The deployment phase commences with delivery of the first operational unit and terminates when the system is removed from the operational inventory. Operational test and evaluation is performed on all operational configuration items to assess the system operational effectiveness and suitability in a deployed configuration. The CRISP continues to be an active document during this phase. It is the basic agreement between the using and supporting commands for managing the computer resource. After a system is in operational use, changes to computer programs may be necessary to remove program errors, improve coding or operation, adapt to changes in system requirements, or incorporate knowledge gained from operational use. [9] Once deployed, ECS management integrates almost inseparably into the system's management.

ADPS Life Cycle

The life cycle of ADPS consists of five phases: conceptual, definition, development, test, and operation. Baseline configuration management is used in the development and maintenance of ADPSs.[12]

The activities performed during the conceptual phase are: identifying the operational requirements, defining initial system concepts, conducting system feasibility studies, performing system requirements analysis, and determining the design requirements and gross system functions. The functions and system requirements are determined by the user with data automation support. The system requirements are first documented formally in a Data Automation Requirement (DAR). Review and approval of a DAR are conveyed in a Data Project Directive (DPD). After a DAR is prepared and a DPD is issued, a Data Project Plan (DPP) is developed to detail the development and testing required to insure the system meets operational requirements on time. Milestones defined in the Data Project Plan delineate "go/no go" decision points in which development progress is reviewed and formal decisions made to continue, halt, or delay development of the system or a component thereof. Cost criteria are heavily weighted in the decision making process.

In the definition phase the developer defines the system's requirements. Examples of these are: interface control, expanded system requirements, computer programs, manual tasks, equipment, system/subsystem specifications, the data requirements document, and the data base specifications.[13]

Analysis, design, coding, debugging, integration, and development testing of computer program configuration items are done in the development phase. All activities such as reviewing system/subsystem specifications, defining preliminary program design, conducting preliminary design reviews defining detail function designs, developing test plans, conducting critical design reviews, coding programs, testing programs, developing software validation and configuration reviews and audits are also performed in this phase.[13]

The activities accomplished during the test phase are system testing and validation testing. The completed programs and documents are reviewed for accuracy and completeness. The system is run and reviewed by the customer to validate its responsiveness to the requirement. Standard systems that will operate at multiple sites will be field tested at a representative site using actual data and validated prior to system deployment. Validation that the system meets the specific objectives and requirements of the master plan and approval of the system for operation completes this phase.[13] Subsequently, the operational phase is started.

During the operational phase, system turnover requirements are updated, and the system operated on a routine basis. Routine maintenance is performed to meet changing operational requirements. All changes to the system configuration are rigidly controlled through a well defined system configuration change control procedure. As a minimum, change control documentation will contain the proposed change, the specifications, analyses of functional and technical impacts, and cost data. The procedure requires the approval signature of an authorized official and retention of the documentation for the system's life cycle plus four years. Periodically, the master plan will be updated to reflect necessary changes resulting from ADP system reviews.[13]

V. ECS/ADPS Management Contrasts

Management of an ADPS differs markedly from that of an ECS. As noted before, a deployed ECS is managed by the same system program office (SPO) or equivalent organization such as an Air Force Logistics Command system manager. Management procedures, policies, and organization are the same for the ECS as for all other components of the system. An ADPS, to the contrary, is distinctly managed from concept to phase-out. Also, each separate ADPS has a manager responsible for identifying objectives, strategies, actions, resource requirements, and providing overall

direction of the ADPS. The ADPS manager's ADPS Master Plan is distributed to HQ USAF and each major command's ADP single manager. The single manager is the focal point of all ADPS management for the entire command. The Major Command ADP Plan reflects the operational management of the command's unique ADP resources. The system is vertically and laterally integrated to provide constant visibility to all levels of ADPS management of the status of ADPSs and their components, their operational capabilities, and their uses and resource requirements.[14]

The Air Force ADP Management Information System (ADPMIS) also supports the Air Force ADP Plan. A separate management tool, the ADPMIS provides official recognition, validation, and programming of resources for approved ADPS requirements.[14] At least annually, updates are made from every data processing installation, major command, and separate operating agency. Studies are currently underway to add a database to the ADPMIS which will provide for collection and reporting of data on computer performance measurement, computer resource management, and life cycle cost and management efforts. These additional data will provide Air Force ADPS Management with better and more extensive information with which to manage an increasingly prevalent and critical ADP inventory.

VI. Summary

In this paper, the authors have attempted to interpret a highly complex and vertically integrated management system which covers the life cycle of Air Force computer resources. These resources are found throughout the DOD and are vital to such diverse systems as the Airborne Warning and Control System, the Joint Uniform Military Pay System, the World Wide Military Command and Control System and numerous resource and management information systems. The diversity of the uses of computers within the DOD and the Air Force has led to two classifications--ECS and ADPS--of computer systems, and two separate management echelons and sets of directives. Consequentially, distinct life cycle management philosophies have evolved for each classification. ECSs are developed and managed integrally as components of overall systems. ADPSs are distinctly developed and managed, separate from the systems they support. Accordingly, life cycle management concepts differ. ECS life cycle elements are concept, validation, full scale development, production, and deployment. ADPS life cycle elements are concept, definition, development, test and operation. The significance of ADP management as resources underlies the pervasiveness and vitality of ADP in national security and defense management systems.

VII. Authors' Comments

This overview of the Air Force's life cycle management concepts is necessarily brief in describing two separate management structures for ECS and ADPS respectively. The opinions and

interpretations of DOD and Air Force directives and regulations made by the authors should not be construed as official policy of the government, the Department of Defense, or the United States Air Force.

The Freedom of Information Act provides access to the referenced DOD and Air Force directives. DOD directives can be obtained through the Assistant Secretary of Defense (Public Affairs) Division of Freedom of Information, Room 2C757, the Pentagon, Washington D.C., 20301. Air Force publications are available through the Chief of Central Base Administration at the nearest Air Force Base.

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