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TABLE OF CONTENTS

EXECUTIVE SUMMARY*

The federal government and other U.S. organizations are about to invest billions of dollars to develop multimedia training materials for delivery on computer-based interactive training systems. Acquisition of a variety of computers and peripheral devices hosting various operating systems and suites of authoring system software will be necessary to accommodate the widely varying requirements of this courseware. There is no single source that will satisfy all needs. Although high-performance, low-cost interactive training hardware is available, the products have proprietary software interfaces. Because the interfaces are proprietary, expensive reprogramming is usually required to adapt such software products to other platforms. This costly reprogramming could be eliminated by adopting standard software interfaces.

DoD's Portable Courseware Project (PORTCO) is typical of projects world-wide that require standard software interfaces. This paper articulates the strategy whereby the Federal multimedia courseware initiative leverages the open systems movement and the new realities of information technology. These realities encompass changes in the pace at which new technology becomes available, changes in organizational goals and philosophy, new roles of vendors and users, changes in the procurement process, and acceleration towards open system environments. The Federal strategy is applicable to all projects and systems which require open systems to achieve mission objectives.

The PORTCO goal is to facilitate the creation of an environment in which high quality portable courseware is available as commercial off-the-shelf products and is competitively supplied by a variety of vendors. In order to achieve this goal, a system architecture incorporating standards to meet the users' needs must be established. The Request for Architecture (RFA) developed cooperatively by DoD and the National Institute of Standards and Technology (NIST) will generate the PORTCO systems architecture. This architecture must freely integrate the courseware and authoring software from the lower levels of machine architecture and systems service implementation. In addition, the systems architecture will establish how the application-specific technologies relate to other technologies. Further, a computer-based interactive training applications profile must be developed. This profile, along with the systems architecture derived as a result of the RFA, provides the basis for identifying the needed standards. NIST will then accelerate the development of these standards using, but not restricted to, existing standards activities within established standards forums.

The Federal multimedia courseware effort has adopted the Interactive Video Industry Association (IVIA) Recommended Practices for Interactive Video Portability as the baseline for the migration of computer-based interactive training systems to an open systems environment based upon international standards. The Federal strategy includes an evolutionary migration to standards-based, Open Systems Environments (OSE). An important aspect of this migration strategy is to move to open systems via step-wise evolution rather than via quantum leaps.

Another area of concern is that of infrastructure issues, such as maintaining and supporting the technologies required for computer-based interactive training. The Federal multimedia courseware initiative will use the RFA-based architecture to differentiate

between those technologies that can be maintained and supported by existing infrastructure mechanisms and those that require new mechanisms. Existing infrastructure mechanisms will be used and where infrastructure mechanisms do not exist, the approach will be to place high priority on establishing the appropriate mechanisms. Establishing an infrastructure mechanism is a non-trivial task requiring sustained investment of resources.

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* The mention of commercial products in this paper is to describe the research environment and does not imply recommendation or endorsement by the National Institute of Standards and Technology.

BACKGROUND

Introduction

Over the next several years the federal government and other U.S. organizations will invest billions of dollars to develop training materials for delivery on computer-based interactive training systems. As part of this investment, these organizations will acquire a variety of computers and peripheral devices. This hardware will host a variety of operating system software and a suite of authoring system software in order to accommodate the widely varying requirements of courseware development. No single source will satisfy all needs.

Several commercial manufacturers currently offer high-performance, low-cost interactive training hardware, but they bundle their products with proprietary software interfaces. Vendors of integrated systems bundle their products with sophisticated interfaces to all system resources, while vendors of individual peripherals (such as mice) bundle their products with simpler interfaces to control their solitary device. Because these interfaces are proprietary, courseware and authoring software written to operate on one product will not run on a competitor's equipment. Expensive reprogramming is usually required to adapt such software products to new peripheral hardware. These reprogramming costs will be eliminated by adopting standard software interfaces to shield courseware and authoring software when training system hardware components are replaced by new ones.

The Portable Courseware Project (PORTCO) is typical of projects within the DoD and other federal agencies that recognize the need for standard software interfaces. In fact, the vast majority of PORTCO software interface requirements are shared across a broad spectrum of other applications within the U.S. federal government. Further, this requirement for standard software interfaces is not limited to the U.S. federal sector. Users world-wide have begun to recognize the importance of establishing standard software interfaces as a strategic element of information technology planning.

The world-wide effort by users to establish standard software interfaces has caused a fundamental change in the information technology industry. There are several aspects of this change that are particularly important to projects such as PORTCO. Perhaps the most important of these aspects is the movement away from proprietary products toward products based on open system concepts.

The Federal strategy for multimedia courseware leverages the open system movement and the new realities of information technology. These realities encompass changes in the pace at which new technology becomes available, changes in organizational goals and philosophy, new roles of vendors and users, changes in the procurement process, and acceleration towards open system environments. While specifically oriented towards Federal computer-based interactive training systems such as PORTCO, the Federal strategy is equally applicable to other projects and systems that require open systems to achieve mission objectives.

The Environment

Federal agencies are under increasing pressure to use information technology to improve efficiency and effectiveness in carrying out assigned missions. At the same time federal agencies are struggling with finding ways to use information technology to improve efficiency and effectiveness; there is a new reality that is becoming increasingly evident. Key aspects of this new reality are that federal agencies

- now recognize that they no longer can create de facto standards and impose them on the commercial market;
- need to rely on the commercial market for information technology products and services; and
- must establish strategies and plans for acquiring information technology products and services based upon open system standards which support applications software portability and interoperability.

The environment within federal agencies is changing. Whereas before there were isolated islands of computing, now there is interdependence of users across the entire organization. This interdependence has served to highlight enterprise-wide needs for common application and system architectures, communication networks, and databases. This interdependence has also raised concerns about infrastructure issues such as maintenance and support of these enterprise-wide resources. These issues are particularly troubling because although the requirement for infrastructure services is increasing, the resources available to support these services are decreasing. As part of the new reality, federal agencies must address infrastructure issues from policy, management, and technical perspectives.

MAJOR CONCEPTS

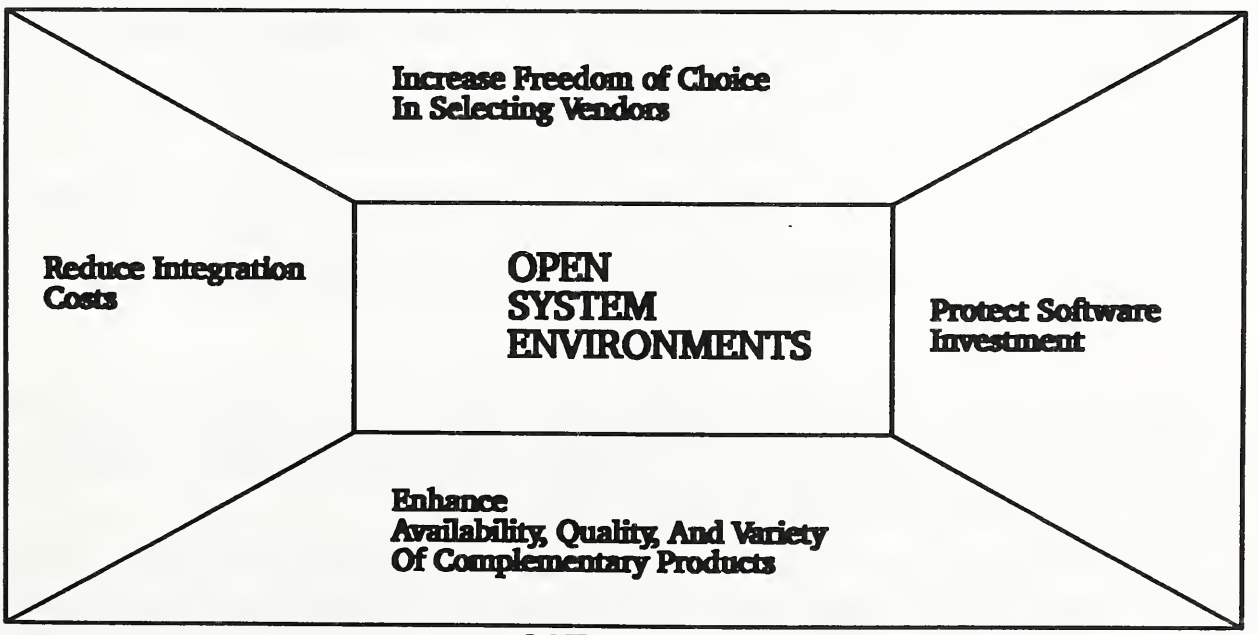
Open System Environment

One of the biggest factors underlying the open system movement is that users now recognize that no single vendor can supply all of their needs for information technology systems and services. Since homogeneity is no longer practical, users need open systems that provide interoperability of products and portability of people, data, and applications across heterogenous computing environments.

This need to improve portability and interoperability has resulted in widespread interest in standards such as POSIX (Portable Operating System Interface for Computer Environments) and GOSIP (Government Open Systems Interconnection Profile). While important milestones in the effort to achieve portability and interoperability, POSIX and GOSIP are not sufficient to address the full spectrum of needs.

A more comprehensive approach is needed to achieve an Open System Environment (OSE) that integrates POSIX with GOSIP and provides additional functionality to accommodate the broad range of application requirements. An OSE is a key aspect of a worldwide movement in which the U.S. federal government and other information intensive organizations are working to

- protect their investment in applications software,
- reduce dependence on single sources of supply for information technology products and services,
- stimulate the availability and quality of products in the commercial marketplace, and
- provide a stable base for the evolutionary development of large, complex systems.



OSE Benefits

The OSE movement is an outgrowth of efforts to establish the groundwork for computing environments that

- are based upon an architectural framework that allows an extensible collection of capabilities to be defined,
- define their capabilities in terms of non-proprietary specifications available to any vendor for use in developing commercial products, and
- control their evolution by a consensus-based process for decisions regarding capability definitions, specifications, and other issues related to the computing environment.

Computing environments having the above characteristics are referred to as "open." The developers of the concept of open computing were concerned primarily with interoperability of computers communicating over a network. The technology that resulted from their work is commonly referred to as Open Systems Interconnection (OSI).

An OSE extends the OSI concept to the broader problems of applications portability and interoperability. Efforts are currently underway by both vendors and users to

- establish an architectural framework for an OSE;
- define OSE interfaces, protocols, services and supporting formats; and
- provide a forum for consensus-based agreements on OSE issues.

Although the OSE concept is relatively new, the concept has matured to the point where there is an emerging international consensus on the functionality (i.e., the collection of interfaces, protocols, services and supporting formats) that should be included in an OSE. Additional information regarding the OSE concept is presented in Appendix A.

The OSE effort has not, however, matured to the stage where there is international agreement on the suite of specifications for the OSE functions. In the absence of an agreement, organizations have used a variety of schemes to select their own specifications to define OSE functions. These schemes result in a suite of specifications called OSE Profiles. These OSE Profiles typically reflect

- the functions that are required by the applications of interest,
- the organization's view of the viability of a particular specification for migration to an international standard when that standard is established, and
- the availability of commercial off-the-shelf products that conform to the specifications.

The Applications Portability Profile (APP), developed at the National Institute of Standards and Technology, is an OSE Profile developed for use by U.S. federal agencies. The OSE functions included as part of the APP are those that have been identified as important to a broad spectrum of U.S. federal agencies.

The APP is defined in terms of open system specifications organized into major service categories. These service categories, along with examples of the specific services in each category, are shown in Appendix B.

The APP provides a conceptual framework for a federal agency to develop application profiles that reflect their particular needs. Application profiles are useful to gain an understanding of open system requirements and to identify targets of opportunity for implementing open system standards. The APP and application profiles play complementary roles in federal agency information technology plans.

Multimedia Technology

Multimedia is an example of a trendy term used in the computing arena. As is the case with most such terms, it hints at substantive notions that are widely used but not well defined. In this case, the term multimedia builds on traditional notions of integrating different data objects (e.g., text, graphics, and numerics) into a single higher level object (e.g., a document). This holistic view of the integration of disparate elements is the theme that is common to the style of computing exemplified by multimedia. The notion of a reference model or architecture that establishes the integrating framework is central to this style of computing. The current interest in multimedia technology is primarily centered on the following:

- data objects,
- storage and transport,
- operating environments, and
- applications.

One dimension of the current interest in multimedia is the focus on data objects such as digital video and audio. There are two aspects of this focus. The first deals with the method for encoding the digital representation of the data. Previously, interest in data encoding dealt primarily with presentation issues such as the fidelity of the image and the sound. Currently, interest in data encoding has been expanded to include concerns regarding the information content of the digital representation to support analysis, editing, and manipulation. Data compression/decompression techniques that preserve both presentation fidelity and information content are particularly important. The second focus of the current interest in multimedia data objects is interactivity. The traditional environment supports dealing with data objects such as text, video, and audio in terms of batch-like operations; e.g., reading a book, viewing a movie, or listening to a recording. The key here is that there is an implied order that characterizes the operations. This is in contrast to an environment that supports interactive operations that deal with data objects in random order; e.g., nonlinear browsing, processes in which external inputs determine what is viewed or heard. Interactivity places additional requirements on data compression/decompression in that both compression and decompression must be done on-the-fly.

Another area in which data compression/decompression is important is in the storage and transport of the multimedia data objects. Data compression/decompression algorithms will play a large role in optimizing the use of storage capacity and network bandwidth. Videodisc is frequently used as a medium to store digital video and audio data. CD-ROM can also be used to store digital video and audio data. Because of the differing perspectives from which these media are viewed, gratuitous differences have evolved in their respective storage techniques. These differences result in incom-

patibilities that severely impact the ability of applications written for CD-ROM to operate on videodisc and vice versa. The recent focus on the storage of multimedia data objects is gradually shifting to the transport of multimedia data objects over local and widearea networks. Broadband ISDN (Integrated Services Digital Networks) appears to be the current transport mechanism of choice. Ultimately, systems supporting multimedia applications will have to provide a continuum of storage and transport mechanisms along with facilities to support interchange of multimedia data objects.

The promise of multimedia brings with it a variety of exotic scenarios in which our ability to receive, process, and interact with information is significantly enhanced. Applications required to support these scenarios can be viewed as a continuum that includes

- entertainment,
- education,
- training,
- presentation, and
- information access.

The current market for applications in this continuum is dominated by vendors from both the computing and entertainment industries. Computing is becoming a plug and play industry. One expects to be able to "configure" one's computer with different components obtained from a variety of sources. Entertainment tends to be a black box industry. One buys a television set, not speakers, tuner and monitor as separate devices. Each industry has a stake in multimedia and each has contributed to the current interest in multimedia. The problem is that manufacturers in the two industries have entirely different perspectives on how systems are put together, and what degrees of freedom are available for users to customize their systems.

There are two main operating environments contending for multimedia applications: workstation operating systems such as Unix, and PC operating systems such as MS/DOS. MS/DOS was designed as an operating environment to support low-end applications and minimal functionality platforms. MS/DOS applications tend to be of the single user, stand-alone variety. Although MS/DOS platforms are configurable, the range of choices for customizing these platforms is relatively limited. Because the environment is of limited complexity, MS/DOS users are expected to be able to operate (i.e., run applications and perform administration functions such as file back-up) with little, if any, assistance. Unix, on the other hand, was designed to support a much more complex situation in which

- there is a mix of low-end and high-end applications operating concurrently,
- there are multiple users being served by the same system, and in some cases by the same application,
- the system is typically several heterogenous platforms linked via a network,
- applications are designed to be interoperable with other applications, and

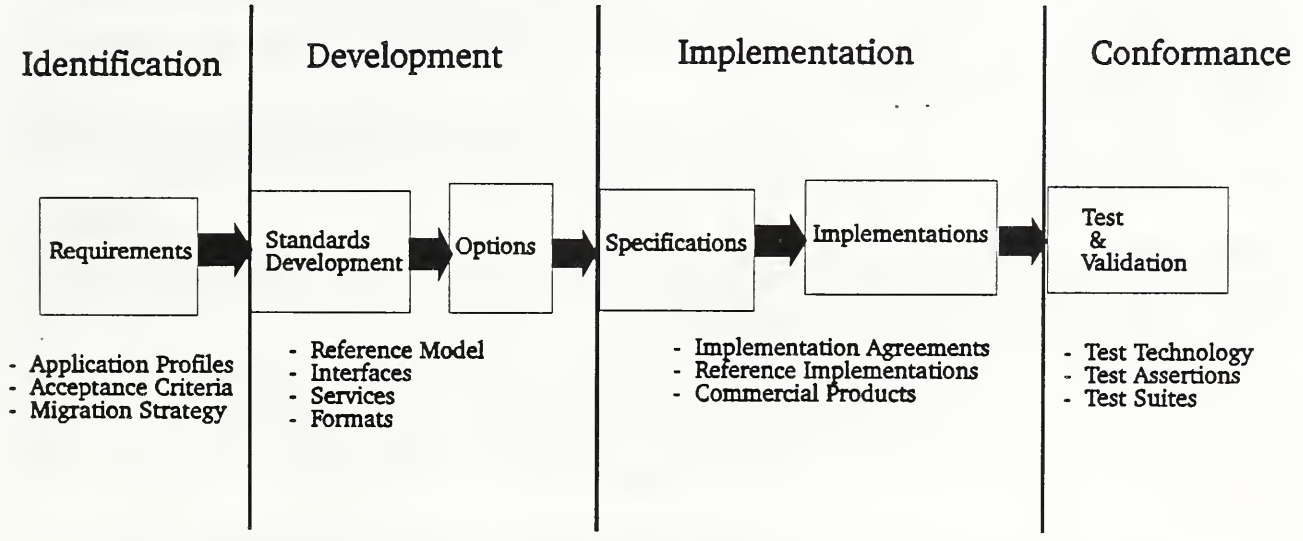
- there is a large range of choices regarding the manner in which a system can be configured and customized.

Because the Unix environment is relatively complex, users typically require technical assistance, primarily from "system administrators" who take care of the administrative functions which arise in a multi-user, networked environment. The Unix and MS/DOS environments should not be viewed as competitors for multimedia applications in that each serves a unique, special user need. The two environments collectively provide the capability to serve a broad spectrum of current and future multimedia applications.

The Standards Process

Standards are documents that set forth requirements, methods of measurement, performance characteristics, and specifications to provide for uniformity of products or services. The standards process can be described in terms of the major types of activities shown in the figure below.

Standards identification starts with the realization that there are benefits to leveraging the commonality of requirements that exists among a broad community of users. A



The Standards Process

primary output of this activity is an application profile that identifies

- the standards that are needed,
- how the standards relate to each other,
- which standards already exist, and
- which standards need to be defined.

Ideally this activity should begin at the time a new application is first being defined. In this way, standards can be built into the evolution strategy for the application and the importance of accelerating particular standards becomes apparent.

Typically, the requirements for several different standards are likely to be identified. These standards will each be in a different stage of maturity. Some will be well defined with conformance tests and test laboratories providing certification for products that adhere to the standards. Others may exist as standards, but not yet have any conformance tests. Still other standards may have already been identified by others and are being developed by the standards community. Finally some standards may not yet have been identified.

Standards development is conducted by some 400 U.S. organizations, each of which operates under its own rules. Formal U.S. standards are normally designated as American National Standards and are developed under criteria meeting the requirements of the American National Standards Institute (ANSI). These criteria relate to the following concepts.

Open Participation All parties with an interest that may be affected by the proposed standard shall have reasonable opportunity to participate in its development or to submit comments covering its provisions.

Balance of Interest The membership of the standards developing body must be so constituted that no single interest shall have a disproportionate share of influence in the content of the document or in its approval. (Interests are categorized based on the subject matter of the standard. For example, such interests may be users, producers, installers, general interests, and government).

Comment Resolution All individual comments received on the content of the standard shall be addressed and a reasonable attempt shall be made to resolve the comment.

Coordination All efforts shall be made to avoid conflict with the provisions of existing standards or with standards being developed by other organizations. To this end, formal liaison with other organizations is encouraged.

Consensus Adoption of a standard is dependent upon achieving a consensus of concerned interests. A substantial voting majority on a ballot may not be responsive to this requirement, particularly if one category of interest is substantially opposed to its adoption.

The strategic focus of standards development is to accelerate the process. The time required to develop a particular standard will vary greatly depending on the degree of consensus that has been achieved for the standard, the maturity of the technology associated with the standard, and the overall requirements of applications expected to use the standard. An effective way to accelerate the standards development process is to develop tools that support implementations of the standard. Examples of tools are tests, feasibility demonstrations, prototypes and procedure toolkits. Another way to accelerate standards development is through workshops that demonstrate an interest in the field and provide preliminary work towards consensus. Workshops also provide a forum to obtain important input from organizations that are not directly participating in the standards development process.

Standards implementation takes place as a result of decisions by

- users to apply the standards in procurement, and

- vendors to incorporate the standards into their products.

A decision to apply the standard in procurement is important to establish a marketplace demand for the standard; a decision to incorporate the standard into commercial products complements the marketplace demand by establishing sources of supply. Unless these two complementary decisions are made in the same relative time-frame, the standards development effort is essentially wasted.

Conformance testing activities are directed toward measuring the extent to which an implementation (i.e. a vendor's product) adheres to the specifications set forth by a standard. The ability to measure conformance is important to assure that a claim that a product conforms to a standard has some basis in fact. It is usually not possible or necessary to devise a test to determine total (i.e. 100%) conformance. It is, however, necessary to obtain agreement between users and vendors regarding the tests that will be used to measure conformance. Increasingly, establishing agreements regarding conformance tests is being dealt with as a consensus process within the formal standards arena.

The formal standards process is by necessity, very slow. Progress toward such standards is typically measured in years. In spite of the urgent need for standards to support multimedia courseware in an open systems environment, federal agencies and other organizations must establish a strategy for dealing with situations in which formal standards are not available. Part of this strategy must include a means for migrating to the formal standards as they become available.

Migration

Few organizations are able to fully exploit the benefits of an OSE. First of all, it is not currently possible for an organization to obtain an OSE with the functionality described in the APP (Applications Portability Profile) and which meets the criteria for "openness." More importantly, even if it were possible to obtain an open system with all of the necessary functionality, pragmatic considerations such as

- the availability of an adequate budget,
- the availability of appropriately trained staff, and
- the need to protect the current investment in information technology

mitigate against immediately replacing a proprietary system with an OSE conforming system.

Organizations should adopt a strategy that allows them to migrate to an OSE conforming system. This migration strategy should be based upon an evolutionary approach in which the computing environment evolves as step-wise refinements

- from an established baseline configuration,
- through a current target configuration,
- toward an objective configuration.

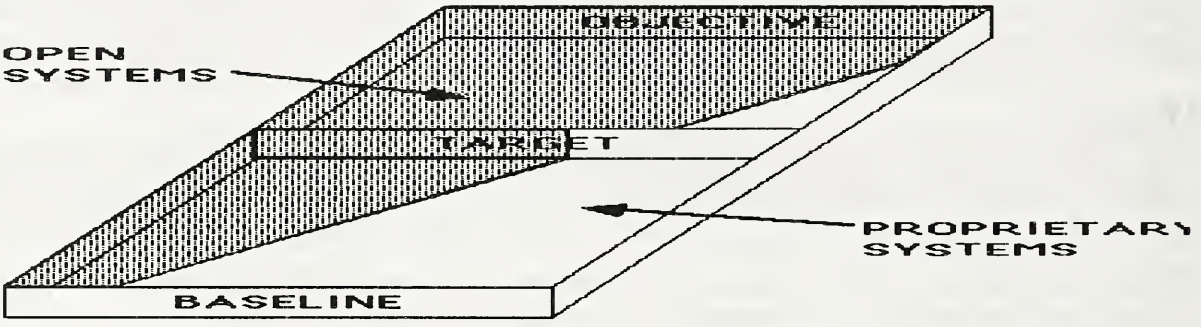
These are illustrated in the figure below and are defined as follows.

The *Baseline Configuration* defines "where we are now." It is comprised of an organization's existing information, programs, policies, standards, procedures, fielded information systems, and their interrelationships. It reflects what an organization currently relies on to accomplish its mission and functions.

The *Current Target Configuration* provides a statement regarding "where we are going" in the near-term. This configuration reflects an organization's pragmatic assessment of what can reasonably be achieved now in moving towards the objective configuration.

The *Objective Configuration* provides a vision of "where we should be" in the long-term. This configuration documents an organization's information requirements based on mission and functions, and the support and services needed to satisfy those requirements. It provides an objective for planning purposes and is not restricted by resource availability; in fact, there is recognition that there are technology, resource, and other obstacles that prevent attainment of the objective.

This type of migration strategy embodies an approach which is a departure from the traditional "completely-specify-then-build" approach. This new approach recognizes that specifications based upon complete and rigorous analysis of requirements is impos-



Migration Framework

sible in an environment in which

- requirements are driven by user-needs, and
- user-needs evolve as technology improves and experience accrues.

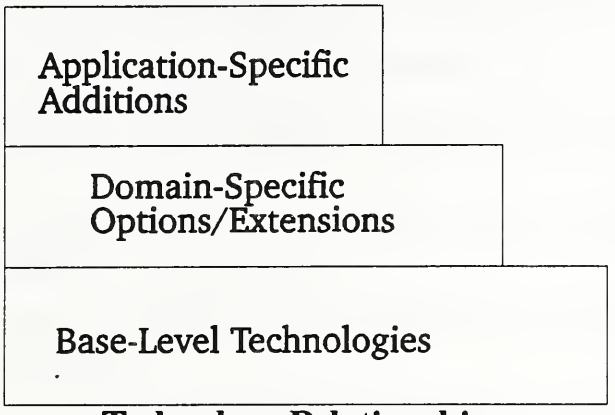
Infrastructure Issues

One of the distinguishing characteristics of computer-based interactive training and other multimedia applications is the need to integrate several disparate technologies into a unified systems framework. This systems framework provides a context for user requirements and standards specification. The framework also provides a context for understanding how the disparate technologies relate to each other. The figure below illustrates the relationship that should exist between

- a particular class of applications,
- an application domain in which related applications classes reside, and

- a computing environment capable of supporting a variety of application domains.

The lowest level represents those technologies required by almost all applications. Examples include technologies associated with operating system services such as I/O, commands and utilities, etc. The next level represents tailoring (typically special exten-



Technology Relationships

sions or options) of those lower level technologies that is required by a particular applications domain. Examples of technologies that are tailored include data management, data interchange, user interface, and graphics. The top level represents those technologies required by a specific class of applications. Examples of technologies at this level are synchronized audio and motion video.

These relationships among the various technologies provide a basis for a strategy to deal with the infrastructure issues of maintaining and supporting the technologies within the unified framework. The strategy requires a way, preferably an application profile, to identify how the application requirements are distributed among the three layers of the model. The requirements that necessitate application-specific technologies should receive the highest degree of concern regarding maintenance and support.

The goal to minimize the cost to a user organization for maintenance and support of application specific technologies suggests the following basic strategy:

- minimize the requirement for application-specific technologies by utilizing, to the maximum extent practical, domain-specific, and/or base-level technologies,
- share maintenance and support costs with other current and/or potential users of the application-specific technologies, and
- migrate application-specific technologies to the domain-specific and/or base-level technologies.

THE FEDERAL STRATEGY

Introduction

The Federal goal is to facilitate the creation of an environment in which high quality portable courseware

- is available as commercial off-the-shelf products, and
- is competitively supplied by a variety of vendors.

The Federal strategy leverages the worldwide open systems movement. Key elements of this strategy include:

- establishing a system architecture that provides the context for user requirements and standards specification.
- developing a plan to identify and accelerate the development of the required open system standards.
- developing a plan for an evolutionary migration to a standards based open system environment.
- the use of application profiles to
  - gain an understanding of open system requirements; and
  - identify targets of opportunity for implementing open system standards.
- leveraging existing open system activities by
  - implementing existing open system standards rather than developing its own standards; and
  - maintaining a collaborative partnership with NIST and other organizations involved in the development and promulgation of open system standards.

Systems Architecture

The Request for Architecture (RFA) developed cooperatively by DoD and NIST will extend the current multimedia portable courseware systems architecture. This architecture will isolate the courseware and authoring software from the lower levels of machine architecture and systems service implementation. This notion of isolating lower level detail from higher level functions is the conceptual basis which underlies software portability. In addition, the system architecture will establish how the application-specific technologies relate to other technologies (i.e., domain-specific and base-level) required to achieve the objectives.

Standards Development

The standards strategy has three major dimensions:

- identifying areas that could benefit from standardization,
- accelerating the development of the identified standards, and

- providing a mechanism to operate during the period in which needed standards are not available.

A computer-based interactive training applications profile will be developed. This profile, along with the systems architecture derived as a result of the RFA, will provide the basis for identifying the needed standards. As the needed standards are identified, NIST will establish a plan for accelerating the development of these standards. To the extent practical, the plans will leverage existing standards activities within established standards forums.

Because the formal standards process cannot be expected to keep pace with the need for standards, the plans will not be restricted to the use of formal standards organizations. There are several vendor-sponsored consortia (e.g., X/Open, Corporation for Open Systems (COS), Unix International (UI), and the Open Software Foundation (OSF)) that have complementary roles in establishing informal OSE standards. Properly utilized, these informal consortia standards can serve an important role in accelerating the adoption of formal voluntary international standards. Leveraging these consortia standards to produce voluntary international standards has the added benefit of accelerating the availability of commercial products which incorporate those standards.

Consortia standards are particularly well suited to use as a basis for international voluntary OSE standards because each consortium has

- a vested interest in having its standards adopted as voluntary international standards,
- consensus based processes for reaching agreements among their members, and
- a world-wide membership that includes every major supplier of OSE products.

These consortia standards will also be used as interim standards in those cases where international voluntary standards are not available or are not appropriate for OSE. Use of consortia standards as interim standards will stimulate the market for OSE products by creating a market demand and by reducing the risks for vendors to produce compliant products.

Migration

The Federal multimedia courseware initiative has adopted the "IVIA Recommended Practices for Interactive Video Portability" as the baseline for the migration of computer-based interactive training systems to an open systems environment based upon international standards. The Federal strategy includes an evolutionary migration to a standards-based, OSE. An important aspect of this migration strategy is to *keep up* with the open systems movement via step-wise evolution rather than *catch up* with the open system movement via quantum leaps. Other aspects of this strategy should include

- identifying targets of opportunity for implementing open systems standards,
- developing a mechanism for planning the migration of the identified targets, and

- managing the migration as a long range process of step-wise refinements toward the desired open system objective.

Part of the effort is to develop a plan that describes the process by which the transition from the baseline configuration through the current target configuration toward the objective configuration will proceed. In particular, this plan will describe how the target configuration is to be periodically adjusted closer to the objective configuration to reflect evolutionary changes in mission, policy, technology, and user requirements. In addition, this plan will describe how the migration will be managed in a manner that

- protects the investment in the baseline configuration,
- minimizes the disruptions to current operations,
- recognizes the reality of limits imposed by available resources, and
- provides flexibility to accommodate local requirements.

Infrastructure

The Federal strategy also deals with the infrastructure issues of maintaining and supporting the technologies required for computer-based interactive training. The Federal multimedia courseware will use the RFA-based architecture to differentiate between those technologies that can be maintained and supported by existing infrastructure mechanisms, and those that will require new mechanisms to provide the required maintenance and support. Where infrastructure mechanisms exist, the approach will contribute to those mechanisms to the extent necessary to ensure that Federal users' needs are addressed. Where infrastructure mechanisms do not exist, the approach will place high priority on establishing the appropriate mechanisms. Establishing an infrastructure mechanism is a non-trivial task. It requires sustained investment of resources over a long period of time. The time period required depends upon how long it takes to get an appropriate mechanism established and nurtured to the point that it can be "passed-off" to an appropriate recipient. Determining what mechanism is appropriate and who is an appropriate recipient are key aspects of the infrastructure issue.

NIST'S ROLE

Overview

The mission of the National Computer Systems Laboratory (NCSL) of the National Institute of Standards and Technology (NIST) is to

- increase productivity in government and the private sector, and
- contribute to the posture of U.S. industry in the international marketplace.

We do this by

- developing standards and guidelines for computer and related telecommunications systems,
- providing technical assistance to federal agencies, and
- conducting supporting research in computer science.

We work with the broad spectrum of

- private sector computer users;
- computer vendors and service providers;
- professional, academic, and research communities;
- international and national voluntary standards groups; and
- managers and users within federal, state, and local governments.

Part of the "value added" of our involvement is that we are aware of what is going on throughout these diverse communities. Further, we are recognized as an objective third party in building a consensus on issues, such as standards, that impact all of these communities.

A primary focus of the NIST mission is technology transfer. We try to thoroughly understand the technology and the problems users experience in attempting to use that technology. We try to find solutions to these problems and then package those solutions in a form that meets the needs of those who have the problems. The products and services shown below are the ways in which we currently package solutions.

- Federal Information Processing Standards and Guidelines
- Special Publications and other Technical Reports
- Reimbursable Assistance to Federal Agencies
- Newsletter and Bulletin Boards
- Conferences and Workshops

While there is a federal flavor in our activities, we make a concerted effort at outreach to users in the private sector. Our view is that the problems federal and private-sector users face are essentially the same. Our activities are

- laboratory based,
- cooperative, not regulatory,
- targeted to areas of biggest payoffs, and
- forward looking, covering areas of new technology.

These activities are directed toward helping users become informed consumers of information system products and services available in the commercial marketplace. Our lab-based environment allows us to develop guidance that helps federal agencies and others reduce the risks of incorporating new technology into their operations. Our technical program is focused on "open systems," with particular emphasis on

- software portability and interoperability,
- information interchange,
- compatibility and interoperability of systems interconnected through networks, and
- computer security.

NIST attempts to maintain a delicate balance between meeting urgent federal needs for open system standards and the consensus process that lies at the heart of the national and international standards process. There are clearly risks associated with attempting to balance such competing interests. To mitigate against these risks, NIST has established collaborative partnerships with

- the standards community,
- state and local governments,
- vendors and vendor-sponsored groups,
- private sector users, and
- other regional/national governments.

Key to the effectiveness of these collaborative partnerships is close communications to assure that each group is acting on the most up-to-date information regarding common goals. Collaborative partnerships also provide the means for building the consensus necessary to achieve worldwide acceptance of and commitment to open system environments which facilitate portability, interoperability, and scalability.

The Multimedia Courseware Project

NIST is currently engaged in standards identification efforts, primarily focusing on standards that support multimedia courseware in an open systems environment. This effort is part of the Multimedia Courseware Project Plan (see Appendix D) and builds on earlier efforts to

- broaden our understanding of multimedia technology, particularly as it applies to computer-based interactive training applications;
- investigate how the ongoing NIST technical activities could be leveraged to support PORTCO and related projects (see Appendix C);
- establish an in-house technical team as a focal point for multimedia and related computer-based interactive training activities;
- establish visibility and support for the U.S. federal multimedia and related computer-based interactive training efforts;
- identify and establish contact with the major players in the multimedia and related computer-based interactive training community; and
- identify standards opportunities that could be leveraged to advance the multimedia and related computer-based training efforts.

Based upon these earlier efforts, we believe that there are

- several existing standards that could form the basis for a computer-based training application profile based upon a more general multimedia specific-domain,
- a minimum of two operating environments in which multimedia applications run under, and
- a proposal that we believe fills in a necessary gap.

The existing standards are POSIX, GOSIP, and XWindows. The two environments are MS/DOS and an OSE-based environment such as Unix. The proposal is the "IVIA Recommended Practices."

Our current efforts will likely result in a dual-platform multimedia courseware strategy: one oriented around the MS/DOS operating system and the other around an OSE-based operating system. Maintaining compatibility with the MS/DOS operating system environment is simply pragmatic recognition of the key role MS/DOS has in the current multimedia courseware arena. Even more important, identifying the MS/DOS operating system as a strategic component of our multimedia courseware strategy reflects our view that MS/DOS

- uniquely addresses user needs for an operating system to support low-end applications and minimal functionality platforms,
- will continue to be a strategic element of desktop computing for the foreseeable future,

- will benefit from technology advances, particularly with regard to user interface and device-independent technologies, and
- will evolve so as to eventually embody many of the characteristics of an OSE-based operating system.

A key aspect of our standards identification effort is to use the RFA to solicit from all interested parties ideas for a multimedia architecture. We will use the "IVIA Recommended Practices" as a baseline. This process has already started with announcements in the Commerce Business Daily and the Federal Register. We will also use the Open Software Foundation and Interactive Video Industry Association to distribute the RFA directly to their respective members. The RFA is presented in Appendix E.

In support of these efforts we are developing plans to evolve our current electronic publishing laboratory into a multimedia systems laboratory. This is a natural evolution because electronic publishing is evolving to multimedia publishing where published materials (courseware, electronic documents, recordings, etc.) are no longer limited to one medium (the printed word, video, audio, bit mapped images, video) but are represented as the integration of a variety of media. The laboratory will be used to study the integration of the different media and related technologies required to support multimedia courseware in an open systems environment.

The laboratory will also serve as a facility to demonstrate the integration of multimedia technologies, as well as a facility to support conformance and interoperability testing. As is the case with other NCSL laboratories, we actively solicit industry support and participation in the multimedia laboratory. This industry support can be provided by loaning equipment and people to work directly with us through one of the many the existing NIST/Industry cooperation mechanisms.

NIST will have to closely track the numerous standards and related activities that impact multimedia courseware and open system environments. This means that we will have to make pragmatic decisions regarding the level of our participation in the various activities. Unfortunately multimedia courseware and open system activities are distributed over a number of different standards and related forums. Fortunately NIST already participates in most of the appropriate activities. We will need to coordinate that participation with respect to multimedia courseware to effectively represent federal agency requirements for standards. The major challenge is to locate the appropriate venues for national and international acceptance of the work related to multimedia courseware. Our knowledge of this arena will help us find the appropriate venues which we can work to accelerate international standards.

In addition to the standards related activities, we have also been working to broaden the visibility of the multimedia courseware initiative within industry and among users in both the government and private sectors. This effort is important if we are to establish collaborative partnerships for leveraging worldwide interest in multimedia courseware in an open systems environment. Leveraging this interest is crucial to the success of the Federal effort to achieve its goal to catalyze an environment in which high quality portable courseware is available as commercial off-the-shelf products that are competitively supplied by a variety of vendors.

APPENDIX A
OPEN SYSTEM ENVIRONMENTS

The OSE Concept

Extensibility

- Based upon an architectural framework which allows an extensible collection of interfaces, services, protocols, and supporting formats to be defined.

Non-proprietary

- Interfaces, services, protocols, and supporting formats are defined in terms of non - proprietary specifications that are available to any vendor for use in developing commercial products.

Consensus Based

- Evolution is controlled by a consensus - based process for decisions regarding definition and specification of interfaces, services, protocols, supporting formats, and other issues related to the computing environment.

OSE Dimensions

Portability

The ability to use application software on heterogeneous hardware/software platforms. This includes *maintainability* -- i.e. portability over time -- perhaps the most important of all the open system dimensions.

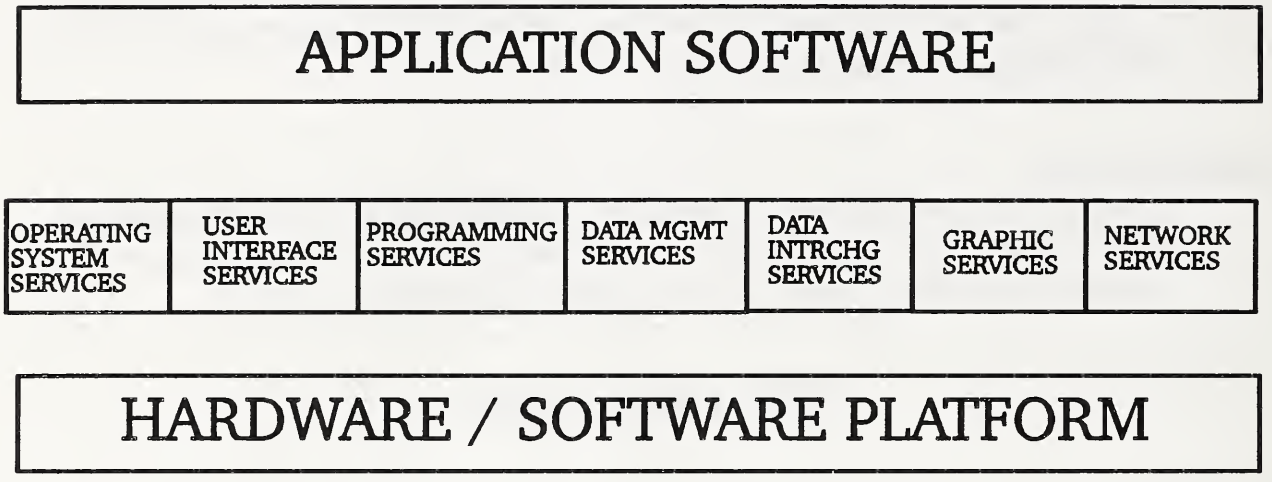
Interoperability

The ability to have application software operating on heterogeneous hardware/software platforms cooperate in performing some user function and sharing data.

Scalability

The ability to use the same application software on many different classes of hardware/software platforms from personal computers to supercomputers (extends the portability concept).

The OSE Framework



OSE Services

Operating System Services
- Kernel Operations
- Commands & Utilities
- System Administration
- Operating System Security

User Interface Services
- Client-Server Operations
- Object Definition & Management
- Window Management
- Dialogue Support
- User Interface Security

Programming Services
- Programming Languages and Bindings
- Integrated Software Engineering Environments and Tools
- Programming Security

Data Management Services
- Data Dictionary/Directory
- Database Management System
- Distributed Data
- Data Management Security

Data Interchange Services
- Document Interchange
- Graphics Data Interchange
- Product Data Interchange
- Data Interchange Security

Graphics Services
- Two- and Three-Dimensional Graphics Support
- Graphics Database Support
- Graphics Programming and Data Security

Network Services
- Data Communications
- Transparent File Access
- Personal/Micro Computer Support
- Distributed Computing
- Network Security

APPENDIX B

THE APPLICATIONS PORTABILITY PROFILE (APP)

A Profile

A suite of specifications describing the functionality required to accommodate a specific class of applications.

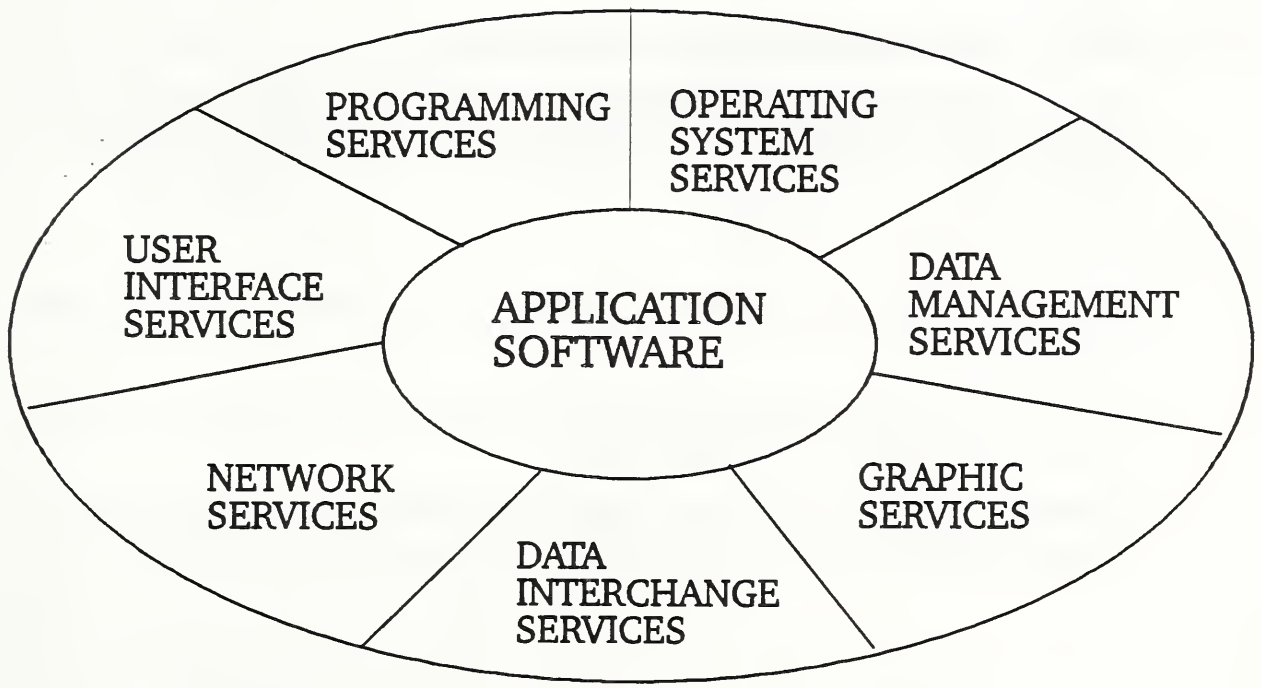
Developing a profile involves:

- Identifying required services and interfaces
- Choosing among alternative specifications
- Tailoring the specifications
- Augmenting the specifications

The APP

An OSE profile developed to meet the application needs of the U.S. Federal Government. The APP specifications have been tailored to enhance portability and interoperability of U.S. Federal

- Software
- Systems
- Personnel
- Data



The U.S. Federal OSE Profile

The APP Project

The APP project is guided by

- A concern for timeliness
- A commitment to voluntary standards
- A need for an architectural framework

The APP project will produce

- *Planning Guidelines* to help agencies develop strategies to realize the benefits and minimize the risks of open system environments
- *Usage Guidelines* to help agencies deal with issues involved with the implementation and migration of open system environments
- *Technical Specifications* that provide guidance to buyers of open system products and services

When International Standards are not available for use as the basis for APP specifications, NIST will use the following order of precedence to select from among alternative sources for specifications

- U. S. national standards (e.g. IEEE Std 1003.1 -1988)
- U. S. national standards committee work in progress (e.g. IEEE P1003.2 Draft 9)
- Other federal standards (e.g. DoD Standards)
- Specifications that are publicly available and for which implementations are commercially available from a variety of sources (e.g. X Window System, Version 11)

In selecting specifications, NIST will

- Use specifications that reflect an appropriate level of maturity, stability, and consensus
- Take steps to ensure that our actions are consistent with the direction being taken within the formal standards arena
- Establish an open process for an orderly migration to international standards as consensus evolves in the national and international community

Evolution of the APP

At any moment in time specifications for individual components of the APP will be at different points along a continuum of maturity, stability, and consensus

NIST has established an open process to ensure that the APP reflects the evolving consensus of the national and international community

Both users and vendors are encouraged to become involved in this process through participation in an ongoing series of NIST sponsored APP workshops

These workshops provide a forum for communicating information and obtaining feedback on the evolving APP

- User workshops address issues of special concern for those interested in using APP specifications in procurement
- Implementors workshops address issues of special concern to those interested in building products to the evolving APP specifications

Current APP Specifications

In examining APP specifications, it is important to keep in mind that

- Many of the specifications have not yet evolved into national or international standards
- A significant number of the specifications have already been adopted as FIPS
- Some of the specifications reflect standards work in progress
- Some of these specifications may not be appropriate for the PORTCO environment

APP Specifications

Operating System Services

Kernel Operations - (POSIX) FIPS 151-1

Commands & Utilities - P1003.2- *Proposed FIPS*

Systems Administration - P1003.7

Security - P1003.6

Data Management Services

Data Dictionary/Directory (IRDS) FIPS 156

Query/Reporting (SQL) FIPS 127-1

Graphic Services

Display Element Definition & Management - (GKS) FIPS 120

Graphic Object Attribute Definition & Management - (PHIGS) FIPS 153

Data Interchange Services

Documents

- SGML - FIPS 152
- ODA/ODIF - ISO/IS 8613

Graphic Data - (CGM) FIPS 128

Product Descriptions - (IGES) NBSIR 88-3813

Network Services

Data Communications - (GOSIP) - FIPS 146

Transparent File Access - P1003.8

Remote Process Execution - P1003.8

User Interface Services

Client-Server Operations (XWindow System) FIPS 158

Object Definition & Management (XWindow System) FIPS 158

Window Management - P1201

Dialogue Support - P1201

Programming Services

Languages

- ADA - FIPS 119
- C - X3.159-1989
- COBOL - FIPS 021-3
- FORTRAN - FIPS 069-1
- PASCAL - FIPS 109

CASE Environments & Tools

Library Support

APPENDIX C
NCSL TECHNICAL ACTIVITIES

The National Computer Systems Laboratory

Computers have transformed the way the government does business. Computer systems offer the potential for increasing productivity, for solving problems, and for rapidly sharing information through networks. However, barriers still exist to the efficient use of computers, to the cost-effective exchange of information, and to the protection of information in computer systems from threats of all kinds.

At the National Institute of Standards and Technology (NIST), the National Computer Systems Laboratory (NCSL) responds to these challenges in many ways, developing standards and test methods, conducting research on computers and related telecommunications systems, and providing technical assistance. Our activities support key goals of the federal government for the 1990s: improved management of resources and delivery of timely and cost-effective services to the public.

To achieve these goals, our laboratory-based research activities advance the efficient use of computer technology and support the development of off-the-shelf, commercial products for computer system users. Technology transfer to federal agencies completes the research cycle.

NCSL consults with federal agencies to solve technical problems. Carried out on a cost-reimbursable basis, projects are selected for their broad applicability to federal agency information processing and their contributions to our programs. Our professional staff is uniquely qualified to address technical problems in computer security, software engineering, advanced computer systems, database management and graphics systems, and distributed processing.

Information Systems Engineering Division

The Information Systems Engineering Division supports standards development and provides technical assistance to government and industry in:

- data administration,
- data management,
- computer graphics,
- geographic information systems,
- standards validation, and
- programming language technologies.

For the past several years, NCSL has actively contributed through research and technical assistance to the Computer-aided Acquisition and Logistic Support (CALS) initiative of the Department of Defense (DoD). Introduced in 1985, this program seeks to reduce costs and improve the quality of all major DoD weapons systems acquired in 1990 and beyond.

To achieve these goals, NCSL assists DoD in selecting and implementing standards for the exchange and storage of digital data. One example is the Computer Graphics

Metafile (CGM) standard which is used by CALS to pass graphical pictures among different computers and graphical devices in the development of technical manuals.

A research initiative resulted in the Information Resource Dictionary System (IRDS) standard and our IRDS prototype, a software system that records, stores, and processes information about an organization's data and data processing resources. The IRDS enables federal government users to improve productivity by identifying information resources that can be shared within an organization and between organizations. There are now over 90 users of our IRDS prototype in federal agencies, private industry, academia, and several foreign countries.

Often the work which we do for one federal agency furnishes long-term benefits to many agencies. One example is the assistance NCSL provided to the National Archives and Records Administration in developing an Archives policy for the preservation of electronic records. The policy provides for the safe and efficient transfer of database information, graphics, text, and technical documents of historical value from the creating agencies to the National Archives for safe-keeping and availability to historians.

Systems and Software Technology Division

Providing assistance to federal consumers of commercial information system products and services is the goal of this Division.

Working with vendors, users, and voluntary standards organizations, NCSL advances the development and implementation of standards for improved software quality and information exchange. One example is the standard on Portable Operating System Interface for Computer Environments (POSIX), Federal Information Processing Standard (FIPS) 151-1. POSIX promotes portability of software applications. Federal agencies benefit with reduced costs and increased flexibility when the standard is used to acquire computer systems.

The ability to move or port an application from one operating system environment to another is important for cost-effective computing. NCSL is working with users and industry to define and implement the Applications Portability Profile (APP), a group of standard elements including database management, data interchange, network services, user interfaces, and programming services. We sponsor workshops for vendors and users to explore common ways to implement the standards that are being developed.

NCSL is a recognized leader in the development of standards and guidelines on software engineering topics including:

- software design and testing;
- software maintenance;
- fourth-generation languages; and
- evaluation and acquisition of software.

In the past our Electronic Publishing Laboratory has assisted federal agencies in the selection and use of publishing systems by demonstrating the capabilities and limitations of different publishing technologies. More importantly, the laboratory supported the development of document processing standards such as the Office Document Architec-

ture (ODA) and Standard Generalized Markup Language (SGML). Currently the lab supports the development of the Standard Page Description Language (SPDL). This laboratory also supports our research in document architectures, multimedia, and hypertext . Our involvement in these emerging technologies enables us to assist agencies in implementing standards in the office environment.

Computer Security Division

Computer systems and the information they process are valuable and critical assets of an organization. The Computer Security Division develops standards and guidelines for cost-effective security measures in computer systems throughout government and industry.

Under the Computer Security Act of 1987, NCSL is the lead agency for standards, guidelines, and technology for information security throughout the federal government (excluding classified, national-security-related systems and information). Computer security standards are important because they provide both users and vendors with technically effective methods for protection and industry-wide interoperability. Our Computer Security Program has four primary components:

Security Technology. Effective use of computer security technology helps assure reliable, low-cost protection. Among the areas which NCSL addresses are personal identification technology, cryptography, Secure Operating Systems, personal computer security, database security, and network security architecture.

Management and Evaluation. Effective computer security requires technical, physical, and management controls, based on an assessment of the tradeoffs between risks and control costs. NCSL develops guidance in the application of risk management techniques, computer security management, contingency planning, and audit.

Planning and Assistance. The Computer Security Act designates NCSL to provide federal agencies with advice and assistance in computer security planning, training, and related activities. With the National Security Agency, NCSL reviews and comments on agency security plans for sensitive, unclassified systems. Regular workshops, meetings, and a national computer security conference comprise our ongoing program to facilitate the interchange of ideas, needs, guidance, and standards.

Research and Development. An ongoing technical research and development program ensures that the needs and opportunities offered by new technology are used in the development of standards and guidelines. Research is conducted in personal identification technologies, computer viruses, network security mechanisms, operating system security, cryptography, and related areas.

Systems and Network Architecture Division

The development and standardization of Open Systems Interconnection (OSI) technology, formal methods for test systems, and integrated, interoperable network management technology are the focus of this Division.

NCSL has been actively supporting the standardization of OSI technology for over ten years. Approved in 1988 as Federal Information Processing Standard (FIPS) 146, the

Government Open Systems Interconnection Profile (GOSIP) defines a common set of data communication protocols which enable systems developed by different vendors to interoperate and enable the users of different applications on these systems to exchange information.

Effective in 1990, the initial version of GOSIP will assist federal agencies in acquiring computer systems that support electronic mail and file transfer applications over a variety of local-and wide-area networks. Future versions of GOSIP will include additional applications, such as virtual terminal, security, office document interchange, directory services, and dynamic routing.

NCSL is in a unique position to provide technical assistance to other federal agencies to support the implementation of GOSIP. One example is our recent work for the Defense Communications Agency. We completed the initial phase of the OSI directory prototype implementation; connecting the prototype directory to the NCSL-developed Department of Defense/OSI electronic mail gateway successfully demonstrated the practical application of the protocols.

NCSL also supports private industry through testing and standards implementations activities. For example, we established OSINET, a cooperative government/industry research network which tests commercial OSI products for interoperability.

As the success of OSI creates large, multi-vendor networks composed of many components, the need for integrated, interoperable network management becomes critical. To respond to the needs of users and vendors over the next five years, NCSL has developed a program to advance the standards necessary for effective integrated network management.

Advanced Systems Division

Division staff has expertise in parallel processing performance, data storage technology, distributed systems, automated recognition methods, and Integrated Services Digital Networks (ISDN).

Research focuses on economical methods of instrumentation that minimally perturb parallel processors and the design of coherent evaluations that reliably characterize the machines. Supported by the Defense Advanced Research Projects Agency (DARPA), NCSL developed the Trace Measurement System (TRAMS), a hybrid measurement tool used to obtain trace measurement information. Government and industry will benefit from this feasible and economical approach to providing measurement capabilities to a wide range of multiprocessors.

Under an interagency agreement with the National Archives and Records Administration, NCSL is developing a testing methodology that predicts life expectancy of optical disk media. This research will assist government managers in planning how long information may safely be stored on these media.

Our continuing research in automated recognition technology supports the work of several federal agencies. One example is our work for the Federal Bureau of Investigations to develop standards for automated fingerprint identification systems. In cooperation with academia and the private sector, our researchers design and develop test

procedures and speech database test materials for the DARPA Speech Recognition Program.

In another research area, NCSL investigates standards and develops conformance test methods for ISDN. ISDN is a new telecommunications technology that makes it possible to send and receive voice, data, and image signals simultaneously over digital telephone networks. NCSL established the North American ISDN User's Forum to create a strong user voice in the implementation of ISDN.

APPENDIX D
KEY MULTIMEDIA PROJECT DATES

Multimedia Courseware Project Schedule

April 1990 - April 1992

April 15, 1990
RFA Announcement in the CBD and Letters Sent.

June - October 1990
Build Multimedia Systems Laboratory.

June 14, 1990
Explanation on RFA Proposal Meeting to be held at NIST.

August 1, 1990
Summary Proposals for Architecture are due from RFA respondents.

August - September 1990
Summary Proposal Analysis.

September 1990
Issue a report on analysis of the Summary Proposals.

October 1990
Government Wide Forum - Open Multimedia Laboratory; Presentations on training and government use of multimedia systems. Also cover CD-ROM and have SIGCAT attendance at Government wide forum.

November - January 1991
Presentation of Detailed Proposals from RFA Respondents (Two or three days of NIST Meetings will be sponsored).

December 1990
Construct overview of CD-ROM operating extension and search/retrieval (S/R) products.

January - April 1991
Evaluation of Detailed Proposals and synthesis of preliminary standards for Portable Courseware.

January 1991
Circulate draft FIPS for ISO/IEC 9660 and ISO/IEC 10149 for comments.

February 1991
Conduct workshops (with SIGCAT attendance) at NIST to discuss proposed FIPS.

March 1991

Preliminary Announcement of RFA results.

Working UNIX Prototype which will run the CAMIS Courseware with a fall back position of running DOS through VP/ix (a LOCUS/Merge routine) on a UNIX Platform.

April 1991

Rationalization Meeting sponsored by NIST.

Write FIPS for ISO/IEC 9660 and ISO/IEC 10149 in Federal Register.

June 1991

Design conformance test strategy for CD-ROM system interoperability. (Determine degree of conformance testing necessary).

July 1991

First set of FIPS Guidelines prepared for Portable Courseware.

August 1991

Additional Publications (Special Pubs, Internal Reports, other appropriate publications) relating to the Portable Courseware Architecture agreed upon and related conformance testing procedures.

New Plan in place accelerating the 1991 standards identified in the Guidelines.

Have CD-ROM implementations for developing conformance tests.

October 1991

Develop industry consensus on tests.

April 1992

Have conformance tests implemented and determine necessity of NVLAP for testing.

APPENDIX E
THE REQUEST FOR ARCHITECTURE

REQUEST FOR ARCHITECTURE[1]

Standards for Portable Courseware[2]

Abstract

Courseware is the leading application in the multi-media systems domain. The evolution of a path for the integration and standardization of multi-media components is the intent of this RFA. It is the first step in a process to enable the National Institute of Standards and Technology (NIST) to publish a family of FIPS[3] specifications encompassing major applications in the domain of multi-media.

Purpose

NIST is requesting architectural proposals for standards for portable courseware. One aspect of these standards will be to provide an alternative to the current practice of distributing courseware with proprietary interfaces to system services. Another aspect will be to specify a standard interchange format so that courseware developed on one authoring system may be modified on another.

The use of portability standards will provide the following benefits.

Consumers benefit by:

- more courseware platforms available off the shelf.
- increased competition among providers.
- elimination of duplicate funding of course development.
- elimination of the need to purchase specialized systems just for courseware.
- a well defined evolutionary path that incorporates the functionality described by the *IVIA[4] Recommended Practices* into an open systems environment.
- preservation of investment over time and accommodation of future technical improvements.

Providers can:

- enjoy a greatly increased marketplace and installed base.
- have access to previously closed markets.
- reduce re-authoring costs by using a standard software interface to common system services.
- be assured of a clear path for the evolution of architecture enhancements to open systems technology.
- reduce stocking and distribution costs.

Scope

NIST is seeking proposed solutions to address a broad set of requirements affecting the creation, distribution, execution and procurement of

1. Considerable portions of this document and the general form have been taken from the *Request for Technology* for the Architecture-Neutral Distribution Format from the Open Software Foundation. Several ideas and some wording are taken from *Portable Courseware A Standard for Government and Industry* Associates under contract to the Department of Defense. Other ideas and wording are taken from *IVIA Recommended Practices for Interactive Video Portability* , Draft prepared for the Interactive Video Industry Association.
2. For the purpose of this document, courseware will be taken to mean computer based interactive training software. Although hardware has a very important role in the training process, this document does not directly address hardware standards.
3. FIPS is an acronym for Federal Information Processing Standard.
4. IVIA is an abbreviation for the Interactive Video Industry Association. The *IVIA Recommended Practices* refers to the document titled "IVIA Recommended Practices for Interactive Video Portability."

courseware. The solution should consist of:

- A specification for a standard for courseware portability. (Possible examples include specification of virtual device interfaces[5] (VDIs) to support the common peripheral devices[6] associated with courseware.) The specification should describe services available from the peripheral devices, e.g., for a graphics display, functions might include draw a line, draw a circle, etc.
- A comprehensive plan and discussion of an evolutionary path to allow stepwise refinement of the architecture to encompass future hardware and software technology.
- A specification for a neutral interchange format for courseware so that courseware developed on one machine may be edited and maintained on another.
- Implementation(s), if available, of one or more of the above.

If complete solutions are not available, NIST encourages the submission of partial solutions that may be combined to yield a complete solution. Additionally, providers with partial solutions are welcome to group together to present a combined solution.

Functional Requirements

All candidate specifications must satisfy the following minimum requirements:

Hardware Independence
The specification should be independent of the host hardware architecture, i.e., the *interface* should be such that there is no recognition of constructs such as stack direction, word size, sign extension, byte order, etc.

Programming Language Support
The specification for interoperative courseware must support applications written in ANSI[7] C, and bindings to interface functions must be specified as C function calls. **Note:** *The interface functions themselves may require another language, e.g., assembly language.*

Operating Environment Concepts
The portable courseware must be able to execute in the interface environment specified in FIPS 151 (POSIX) and MS-DOS systems. In order to provide a framework from which contributors can relate specific ideas and structures, two instances of possible structures are presented below. The first example presents an MS-DOS model, and the second example presents an Open System Architecture model.

The MS-DOS Model, Figure 1, was constructed from the two known MS-DOS contributions to portable courseware standards. The first of these contributions is represented by the IVIA's "Recommended Practices for Interactive Video Portability" which presents the recommendations of the committee for commands and interface mechanisms used in level three Interactive Video (IV) systems. The second contribution is represented by the Navy Personnel Research and Development Center's (NPRDC) "Portable Courseware Architecture". This contribution addresses the logical control of devices over different device classes. It constitutes a lower level interface into the overall courseware model.

The Open Systems Model, Figure 2, was constructed from the standard Open System Architecture with the insertion of an "IVIA Toolkit" at layer 5 in the model. This configuration represents one possible approach to incorporate the functionality of the IVIA Recommended Practices into an Open Systems environment.

These models only deal with source language portability. The purpose of this RFA is to solicit solutions that address current and future technical

5. A virtual device interface is a software mechanism that allows an application to use a peripheral device without knowledge of the hardware characteristics of that device.
6. Common devices might include: graphics display, video disc, printer, speech synthesizer, or mouse (or other pointing device).
7. ANSI is an acronym for the American National Standards Institute.

advances in all aspects of portability.

Distributed System Support
The technology must be capable of being distributed across a network such that new users can easily be added to the system without impacting existing users. The system should be able to be easily scaled to meet the needs of one user to many thousands of users.

Extensibility
The technology must be extensible to allow for new devices.

Image Management
The portable courseware system shall provide a means of managing a variety of images, including video, raster, vector graphics, and page description language.

Key Evaluation Criteria

Submissions should provide for a high level of portability and functionality. In addition, the following evaluation criteria will be used:

Courseware Quality
The submissions should support courseware of the quality and functionality used by the federal government. Specifically, they should include a statement, with appropriate justification from the submitter, that the proposed system can support courseware of the quaility required by the federal government both now and in the foreseeable future.

Standards
Besides the FIPS 151 and ANSI C standards already referenced, submissions should conform to existing (or emerging) FIPS, ANSI, or ISO[8] standards wherever possible.

Architecture Evolution
As noted in Attachment 1, the IVIA Recommended Practices functionality is the baseline for the evolution of the architecture in a logical progression; all architectures must provide a mechanism for upward movement from the baseline functionality.

Product Readiness
An implementation of the proposed specification must be available by January, 1991.

Documentation
Submissions shall provide clear, accurate, and usable product documentation of the specification(s) at the interface and interchange level. Documentation should include any known limitations. Additionally, it should be available in machine readable source format. The source should be in a portable interchange format such as in AAP SGML tags[9] or should be easily transformable to such format by the submitter.

General
Consideration will be given to other criteria such as ease of use, breadth of applicability, functional richness and innovation.

Evaluation Process and Milestones

Stage 1
NIST will conduct a meeting on June 14, 1990, to explain its goals and the RFA process.

Stage 2
Notification of intent to respond is required by August 1, 1990. The notification must be accompanied by a summary proposal that will be reviewed by NIST staff to allow preparation for the evaluation phase. Additionally, NIST may contact submitters so that they can improve the quality of their submissions. Feedback to the submitters will be provided by September 1, 1990.

8. ISO is an abbreviation for the International Standards Organization.

9. American Association of Publishers Electronic Manuscript Series: *Standard for Electronic Manuscript Preparation and Markup.*

Stage 3
Detailed proposals must be received by October 1, 1990. At that time, an evaluation team consisting of NIST staff, industry and academic consultants will review submissions according to the requirements of this request. Submitters of qualifying technologies will have an opportunity to present their material to NIST in November, 1990.

The evaluation team will then select a group of technologies to participate in the proof of feasibility phase that will begin in January, 1991.

Stage 4
A final group of technologies will be selected by the evaluation team after feasibility has been shown. This group of submitters will be involved in the final evaluation phase that will include a lab trial at NIST.

NIST will announce the selected technologies along with the selection rationale in April, 1991.

If no submissions meet the requirements of this request for architecture, then NIST will consider modifications to the request not later than April, 1991.

What to Submit

Summary Proposals
Excluding figures, charts, etc., summary proposals should be no more than 10 pages in length (excluding figures, charts, photos, etc) and should include a response to each of the requirements stated in this document. Summary proposals should also contain a discussion relating to each of the key evaluation criteria, and an outline of the architecture.

Detailed Proposals
Detailed proposals should include:

1. A specification for an architecture for courseware portability and/or a specification for a neutral interchange format for courseware.
2. A detailed and complete description of the proposed implementation and demonstration.
3. A proposed documentation plan.
4. For submissions that include an actual implementation, documentation for using the implementation on two or more different hardware platforms should be provided.
5. A statement of the cost benefit for the federal government if this technology is chosen.
6. Any other materials the submitter deems relevant to this evaluation process, such as internal documentation, source code, functional specifications, etc.

How to Submit

Send submissions to:

Chief, Systems and Software Technology Division
National Institute of Standards and Technology
Building 225, Room B266
Gaithersburg, Md. 20899

Attn: Portable Courseware Project

Questions concerning this Request for Architecture should be directed to:

Dr. Larry Welsch
National Institute of Standards and Technology
Systems and Software Technology Division
Building 225, Room B266
Gaithersburg, MD 20899
(301) 975-3345

Attn: Portable Courseware Project

MS-DOS MODEL
APPLICATION PROGRAMS
IVIA TOOLKIT(IVIA Contribution)

DEVICE SERVICES INTERFACE (NPRDC Contribution)

DEVICE SERVICES (NPRDC Contribution) LAYER

DEVICE HANDLER INTERFACE (NPRDC Contribution)

DEVICE HANDLER (NPRDC Contribution) LAYER

MS-DOS

INTEL 80x86

Figure 1.

OPEN SYSTEMS MODEL		
Name	Description	Layer
Application Program Level	APPLICATION	LAYER 6
Graphic Tool Set Level	IVIA TOOLKIT (IVIA Contribution)	LAYER 5
	X - TOOLKITS	
	X - INTRINSICS	
Display Manager Level	X - LIB (LIBRARY)	LAYER 4
	X - PROTOCOLS	
Network Level	TCP IP or OSI	LAYER 3
Operating Systems Level	POSIX	LAYER 2
Instruction Architecture Level	VARIOUS HARDWARE ARCHITECTURES	LAYER 1

Figure 2.

Introduction to

Portable Courseware Standards

April 17, 1990

National Institute of Standards and Technology

Portable Courseware Standards[10]

Preface

This document provides an overview of the concept of portable courseware. It is intended to answer basic questions concerning purpose and function. The accompanying Request for Architecture should be consulted for specific technical requirements.

Introduction

The National Institute of Standards and Technology (NIST) is soliciting proposals to define and implement standards for portable courseware[11]. Portable courseware will be interoperable on a variety of hardware platforms and portable courseware developed on one authoring system will be maintainable on others.

The goal of this program is to achieve current and future interoperability, compatibility, interchangeability, and modularity for federal courseware. This should be true not only for common systems but across processors, architectures, and peripheral devices. Courseware portability can be achieved by establishing software interface and interchange standards to be used for federal courseware.

What problems will portable courseware solve?

Several commercial manufacturers offer high-performance, low-cost, interactive training hardware, but bundle these products with proprietary software interfaces. Because of these proprietary interfaces, courseware developed for these machines is not portable to others without expensive reprogramming. Additionally, differences in operating system interfaces such as those between MS-DOS™ and POSIX interfere with courseware portability.

A second problem concerns the authoring and maintenance of courseware. There are several software tools to assist courseware development. These tools, commonly known as 'authoring systems', allow non-programmers to develop courseware by interacting with sophisticated menus and forms, or by using courseware specification languages. Using these authoring systems may substantially reduce the costs of courseware by

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10. Several ideas and much of the wording for this document were taken from *Portable Courseware A Standard for Government and Industry* prepared by Systems Engineering Associates under contract to the Department of Defense. The general form of the document and some of the wording were taken from the document, *Introduction to the Concept of the Architecture—Neutral Distribution Format, April 25, 1989* of the Open Software Foundation.

11. For the purpose of this document, courseware will be taken to mean computer based interactive training software. Although hardware has a very important role in the training process, this document does not directly address hardware standards.

minimizing the participation of high-priced programming staff during the development cycle. Unfortunately, courseware developed on one authoring system often cannot be modified on another.

Courseware development and maintenance costs increase dramatically with changes in hardware, operating system, or authoring tools. Advances in hardware and software technology and market pressures encourage each of these key system components to evolve, so the costs of developing and maintaining courseware are high. Standards are needed to insulate courseware from changes in these underlying system components.

How will portable courseware standards solve these problems?

Portable courseware standards will solve the problems associated with variations in hardware and operating systems by defining standard interfaces, i.e., courseware and authoring systems will not directly interact with hardware or the operating system but will instead bind to these via standard interfaces. In particular, POSIX (with possible extensions) will provide the operating system interface, X-Windows will provide the graphical interface, ANSI C will be the *interface definition*[12] language, and other standards (such as those for CD-ROM, etc) may be needed.

The problem of authoring system independence will be addressed by defining a standard interchange format that allows for the presentation features, control flow, etc. available in popular federal and commercial systems. Where possible, data interchange standards will be used to represent text, graphics, audio, etc. The definition of an interchange format that provides true authoring system independence will be challenging but very cost effective once it is complete.

All standards that are defined to support portable courseware must be easily extensible to support the new technologies that will become available over the next few years.

What work has been done to date?

Known work in the arena of portable courseware standards has focused primarily on MS-DOS based systems. In that regard, contributions are currently available from two organizations. They are the Interactive Video Industry Association (IVIA) and the Navy Personnel Research and Development Center (NPRDC). IVIA is a non-profit organization whose members are companies actively involved in courseware hardware, software, and systems. NPRDC is the Navy's manpower and personnel laboratory, and has been designated by DOD as the main point of contact on Portable Courseware issues.

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12. The portable courseware architecture will be specified in ANSI C. This will not constrain the language that programmers use to write courseware applications.

Documentation on these contributions should be solicited from the principals. The IVIA contribution provides a high level command and interface mechanism functionality. The NPRDC contribution addressed the logical control of devices over different device classes and constitutes a lower level interface defintion. To this end, the Department of Defense (DOD) has adopted the IVIA application interface specification for training systems.

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Code 15
San Diego, CA 92152-6800

Attn: Walter F. Thode
Phone: (619) 553-7703 or Autovon 553-7703

Who will benefit from portable courseware?

The use of standards for portable courseware should provide the following benefits:

Consumers benefit by:

- more courseware platforms available off the shelf.
- increased competition among providers.
- elimination of duplicate funding of course development.
- elimination of the need to purchase specialized systems just for courseware.
- a well defined evolutionary path that incorporates the IVIA[13] standard's functionality into an open systems environment.
- preservation of investment over time and accommodation of future technical improvements.

13. IVIA is an abbreviation for the Interactive Video Industry Association. The IVIA 'standard' refers to the document titled "IVIA Recommended Practices for Interactive Video Portability."

Providers can:

- enjoy a greatly increased marketplace and installed base.
- have access to previously closed markets.
- reduce re-authoring costs by using a standard software interface to common system services.
- be assured of a clear path for the evolution of architecture enhancements to open systems technology.
- reduce stocking and distribution costs.

Why is the federal government addressing the problems of portable courseware now?

The reasons for addressing portable courseware standards are economic and practical. By providing courseware interoperability, the costs associated with converting courseware to execute on different hardware will be eliminated. Additional savings will result from not having to buy the specialized systems that are commonly required for courseware. Finally, more savings will result from economies of scale. The wider availability of courseware will result in better prepared civilian and military staff.

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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.)

The Department of Defense (DoD) Portable Courseware Project (PORTCO) is typical of projects worldwide that require standard software interfaces. This document articulates the strategy whereby PORTCO leverages the open systems movement and the new realities of information technology.

The Federal strategy for multimedia courseware is to facilitate the creation of an environment in which high quality portable courseware is available as commerical off-the-shelf products competitively supplied by vendors. The Request for Architecture developed cooperatively by DoD and NIST will generate a portable courseware system architecture incorporating standards which meet users' needs. A computer-based interactive training applications profile must be developed which, along with the system architecture, will provide the basis for identifying needed standards. NIST will then accelerate the development of these standards through established standards forums.

12. KEY WORDS (6 TO 12 ENTRIES; ALPHABETICAL ORDER; CAPITALIZE ONLY PROPER NAMES; AND SEPARATE KEY WORDS BY SEMICOLONS)
computer-based interactive training systems; courseware; courseware development; information technology; interactive training; multimedia courseware; open system environment; portable courseware; standards; standard software interfaces; training systems.

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