U.S. DEPARTMENT OF COMMERCE
National Institute of Standards and Technology

NISTIR 4413

National PDES Testbed
Report Series

Development Plan

# Configuration Management Systems and Services

NATIONAL PDES TESTBED

NIST

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# Configuration Management Systems and Services

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## *Preface*

This document describes a plan to establish configuration management systems and services to serve the needs of both international and national efforts. The National PDES Testbed was established at the National Institute of Standards and Technology (NIST) in 1988 under the sponsorship of the U.S. Department of Defense Computer-aided Acquisition and Logistic Support (CALS) program. A major goal of the Testbed is to provide technical leadership in a national effort to implement a complete and useful specification for the exchange of product data. This specification must be designed to meet the needs of American industry and the CALS program.

The National PDES Testbed supports and actively participates in the international effort to develop the Standard for the Exchange of Product Model Data (STEP). The STEP development effort is lead by the International Organization for Standardization (ISO) TC184/SC4.

This plan describes one of several technical project threads that have been established for the National PDES Testbed. Other threads address such areas as:

- development of testing systems to validate the proposed standard,
- specification and testing of application protocols,
- construction of a prototype STEP-based manufacturing cell,
- establishment of a product data exchange network, and
- development of conformance testing systems.

The level of support provided for these technical threads and others will be determined by sponsor needs and a number of different priorities. As such, the development plan contained within this document outlines a reasonable schedule to accomplish the objectives of the thread. Changes in priorities and levels of support may either accelerate or delay the proposed schedule. This plan will be updated periodically to reflect technical changes in the project, current level of effort, and expected continued support.

Charles R. McLean
CALS PDES Project Manager
NIST

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## *Executive Summary*

The process of developing an information processing standard involves the creation and management of thousands of documents and computer programs. Knowing which documents and computer programs are up to date, and which are obsolete, is critical to the development process. Configuration management provides the fundamental operational capability for tracking and maintaining versions of documents and software. This plan outlines the major functional areas, goals and objectives of the configuration management functions to be performed by the Information Services Center (ISC) of the National PDES Testbed (NPT). These services support the development of the Standard for the Exchange of Product model data, known as STEP, and will be undertaken in coordination with participating organizations.

The development of STEP is an enormous and very complex task. The task is all the more complicated because of the many organizations involved. A system or collection of systems will be put into place to address the configuration of both document and software development. This system will mirror the procedures defined by each organization.

Given the number of organizations and complexity of issues we will put into place an interim configuration management system. This interim system will provide adequate functionality to create baseline documents and software releases. Conversion to the more functional and flexible long term system will be built into the design of the long term system.

A set of core requirements will be defined and implemented. Each organization's procedures will then be customized or refined from the core set of requirements and implemented.

For the developing standard itself, we will take the philosophy that anyone may be able to read and obtain copies of the documents, however only authorized individuals may place new versions into the system. The security restrictions each organization desires will be implemented as deemed feasible.

Finally, as each system comes on-line, appropriate documentation and training will be provided to the users. In order for the systems to aid the development process they must be viewed and implemented as practical, convenient tools, not impediments.

# 1 Goals and Objectives

The primary goal of Configuration Management (CM) is to provide an orderly framework within which the development of the Standard for the Exchange of Product model data (known under the acronym of STEP) can take place. In support of this goal, CM must not only provide basic CM functions but must also provide coordination mechanisms for the organizations involved in STEP development.

The ISC provides CM services to four organizations involved in the development of STEP: the International Organization for Standardization Technical Committee 184 Subcommittee 4 (ISO TC184/SC4), the IGES/PDES Organization (IPO), PDES, Inc., and the National PDES Testbed (NPT). These organizations have various types of information that must be maintained under CM, including documents, computer programs, and diagrams. Because of the organizational and geographic diversity of the STEP development projects, a carefully coordinated CM system is needed.

The CM system must provide the following basic services to its users:

(1) Track the progressing versions of documents and software modules, their relationships and interdependencies.

(2) Allow participating organizations to query the system for status updates, view all the latest materials, and contribute updated versions of their own work.

(3) Allow update access only to authorized individuals, and ensure that only one user can change an item at a time, so that conflicting versions do not arise.

(4) Provide a historical log of the development of each document and software module.

(5) Maintain certain information, such as the date and time each item is accessed, user name, and type of access granted.

(6) Allow the user to provide other information, such as comments explaining reasons for change.

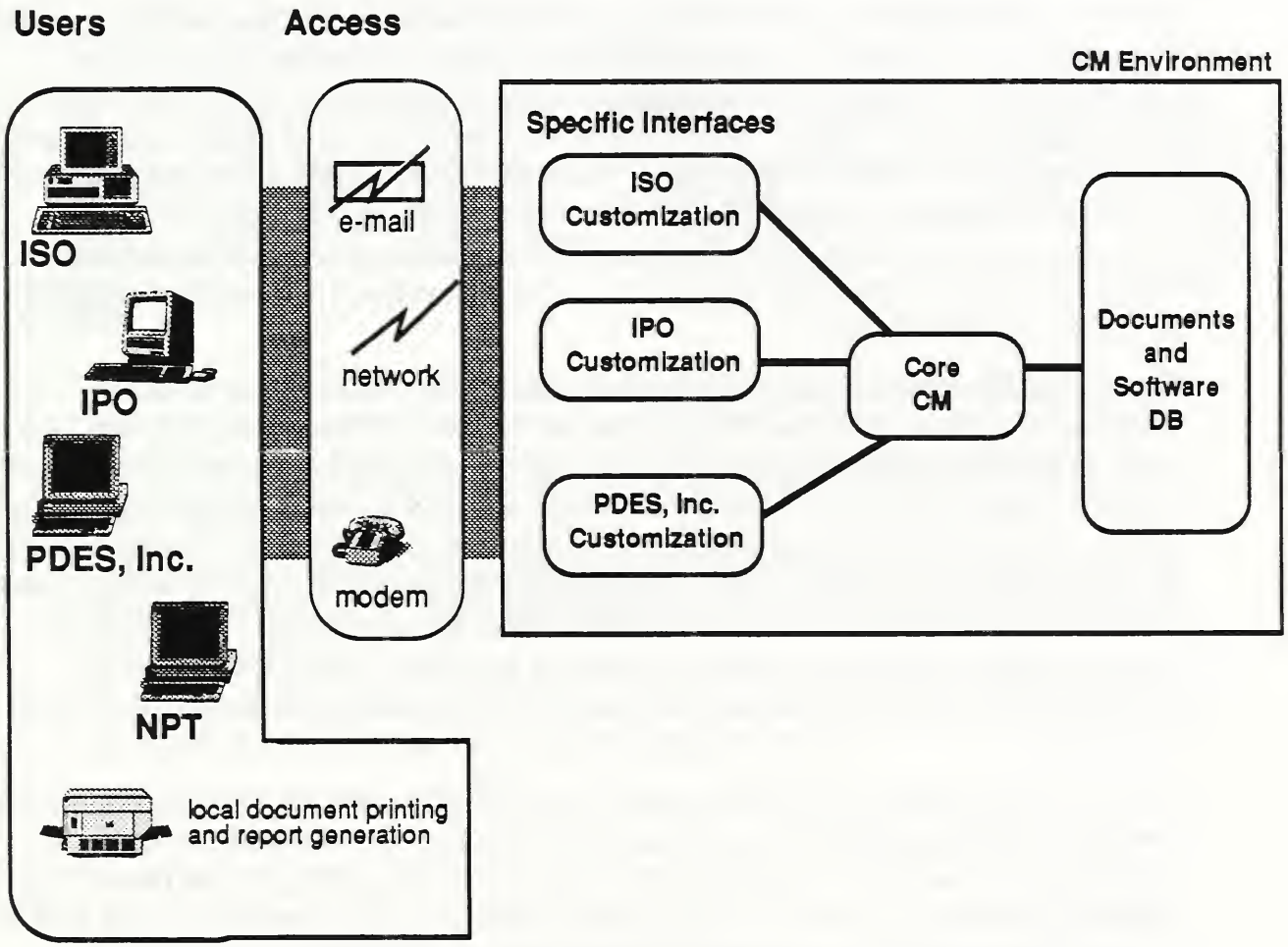
The requirements of each organization need to be understood before obtaining software to implement a CM system. The system must be based on the defined procedures of each organization, whether aiding a document approval process or a software testing and integration process. The Information Services Center (ISC) will work with each organization to define CM procedures, and will then develop systems which address each organizations' requirements.

## 2 Configuration Management Overview

The ISC will provide configuration management services to four organizations: the ISO TC184/SC4, PDES, Inc., IPO, and the NPT. These organization will access the CM system by the methods illustrated in Figure 1.

At present two categories of information will be controlled: 1) documents, and 2) software. In the future, product models, which include some graphical presentations, may also be configured. Some organizations have both documents and software modules that need to be configured; others have only documents, or only software.

FIGURE 1. **Configuration Management System Architecture**




Implementing a successful configuration management service requires an understanding of the development processes. These include document approval processes and software testing and integration procedures. The configuration management staff of the ISC will work closely with each of the four user organizations in defining requirements. The first step of this activity involves

learning how the organizations are now handling document and software updates, and what problems they are encountering. A careful analysis of the user environment against good configuration management practices should yield a more productive set of procedures. The agreed-upon procedures can then be further facilitated by incorporating them into a computerized CM system. This will increase reliability and improve communications.

## 2.1 Procedural Issues

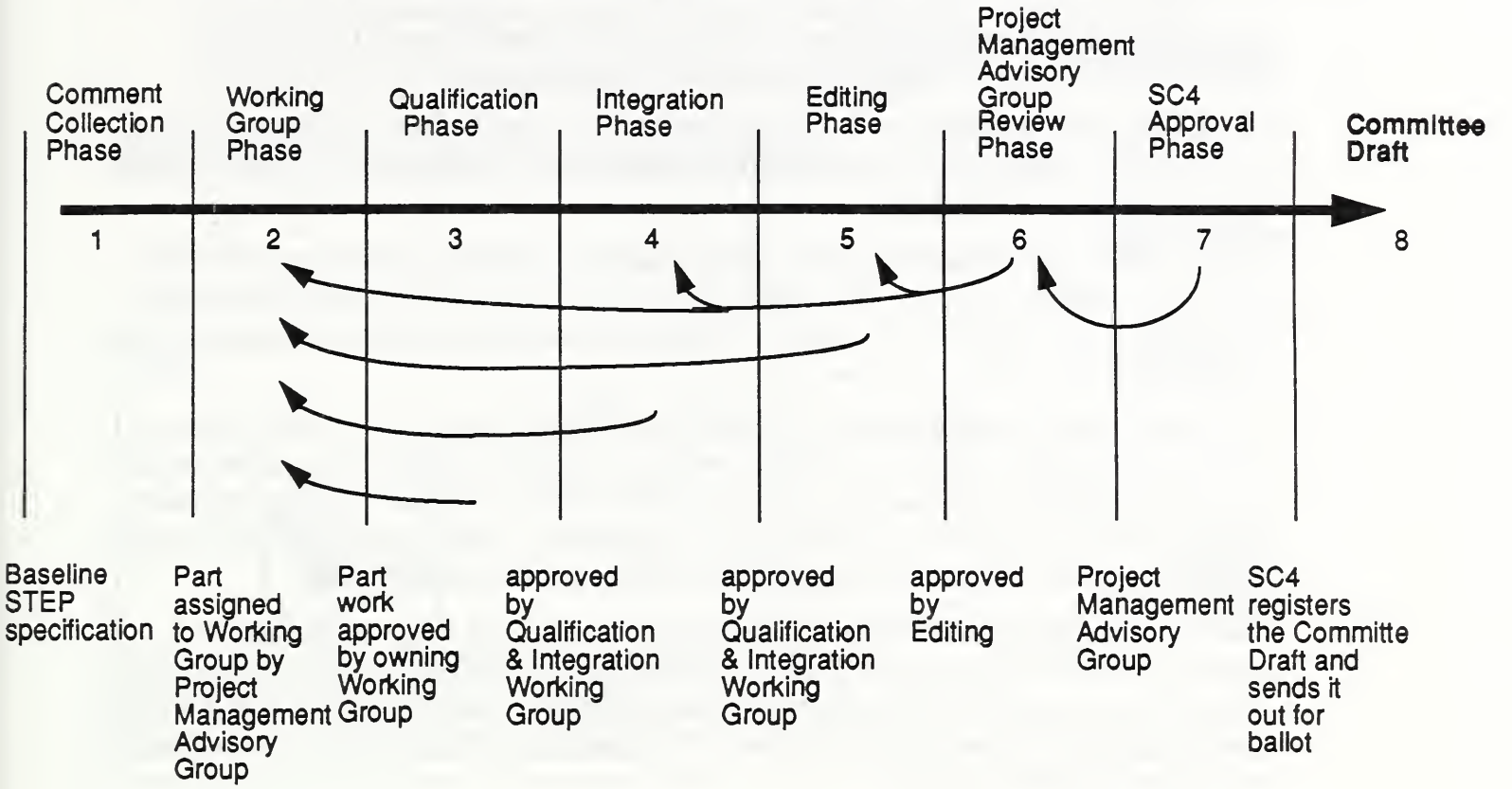
Aside from the technical systems and interfaces which must be in place to configure documents, there must also be a set of procedures in place to send the documents through the approval process.

The work undertaken by all of these organizations is intertwined at many levels. Managerial and technical issues cross organizational boundaries, and clear interfaces with explicit communication mechanisms must be identified. Each organization must define its own procedures. Yet, each must communicate with the others and provide input and/or feedback to the others. Since the end goal of the STEP development process is a formal international standard, the ISO procedures for the management of the STEP documents themselves will be implemented first. This will provide a model of services to be implemented for the other organizations.

Figure 2 illustrates the current proposal to ISO from the NPT for its STEP documents approval process. Key points are: 1) that a distinct event must take place to promote each document into the next phase, and 2) the requirement that only the owning Working Group (WG) may actually make changes to a Part (a WG is a formal collection of technical experts organized for one or more related technical areas). Reviewers make suggestions separately, but do not have update access to the actual Part. This illustration serves as an example of the type of requirements analysis that must be done for the other user groups as well. Definitions for terms and acronyms used can be found in the glossary at the end of this plan.

It must also be clearly understood that the NPT will serve in the role of systems developer and integrator, but not the role of configuration manager for each organization. The NPT is dependent on receiving the configuration items from each organization in order to place them under CM. The management of each of the four organizations must establish their own requirements and make a determination as to the items which need configuration management. The NPT will then attempt to meet those requirements as possible.

FIGURE 2. **STEP Documents Configuration Management Flow (proposed)**




*Notes*: a. Each numbered Phase represents one to many versions of a STEP Part that are stored on-line under the configuration management system.

b. Each vertical bar represents the action necessary to promote the Part from one phase to the next.

c. During each phase, the documents may be checked in and out many times; however, the promotion points (vertical bars) pertain to the entire Part, and require appropriate signature authority.

d. At any time during the life cycle of a Part, that Part may be returned to the owning WG for rework (e.g. if it is not approved by the Editing Committee.)

## 2.2 Technical Issues

The technical challenges involved in the development of a good CM system include ease of use, reliability, security, and remote access.

The CM system must be easy to learn and easy to use. It should use terminology and interface methods that are familiar to the users. Using the CM system should be preferable to not using it.

It is important that the CM system clearly identify the documents and software modules under its control. The system must be reliable both in terms of on-line availability and in terms of accuracy of document and computer program storage and retrieval.

The CM system should provide certain access restrictions, but it is important to note that it will not provide a full-blown security system. Read and write access may be defined by the users on an item by item basis. Furthermore, promotion points (raising the status of a document or program to the next level) will require proper approval, as defined within the context of each organization.

Users of the CM systems are geographically distributed, all over the world. Access for users throughout the U.S., Europe and elsewhere must be considered. Mechanisms must be put into place which meet these users needs. In addition, the cost of usage must be minimal as the NPT is dealing primarily with a collection of volunteer technical experts.

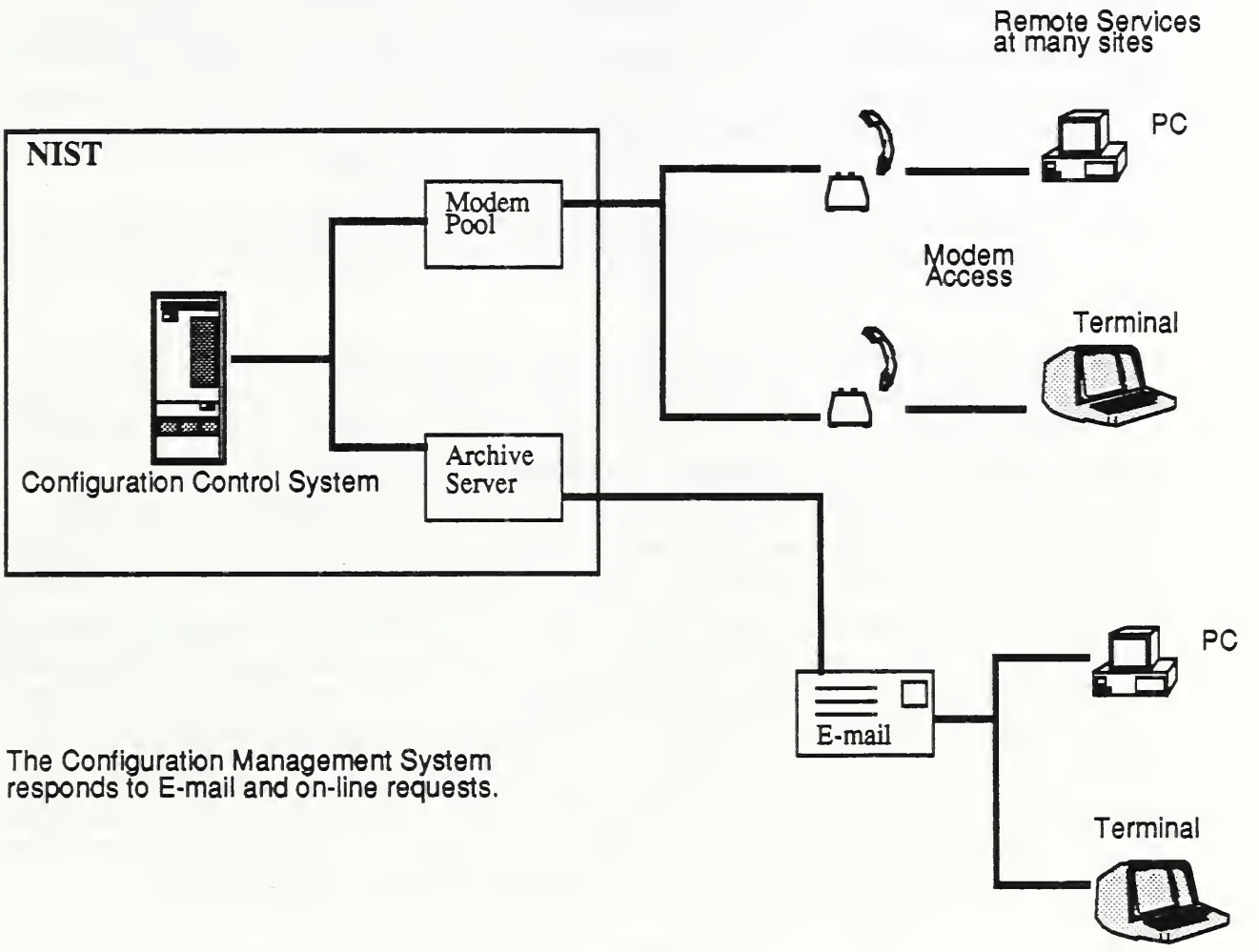
The NPT solution at the present time is to provide electronic mail (e-mail) access as well as direct modem access. E-mail is a low cost access mechanism which can be enhanced by the use of an "archive server." Users would send e-mail messages to the NPT archive server. The archive server can interpret commands, sent in the mail messages, and interface with the CM system to carry out those commands. The archive server can then send responses or entire files back to the user via e-mail.

Direct modem access can also be installed. To use direct modem access, remote users would simply dial in to the NIST modem pool, and be able to submit commands directly to the configuration management system as if they were local users. File transfers or simple information requests can be accomplished with either e-mail or modem access method. Figure 3 illustrates access to the configuration system.

Providing CM services to the various organizations will require significant resources and interaction with the management structure of each organization. It is important to note the backdrop against which the processes of CM will occur. All of the organizations have and some still are undergoing various forms of internal reorganization. While everyone recognizes the importance of CM, clear statements as to the exact form that CM is to take are not easy to locate. The tasks are large and sometimes ill-defined, and the structure within which each of them

must function is fluid. CM can provide some structure and serve as a focal point to aid in the management and technical development of tasks for each organization. CM is as much a definition and breakdown of organizational procedures as it is technical systems development.

FIGURE 3. **Access to the Configuration Management System.**




The Configuration Management System responds to E-mail and on-line requests.

## 2.3 Configuration Management System Usage

*Management of Documents for ISO*

The following paragraphs illustrate how the configuration management system will function with the archive server in the context of an ISO committee.

The development of STEP is taking place within ISO under the auspices of TC184/SC4. This large and geographically diverse organization contains many individuals responsible for the progression of documents. The STEP standard is divided into Parts, and each Part may contain many documents. Each document is assigned ownership, and only the document owner may make changes to that document, although other reviewers may suggest changes.

In the configuration management system, any user can read any document, and the comments submitted against it. However, only the document owner can check out a document for update purposes.

First, a document owner sends an electronic mail request to the NPT archive server to view all the comments against the document, and to check out the latest copy of the document for read-only purposes. The archive server reads its mail, and interfaces with the configuration management system to fulfill the request. The archive server then mails the result back to the requestor. The document owner decides on the necessary changes to the document, based on the comments and on general technical coherence. Then, to check out the document for update purposes, the document owner would send an electronic mail request to the NPT archive server. When the document owner has finished editing the document, he or she sends another electronic mail message back to the archive server, to check in the revised document. If desired, a command may also be submitted to the archive server to send copies of the new document version to all members of the committee. This electronic mail mechanism is also used to obtain feedback from other committee members, such as voting to decide if a Part is ready to progress to the next phase in the configuration management flow (see Figure 2).

*Management of Software for Developers*

The following paragraphs illustrate the use of a revision control system in software development:

The NPT builds many software tools, which are used in various stages of product model testing. For instance, the STEP information models are described in a language called EXPRESS. Each EXPRESS file is compiled into an EXPRESS Working Form, using a compiler built in the Testbed. To populate a particular model with the data for a specific manufactured part, another tool must be used. A third tool is used to edit the resulting STEP file.

It is important that the software tools used are consistent with each other. If a particular tool is being worked on by a developer, then it must be tested in a

known environment. The configuration management system must allow for distinct environments for model testing as well as for tool development. In addition, during the development process, the CM system stores the progressing versions of each tool, and defines matched sets of the tools. The developers can then easily identify existing matched sets (software of the correct version), and define new sets as they are tested.

# 3 Technical Plan

The ISC provides configuration management systems and services for four organizations. All the tasks and functions described in the development plan below are aimed at meeting functional requirements of these four organizations. Configuration management is a difficult problem because it reflects organizational procedures and processes as much as it is deals with technical problems.

Providing CM services to the various organizations will require significant resources and interaction with the management structure of each organization. It is important to note the backdrop against which the processes of CM will occur. All of the organizations have and some still are undergoing various forms of internal reorganization. While everyone recognizes the importance of CM, clear statements as to the exact form that CM is to take are not easy to locate. The tasks are large and sometimes ill-defined, and the structure within which each of them must function is fluid. CM can provide some structure and serve as a focal point to aid in the management and technical development of tasks for each organization. CM is as much a definition and breakdown of organizational procedures as it is technical systems development.

There are a number of common elements when looked at from the point of view of the two broad domains of document and software CM. An additional third domain, graphical information models, must also be configured but is not being handled at this time by the various organizations.

The tasks to be accomplished over the time period covered in this plan can be viewed in five stages. 1) Development and implementation of an interim CM system to meet immediate needs (due Oct 90); 2) Planning, background research and requirements analysis (due Dec 90); 3) Development and implementation of a core CM system (due Mar 91); 4) Customization of core CM system for each of four organizations (due Jan 92); 5) Hardening for production and training (Mar 92). These stages consist of many detailed tasks of which the higher level ones are presented in this document.

**CMS 0** **Prepare Technical Development Plan**

This document meets this deliverable.

**CMS 1** **Prepare Technical Concepts Document**

Provide background materials and an overall approach for the support activities for CM. The four organizations to be serviced, ISO, IPO, PDES Inc., and the NPT, have certain required functions in common. The Technical Concepts Document will compare the needs of the various user

groups, and present a plan for meeting their requirements in the most efficient way possible.

**CMS 2 Develop Interim Configuration Management Capability**

Provide an interim configuration management capability including basic functions of checking in and checking out documents and software modules. Provide brief user instructions for dial-in access and use of the system.

**CMS 3 Develop Core Configuration Management System**

Develop a core configuration management system which addresses the basic configuration management functions common to all the user groups. This system will build upon the basic check in, check out, and access capabilities. It will also integrate the functionality of the Document Tracking System (DTS) and the Ballot Manager (BM). The core system will become the CM baseline, which can then be customized to meet specific needs of the four user organizations.

**CMS 3.1 Prepare Comprehensive Requirements Document**

Prepare a Comprehensive Requirements Document which identifies the CM needs of all four user groups. This activity involves determining existing procedures, if any, of the four user groups, suggesting configuration management solutions, and agreeing on system requirements with each user group. The requirements will then be compared and analyzed. Common requirements will become the basis of the core system. User-specific requirements will be implemented during the customization phase.

**CMS 3.2 Prepare CM System Design Document**

Prepare a CM System Design Document which will describe the technical implementation plan for the core system.

**CMS 3.3 Implement Core CM System**

Write and/or adapt software to meet the needs outlined in the Requirements Document. The implementation will follow the system design put forth in the Design Document. This portion of the implementation will provide basic CM functions with local access only.

**CMS 3.4 Establish Communication Services**

Write and test the software necessary to link the locally implemented core system with the outside world.

**CMS 4** **Customize Configuration Management System**

Obtain user (organization) requirements and procedures. Write and test the software necessary to implement user-specific requirements. Provide user-specific users' guides.

**CMS 4.1** **Implement ISO CM System**

Customize the core system for ISO, and add any features which are needed specifically by that organization. ISO features pertain only to document management.

**CMS 4.2** **Implement NPT CM System**

Customize the core system for the NPT, and add any features which are needed specifically by that organization. This system will deal only with software modules.

**CMS 4.3** **Implement PDES, Inc. CM System**

Customize the core system for PDES, Inc., and add any features which are needed specifically by that organization. This system will involve mostly software, but also some documents.

**CMS 4.4** **Implement IPO CM System**

Customize the core system for IPO, and add any features which are needed specifically by that organization. This system will include document tracking, and may also involve management of graphical information models at some point in the future.

**CMS 4.5** **Integrate CM Systems**

Ensure that the customized versions are functioning consistently, and fulfill requirements specified in the Comprehensive Requirements document in addition to the user-specific requirements.

**CMS 5** **Demonstrate CM System**

Provide a demonstration of the final product. After the customized systems have been integrated, the ISC will demonstrate that the final configuration management system meets the needs outlined in the Comprehensive Requirements Document.

**CMS 6** **Provide User Training**

The ISC will provide further training as necessary, in addition to providing the Users' Guides. This may be necessary for any complex customized functions, or for users who are new to configuration management procedures.

FIGURE 4. **Overall High Level Schedule**

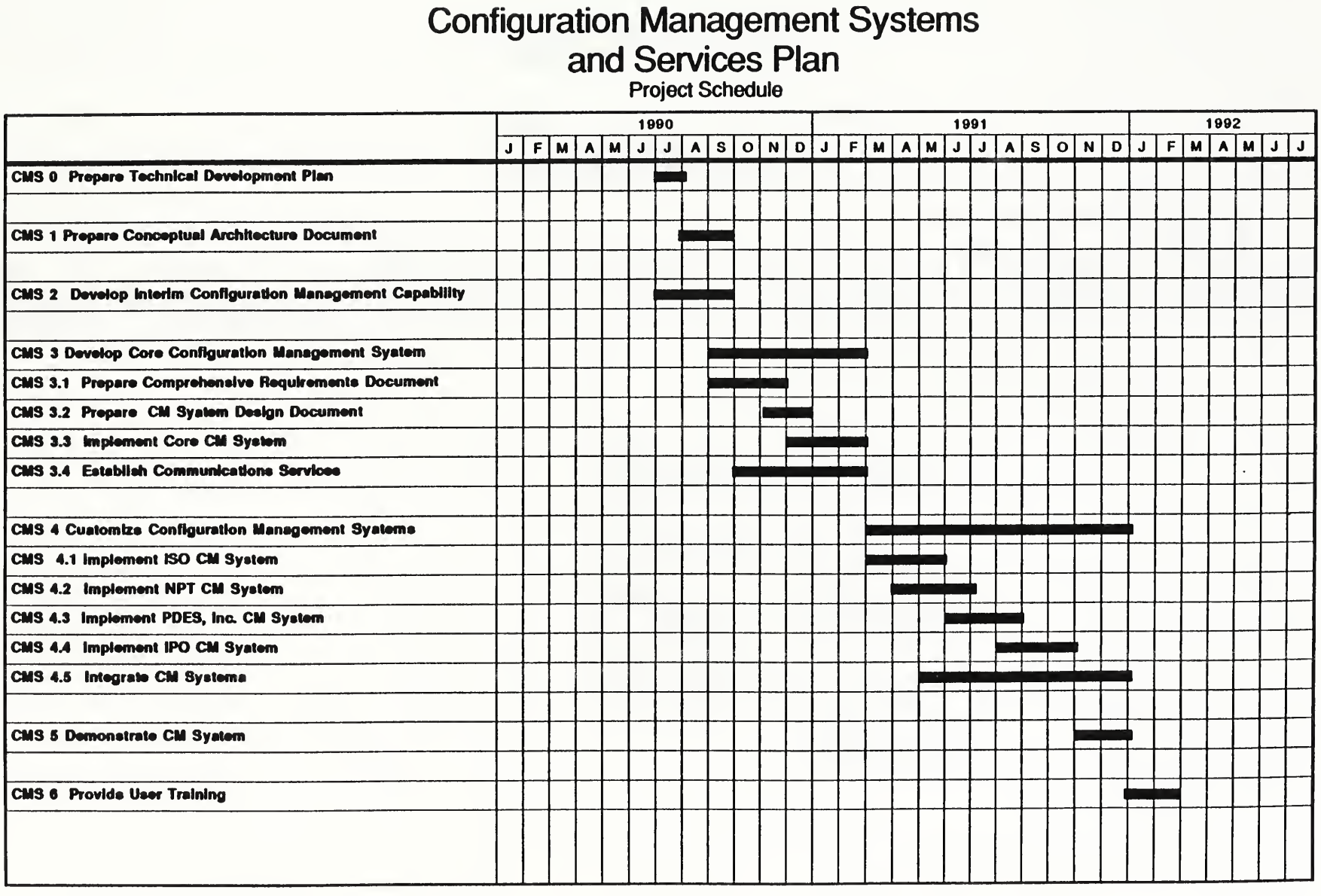


FIGURE 5. **Work Breakdown Structure**

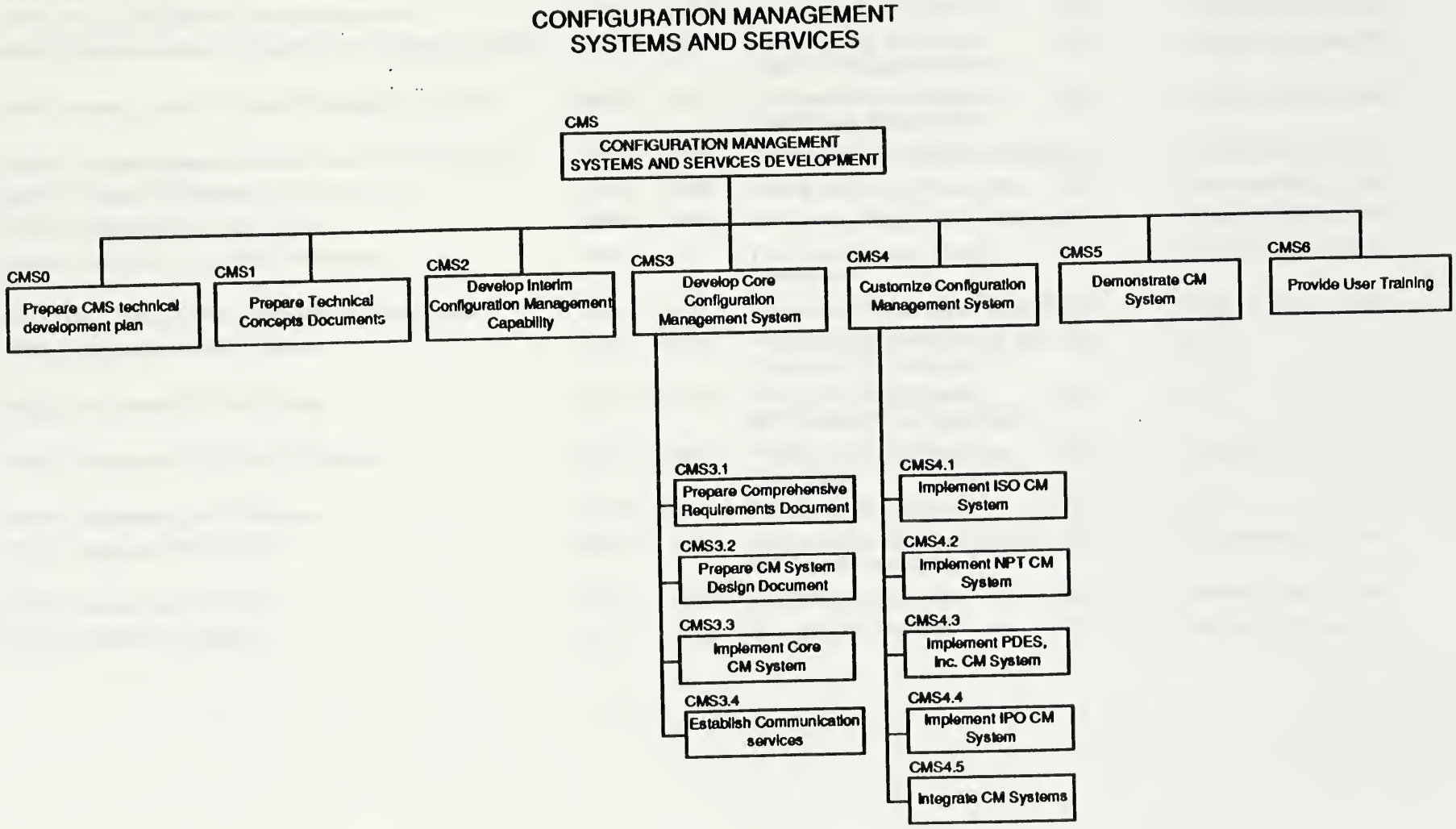


TABLE 1. **Deliverables**

| TASK | START | STOP | DELIVERABLE | SUPPLIER | CUSTOMER |
|---|---|---|---|---|---|
| CMS 0 Prepare Technical Development Plan | 07/90 | 08/90 | Technical Development Plan | ISC | CALS/ISO/IPO/PDES, Inc./NPT |
| CMS 1 Prepare Technical Concepts Document | 07/90 | 10/90 | Conceptual Architecture Doc. | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 2 Develop Interim Configuration Management Capability | 08/90 | 11/90 | Interim Config. Mgmt. Sys<br>Interim CM Procedure Guide | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 3 Develop Core Configuration Management System | 09/90 | 04/91 | Documented and Functional Core Config. Mgmt System | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 3.1 Prepare Comprehensive Requirements Document | 09/90 | 12/90 | Comprehensive Requirements Doc | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 3.2 Prepare CM System Design Document | 10/90 | 12/90 | Config. Mgmt. Sys. Design Doc. | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 3.3 Implement Core CM System | 11/90 | 03/91 | Core Config. Mgmt Sys Functional | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 3.4 Establish Communication Services | 10/90 | 03/91 | Functional Communications to Core System | ISC | ISO/IPO/PDES,Inc./NPT |
| CMS 4 Customize Configuration Management System | 02/91 | 11/91 | Customized Config. Mgmt. System | ISC | ISO/IPO/PDES, Inc/NPT |
| CMS 4.1 Implement ISO CM System | 02/91 | 05/91 | Functional ISO Config. Mgmt. Sys<br>CM System User Instructions | ISC | ISO |
| CMS 4.2 Implement NPT CM System | 04/91 | 07/91 | NPT Config. Mgmt. System<br>NPT Config. Mgmt. Users Guide | ISC | NPT |
| CMS 4.3 Implement PDES, Inc. CM System | 06/91 | 09/91 | PDES, Inc. Config. Mgmt. Sys.<br>Users Guide | ISC | PDES, Inc. |
| CMS 4.4 Implement IPO CM System | 07/91 | 10/91 | IPO Config. Mgmt. System | ISC | IPO |
| CMS 4.5 Integrate CM Systems | 09/91 | 11/91 | Integrated Config. Mgmt. System<br>CM System Users Guide | ISC | ISO/IPO/PDES,Inc/NPT |
| CMS 5 Demonstrate CM System | 11/91 | 12/91 | Demonstration Package | ISC | ISO/IPO/PDES, Inc/NPT |
| CMS 6 Provide User Training | 11/91 | 01/92 | User Training Materials | ISC | ISO/IPO/PDES, Inc/NPT |

# 4 Resources

## 4.1 Personnel

*Information Services Center Manager*

Responsible for the overall structure and planning of the ISC. This includes technical participation and review of the design and implementation of the developing configuration management system. Ensuring smooth operational procedures and the dissemination of appropriate documentation for those procedures will be a continuing maintenance activity.

*Configuration Management Systems Analyst*

Responsible for analyzing the requirements, developing procedures in conjunction with user groups, and designing and implementing the system (with the support of those listed below).

*Network Engineer*

Provides design support to the systems analyst, and implementation support to the programmers.

*Software Engineer*

Provides analysis, design, and implementation support under the direction of the systems analyst.

*Support Programmer*

Implements requirements established by the configuration management systems analyst. Provides the interface to the archive server and write utility scripts to simplify usage of the systems.

*Configuration Management Administrator*

Responsible for insuring the integrity of indexes to documents on the various systems. This includes input to the document tracking systems and synchronization of the archive server indices with the contents of data accessible by the archive server.

*Configuration Management Specialist*

Provides support to the systems analyst during the requirements analysis effort. This includes defining procedures in conjunction with the user groups, recommending procedural solutions, and evaluating available CM software packages.

*Other Personnel*

Support secretarial staff will be necessary to meet requests for physical documents and media. Division resources for global systems will provide support for network interface and systems integration issues.

## 4.2 Equipment

VAX cluster— will be used to store the anticipated large quantities of data and many versions of that data.

6 SUN workstations, 2 DECstations— will be used for software development by both NIST and PDES, Inc. staff.

## 4.3 Computer Software

RCS source code configuration control software

Archive server

Expect; for writing scripts to take the place of human interaction with the computer

Licenses for commercial software products, as deemed necessary for configuration management support.

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# 6 Glossary

*APC*

Application Prototype Center of the NPT

*Archive Server*

Generically speaking, an archive server interprets and executes commands. As used here, the archive server will read e-mail from remote CM users, interface with the CM system and/or the local file system to fulfill the request, and send the response back to the user via e-mail.

*Ballot Management*

The process of logging and collating the ballot comments against a particular ballot. This includes producing managerial summary reports.

*BBS*

Bulletin Board System

*BM*

Ballot Manager

*BPR*

Block Point Release (a software configuration management term)

*CALS*

Computer-aided Acquisition and Logistic Support

*CCB*

Configuration Control Board (a PDES, Inc. organizational unit)

*CD*

Committee Draft (formerly DP - Draft Proposal)

*Comment Database*

A database of ballot comments sent along with the ballots. These comments shall become the basis for changes to the configured STEP documents.

*Configuration Management System*

The software which enables users to access files on a version by version basis in a controlled manner.

*Document*

n item in either electronic or paper form.

*DP*

Draft Proposal (now called CD - Committee Draft)

*DTS*

Document Tracking System

*E-mail*

Electronic Mail

*Hard Copy*
A paper form of a printable electronic form.

*IPO*
IGES/PDES Organization

*ISC*
Information Services Center of the NPT

*ISO*
International Organization for Standardization

*NPT*
National PDES Testbed

*PDES*
Product Data Exchange using STEP

*PDES, Inc.*
A consortium of international companies involved in the development of the STEP standard.

*PMAG*
Project Management Advisory Group of TC198/SC4

*SG*
SubGroup

*SC*
Subcommittee of ISO

*SIB*
Systems Integration Board (a PDES, Inc. organizational unit)

*STC*
Standards Testing Center of the NPT

*STEP*
Standard for The Exchange of Product model data

*TC*
Technical Committee of ISO

*WG*
Working Group

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[ ] DOCUMENT DESCRIBES A COMPUTER PROGRAM; SF-185, FIPS SOFTWARE SUMMARY, IS ATTACHED.

11. ABSTRACT (A 200-WORD OR LESS FACTUAL SUMMARY OF MOST SIGNIFICANT INFORMATION. IF DOCUMENT INCLUDES A SIGNIFICANT BIBLIOGRAPHY OR LITERATURE SURVEY, MENTION IT HERE.)

This paper outlines the development plan for a configuration management system at NIST. This system will control both document and software development for four organizations: the International Organization for Standardization (ISO), the IGES/PDES Organization (IPO), PDES, Inc., and the National PDES Testbed (NPT). The primary goal of configuration management is to provide an orderly framework within which the development of the STEP standard can take place. This paper provides an overview of configuration management, describes the procedural and technical issues that must be handled in developing a system, outlines the steps that will be taken to reach the goal and defines the deliverables and the resources needed.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)
CALS; Configuration Management; IGES/PDES; PDES; Revision Control System; STEP

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