# 1. Introduction

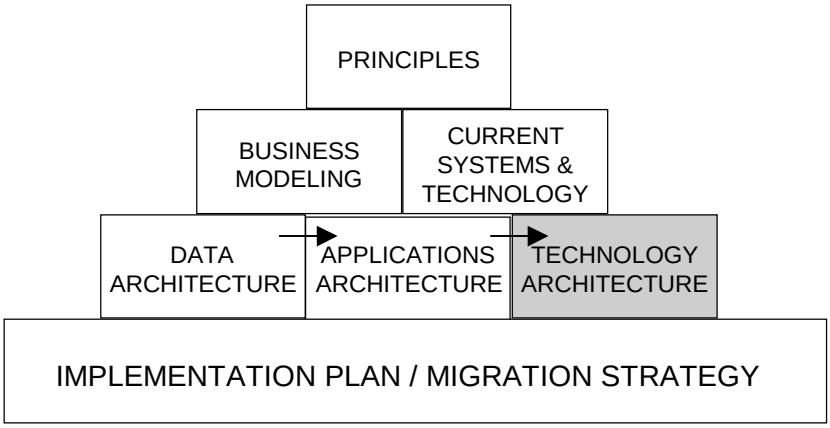
The Technology Architecture defines the technology platforms needed to provide an environment for the applications that manage the data and support the business functions. The Technology Architecture defines how information technology is deployed to support CH's planned applications. The Technology Architecture is one component of the Chicago Operations Office (CH) Strategic Plan for Information Management. The strategic planning process creates business models and information architectures that form the building blocks of CH's strategic vision. A Strategic Information Management Plan is created that provides an "architected environment" where applications development and technology deployment work in tandem to meet CH's business needs over a five-year time frame.

The Technology Architecture shall be reviewed in an annual process that defines Technology Projects needed to create and maintain a viable technical infrastructure of hardware, software, and connectivity to support the rollout of specific CH capabilities. The process may vary from year to year, depending on available resources, scope of work to be accomplished, and other factors. The Technology Architecture is entirely driven by CH's business needs.

## 1.1 The Technology Architecture Perspective

The illustration below shows the placement of the Technology Architecture within the Enterprise Architecture Planning methodology used by SC and adopted by CH to create the CH Strategic Plan for Information Management.

Components of CH's Strategic Information Planning Environment




Decisions made in crafting the Technology Architecture are based on Principles of Information Management, which are the basic tenets the CH organization follows to conduct information management activities. Standards appropriate to specific

technologies are documented in the detailed core of this report, the Technology Positioning Statements.

## 1.2 Overview of the Technology Architecture

The CH Technology Architecture is used to accomplish several goals within the Information Management:

- To provide the framework for selecting and deploying new information technologies
- To assure technology interoperability to support data sharing and exchange in a secure environment
- To provide guidance for CH's future technology infrastructure
- To aid in planning for technology obsolescence.

The two primary components of the Technology Architecture are the Business Systems Architecture and the Technology Positioning Statements.

- The *Business Systems Architecture* reviews the configuration of the technology projects as they are used by CH personnel and by other information systems.

- The *Technology Positioning Statements (TPSes)* examine in detail the various components of CH's current technology baseline and compare them with foreseeable technology trends near-term and long-term. These statements are used to help direct the procurement and deployment of information technology components.

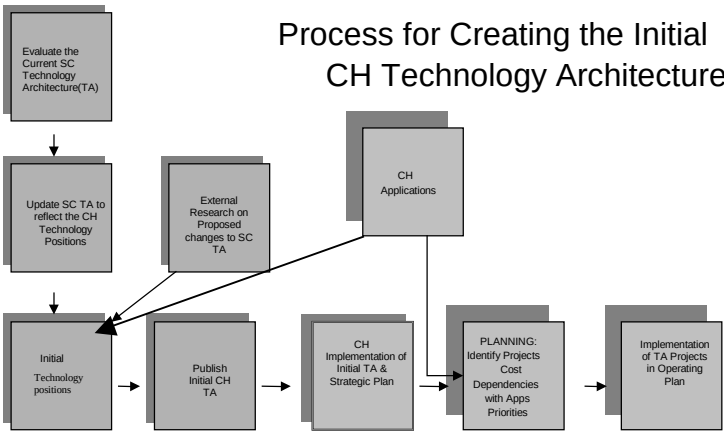
## 1.3 Objectives and Scope

The scope of the Technology Architecture is restricted to the technologies over which CH has complete or partial control. It does not address areas outside CH.

## 1.4 Background

The initial Technology Architecture is a definition process to begin the implementation of the Strategic Plan for Information Management. This component of the strategic plan provides a technological perspective to the process to align technology and supporting infrastructure to implement the rest of the plan. This component also identifies the infrastructure standards needed to ensure the principles are met and the applications will be supported in a cost-effective manner.

## 1.5 The Technology Architecture Process




Current CH information technology covers a wide spectrum of elements, such as desktop computers, servers, peripheral hardware devices, end-user software, remote-access devices (Virtual Private Networks VPN), infrastructure software such as database systems, network hardware, programming languages, and many more. In order to assure the most thorough coverage possible, CH has established a process that includes:

- Taking the proven success of SC to start with
- Researching and articulating CH's technology positioning.
- Proposing Technology Projects.
- Presenting the proposed Technology Architecture as part of the CH Strategic IM Plan to CH Management for review and approval.

Updating the Technology Architecture will be a cooperative process involving TAS-IAS management and technologists, representatives from Operations Office organizations, SC-621 representatives, Program Offices, and the CH Management Council. The process is driven by the need to include as many CH representatives as possible to ensure support to all CH.

### 1.5.1 Highlights of the Technology Architecture

- The Technology Architecture shall focus on strategic issues. As an architecture-based process, the Technology Architecture must be primarily oriented to a strategic vision, as well as dealing with tactical concerns. The strategic-planning issue demands continuing attention to assure that long-term technological concerns are kept clearly in view.

- From the collaboration in the development of the IA for CH, the Technology Architecture is based on the same format and content as that of SC. The differences are the actual positions in the architecture.

# 2. Business Systems Architecture (BSA) and Technical Infrastructures

## 2.1 Overview

The Business Systems Architecture (BSA) represents the point at which the applications meet the technology infrastructure that supports CH's computing and communications functionality. The IM principles provide the basis for the BSA and support the alignment among technology elements and business needs (applications).

Alignment means providing a technical environment based on standards and principles that provide all CH users with access to a range of corporate-level and local CH capabilities that operate easily with one another. It aims for cost/benefit maximization and use of industry standards in the technical environment.

On a technical level, alignment means that standards are followed to ensure that technologies support integration and inter-application compatibility. The concept of alignment encompasses all technology elements in the CH environment, as well as file formats, programming conventions, the multifunctional expectations of messaging.

### 2.1.1 BSA Specifications

The BSA is aimed at specifying the technology infrastructures that will be made up of the technology components described in the Technology Positioning Statements and that meet CH's Security Schema. These infrastructures are installed to support specific architected applications. In some instances the connection between a particular technology and one or more specific applications is obvious, but in others the link is only indirect and not readily apparent, so the connections of technologies to user activities will be noted wherever appropriate.

The following paragraphs and diagrams summarize the near-term, or tactical, portrayal of CH systems in the architected environment, along with a high-level view of the supporting hardware. These elements are based on the Technology Positioning Statements as summarized above and on the CH Technology Projects planned.

The most apparent connection of technologies to specific business needs can be seen in the technologies that are required by individual development projects, and these linkages of technologies to projects are noted in this section. Hardware components are also a highly visible component, so there are descriptions of the "typical" CH user, specialty, and developer workstations, and network-based computing equipment, specifically servers. Similarly, the networking infrastructure is summarized according to the dominant types of connectivity. Finally the framework for managing these technologies is described.

## 2.2 Technology Projects Linked to Applications Architecture

Technology must be implemented according to explicitly stated business needs. This information architecture effort has assembled a complete statement of the proposed technology projects and their business justifications, as linked via the application development processes currently in operation. As a result, the business foundation for CH's technology projects shall be made clear.

### 2.2.1 Technology Projects Based Directly on Business Needs

The architecture process has specified several technical capabilities that are required to support a comprehensive architected information system for SC and CH. In order for these capabilities to be implemented, CH must first document the technological infrastructure that will support them. Applications cannot be developed or run separately from their infrastructure.

### 2.2.2 Technology Projects Driven by General Requirements for Infrastructure Support (Indirectly Linked to Business Needs)

Three projects are essential to the technical support of daily operations and of other technological elements. They provide the underpinnings for high-speed data communications, high-performance processing, reliable transactions, and other essentials of the data- and processing-intensive operations that the new SPA applications will demand. There are no explicit architected applications that depend directly on these capabilities. Nonetheless these technology projects form a foundational behind-the-scenes structure that is needed for all the explicitly stated technology projects to be operational.

## 2.3 Hardware and Equipment Configurations

The hardware elements of CH's architected systems exist as computing platforms on which CH users are now and in the future will be doing their work, and on which the network will run. The following sections describe the characteristics and estimated capabilities for the hardware configuration classes. These "model" patterns for computers and networks are based directly on the technology projects and their technical requirements, which are in turn based on the business needs of CH as expressed in the SPA-based Applications Architecture.

### 2.3.1 Workstation Configuration

The computer that functions as the office-based workstation used for most users' access to most information functions, will be the "primary user workstation system." Through these machines users will accomplish their information processing tasks while at CH offices, such as electronic mail, database operations, and word processing.

#### 2.3.1.1 The Typical Workstation

The typical workstation on the user's desktop will be specified by a “standard image”, which specifies a combination of hardware and pre-loaded software that adheres to the CH Technology Architecture and is easily supportable by CH contracted technical support staff. Multiple “standard images” may be required to handle the requirements of various components of the CH user community, but all will adhere to the mandates of the CH Information Architecture. Software or hardware that are not included in a standard image will be available from the CH Help Desk or will be accessible through menus and loadable directly from the CH network. The technical details, drawn from the Technology Positioning Statements and the Technology Projects, would appear in broad outline as follows:

The user's desktop will be consistent with the most recent technology in conformance with CH refresh policy. Other peripherals will include at least a 100 MHz PCI bus, a 17inch SuperVGA or flatpanel color monitor, a sound system with sound interface card and speakers, and a dualspeed SNMP-capable network interface card (NIC) capable of running at 100 Mbps or Gbps. Additional specifications can be noted in the TPS titled, “Desktop – Hardware – Workstation.” The operating system of choice for CH will be a Novell NetWare/Windows NT hybrid. Access to network OS's will be available through native Novell NetWare NDS server connections.

The desktop machine will run Microsoft Access as the standalone or small workgroup database system. Workgroup services will include collaborative services available through Microsoft Exchange email and packages that offer whiteboard or applicationsharing, along with calendaring and scheduling. Authoring tools for the foreseeable future include the Microsoft Office suite (Microsoft Word, Microsoft Excel, Microsoft PowerPoint).

Security will consist of OS and applicationlevel security features, McAfee Antivirus software, backup of local disk data to CH servers, some level of data encryption during network transmission, and where needed the use of digital authentication together with Smart Card technologies. Additional security features will be implemented in accord with the CH Cyber Security Program Plan (CSPP).

Enterprise services will include all CH-wide business applications as well as document management software. Infrastructure directory and access control services will be provided by the Novell NetWare NDS operating system on network file servers. Electronic mail infrastructure services are supplied by the MS Exchange system. Systems and network management will be supplied by networkbased software and SNMPcapable network interface cards (NICs). Enterprise network support will consist of Category 5, Category 6 or fiber optic cabling, along with NICs handling multiple protocols and 100 Mbps rates.

The conceptual diagram of such a machine might look like this:

| NEAR-TERM CLIENT REFERENCE MODEL: OFFICE WORKPLACE | |
|---|---|
| ***SOFTWARE INFRASTRUCTURE ELEMENTS*** | |
| **Operating System:**<br>Microsoft Windows 2000 | **Infrastructure Services:**<br>Novell NetWare NOS, MS Exchange E-mail |
| **Database Management System:** | **Workgroup Computing:**<br>MS Exchange E-mail and White Board/Application Sharing |
| **Security:**<br>Password and Network Data Encryption, OS- and Application-based Security Features, Backup of Local Storage to Servers, Digital Authentication | |
| ***HARDWARE/NETWORK INFRASTRUCTURE ELEMENTS*** | |
| **Workstation Hardware:**<br>Pentium III-class (Slot 1) 550 MHz CPU,<br>256 MB SDRAM, 20.0 GB local disk space,<br>100 MHz PCI bus, 17-inch monitor | **Enterprise Network:**<br>Category 5/Category 6 Wiring for 100 Mbps, SNMP Network Interface Cards (NICs) |
| **Systems and Network Management:**<br>Network Software to Manage SNMP NICs | |
| ***SOFTWARE PRODUCTIVITY ELEMENTS*** | |
| **Authoring Tools:**<br>Desktop Packages (MS Office Suite, etc.), Workgroup Applications | **Enterprise Services:**<br>CH Business Applications, Document and Image Management |

**Figure 2-1. CH Workstation Configuration**

#### 2.3.1.2 Developers' Workstations

The workstations that CH's contractors will use in developing customized software, will have higher performance and storage requirements than the desktop systems available to the general user. Developer machines must be able to develop, test, debug, and perform all other operations essential to providing the best possible service to the customer.

### 2.3.2 Network Server Systems

In addition to user workstations, the CH information system infrastructure encompasses a great variety of network servers for file and print services, database access, and special-purpose machines to handle remote access or other services less widely used. CH will specify the configuration of each of these high-end machines according to their individual functions, so that the detailed characterization of each machine will be omitted here. However, the following generalities sum up their logical functions and their technological appearance.

The hardware will be high performance processing chips forming the basis of machines with very large memory and disk storage capacities. Disk systems will feature high levels of redundancy and on-the-fly replaceability ("hot-swappability"). The network interface cards (NICs) will offer high-speed data transmission and will support multiple transmission protocols. Category 5, Category 6 and fiber optic cable will connect all such machines to the network. The OS will be Microsoft Windows 2000 for all desktop equipment, except where proprietary system requirements demand otherwise. A hybrid of Novell NetWare and Window NT will be used for servers. Other system-level features will include several security functions that interact directly with the OS, including encryption and firewall protections, and centralized management of network functions as specified in the pertinent Technology Positioning Statements.

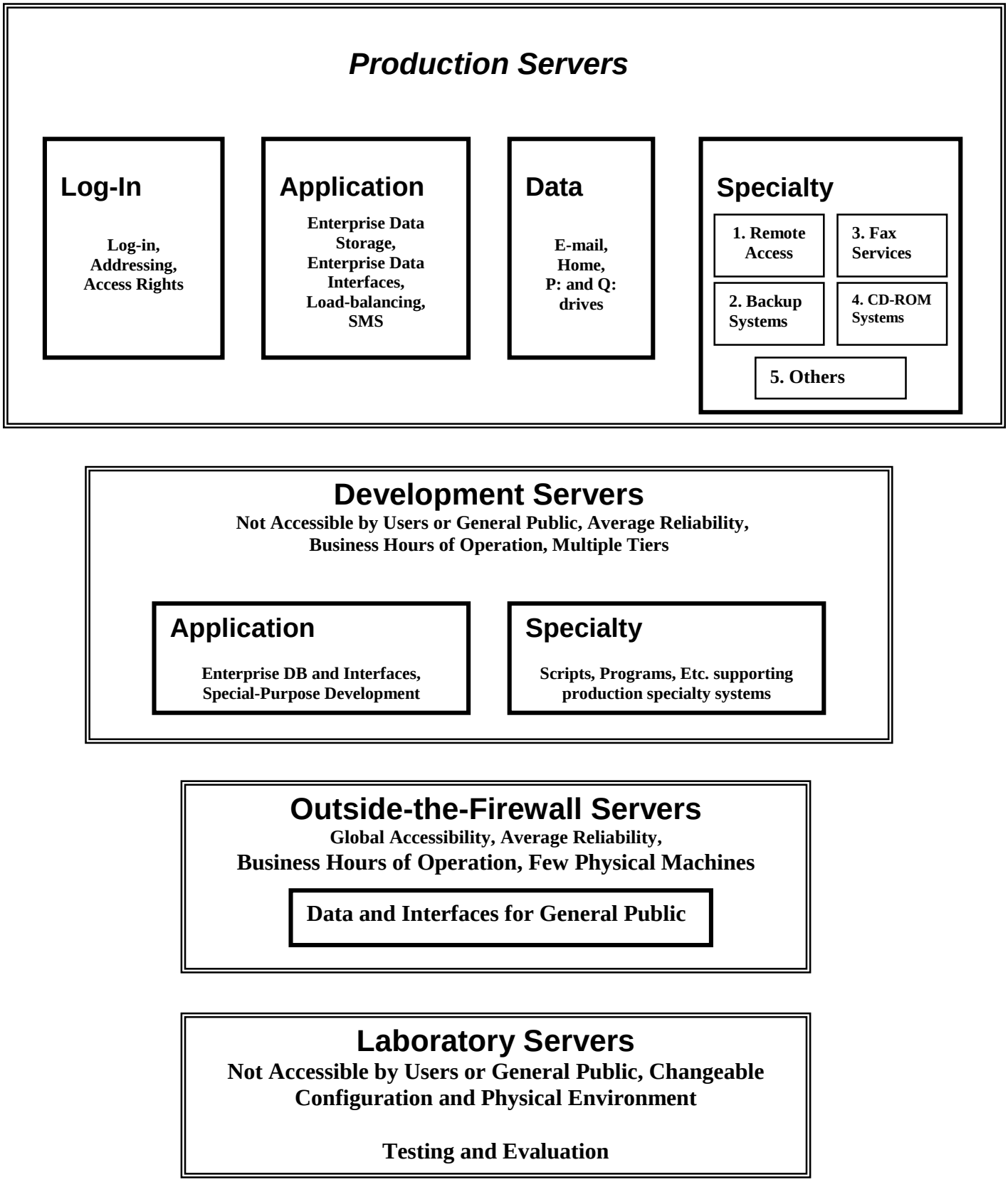
To some degree the network servers will be standardized in platform and configuration. While this is not possible in every case, standardization helps to facilitate several aspects of network operations. Monitoring of system performance is easier when one monitoring system observes multiple machines, and performance management possesses meaningful data when comparing the performance of one machine to another. CH is continuing its reliance on Compaq server systems and bringing in standardized equipment as much as possible for both new and replacement acquisitions.

#### 2.3.2.1 Conceptual Layout

The conceptual or structural layout to be implemented for the network servers is detailed in the sections below, but the following diagram provides a high-level perspective on this detail. The actual server machines are not important in this overview, since it is the structures of network services that are central to the

architecture of the networking equipment, rather than the physical or electronic placement of particular machines.

# Figure 2-2. CH Server Configuration



The above diagram depicts both the arrangements of servers by category and by domain.

- The greatest complexity resides at the production level, which directly supports the largest number of users and applications and must be available continuously. Production therefore requires the most elaborate arrangement of equipment by functional category.
- The development level is less complex, since it supports the CH community at a different level rather than directly, and is of necessity subject to potentially negative impacts of development activities.
- The data available on the domain outside-the-firewall or DMZ is not in any way critical to CH users performing their work, and hence may consist of only one or two machines with little or no backup or other redundancy. The services provided on such equipment can readily be reconstituted in case of equipment failure or intruder tampering.
- The test laboratory will constantly be in flux, as support personnel set up, take down, connect, or disconnect various kinds of equipment. This environment will not be linked with the CH network in any way, in order to afford the production and development environments complete protection from test and evaluation activities.

#### 2.3.2.2 Network Server Functional Categories

With the number of server machines connected to the CH network, it has become essential to group them into specialty functions, rather than simply to add further general-purpose servers. The four tiers, or categories of server functions, are login servers, application servers, data servers, and specialty systems.

Login Servers.
The first tier of network servers will handle login activities. This group of services includes not merely the start-of-day network login, but also provides ongoing support. It handles the dynamic assignment of TCP/IP (Internet) addresses to optimize the limited pool of IP addresses allocated to CH, manages access rights to various types of data and resources on the network, and supports the transport of network data packets.

Application Servers.
The second tier of network equipment will be home to CH's enterprise-wide databases such as LIMS, CHRIS, and electronic mail. Known as application servers, this set of systems is arranged in a multi-tier (client/server) configuration, with the data storage established on one set of machines and the processing of that data set up on another set. This arrangement provides significant improvement in system availability and fault tolerance. It also facilitates load-balancing, speeds up data retrieval, and opens up the architecture for more readily delivering data to alternative interfaces such as World Wide Web browsers without significant redesigns of the database system. The application server group will also handle automatic rollout and updating of standard software installations on users' workstations, along with other functions of Novell Zenworks.

General Data Servers.
The third tier of network computers will handle user-generated data that falls outside of the formal systems of enterprise-wide data noted under Application Servers. This type of data includes general-purpose documents and files such as those now found on home directories (the H: drive). The interfaces to these data areas may be handled by drive letters, as they are now, to promote ease of use, but access may be broadened to include entry points from the user's Web browser, such as pre-set hypertext links, pre-configured bookmarks, or options available from a right-click on the mouse.

Specialty Network Machines.
Various specialty functions remain outside of the scope of activities of the three general types of servers noted here. These functions will be supported by certain kinds of special-purpose equipment on the network.

- Remote access functions will be handled by several disparate systems, comprised of wireless access systems, dial-up access, and connections over TCP/IP (Internet), all controlled by DOE-based equipment to assure valid usage and prevent unauthorized connections.
- CH's back-up systems are invisible to the user community, but tape back-up and off-site storage is fundamental to good system reliability and disaster recovery. These specialty servers work in addition to the "live" back-up systems that are built into the three-tiered structure of login, application, and data servers noted above.
- Other specialty functions also exist, such as paging, CD-ROM services, and certain less common types of file storage and printing activities. CH will always have a need to maintain certain specialty network machines to address these and similar needs.

#### 2.3.2.3 Network Server Domains

The domain function describes which services are available to what points on the network. Most users do not need immediate and unrestricted access to the work-in-progress of programmers, for example, and in fact such access would likely be harmful to the efforts of both parties. The use of domains helps provide better security and improves services as hardware and software systems can be set up and tested thoroughly before being deployed to general users. The Three domains are development, production, and outside the firewall or DMZ.

**Development.**
Work that must be prepared on network systems often holds the potential for affecting the performance of other network operations. The use of the development domain permits development to be electronically isolated from the systems that users depend on for their daily work.

**Production.**
Systems that are in operation or that have been proven reliable are placed into the production domain. This is the area of the network to which CH users have access while using the network from their offices.

**Outside the Firewall (DMZ).**
Certain information managed by CH needs to be made available to the general public. Because of the great risk posed by hackers and other intruders to systems that are open to the Internet, a separate domain outside the DOE and CH electronic firewall systems allows CH to share its data with the outside world, while keeping development and production fully protected.

Strategic Directions for CH Network Infrastructure
The current system of servers and other network support equipment was originally designed for use by in-house workstations, with the CH community and its office-based equipment as the primary and nearly exclusive group of users. The industry has been changing, however, and the last two years have now made the direction of that change quite apparent. Remote access dominates all development scenarios, whether users access their data and applications via the World Wide Web or direct dial-up to the CH network.. As a result of this market direction and because of statements of the users in CH themselves, the IT support group is now laying plans to restructure its network infrastructure to more effectively and securely support the demands for the provision of extensive information services via remote access to both the CH community and to its customers.

Plans are now being made to consider reorganizing the infrastructure so as to modify the current functional categories somewhat. While applications and data would be managed in separate logical areas as the current structure has them, the login-server function would be replaced by two layers of functionality, one performing load-balancing to support the projected large user base, and another presenting front-ends to these remote requests and performing as Web hosts. In this configuration it is the presentation layer that will issue calls to the application layer. In support of the data layer, in turn, an additional service layer will provide redundancy and reliability, effectively working as a backup and disaster recovery system. Each of these five layers (load-balancing, presentation, application, data, and backup) is comprised of additional internal components, each representing specialization’s of functionality.

## 2.4 Network and Connectivity

The connections by which computers and other equipment communicate across the CH network can be divided into three groups. These represent the three major connection systems in use both within the CH network and to DOE. The backbone consists of both cabling and signal-routing equipment, running throughout building 201 into the telephone closets on each floor. Second, the DS1 connection functions as a private network provided by the ANL telephone services group to CH sites. Finally, all

workstations are connected to the network in the telephone closets over 100 Mbps Cisco Switch connections via Category 5 wiring.

### 2.4.1 Fiber Optic Backbone

The fiber optic system that forms the network backbone uses a low-level software protocol, standard across DOE sites. This is an industry standard for transmitting network data across a variety of cabling systems, including fiber optic cable. Fiber optic cabling in and of itself is theoretically capable of network speeds thousands of times higher than CH's current 100-Mbps connections, but the current speeds are dictated by cost and availability constraints that affect routers, NICs, and other associated hardware components. Some segments of the CH network, however, will be running in the near term at speeds well above the 100 Mbps. The equipment installed at CH is industry-standard issue, generally available in the marketplace for connecting multiple network segments. Higher-capacity connections cost substantially more and are often custom-manufactured rather than mass-produced. There are also capacity limitations on the network protocols and software standards that control transmission throughout a network.

### 2.4.2 Category 5 Workstation Wiring

Workstations are connected into the network via network interface cards (NICs) and cabling that leads from the desktop systems to the network Cisco switches in the telephone closets. This cabling is copper wiring conforming to category 5 wire standards. Switches in the telephone closets in turn provide the connection to the fiber optic backbone.

Current CH workstations connected with Category 5 wiring all run at 100 Mbps, a major advance over the bandwidth of the previous cabling system. This boost in capacity will assure that all workstations will be able to communicate with the network at speeds that will handle the projected growth in graphics-intensive applications and full-motion video.

# 3. Technology Positioning Overview

The Technology Positioning Statements form the basic description of CH's current technology baseline and a portrayal of the directions it must take in order to support the applications that will arise from Application Architecture, Data Architecture, and Business Modeling. The structure of these statements can be called the "vision" of CH's technology. The direction that CH takes technologically and the reasons for that direction are stated here. Following that statement is a set of summaries of the 10 categories and 40 individual technology elements.

## 3.1 Vision: What is Technology Positioning?

The first major effort in the Technology Architecture work is "technology positioning." In a series of detailed statements, technology positioning formally describes the framework which CH uses to determine which technologies will be implemented, according to need, to support the applications specified by the architecture process over the strategic time frame. There are 10 technology areas containing 40 specific technologies addressed by CH's Technology Positioning Statements (TPSes).

### 3.1.1 Structure of Technology Positioning Statements

The resulting technology positioning statements all are laid out in a specific structure. Each one contains a set of vision statements, a set of applicable standards, and a set of execution statements. The ***vision*** statements are oriented toward projected future roll-outs in the industry:

- **Current Environment:** Technologies that CH uses today.
- **Tactical Deployment 3-27 Months:** Technologies that CH may use in a near-term, tactical time frame, beginning with the publication of the Technology Architecture report.
- **Strategic Direction 2-5 Years:** Technologies that CH envisions using in the long-term, strategic time frame, which are forecast for consideration in more than two years.

- The ***standards*** statements are oriented toward protocols, standards, and directives that are followed in the larger computing community:

  - **International, National:** Acknowledged formal standards or standards organizations that are recognized across the nation or the world.
  - **Industry, de Facto:** Widely used protocols, standards, or other systems, whether proprietary or cross-vendor, with extensive market penetration and industry utilization.

- **DOE:** Widely used protocols, standards, or other systems, whether proprietary or cross-vendor, with extensive utilization within the Department of Energy.
- **CH:** Widely used protocols, standards, or other systems, whether proprietary or cross-vendor, with extensive utilization within the Chicago Operations Office.

- The ***execution*** statements are oriented toward support concerns and interactions with other CH systems:

  - **Retirement:** Obsolete or unsupportable technology elements for which a viable alternative is available, to be removed from service in a tactical time frame (three to 27 months).
  - **Containment:** Technology elements that are not CH's primary technologies, and consequently are not promoted for use within CH. Support for these technologies will be described by a Service-Level Agreement on a case-by-case basis.
  - **Mainstream:** Primary technology elements that are currently, and in a tactical time frame, fully supported within CH. These technology elements are supported by, or are targets for, Service-Level Agreements..
  - **Feasibility Target:** Technology elements that may be of significant benefit to CH and thus may warrant creating a pilot project.
  - **Emerging:** Technology elements with potential value for CH that CH is positioned to use, if the need arises.

This not only ties technologies closely to specific strategic architectural goals, but it also helps assure that technology elements are brought in explicitly to support CH-required applications and data.

## 3.2 Topics Reviewed

Forty separate topics are covered in the Technology Positioning Statements, categorized into ten general technology areas.

## 3.3 CH Technology Position Statement Summary

Below are summaries of the Technology Positioning Statements (TPSes) developed for the Technology Architecture. Each boldface title below corresponds to the title of a TPS statement, and the description in parentheses following the title corresponds to the subtitle of that TPS. The italicized sentence introducing the descriptive paragraph briefly summarizes CH's architectural position for the given TPS topic.

### 3.3.1 End-User Tools

The set of end-user tools encompasses all applications used across the enterprise, including commercial off-the-shelf (COTS) software, to facilitate the handling of data by the business user. These end-user tools include word processors, applications for graphical, multimedia, and numerical manipulation, and various special-purpose functions. The term “manipulation” here covers a broad range of activities, including creating, preparing, editing, importing, exporting, calculating, merging, translating, and scanning data that is pertinent to the particular type of end-user application tool.

3.3.1.1 **End-User Tools -- Productivity Elements -- Document Processor** (Applications manipulating the contents of text documents and analogous material)

CH plans to install MS Word 2000. CH will use Java/C++ for Web-deployed word-processing in the long term using Java/XML. The architectural direction of CH and of the Web industry generally is toward standards, as defined by the World Wide Web Consortium (W3C). Web-based deployment of all productivity applications is central to CH's long-term planning.

3.3.1.2 **End-User Tools -- Productivity Elements -- Authoring Tools and Suites** (Ensemble of applications interacting cooperatively to manipulate electronic data and documents)

CH plans to adopt MS Office 2000 and plans for Web-based deployment of authoring functionality in the long term. Suite products offer substantial the cost savings of buying desktop software in suite form rather than as separate packages

3.3.1.3 **End-User Tools -- Productivity Elements -- Project Management** (Applications manipulating detailed project plans and time lines, supporting charting and graphing capabilities)

CH uses MS Project for Web-deployed capability in the long term. The market leader is MS Project assuring compatibility with project management requirements.

3.3.1.4 **End-User Tools -- Productivity Elements -- Spreadsheets** (Applications manipulating data in spreadsheet format to perform numerical analysis)

CH uses MS Excel with long-term plans for Web deployment.

3.3.1.5 **End-User Tools -- Productivity Elements -- Graphics** (Applications manipulating graphical and photographic images)

*Amid a diversity of user requirements, CH uses those applications that comply with Java standards.* The plethora of graphics applications currently in use is needed to fulfill various specialized functions, required by the variety of tasks conducted by CH users (presentations, complex scientific/engineering diagrams, charts, photographs, etc.). New procurements will be Java-compliant to assure their ability to be integrated

with CH's architected applications. Long-term needs include a graphics browser with thumbnail viewing, a robust graphics search engine (analogous to Web-based search facilities), and planning for migration of Web graphics to Scalable Vector Graphics (SVG) for full integration with multimedia services and Extensible Markup Language (XML).

3.3.1.7 **End-User Tools -- Remote Access Client** (Client services and software for access to the CH network via diverse platforms (including laptops and PDAs) from remote sites such as home, travel, etc.)

CH will employ Virtual Private Networks (VPN) in the near future to provide for the remote access requirements of the user community. VPNs provide the required adequate security necessary to allow for remote platform computing. CH has deployed multiple access points to its network via dial-up network, ISDN, and TCP/IP, with full Windows NT support. The increasing variety of remote platforms, such as laptops, pagers, Unix-based workstations at laboratories, personal digital assistants (PDAs) including Palm devices, and handhelds with Windows CE operating system, is driving CH toward Web-based solutions. While many architected CH applications require some level of remote access, the sensitivity of their data poses significant concerns about security, and OS compatibility problems may impact operational reliability.

3.3.1.8 **End-User Tools -- Workgroup Computing -- Collaborative Services** (Services including videoconferencing, calendar and scheduling functions, collaborative editing, and document sharing that support electronic mail and workflow services and enable multiple users to interact with a variety of applications and data types)

CH will rely on MS Exchange and other standards-based near-term solutions and targets a full-function integration as the strategic goal. The current piecemeal solutions to workgroup computing are now handled with two different approaches, one for group conferencing and one for desktop conferencing. These will be replaced by systems that are robust, comprehensive, and better aligned with other technologies. Group (multi-point vs. one-to-one) videoconferencing now functions acceptably, but desktop-to-desktop conferencing remains a central goal for true collaborative services. CH uses desktop conferencing solutions on a client-to-client basis for document sharing and application sharing. These include solutions based on customized front-ends that are based on CH's MS Exchange database. Videoconferencing, the current group conferencing system, remains central to CH's general services. The full deployment of real-time audio, video, and application-sharing collaborative capabilities depends heavily on infrastructure solutions to the current problems of quality product availability and control of bandwidth usage.

CH will also investigate desktop video conference capabilites for use internally and with other DOE sites.

3.3.1.9 **End-User Tools -- Workgroup Computing -- Workflow** (Software and services for automated structuring and scheduling of work to conform to actual business processes, with the support of collaborative services and electronic mail)

CH adheres to Java-based systems that integrate workflow and collaborative services as a strategic goal, along with development of Web-deployed systems to permit platform-independent use of these tools. Several vendors now offer workflow products based on Microsoft Exchange. Most packages require additional customizing after procurement. Strategically CH is moving toward extensive migration of its software systems to the Web, and the development of workflow systems is included CH's planning. CH will examine Java compliant/MS Exchange-based workflow services and bridge these systems to CORBA-standard systems to communicate with other agencies within the Government.

### 3.3.2 Desktop

The desktop is the topmost level of a computer system, the point where users interact directly with their information systems. The components of the desktop include the monitor, keyboard, mouse, disk drives, CPU, printer, and other peripheral equipment. Desktop machines typically have lower performance requirements than network computers or other special-purpose equipment. The applications that permit users to view and modify data appear to them on the desktop system. Desktops are owned, configured, and controlled by CH, in contrast to remote-access platforms.

3.3.2.1 **Desktop -- Operating System** (Operating system software for the general desktop office computer)

CH commits to Windows NT and in the long-term targets 64-bit OS migration.

3.3.2.2 **Desktop – Hardware – Workstation** (All hardware components that comprise office workstations, including CPU, keyboard, disk drives, monitor, sound system, network interfaces, and other devices)

CH upgrades to high-end workstations tactically and targets 64-bit USB machines with broad-range capabilities strategically. The foundation for the planned rollout of Windows 2000 during late 2000 was laid by upgrading all CH desktop workstations during the current fiscal year. As a result, the current minimum desktop machine contains a 400 MHz Pentium II CPU with 128 MB RAM, 8.4 GB disk capacity, and a 100 MHz PCI bus, connected to the network at 100 Mbps with an SNMP interface to permit network management functions. Many workstations are built to even higher and faster specifications.

3.3.2.3 **Desktop – Hardware – Printers** (Local desktop and network-based printers and multi-function devices with printing functions)

CH is pursuing a printer consolidation effort within building 201, in the interest of providing a cost effective manner to manage network resources and still provide a good print service for the user community.

### 3.3.4 Application Toolset

The tools for customized system development and delivery include the programming languages themselves, the tools for designing data systems in the analysis phase of a development project, and the automated systems that govern the roll-out of both customized and commercial software to CH users.

3.3.4.1 **Application Toolset – Programming Languages** (Programming languages used for development of customized applications for use on client platforms, for use both in-house and remotely)

CH targets Java for alignment with standards, along with Internet-programming languages (HTML, DHTML, XML, and scripting languages) as both short- and long-term goals. The segregation of programming languages into two categories (and two TPSes) – one for desktop applications and another for Web programming – is no longer sensible in the face of extensive Web-deployment of most new software development.

3.3.4.2 **Application Toolset -- Supplementary Developer Tools** (Software used to automate routine functions in the development of applications)

CH uses Web-based development support tools including the HTML/Java. The long-term direction is aimed at movement toward the 64-bit development environment, together with support for Java and XML development.

### 3.3.5 Infrastructure Services

Encompassing a variety of technologies hidden from user view, the software and systems of infrastructure services keep the systems running that make a network possible.

3.3.5.1 **Infrastructure Services -- Network Operating System** (Operating systems for network file servers, print servers, and special-purpose network servers)

CH moves toward its 64-bit implementation. Novell Netware and NT now function not only as the file server platform, but also as the platform for e-mail (MS Exchange), Web hosting, and other services. Upgrades to Microsoft Windows 2000 (formerly Windows NT), will be implemented at the workstation level in calendar year 2001, the Novell NetWare NDS for NT will be used for a common Directory services infrastructure.

3.3.5.3 **Infrastructure Services -- Directory Services** (Services supporting several network-wide services, including security, user access rights, messaging, and remote access)

CH will continue to use Novell Directory Services expanding to NDS enterprise services.

3.3.5.4 **Infrastructure Services -- E-Mail -- Enterprise E-Mail** (Enterprise-wide electronic mail system supporting workflow and collaborative services)

CH commits to MS Exchange, with a long view toward integration of workflow and collaborative services in Java compliance. CH client services for e-mail are expanding and now include multiple production methods of accessing one's own MS Outlook mail account: desktop, application server (remote dial-up), Web, and PDA.

3.3.5.5 **Infrastructure Services -- E-Mail -- E-Mail Gateway and Backbone** (Systems for e-mail conversion and transmission across disparate mail systems and platforms)

The Microsoft Exchange Server with the Exchange Relay box provides mail conversion services to and from external mail systems, such as X.400 or SMTP over the Internet. The same e-mail infrastructure remains the short-term goal, while long-term CH will be moving toward unified messaging (multiple e-mail protocols, faxes, voice mail).

3.3.5.2 **Infrastructure Services -- Remote Access** (Back-end services providing access to CH network and information services from remote sites such as home, travel, etc.)

3.3.5.3 **Infrastructure Services -- Web Information Delivery** (Back-end systems supporting delivery of enterprise information and applications via the World Wide Web)

CH commits to IBM's WebSphere, with appropriate security, and a similar Windows 2000 workstation strategic target inclusive of XML. The current environment for presenting CH data across the World Wide Web is based on IBM WebSphere, together with security provided by a proxy server and other firewall services. The long-term direction is to configure a standard core of Web infrastructure systems, running exclusively on Novell NetWare systems.

3.3.5.4 **Infrastructure Services -- Utilities** (Services for performing special functions at the desktop, including browser plug-ins, Internet transfers, CH directories, file compression, and data format conversion)

CH uses multiple utilities in compliance with the CH architecture. The major CH utilities compress files, perform Internet file transfer (ftp), display file contents quickly, encrypt file contents for a method of security, and facilitate Internet multicasting. Browser plug-ins facilitate multimedia and other services via the Web. Adobe Acrobat Reader is used in containment status to permit CH users to read Web-based PDF files. Utilities generally follow no standards, and the acquisition of new utility services is done in accord with the published CH Information Architecture.

3.3.5.5 **Infrastructure Services -- Streaming Media** (Services for presenting multimedia data to users at the desktop, including live and recorded video and audio feeds)

### 3.3.6 Enterprise Network

This category addresses the network hardware systems at the lowest infrastructure level, the physical equipment that transfers the computer signals and the physical wiring that actually conducts the signals.

3.3.6.1 **Enterprise Network -- Physical Network -- Switches/Routers** (Hardware for interconnection of workstations to the network and of multiple network segments)

CH provides 100 Mbps service to users' desktops connection on the network itself, and it targets VPNs, network redundancy, and 1 Gbps on the backbone with multi-protocol support. CH supports 1 GBPS to the general user's workstation, connects access switches to the network at 1 GBPS and core switches at 1 GBPS, and provides Virtual LAN connectivity where required. Near-term goals include Virtual Private Networks (VPNs) within the network, redundant connections to the network from servers and switches, and equipment support for multicasting. Strategically CH is aiming at 1 gigabit per second (1,000 Mbps) connections among switches and to the desktop. Multiple protocols will also be supported by the new equipment to accommodate the various pertinent industry standards.

3.3.6.2 **Enterprise Network -- Physical Network – Wiring** (Physical media providing network connections)

CH installs only Category 5 copper cabling to workstations and fiber optic to network equipment. In support of desktop connectivity at 100 Mbps, only Category 5 wiring is in use for workstations. Network server equipment is all wired exclusively with fiber optic connections in support of the strategic direction toward 1 Gbps networking. The tactical time frame envisions further deployment of physical connections with Category 5 and Category 6 copper cabling and fiber optic cabling, according to their purpose.

### 3.3.7 Systems Management

This category addresses automated control of the network and the computer systems connected to it. These topics include automated software tools working in conjunction with built-in hardware features, like the hard-coded network addresses in the network interface card (NIC) in each user's workstation or in routers. These tools track usage metrics, detect hardware failures and security problems, provide automated solutions where possible, and alert any on-call support personnel for situations not subject to automated control.

3.3.7.1 **Systems and Network Management** (Mechanisms for network management, software distribution/tracking, asset management, problem tracking/escalation and resolution, and desktop configuration management)

### 3.3.8 Security

Security of information on a network includes its accessibility, reliability, and prevention of release to unauthorized persons or requestors. Security must be in place at several points, including the desktop with its vulnerability to viruses, backup of local workstation data, network security and monitoring of network accesses, application-specific access control, and encryption of data transmissions.

3.3.8.1 **Security -- Desktop Computing -- Virus Protection** (Software for desktop-level protection against viruses and unauthorized access)

CH targets a unified security product long-term based in the operating system, though tactical alternatives are being examined, such as scanning all e-mail attachments. Viral defenses are quite platform-dependent. Until a reliable OS-based system is available, CH plans to continue with McAfee Antivirus in the short term, as well as scanning all incoming e-mail and attachments to e-mail for viruses before making the messages available to users. The long-term goal is a unified security product that will address all facets of this general category, including workstation backup, virus protection, and network and transport security. All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

3.3.8.2 **Security -- Desktop Computing -- Data Backup and Redundancy** (Services for data storage, retrieval, and loss prevention)

CH backs up network data regularly and provides for automatable workstation backup. Tactically CH implements storage-area networks (SANs), with long-term services supplemented by workgroup and collaborative packages. Network data (stored on file servers) is backed up automatically onto redundant servers in real time and onto tape once each day. RAID hardware assures internal data redundancy in hard-disk subsystems. Strategically CH is looking to options such as high-capacity DVD and similar digitally oriented storage media, data replication, and network-attached storage (NAS). All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

3.3.8.3 **Security -- Transport and Network** (Proactive security mechanisms implemented to monitor data transmission)

CH monitors network for security using COTS systems, targeting 24x7 monitoring of all network and server activities tactically, and global encryption with intrusion detection and prevention strategically. In the absence of industry-wide standards for network-

wide security, CH uses commercial network-monitoring systems and node management. Monitoring will soon be expanded to 24x7 automatic service for coverage of network data and server operations. The strategic objective is encryption of all network traffic, combined with detection and prevention of any system intrusion. All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

3.3.8.4 **Security -- Application Services** (Mechanisms to assure appropriate user access to network-based applications)

CH implements security functions of Novell NetWare and Windows 2000 workstation in the near term, together with public-key/private-key encryption and single sign-on services for new applications, and requires multiple security measures long-term. Security at the application level is currently limited to password prompting in certain applications and to the security services offered by the desktop and network OSes. Novell NetWare 5.1 will offer single authentication across multiple NetWare and NT systems, an encrypted file system, IP encryption, and NDS services. Upcoming technologies include the PKI effort for public/private-key security systems, to be included in near-term upgrades, and complete client/server OS security services, which belong to CH's strategic direction. The numerous types of remote access (e.g., PDAs, e-mail handhelds, Web access to CH corporate applications) that will increasingly be used to access CH information pose significant security risks. These systems typically provide few effective security features, placing CH information and systems at some risk of exposure, loss, and corruption of data. All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

3.3.8.5 **Security -- Datalink and Encryption** (Systems to secure data during transmission)

CH broadens current password and certificate protections to strategic encryption of all network data.The CH WAN uses RAS encryption.. The growth of electronic data interchange, Web usage, and remote access, in addition to potential threats to sensitive CH data within the DOE network, mandates point-to-point encryption at the data level. The PKI effort, supported by X.500, and CH’s proposed Novell Border Manager remote access to the network will begin improving protection in the near term. Long-term there will be little or no clear-text network transmission; all packets will be encrypted. All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

3.3.8.6 **Security – Digital Authentication** (Mechanisms for identification of origination of an electronic transmission, providing assurance of authorship and guarantee against forgery)

CH aims at a single authentication technology in the strategic time frame. To assure the originator of a transmission, whether human- or machine-generated, information enterprises rely on digital authentication systems. Such systems encompass

technologies such as mathematical assurance of message integrity, electronic certificates together with network-based certificate authorities, user verification with Smart Card technology and other identification systems. The growth of public/private key encryption has DES standards underlying many of the components of digital authentication solutions. CH implementations will attempt to couple with DOE solutions and standards and the DOE Digital Signature Working Group in the near and long term. All CH computer security will comply with the security requirements of the CH Cyber Security Program Plan (CSPP).

### 3.3.9 Enterprise Services

The management of the results of CH operational activities, specifically reports, documents, visuals, and other types of high-level data collections, is fundamental to presenting CH's customers with the information they need. This includes the archiving, management, and retrieval of documents and other textual material, automated systems providing support for decision-making, and the archiving, management, and retrieval of images and multimedia materials.

3.3.9.1 **Enterprise Services -- Document and Multimedia Management** (Hardware and software for storage, indexing, location, and retrieval of multiple types of user-generated files, including documents, presentations, graphics, scanned images, recordings, and similar document, audio, and visuals files)

CH positions itself to implement document management and multimedia management systems for interoperation with tactical collaborative and workflow systems, aiming strategically at Web-enabled systems. Strategies for the future must be tied to CH's collaborative and workflow services directions A central repository is needed to make all materials available to appropriate personnel as needed. Strategically CH will move toward Web-enabled open services for multimedia document management and integration of document management/multimedia management with all CH applications.

3.3.9.3 **Enterprise Services -- Disaster Recovery** (Hardware software, and services for maintaining IM operations in the face of major disasters or destruction of normal-use facilities)

CH provides basic pre-disaster backup of data, plans for on-site recovery of server operations and off-site data redundancy, and targets automatic operational recovery of mission-critical functions and data strategically. The first step in disaster recovery is access to usable data. CH backs up its network data automatically and its workstation data on demand, with a user option to automate workstation backup, too. CH provides live, continuous backup of server data and protection against failure of critical network equipment by means of server clustering, load balancing, uninterruptible power systems (UPS), and fire defense. Tactical goals include full automated workstation backup, off-site storage and recovery facilities for backed-up data, and workable disaster recovery

operations. Long-term targets include the capability of an immediate return to operations for mission-critical systems and data on a 24x7 basis.

### 3.3.10 Database Management

The control of information as mediated by data is central to CH's mission. The systems that provide access and control of this data form a critical segment of Technology Architecture. These include both enterprise-wide database management systems and workgroup-specific database management systems. The functions of data summarization and presentation tools, collectively termed a data repository or data warehouse, have been subsumed this year under the TPS on document management.

3.3.10.1 **Database Management -- Enterprise Database Management System (DBMS)** (High-performance network-based database management system in a multi-tier system)

CH uses MS SQL Server and targets Oracle and relational databases near- and long-term. Long-term goals look to systems that support both Oracle based and object/relational database management systems.

3.3.10.2 **Database Management -- Workgroup Database Management System (DBMS)** (Workstation-based (often stand-alone) database system used by small groups)

CH supports Java Script but tactically and strategically moves to Oracle-based systems. The goal both short-term and long-term is the adoption of Oracle-based workgroup systems for all databases, displacing MS Access, and SQL-based DBMS' as their need to interoperate increases.

# 4. Conclusion

Much of CH's technology infrastructure is up-to-date, current with typical industry patterns, offering high-powered workstations and network capabilities to the user community. The fundamental issue in CH's architected environment, however, is the integration of all technology with the directions of future IT activities as planned by the users as a whole through the architecture effort.

## 4.1 Business Architecture Summary

The business needs of the CH community drive CH's technology architecture. The proposed implementation of the planned applications as web-based systems directly require several of the proposed Technology Projects, while other Technology Projects are indirectly mandated by these applications. A third group of projects is necessitated by general infrastructure requirements that in turn support the capabilities of the first two groups and of additional strategic technological directions.

Three areas of infrastructure components constitute the underpinnings of CH's operations. Client equipment comprises the first area, including office workstations, Web browser platforms both within and outside of the CH offices, and other remote-access devices such as PDA systems. The second area of infrastructure is server hardware and supporting elements, including disk subsystems, tape backup devices, and network-based equipment for specialty needs. The network itself, including networking equipment, cabling, phone lines, and supporting services, constitutes the third.

- Client equipment can be categorized by ownership and by usage location. Equipment management or ownership divides two ways: it is either CH-controlled or user-controlled. CH controlled equipment includes office workstations, loaner laptops, and Web-centric devices like the PDA system, while user-controlled equipment includes home computers, field-office and lab-based machines used to access CH information systems, and a great variety of other systems. The location of the client platforms is either in-house or it is remote, which encompasses all off-site access. With the growing use of Web-mediated access, however, the client usage location increasingly defies such an easy split, with users sometimes using remote devices from within the CH, and remote-access users able to perform most tasks via the CH application server. Traditional in-house workstations are to meet specific performance minimal ranging from the type of CPU chip along with disk and RAM capacities, through the desktop software systems to be implemented on users' machines (the "standard image" approach), and on through the network interface installed in each desktop computer. Additional specifications are listed for developers' workstations and for any non-standard office workstations in use by CH personnel.

- Network servers will be configured so as to help facilitate both modular construction of systems and performance measurement. Currently, servers are to be arrayed by domain and by category. Domains indicate the types of user groups (CH user, developer, general public, and network lab) and the associated levels of security and reliability for each in the group of servers used by each user group. Categories specify the clustering of servers by function, since CH will assign specialization to server clusters such as login and allied functions, application services, general data storage, and specialty operations. Plans are now being developed, however, to restructure the hardware infrastructure so as to accommodate the projected explosion in remote-access usage in the near future, as noted earlier. These plays lay out a layering of services provided by network-based machines, which will facilitate reliability, security, and robustness of CH's remotely accessible information systems.

- The network itself consists of workstation connections, intra-building backbones, inter-site links, and external connectivity via the ESNet. Workstation wiring is currently done with Category 5 copper. The CH buildings currently have fiber optic backbones.

## 4.2 Technology Summary

CH's overall Technology Architecture is based on the standards specified by the CH contractor effort. Several of the proposed Technology Projects explicitly present some technology solutions planned for the near-term that will promote these architectural standards.

Specifically this means that in the applications and services arena CH will move toward:

- 64-bit tools and infrastructure elements,
- systems directly complying with specified Standards,
- tools that are object based and that offer object-oriented programming and programmability,
- data systems based on XML and SQL DBMS Systems,
- enterprise services and infrastructure services based on open, published standards

Network technologies will standardize on:

- TCP/IP,
- open, published language standards from the World Wide Web Consortium, including HTML and XML, and
- integrated solutions.

Hardware components such as desktop equipment, cabling, servers, and the like will meet:

- requirements for high system capacities for the long term (bandwidth, storage, speed, etc.), particularly in the areas of desktop workstations, in view of their planned three-year life span, and of network wiring and cabling with their even longer life cycles,
- open, published standards for hardware systems management such as Zenworks/Managewise, etc.

Technologies such as security and remote access that find less standardization among market offerings will target a high performance level in compliance with appropriate industry and government standards.

The result of this commitment is several stances that can be summarized per technology category, whose details are as follows:

- End-User Tools: All products for productivity will comply with industry and de-facto standards like COM, Java and XML to permit object-oriented and network-aware programming and will be native 32-bit in their architecture. A broad range of products is encompassed in this category, from word processors and spreadsheets to client software for remote access.

- Desktop: This category comprises both hardware and operating system software for the typical office desktop workstation. The operating systems will be Novell NetWare for servers and Windows 2000 for workstations. The hardware will meet several high-end performance requirements to prepare for the multimedia and other high-functionality needs foreseen in the coming years.

- Application Toolset: The programming languages and ancillary development tools will comply with Java, XML, and component- and object-oriented standards. In the area of network-aware tools in particular, CH adheres to the World Wide Web Consortium languages for Web development, targeting XML as a strategic goal.

- Infrastructure Services: Remote access facilities, one subset of infrastructure services, will generally be based on TCP/IP services, but the great variety of access methods and associated technologies expected to be available for several years makes standardization impossible now. The Novell offerings Novell Director Service Enterprise Services form the foundation of CH's application-dependent infrastructure strategy. The adoption of the industry standards such as Enterprise Java Beans and COM compliance also move CH to expand its use of e-mail infrastructure systems, NDS, and Web infrastructure systems.

- Enterprise Network: CH has upgraded the hardware components of the network, both cabling and the electronic switching systems, to support 100 Mbps to the office desktop and 1 Gbps on the backbone.

- Systems Management: Managing the network and its assets requires coordination of disparate systems. CH’s consolidation to Zenworks/Managewise provides the

introduction of integrated system management support of hardware configurations, software distribution, problem tracking, and problem resolution.

- Security: The assurance of information security requires a multi-frontal approach. Viruses are being combated by the more rigorous OSes now being installed on servers and workstations. Data backup will be expanded to cover local workstation storage automatically. CH will implement technical security in all customized applications and in network components. Data will be encrypted both on disk and during transmission across the network. Digital authentication systems will be put in place to assure against forgery and loss of transmission integrity. All security will be guided by the CH Computer Security Program Plan (CSPP).

- Database Management: Enterprise-wide database management systems will be SQL-based. Standalone or small-workgroup database systems will be SQL compatible.

- Enterprise Services: Document and image management, decision support systems, and disaster recovery efforts will be controlled at the enterprise level, with long-term integration with CH's other enterprise-wide database systems. Document and image management systems will handle multiple electronic document formats natively in order to accommodate documents from other Federal and state agencies and other organizations.

# 5. Glossary

The definitions that follow present some essential information about acronyms and terms commonly used in this Technology Architecture Report and in other information architecture documents.

| | |
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| 16-bit | Outdated microprocessor (CPU) chip technology (e.g., Intel 8088, 80286) |
| 32-bit | Current microprocessor (CPU) chip technology for desktop workstations (e.g., Intel 80486, Pentium), fully exploited by Microsoft Windows NT and Windows 95 OSes |
| 4GL | (See *Fourth Generation*) |
| 64-bit | Current high-end microprocessor (CPU) chip technology for high-performance server machines and for mainframe systems (e.g., DEC Alpha) |
| | An IEEE standard for wireless network communications (radio, infrared, and optical) |
| ACPI | Advanced Configuration and Power Interface specification (Microsoft, Intel, Toshiba) for managing and conserving electrical usage in servers, small computer systems, and other business equipment |
| AD | Active Directory, an advanced directory service available with Windows NT 5.0 that is LDAP-compliant and DNS-based and interacts in a heterogeneous network |
| ActiveX | A Microsoft Internet-based standard for intra- and inter-application information sharing, that supersedes OLE |
| ADSL | Asymmetric Digital Subscriber Line, a new, high-performance telephone service for high-volume data transmission, offering faster downstream speeds than upstream speeds, and forming a part of a larger family of xDSL communications services |
| ADSM | A system for backing up local desktop disk storage to the DOE mainframe |
| AGP | Accelerated Graphics Port, a high-speed graphics port offered by Intel promoted to enhance 3-D graphics displays |
| AIIM | Association for Information and Image Management, an international consortium of multiple industries publishing standards for document management and workflow, including WfMC, ODMA, and others |
| Analog | Signaling accomplished by varying the information signal continuously so as to match the incoming real-world signal physically, as in basic telephone or sound-amplification technologies (in contrast to *digital*) |
| ANSI | American National Standards Institute, an organization coordinating industry standards across government and industry |
| API | Application Programming Interface, a set of programming and messaging conventions in an application allowing other programs to interact with it |
| ASP | Microsoft's Active Server Pages, a technology for delivering data to Web users querying an information system |
| ATM | Asynchronous Transmission Mode, a high-speed low-level method of transmitting data packets across networks, compatible with QOS and other advanced features |
| Attachment | (See *File Attachment*) |
| Authentication | (See *Digital Authentication*) |
| Backbone | The network infrastructure supporting all other portions of an enterprise network |
| Bit | Binary digit, capacity for just a 0 or a 1, or one-eighth element of a byte, a measurement of data transmission rate |
| Bridge | 1) (See *Router*); 2) any software or hardware system that connects diverse components to permit interaction and data exchange |
| Bus | Hardware providing communications between CPU, memory, and computer ports and peripherals, normally built into the motherboard |
| Byte | Eight bits, capacity for 256 numbers or characters, a measurement of data storage capacity |
| Cable modem | A modem that communicates with cable television connections for high-speed network links, often at 10 Mbps to the remote machine, though at lower speeds from the remote machine to |

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| | the network |
| Cache | Memory cache or CPU cache, high-speed memory regions servicing the CPU with frequently-used instructions and data, available as Level 1 (L1) cache built into the CPU or as Level 2 (L2) cache external to the CPU |
| Category 5 Wiring | Network cabling using copper wire and electrical signaling that provides speeds of 100 Mbps or better by conforming to certain technical specifications, in contrast to lower-grade Category 3 cabling |
| CGI | Common Gateway Interface, a method of programming Web servers to permit users to submit queries |
| C/S | (See *Client/Server*) |
| CD-ROM | Compact Disk-Read Only Memory, current widespread optical data storage technology holding up to 680 MB (0.68 gigabytes) per disk |
| Client/Server | Distribution of processing tasks between a high-performance network database machine (server) and a user's workstation (client) to reduce network traffic and to enhance data processing efficiency |
| COM | Common Object Model, a Microsoft standard for database object creation and management across networks, enhanced as COM+ and allied with DCOM (Distributed COM) |
| Concentrator | A hardware device connecting several desktop computers into the network, or linking several network segments together |
| CORBA | Common Object Request Broker Architecture, a multi-vendor standard for database object creation and management |
| COTS | Commercial off-the-shelf prepackaged software, often customizable or programmable |
| CPU | Central processing unit, the microprocessor chip at the core of desktop and other computers (e.g., Intel Pentium, Motorola 68040, DEC Alpha) |
| DBMS | Database management system, a software system controlling databases and their user interfaces |
| DCE | Distributed Computing Environment, an industry standard for multi-platform programming and communication |
| DCOM | (See *COM*) |
| DEN | Directory-Enabled Networking, a Microsoft-led multi-vendor effort to integrate DS features with network management, security, telephony, and other network services |
| DES | Digital Encryption Standard, a Federally mandated method of data encryption, using a single key for both encryption and decryption (a.k.a. symmetric) |
| DHCP | Dynamic Host Configuration Protocol, based on Microsoft Windows NT services, a method of assigning TCP/IP network addresses to logged-in users as needed, rather than on a static or fixed basis, in order to improve utilization of the limited pool of IP addresses |
| Digital | Signaling accomplished by varying the information signal in only two ways (representing 0's and 1's) according to a numeric encoding of the incoming real-world signal, as in long-distance telephone services or satellite transmissions (in contrast to *analog*) |
| Digital Authentication | A security system that assures the identity of the origin of an electronic transmission (non-forgery and non-repudiation) and its integrity (non-tampering) via a system of digital signatures, electronic certificates, and certification authorities |
| Directory Services | System for making network-wide resources available transparently to users on a secure basis |
| Disk | (See *Drive*) |
| DMI | Desktop Management Interface, a standard for network-based manipulation of workstation components from a central site |
| DMTF | Distributed Management Task Force, Inc. (formerly Desktop Management Task Force, Inc.), a standards organization that governs DMI and other systems management specifications and standards |
| DNS | Domain Naming Service, an Internet system for hierarchically organizing workstations and networks |
| Document Management | Managing, indexing, and searching facility for many varieties of electronic documents and files |
| DOS | Outdated 16-bit operating system for desktop computers, using character-based screens |
| Downstream | Data sent from a high-performance network machine to a user's desktop computer, i.e., from |

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| | the network |
| DRAM | Dynamic RAM, the moderate-speed type of general memory found in older computers |
| Drive | A hardware device housed in a computer, containing a disk for data storage; hard disks are normally permanently installed in their drives, while diskettes and optical disks (CD-ROMs, DVDs, etc.) are removable or swappable |
| DS | Directory Services, a database offering applications access control and security of users on a network |
| DS3 | A network transmission technology rated at 44.7 Mbps |
| DSL | (See *ADSL*) |
| DSS | Decision support system, a specially configured database designed to present information in easily comprehensible formats |
| DVD | Digital Versatile Disk, a new optical storage technology resembling CD-ROM but with data storage capacities between about 5 GB and 20 GB per disk (DVD-ROM means DVD-Read Only Memory, DVD-RW means DVD-Read/Write technology) |
| EDI | Electronic data interchange, the secure direct exchange of corporate information in computer-processable format according to industry standards |
| EDO | Extended Data Out RAM, a moderately high-speed type of general memory |
| EIS | Executive information system, a database designed to filter and summarize data |
| E-mail | Electronic mail, the transmission and storage of text-only messages, now expanded to incorporate transmission of more advanced types of data |
| Ethernet | A widely used networking technology operating in CH at a rate of 100 Mbps to the desktop |
| FDDI | A low-level method of transmitting packets across a fiber optic network, now superseded by ATM and other technologies |
| Fiber Optic | A type of network cable with a glass core that transmits data using optical (light) signals rather than electrical, providing protection against electrical interference and eavesdropping, but costing more than copper wiring for cabling and concentrators |
| File | The lowest unit of data organization during storage, analogous to the packet as the lowest unit of data organization during transmission; databases and applications consist of multiple files |
| File Attachment | A file sent as part of an electronic mail message, specially handled to prevent data corruption during transmission |
| FIPS PUBS | Federal Information Processing Standard Publications, documents and white papers for computer and information system standards and practices, issued by NIST |
| Firewall | A security feature to protect a network site and its systems from outside attack, often phrased as “inside the firewall” meaning the protected in-house portion of the network, and “outside the firewall” meaning the unprotected area of network services |
| Fourth Generation | Advanced and current computer-programming languages, with substantial automation of many routine processes |
| GB | Gigabytes (billion bytes), a measurement of data storage capacity |
| Gbps | Gigabits (billion bits) per second, a measurement of data transmission rates across networks |
| H.323 | An ITU standard for videoconferencing over local networks and the Internet |
| HSM | Hierarchical storage management, a data storage system that speeds up access to frequently used files while migrating rarely used files onto cheaper, slower storage media |
| HTML | Hypertext Markup Language, a W3C scripting standard for presenting World Wide Web pages on the Internet, defining page layout, fonts, and multimedia elements |
| HTTP | Hypertext Transport Protocol, a method of data exchange fundamental to World Wide Web technology |
| Hub | (See *Router*) |
| IEEE | Institute of Electrical and Electronics Engineers, an international professional society promoting the advancement and standardization of electronic and computer engineering |
| IIS | Microsoft’s Internet Information Server, a system of server software for building Internet and Web information sites |
| IMAP4 | Interactive Mail Access Protocol 4, an Internet standard for accessing e-mail on a server |
| IMSC | The corporate database system being developed within and for the Office of Science in accord with the ongoing Information Architecture project |
| IP | Internet Protocol, a global standard for routing data on the Internet (part of TCP/IP) |

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| IPng, IPv6, Internet 2 | Internet Protocol Next Generation (version 6), the new specification for Internet data transmissions currently under development, with significantly improved technical capabilities such as speed, addressing, and quality-of-service control |
| IPX/SPX | Internetwork Packet eXchange/Sequenced Packet eXchange, a proprietary Novell system for transmitting data on a network |
| IRC | Information Resources Catalog, a database compiled by the CH Strategic Planning and Architecture effort |
| ISDN | Integrated Services Digital Network, a digital connection standard and service for data transmission, available from telephone companies |
| ISO | International Standards Organization, representing 75 nations including the U.S., and governing standards for computing, networking, and other technical fields |
| ISP | Independent Service Provider, a company providing Internet connections to dial-up users |
| ITU | International Telecommunication Union, incorporating the former Comité Consultatif International Téléphonique et Télégraphique (CCITT), an agency of the United Nations that promotes public- and private-sector coordination of global telecommunications |
| Java | A proprietary programming language from Sun Microsystems, Inc., based on the C++ language and supporting Internet and World Wide Web browser functions |
| KB | Kilobytes (thousand bytes/characters), a measurement of data storage capacity |
| Kbps | Kilobits (thousand bits, which are one-eighth divisions of a byte) per second, a measurement of data transmission rates across networks |
| L2 | (See *Cache*) |
| LAN | Local area network, a computer network at a single site |
| LDAP | Lightweight Directory Access Protocol, a directory services suite that is a subset of X.500 |
| Load | The amount of data packets being sent through a network (transmission load), or the number of requests to access data in a computer (transaction load) |
| MAPI | Mail Application Programming Interface, a programming structure for sending and receiving e-mail with the Microsoft messaging system |
| MB | Megabytes (million bytes), a measurement of data storage capacity |
| Mbps | Megabits (million bits) per second, a measurement of data transmission rates across networks |
| Memory | Short-term computer storage, electrically powered, used for rapid transfer of programs and data to and from the CPU, also called RAM (random-access memory) |
| MIME | Multipurpose Internet Multimedia Extensions, a protocol for Internet e-mail and information transfer accommodating file attachments |
| MMX | Multimedia Extension, a set of CPU instructions for enhancing multimedia processing |
| MPX | Microsoft Project Exchange, a file format for data transfer used with MS Project |
| MS | Microsoft Corp. |
| N-tier | Distribution of processing tasks across two or more platforms connected via a network, to reduce network traffic and to enhance data processing efficiency (as in client/server architecture, which is commonly just two-tier in structure) |
| NDS | Novell Directory Services, a directory services suite integrated into the current version of Novell Netware |
| Network Management | The technical "control tower" for monitoring and maintaining network functions in real time |
| NIC | Network interface card, the circuit board inserted into a computer to provide network access |
| NT | (See *Windows NT*) |
| Node | A computer, router, or similar electronic device forming part of a network |
| OC3 | A medium-speed optical network technology, rated at 155 Mbps |
| OC12 | A high-speed optical network technology, rated at 622 Mbps |
| OCR | Optical character recognition, the automated conversion of graphical images of text, such as fax files or scanned documents, into actual text files |
| ODMA | Open Document Management Architecture, an AIIM standard for managing many varieties of electronic documents and files |
| OLE | Object Linking and Embedding, an obsolete Microsoft standard for intra- and inter-application information sharing |
| OO, OOP | Object-Oriented programming methods, as opposed to procedural programming, which |

| | |
|---|---|
| | expressly supports reuse of program modules |
| OS | Operating system software, which runs the hardware and makes it possible to run application software on a computer |
| OSI | Open System Interconnection, an ISO standard for network connectivity and communications, constructed in a seven-layer model |
| Packet | The lowest unit of data organization during transmission, analogous to the concept of the file as the lowest unit of data organization during storage; packets are fixed in size or length, however |
| Partition | 1) The use of a single hard disk to emulate two or more independent disks, to accommodate multiple operating systems or to optimize the disk's performance, or, 2) the division of a single network into two or more subset networks in order to optimize traffic flow |
| PCI | Peripheral Component Interconnect, an Intel-proprietary standard for connecting peripheral devices to a computer or CPU |
| PKI | Public Key Initiative, an effort to coordinate the use of RSA and digital authentication |
| PDA | Personal digital assistant, one of several portable/hand-held computer-like devices with connections to a network |
| Pentium | Family of current-generation 32-bit CPUs from Intel, whose most up-to-date version is called the Pentium II, offering high-speed processing from 233 MHz to 400 MHz and containing built-in MMX instructions |
| POP3 | Post Office Protocol 3, an Internet standard for receiving e-mail from a server |
| PowerPC | Family of current-generation CPUs used in Apple Macintosh computers, ranging in processing speed up to 350 MHz |
| Protocol | A set of technical rules for data and network information exchange |
| Proxy | Use of a buffering computer or system to help provide security for a network against outside attack |
| QA | Quality assurance, the debugging and correction of customized applications |
| QOS | Quality of service, an "intelligent" method of sending data on a network, according to requirements of speed, non-delay, and guaranteed delivery |
| RAID | Redundant Array of Inexpensive Disks, a system of multiple hard disks providing greater reliability, fault tolerance, and hot-swappability |
| RAM | (See *Memory*) |
| Router | A network device that directs data packets toward their destinations, similar in function to switches, hubs, and bridges |
| RSA | Rivest/Shamir/Adleman method of data encryption, using one key for encryption and a separate key for decryption (a.k.a. asymmetric, public-key/private-key) |
| SANs | Storage Area Network System, large-capacity storage systems of varying types (such as mainframe, tape, or file server) whose services are made accessible via the DOE network to a wide variety of users for any storage function |
| SDRAM | Synchronous Dynamic RAM, a high-speed type of general memory linked to the system clock |
| SGML | Standard Generalized Markup Language, the standard for creating markup languages like HTML, VRML, or XML |
| Slot 1 | A physical configuration of computer motherboards to permit easy upgrading of one or two CPUs and cache, with an advanced version known as Slot 2 accommodating four CPUs |
| S.M.A.R.T. | Self-Monitoring Analysis and Reporting Technology, a system for reporting deteriorating disk drives in advance of actual failure |
| Smart Card | A "computer on a card" with built-in CPU and memory, along with wired-in or wireless network connections, carrying critical information such as security information, account balances, etc. |
| SMP | Symmetric multiprocessor technology, computers using multiple CPU chips simultaneously for core processing |
| SMS | Microsoft Systems Management Server, automation of distribution and management of desktop software |
| SNMP | Simple Network Management Protocol, a set of specifications for technical management of networks from a central point |
| Socket 7 | Outdated method of managing and upgrading CPUs and their motherboards, including speed limitations of 300 MHz on CPU operations |

| | |
|---|---|
| SQL | Structured Query Language, an industry standard for database access in a client/server environment |
| SRAM | Static RAM, an expensive, high-speed type of memory used for caching and similar specialty functions |
| SSL | Secure Sockets Layer, a networking security feature utilizing encryption, commonly found in World Wide Web communication |
| Storage | Magnetic or optical hardware devices for keeping data intact and making it available for use indefinitely without the need for continuous electrical power; examples include hard disks, CD-ROM, DVD, and tape backup |
| Switch | (See *Router*) |
| System 8 | Operating system for Apple Macintosh computers, designed to take advantage of newer CPU hardware and to improve graphics and networking capabilities, and replacing the obsolete System 7 |
| T1 | A network transmission technology rated at 1.544 Mbps |
| T3 | A network transmission technology rated at 44.7 Mbps |
| T.120 | A series of ITU standard specifications for real-time data conferencing, including application sharing and whiteboards. |
| TB | Terabytes (trillion bytes), a measurement of data storage capacity |
| TBD | To be determined |
| Tbps | Terabits (trillion bits) per second, a measurement of data transmission rates across networks |
| TCP/IP | Transmission Control Protocol/Internet Protocol, a standard for transmitting data on the Internet |
| Thin Client | A workstation or desktop computer with reduced functionality (and typically with a lower price) that relies on other network equipment for most of its processing needs |
| UML | Unified Modeling Language, an object-based standard for database constructions including business process, data, application |
| Unix | High-end operating system for 32-bit and 64-bit high-performance CPUs and mid-level computers |
| Upstream | Data sent from a user's desktop computer to a high-performance network machine, i.e., to the network |
| USB | Universal Serial Bus, a hardware interface supporting multiple desktop computer peripherals (keyboard, mouse, printer, etc.) on one port |
| uuencode, uudecode | A scheme for converting computer files into text transmissible over e-mail |
| VIM | Vendor-Independent Messaging, a programming interface supported by multiple vendors for easy e-mail access from within desktop applications |
| VLAN | Virtual Local Area Network, a network functioning like a LAN but defined by groups or addresses rather than merely by geographic arrangement, used in configuring network management, and supported by the draft IEEE standard 802.10 |
| VPN | Virtual Private Network, a private network operating on a public network infrastructure as a VLAN, using various security features to assure privacy |
| VRML | Virtual Reality Markup Language, a multimedia markup language for presenting virtual reality systems |
| W3C | World Wide Web Consortium, the international body that controls World Wide Web standards and protocols |
| WAN | Wide-area network, a computer network encompassing multiple geographical sites |
| WBEM | Web-based Enterprise Management, a Microsoft initiative for technical management of network infrastructure systems via the World Wide Web |
| WfMC | Workflow Management Coalition, an international subgroup of AIIM and its published standard for workflow products |
| Windows 3.x | Outdated 16-bit operating environment for desktop computers, using graphics-based screens and based on DOS foundation |
| Windows 95 | Hybrid graphics-based operating system for desktop computers, mixing 16-bit and 32-bit operations |
| Windows NT | Current 32-bit operating system for desktop computers, using graphics-based screens, |

| | |
|---|---|
| | supporting multiple file systems and expandable to 64-bit CPUs, and available in NT Desktop and NT Server versions |
| X.400 | A set of ITU standards for e-mail addressing and transmission |
| X.500 | A set of ITU standards for directory services, e-mail transmission, and other network services |
| xDSL | (See *ADSL*) |
| XML | Extensible Markup Language, a W3C advanced scripting standard with detailed style sheets for presenting World Wide Web pages on the Internet |
| Year-2000, Y2K | The potential for computer system errors in working with dates in the year 2000 and beyond, due to older programming techniques that handled dates as two-digit numbers |

# 6. Appendices

The appendices present the detailed information noted in the foregoing material.

Appendix I lists the full detail of the CH Technology Positioning Statements
Appendix II lists the proposed Technology Projects

# Appendix I: Technology Positioning Statements

The Technology Positioning Statements for the 2000 Technology Architecture Report are included below, as summarized above in Chapter 3.

## End-User Tools – Productivity Elements – Document Processor

Applications manipulating the contents of text documents and analogous material.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Word 97 | MS Word 2000 | Web-deployed and component-based document processor based on XML standards |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | MS Word | Corel WP; MS Word | MS Word |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| All 32-bit applications except MS Word 97 and WP 6.1 | MS Word 97; MS Word 2000 |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| Corel WordPerfect 6.1; PDF-authoring applications | | Standards-based Java-compliant application suites; Web-deployed desktop applications |

**Implications and Dependencies**

**Industry Position:** Word provides interoperability with other MS Office applications and with Netscape, and it directly supports MS Outlook. As a component of MS Office, Word is found on the majority of desktops with software suites. With the release of Office 2000, Microsoft it is projected to take more market share of the document processing in today's workplace and to continue dominating in the technological arena of compatibility across standards.

**CH Baseline Description:** CH has standardized on MS Word as it moves to a Java-based environment. With the standard computer image now distributed throughout CH, document-processing with Word is the foundation technology for all desktop systems. Most Federal agencies outside DOE have moved to MS Word, which minimizes the need for file conversion when exchanging files with outside agencies. Many branches of DOE still use WordPerfect, however, and the WordPerfect 5.1 format is generally used as the format for file exchange.

CH users need to read PDF documents. However, the PDF specification is proprietary and not publicly available or controlled by a standards organization. However it is supportable with Java, which is part of the overall CH information architecture. The specific CH architectural direction points toward the XML suite of standards for Web development, which is supported and controlled by the global World Wide Web Consortium. Therefore, although PDF-reading software is acceptable, PDF authoring tools are not supported by the CH Technology Architecture.

**CH Application Architecture:** The HR-mandated CHRIS requires MS Word. Budget Formulation, Standard Reports, Supplementary Materials, and all Budget Execution applications require Document Processor functionality. With the migration to an MS office environment, internal agencies become interoperable. COTS applications will bridge the gap to external requirements.

## End-User Tools – Productivity Elements – Authoring Tools and Suites

Ensemble of applications interacting cooperatively to manipulate electronic data and documents.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Office 97 | MS Office 2000 | Java-based and Web-deployed application suites |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | MS Office; Lotus Smartsuite; Corel WordPerfect Suite; Lotus Notes | MS Office; Lotus Smartsuite; Lotus Notes | MS Office |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| MS Office 97 | MS Office and Notes |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | Standards-based applications deployed on the Web; Just-in-time (JIT) and subscription software and software channels |

**Implications and Dependencies**

**Industry Position:** The force of the Internet and intranets will drive change through out the nature of communication and source utilization on the desktop. Office suites will use these technologies to change authoring to a "publish and retrieve" paradigm, and provide access to collaborate and coordinate transparently.

The cost savings offered by software suites, vis-à-vis the expense of purchasing high-quality yet individual COTS applications, now drives the market. Suites are at the forefront of desktop software sales.

The emerging market of just-in-time (JIT) distribution of software by subscription, software channels, and other alternative, mostly Web-based methods of software distribution will change the face of software suites.

CH Application Architecture: All architected applications will be integrated with tools associated with the office suite on the desktop in compliance with the CH Information Architecture and the CH infrastructure for the business aspects.

Certain users must still use alternative desktop software components to accommodate data owned by other Federal agencies that is in alternative formats. Two options may resolve these difficulties: robust data-conversion software that translates between the CH's data format and that of its customers; or continued use of alternative software components by limited sectors of the CH user community on a containment basis.

## End-User Tools – Productivity Elements – Project Management

Applications manipulating detailed project plans and time lines, supporting charting and graphing capabilities.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Project 98 | MS Project 2000 | Web-based applications |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | PERT; Gantt | PERT; Gantt | PERT; Gantt |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| MS Project 98 | Microsoft Project |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** As with all desktop software applications, the current trend is toward Web-enabled versions of packages that are already familiar in the desktop environment. This permits greater flexibility in data-access locations, working hours, and required hardware platforms, and it offers better and more fine-grained control of software, security, and monitoring at the server and network level. Until Web-deployed applications come to full maturity, however, MS Project will continue to dominate the desktop for project management tools. Requirements for a centralized project repository can be combined with MS Project as a front end, enabling multi-project roll-up, consolidation and analysis which, in turn, is a requirement for effective resource planning and deployment. Support for multi-user and multi-team access to multiple projects, along with larger task networks, task-dependency links between projects, and record-level resource-locking capabilities, will increasingly be required of project-management software, many of which are already included in MS Project 2000, which is tightly integrated with MS Exchange and Outlook.

**CH Baseline Description:** MS Project is well integrated with other Java-based applications, and particularly with the MS Office suite, in particular the Excel spreadsheet application, and MS Exchange and Outlook. Designed for Web-deployment, will also include modules capable of performing some project management functions and Gantt charting.

**CH Application Architecture:** Budget Execution will require access to project management capabilities.

## End-User Tools – Productivity Elements – Spreadsheets

Applications manipulating data in spreadsheet format to perform numerical analysis.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Excel 97 | MS Excel 2000; Web-deployed spreadsheet tools | Web-deployed spreadsheet tools for remote and mobile access devices |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | Java | Lotus 1-2-3; MS Excel | MS Excel |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| MS Excel 97 | MS Excel 97; MS Excel 2000 |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Web-deployed technologies | |

**Implications and Dependencies**

**Industry Position:** As with all desktop software applications, the current trend is toward Web-enabled versions of packages that are already familiar in the desktop environment. This permits greater flexibility for users in their work locations and required hardware platforms, particularly for road warriors, along with gaining greater control at the server and network level.

User interface standards, data formats, and integration options built into software suites ease the integration of documents created in the suite's product set. Excel provides interoperability with other MS Office applications, Netscape, and directly supports MS Exchange. As a component of MS Office, Excel is found on 97% of desktops with software suites.

**CH Baseline Description:** Microsoft Office 97, SR2 (with Excel 97), and Microsoft Office 2000 (with Excel 2000). There are many spreadsheet-based information systems that represent significant historical data for CH program offices.

**CH Application Architecture:** Budget Formulation Analysis, Budget Execution Analysis, and Budget Guidance require spreadsheet functionality.

## End-User Tools – Productivity Elements – Graphics

Applications manipulating graphical and photographic images.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ MS Office (MS PowerPoint, Draw, Photo Editor, Organization Chart, and Graph)<br>▪ Visio<br>▪ Adobe PhotoShop<br>▪ Adobe Illustrator<br>▪ PageMaker | ▪ Multimedia (animation and full-motion video)<br>▪ Unified visuals browser<br>▪ 32-bit graphics software and graphics conversion software | ▪ W3C/XML-compliant scalable vector graphics (SVG) and PNG formats<br>▪ Interactive 3D graphics and imaging with VRML<br>▪ Graphics search engine<br>▪ Web-based unified browser |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| JPEG; MPEG; W3C XML/SVG; PNG (Portable Network Graphics) | Multiple widely accepted graphics formats | Multiple widely accepted graphics formats | Multiple widely accepted graphics formats |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Corel Draw; Quark XPress | MS PowerPoint, Photo Editor, and Organization Chart; Adobe PhotoShop; Adobe Illustrator; Visio |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| PageMaker | 64-bit Corba based applications; Multimedia authoring toolset; Drawing and chart tools; Desktop publishing | Standards-based Java-compliant application suites (graphics components of MS Office 2000); VRML applications; W3C SVG implementations; PNG-capable browsers |

**Implications and Dependencies**

**Industry Position:** Integration with other desktop facilities is a primary consideration in setting a direction for graphics applications and file formats, because graphical images are frequently incorporated into electronic documents and due to the extensive use of graphics on the World Wide Web.
The World Wide Web Consortium language, Scalable Vector Graphics (SVG), defines a standard for interactive, dynamic graphics and is central to improving Web graphics under the W3C Extensible Markup Language (XML) standard. SVG works together with XML to provide faster versions of all three types of two-dimensional graphics – vector, image, and text – along with an extensive feature set. SVG-viewer plug-ins are already available for both Netscape Communicator and Microsoft Internet Explorer, and manufacturers including Apple, IBM Alphaworks, and Corel have already produced software tools related to SVG. Among the members of the W3C SVG working group are Microsoft, Netscape, and numerous other Web players. The seventh Working Draft was released in December of 1999 in response to the "Last Call" of that August, and a final official SVG recommendation is expected from W3C in 2000. This will provide significant advantages over Web-deployed graphic representations based on bitmaps or other file-based systems.

**CH Baseline Description:** MS Office97 includes Draw, PowerPoint, Photo Editor, and Organization Chart, all in 32-bit versions. Several graphics packages are still in use throughout the user community, some of them without any formal support. Some of these will be retired, but a few will be retained either in containment or in mainstream, due to the many specialized needs that these packages fill.

The user community sees an urgent need for utilities to convert graphics data files among the various industry formats and to provide quick-viewing or thumbnail-viewing options such as a graphics browser might provide. It also notes a longer-term need for a graphics search engine and for Web-based graphics browsing.

**CH Application Architecture:** Budget Formulation and Supplementary Materials applications will require graphics functionality.

## End-User Tools – Productivity Elements – Speech Recognition

Hardware and software combinations permitting users to control the desktop workstation and to input text by means of normal speech, complementing other input devices.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| | Dragon Naturally Speaking | Deployment of speech-recognition as complementary desktop method for input and control |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | SRAPI | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Dragon Naturally Speaking | Speech-recognition technologies based on standards and deployed on the Web |

**Implications and Dependencies**

**Industry Position:** The power of modern desktop microprocessors now permits users to speak at normal speeds to provide input through microphones for their office computers, complementing (but not replacing) input from the traditional devices, the keyboard and the mouse. Two important uses exist for speech-recognition technology, one which controls menus and commands, analogous to a mouse or other pointing device, the other which permits dictation, duplicating the function of the keyboard. The best current technology permits users to speak at normal conversation speed, that is, to use "continuous speech," to dictate text into their workstations. This is a highly desirable advance over less mature speech-recognition technologies that required users to pronounce words discretely, leaving silent intervals between each word.

A consortium-based standard, the Speech Recognition Application Programming Interface (SRAPI) appears to have been discontinued.

Commercially, the market continues to shake out less powerful vendors in the field of speech recognition software. Still in play are Philips (FreeSpeech), Fonix (Fonix), IBM (ViaVoice), and L&H (Voice Xpress). Dragon, or like products, an independent and strong firm founded by

linguistics experts, had been its leading competitor in the desktop arena and the manufacturer preferred by Corel for its office suite line.

**CH Baseline Description:** CH has not deployed speech-recognition systems yet, but its infrastructure is sufficient to handle requirements.

**CH Application Architecture:** None as yet.

## End-User Tools – Remote Access Client

Client services and software for access to the CH network via diverse platforms (including laptops and PDAs) from remote sites such as home, travel, etc.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • PC Anywhere | • WebSphere<br>• Novell Network BorderManager - virtual private networks (VPN) | • Security structures;<br>• Support for additional secure protocols (e.g.,<br>• Novell VPN |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| ISDN; IEEE 802.11 | ICA; Secure ICA; XML | ICA; Windows Remote Access Server | XML |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| PC Anywhere | Windows NT and Windows 2000; Netscape |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Handhelds and PDAs, WebSphere | PDAS |

**Implications and Dependencies**

**Industry Position:** The profusion of remote-access client platforms (handhelds, palmtops, Internet-capable cell phones, thin clients, remote notebook and remote desktop computers, etc.) precludes providing service to them all. CH infrastructure is targeting Windows-based client platforms, systems that complement the CH infrastructure, and Web access to CH systems.

The preferred Web-authoring system continues to evolve toward XML and its associated protocols, as determined by the World Wide Web Consortium. XML will become a fundamental component of data presentations via the Web.

**CH Baseline Description:** Client ease-of-use is a universal support goal for remote users. Initial installation requires little client-side disk space and takes only a few minutes and little effort by the user Dial-up continues to require high levels of back-end support.

## End-User Tools – Workgroup Computing – Collaborative Services

Services including videoconferencing, calendar and scheduling functions, collaborative editing, and document sharing that support electronic mail and workflow services and enable multiple users to interact with a variety of applications and data types.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ Desktop conferencing: MS Exchange with calendaring and network folders;<br>▪ Polycom ViewStation<br>▪ Group conferencing | • TCP/IP-based collaboration capabilities with video;<br>• Web-based unified calendering<br>• MS Exchange upgrades | ▪ Enhanced IP-based collaborative activities (virtual workplace)<br>▪ Polycom - Desktop USB |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| T.120; H.323 | | | TCP/IP-based products |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Daytimer | Videoconferencing; MS Exchange with calendaring and network services; Polycom ViewStation |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| PictureTel desktop videoconferencing; GroupCal; PictureTalk | TCP/IP-based workflow and collaboration applications; QoS technologies; PDAs and wireless technologies | Improved IP-based, prioritized support for voice and video |

**Implications and Dependencies**

**Industry Position:**
Packetizing voice and video data in an IP environment is a scalability and data-stream quality issue that must be addressed. QoS technologies are fundamental to solving such problems..

## End-User Tools – Workgroup Computing – Workflow

Software and services for automated structuring and scheduling of work to conform to actual business processes, with the support of collaborative services and electronic mail

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| | Web-deployed workflow; JAPI | Integrated Web-based suite of workflow and document management components |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| WfMC and WfMC API | CORBA; VIM; MAPI | | JAPI |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | Web-based workflow and document management components |

**Implications and Dependencies**

**Industry Position: Cohesive** products for building and managing workflow are growing in number and robustness. A number of workflow vendors already are working to build workflow on top of MS Exchange. The surge of interest in Web-based application development will shortly overtake these efforts, however, as Web-deployed versions of workflow systems prove more practical, without geographic or platform restrictions.

## Desktop – Operating System

Operating system software for the general desktop office computer.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Windows NT; | Windows 2000 Workstation | 64-bit OS |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| Windows 95/98; Windows NT and Windows 2000 | Windows 95/98; Windows NT and Windows 2000 | Windows 95/98; Windows NT Workstation; Unix (support personnel); Windows 3.X | Windows 2000 |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Windows NT |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** Windows 95 and 2000 (formerly Windows NT) migrations should continue at their current pace, with the appropriate OS deployed according to end-user needs, based on network and application architecture Windows 2000 with NDS for NT is available, one for desktops and one for servers. Factors such as the business applications in use, and the diversity of workstation hardware and peripherals, make the use of Windows NT Workstation an absolute must. The fully stable version may not be realized until well into 2001.

## Desktop – Hardware – Workstation

All hardware components that comprise office workstations, including CPU, keyboard, disk drives, monitor, sound system, network interfaces, and other devices.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • Intel Pentium II- and Pentium III-class 500 MHz or faster Slot 1, with…<br>▪ 128 MB of SDRAM<br>▪ 512 KB L2 cache<br>▪ 8.4 GB or greater EIDE or SCSI local storage<br>▪ 100 MHz PCI bus<br>▪ 17-inch or larger SVGA monitor or flat-panel monitor<br>▪ AGP Graphics with 8 MB VRAM<br>▪ ACPI-compliant<br>▪ SNMP-capable 10/100 Ethernet network interface card (NIC)<br>▪ Speech recognition (case-by-case basis); | • Speech recognition devices and software<br>• 100 MHz NICs or higher | • WebCentric<br>• USB peripherals<br>• Digital authentication devices<br>• 2+ GHz microprocessor<br>• DVD-ROM drives |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | CPU Socket 7;<br>CPU Slot 1;<br>100 MHz PCI bus | | Current PC-based technology |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Pentium machines | Pentium II & III-class desktops |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | DVD-ROM;Desktop videoconferencing; WebCentric | Merced 64-bit processor; DVD-RW; USB peripherals; WebCentric; Speech recognition; Security cards |

**Implications and Dependencies**

**Industry Position:** The Pentium III does advance chip technology far enough to warrant immediate upgrades from Pentium II CPUs for anyone except the most intensive users of multimedia data. Questions remain about the security of the unique CPU identifier, which can (and should) be switched off at the BIOS level before deployment within CH, but which according to some reports may not be secure even in this configuration, but they are no longer much discussed or opposed

## Desktop – Hardware – Printers

Local desktop and network-based printers and multi-function devices with printing functions.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Networked:<br>• HP4, HP5 Si/HP5 Si MX PS, 600 dpi, 33 MHz CPU<br>• HP 8000, 1200 dpi<br>• Tektronix, color models Phaser 350 through Phaser 840 Plus, 600 x 300 dpi<br>Standalone (local):<br>• HP LaserJet III, HP4, HP5 | • 1200 dpi color laser or LED printers, duplex, running at 16 ppm<br>• IP-addressable<br>• multifunctional equipment as needed<br>• 32 MB RAM minimum<br>• PCL- and PostScript-compatible<br>• network, USB, serial, parallel connections<br>• 133 MHz CPU<br>• multiple media types (plain paper, envelopes, transparencies, labels, business cards, etc.)<br>• toner with sub-micron particles<br>• usage monitoring with Web/remote access for management<br>• Energy Star compliance | • 2400 dpi color, duplex<br>• IP-addressable<br>• Network and USB connections<br>• 64 MB RAM minimum<br>• on-board multi-gigabyte hard disk<br>• PCL- and PostScript-compatible<br>• 133 MHz CPU<br>• multiple media types (plain paper, envelopes, transparencies, labels, business cards, etc.)<br>• usage monitoring with Web/remote access for management<br>• multiple-function devices (print, copy, scan, fax, etc.)<br>• Energy Star compliance |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| ISO Document Printing Application (DPA) 10175 (Distributed Printing Architecture) | HP PCL 5 and 6;<br>Adobe PostScript 2 | | HP PCL 5 and 6;<br>Adobe PostScript 2 |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| HP LJ II and III | HP LJ 4, 5, and 6, 4000 and 8000 series; Tektronix |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | Web-based printing |

**Implications and Dependencies**

**Industry Position:** Despite the presence of formal standards for printing, the long-standing standards have been the *de facto* options of the Printer Control Language (PCL) from Hewlett-Packard or else the PostScript language from Adobe, supported by Microsoft. These two printing protocols long ago came to determine how all other printer manufacturers positioned their products in the market. Most products offer compatibility with both protocols.

Color printing is becoming mandatory as product quality improves and prices drop. Three color technologies compete with one another: multi-pass laser, ink jet, and solid ink. A fourth, relatively new technology, the use of light-emitting diodes (LEDs) as an alternative to lasers to charge the toner drum, also is contributing to the price drop.

Communications are done through serial, parallel, USB, or network connections, with IP-addressability over networks offering significant advantages over most other forms of remote printing and other network-printer configurations. Medium to high-end product lines offer all four communications options, and high-end equipment also permits network-based remote printer management, such presenting a Web page to function as a remote printer-control console.

## Application Toolset – Supplementary Developer Tools

Software used to automate routine functions in the development of applications.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ Crystal Reports;<br>▪ VBA<br>▪ Multiple ActiveX components;<br>▪ FrontPage;<br>▪ Dreamweaver | ▪ HTML/Java/XML version of Ayres Software EDI Standards Modification Tool;<br>▪ All appropriate upgrades to current tools;<br>▪ Lotus Notes Web development | ▪ 64-bit development environment |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry, De Facto** | **DOE** | **CH** |
| | | | Lotus Notes Web Development, Dreamweaver |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Tools to support Visual Studio; Web-based development tools |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| Sheridan Software SS Tab; Ayres Software EDI Standards Modification Tool | XML toolsets, Lotus Notes Web Development | |

## Application Toolset – Programming Languages

Programming languages used for development of customized applications for use on client platforms, for use both in-house and remotely.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ MS Visual Basic (with MS Studio);<br>▪ MS Access 97;<br>▪ HTML and DHTML;<br>▪ Scripting languages (JavaScript and VBScript);<br>▪ MS FoxPro;<br>▪ C++ | ▪ Upgrades to MS tools only;<br>▪ MS Visual Studio;<br>▪ XML;<br>▪ XML additions and other robust markup languages | ▪ Object-oriented Web-development languages<br>▪ Java<br>▪ XML |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| SGML (includes markup languages, such as HTML and XML); W3C review | Markup languages; Scripting languages | DHTML | Java |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Clipper; PDF authoring applications | Java |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| MS Access 97; Visual Basic 4.0; MS FoxPro | XML tools | Java and component-based technologies; interobject interface programming, Lotus Notes programming tools (Application Development) |

## Application Toolset – Design Tools

Software for modeling of database structures and applications.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| | • ERwin;<br>• BPwin<br>• N-tier design tools;<br>• OO design tools | • ERwin;<br>• BPwin<br>• Integrated data analysis and design tools |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | UML, Java, XML | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| BPwin | Rational Software design tools | UML-based tools<br>Java, XML |

## Middleware – Interapplication Programming Interface

Standards-based applications connecting enterprise data and front-end database systems.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| N-tier | XML /CORBA | XML /CORBA |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | Enterprise Java Beans (EJB); CORBA; | | HTML, Java |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Java, HTML, DHTML |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| OLE; 2-tier | XML | |

**Implications and Dependencies**

**Industry Position:** Industry leaders have based their strategy on XML, Java, CORBA, and Enterprise JavaBeans through the tactical time frame. This strategy includes preferences for suite development tools that include Java and Internet development tools.

Enterprises requiring robust support for applications should design them in a component-based fashion. Applications servers also function in this arena, and they require the right combination flexibility, scalability, fault tolerance, and support for the underlying communications technologies.

## Infrastructure Services – Remote Access

Back-end services providing access to CH network and information services from remote sites such as home, travel, etc.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| | VPN | Design for intermittently connected users, for alternative access devices, and for multiple access protocols |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| ISDN; V.90; 802.11 | CDPD; ISDN; V.90 | ISDN; V.90 | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| | | |

## Infrastructure Services – Web Information Delivery

Back-end systems supporting delivery of enterprise information and applications via the World Wide Web.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Microsoft IIS Active Server Pages; Netscape Communicator | WebSphere | Delivery mechanisms and techniques that meet W3C Accessibility guidelines for the disabled; Client browser utilizing rules to invoke information "push/pull" technologies |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| W3C recommendations (available from W3C Web site) | CGI; ASP; DHTML; XML; CDF; MS Internet Explorer; Netscape Communicator | | Netscape, WebSphere |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Netscape, WebSphere |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | XML |

**Implications and Dependencies**

**Industry Position:** Delivery of information via Web-based technologies is employed by a large majority of public and private sector organizations. The volume, business value and media-type of web-delivered information and the currency of the information is a key concern for those organizations developing or enhancing their corporate knowledge management initiatives.

Also, the use of event triggers to invoke information distribution will assist with filtering irrelevant or non-essential business information. However, this feature presents a risk to network utilization, since triggers do not rely on the somewhat predictable end-user interaction at a workstation.

## Infrastructure Services – Utilities

Services for performing special functions at the desktop, including browser plug-ins, Internet transfers, CH directories, file compression, and data format conversion.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • WinZip<br>• Adobe Acrobat Reader | | |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>• WinZip<br>• WS_FTP<br>• Adobe Acrobat Reader |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| Adobe Acrobat Reader | Video and DVD recording; Multicasting | |

**Implications and Dependencies**

**Industry Position:** The plethora of utilities covers a number of important desktop operations that software suites generally ignore. These include such varied functions as file compression to save space in e-mail attachments and on diskettes (WinZip), file transfer point-to-point over the Internet (ftp), document viewers for data formats not supported by CH, encryption of e-mail for better en-route message security (Pretty Good Privacy, or PGP), and transmission of video and audio streams to multiple, specific targets (multicasting). This category excludes multimedia player software, since the TPS topic "Infrastructure Services -- Streaming Media" addresses this area.

There are effectively no standards for utilities, since this topic area tends to service needs that arise intermittently and irregularly or that pertain to small groups of users.

## Infrastructure Services – Streaming Media

Services for presenting multimedia data to users at the desktop, including live and recorded video and audio feeds.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment** 3-27 Months | **Strategic Direction** 2-5 Years |
| • RealNetworks RealPlayer<br>• Microsoft Windows Media Player | • Microsoft Windows Media Technologies (Media Tools, Media Services, Media Player) | • Integration of graphics, multimedia, and videoconferencing |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| IETF RTSP (Real-Time Streaming Protocol) and RTP (Real-Time Transport Protocol); W3C SMIL (Synchronized Multimedia Integration Language) | RTSP; RTP; SMIL | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Macromedia Shockwave; Macromedia Flash | Microsoft Windows Media Technologies; RealNetworks RealPlayer |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** The leading industry systems for broadcasting live or recorded multimedia streams are RealNetworks RealPlayer, Apple QuickTime, and Macromedia Shockwave. Apple, Lotus/IBM, and AOL have both turned their support to the RTSP standard, initially developed by RealNetworks and Netscape jointly and now supported by Microsoft in its Windows Media Player, which comes bundled with Internet Explorer versions higher than 4.0.

The standards issue is problematic. The IETF RTSP and RTP standards, initially pushed by Apple, are only partially supported by other vendors. The World Wide Web Consortium produced the Synchronized Multimedia Integration Language (SMIL) specification, but neither of the dominant browsers, Netscape Communicator and Microsoft Internet Explorer, supports it.

## Infrastructure Services – Network OS

Operating systems for network file servers, print servers, and special-purpose network servers.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Novell NetWare 4.11 | NetWare 5.1/6.0 | 64-bit NOS |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | Netware; Unix, NT | Netware; Unix; NT | Novell NetWare 5.1/6.0 |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Novell NetWare 4.11 | Novell NetWare 4.11/5.1/6.0 |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | Novell NetWare 5.1/6.0 |

**Implications and Dependencies**

**Industry Position:** Unix (HP-UX and Linux are variants of Unix) is the leader in large organizations (thousands of users per server) and engineering environments, while NetWare is the leader in Large and Medium PC-based networks.

**CH Baseline Description:** All server systems have been migrated to the Novell NetWare/Windows NT hybrid platform. MS Exchange (NT-based) is providing Internet mail services, and Novell NetWare and Websphere will serve as the Web platform.

**CH Application Architecture:** All architected applications will require network services from Novell NetWare OSes using Oracle.

## Infrastructure Services – Directory Services

Services supporting several network-wide services, including security, user access rights, messaging, and remote access.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Novell NDS | Novell NDS | Novell NDS Enterprise Edition |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| X.500; LDAP | NDS; AD; DEN | AD; NDS; X.500; LDAP | NDS |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>NDS |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | NDS | Novell NDS |

**Implications and Dependencies**

**Industry Position:** Directory Services (DS) tie together application access and management under one comprehensive database.

## Infrastructure Services – E-Mail – Enterprise E-mail

Enterprise-based electronic mail system supporting workflow and collaborative services.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Exchange with MS Outlook | Upgrades to MS Exchange | Unified messaging |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | POP3; MIME; SMTP; LDAP | MS Exchange; Lotus Notes Mail | MS Exchange |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>MS Exchange |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

## Infrastructure Services – E-mail – E-mail Gateway and Backbone

Systems for e-mail conversion and transmission across disparate mail systems and platforms.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Exchange Server and Exchange Relay Box; | MS Exchange Server and Exchange Relay Box; MS Exchange 2000 | Unified messaging |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| X.400; X.500 | POP3; MIME; IMAP4; SMTP; uuencode; BinHex | MIME; IMAP4; SMTP; uuencode; BinHex; Tumbleweed Messaging Management Server | MIME; IMAP4; SMTP |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>MS Exchange Server; |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** Unified messaging is the current industry direction of e-mail infrastructures. This concept encompasses multiple message sources, including “traditional” e-mail, voice mail, and faxes, and handles multiple messaging protocols at the infrastructure level. The "universal inbox" functions as the access point to the unified messaging system. The X.400 protocol is useful because of its universal support of multiple mail protocols, since it is the lowest common denominator for transport services and routing to a mailbox.

## Systems Management – Systems and Network Management

Mechanisms for network management, software distribution/tracking, asset management, problem tracking/escalation and resolution, and desktop configuration management.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ Sniffer;<br>▪ Compaq Insight Manager;<br>▪ Zenworks - Managewise | ▪ Upgrades to functionality of switches;<br>▪ VLAN implementation;<br>▪ DMI | ▪ Gigabit Ethernet;<br>▪ Integration of directory services into network infrastructure;<br>▪ Storage Area Network System (SANS) |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| ITU X.500; ITU H.323; IEEE 802.xx series; DMTF DMI; DMTF WBEM | TCP/IP; SNMP; LDAP; SNPP | TCP/IP; SNMP; DMI; LDAP; X.500; H.323; 802.1d; SNPP | TCP/IP; SNMP; |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>HP Openview; Compaq Insight Manager, Sniffer; Zenworks - Managewise |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | SANS; Zenworks - Managewise |

**Implications and Dependencies**

**Industry Position:** SNMP is considered the *de facto* standard for network systems management, specifically for monitoring and notification. Today no single product provides all desired functionality. Single-console management is not available today. DMI standard will provide the framework for single console management. SNPP (Simple Network Paging Protocol) addresses paging.

## Security – Virus Protection

Software for desktop-level protection against viruses and unauthorized access.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| McAfee Antivirus | McAfee Antivirus | Unified security product at the OS level; scanning of e-mail message transfer queues |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | McAfee; Tumbleweed Messaging Management Server | McAfee Antivirus; CH Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>McAfee's Antivirus version 4 and related products |

| | | |
|---|---|---|
| **Containment Target(s)** | **Feasibility Target(s)**<br>Scanning of e-mail message transfer queues | **Emerging Technologies** |

## Security – Digital Authentication

Mechanisms for identification of origination of an electronic transmission, providing assurance of authorship and guarantee against forgery.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment** 3-27 Months | **Strategic Direction** 2-5 Years |
| | Novell BorderManager | |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| NIST FIPS PUBS ANSI X.9.17; ISO/IEC9796; DES; RSA; X.500; LDAP | MOSS; Kerberos | DOE guidance inclusive of the aforementioned formal and *de facto* standards | Novell BorderManager CH Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** Not to be confused with digital encryption or digital techniques of physical authentication of the user, digital authentication from a network perspective guarantees identification of the originator of a message or transaction. It is the result of mathematically mixing ("hashing") the message with the originator's private key to provide assured identification and security against forgery (non-repudiation). At the network level originators include automated equipment such as servers, workstation computers, and network switches. Digital authentication normally also requires access to a trusted "certificate authority" which assists in verifying electronic identification.

Industry analysts make no specific recommendations about standards for digital authentication algorithms, since these algorithms are application-dependent. Leading suppliers of public key infrastructure (PKI) encryption and digital authentication components include: VeriSign, Entrust Technologies, and GTE.

## Security – Data Backup and Redundancy

Services for data storage, retrieval, and loss prevention.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • Backup Exec 8.5 | • Enterprise-wide SANS-based network backups | • Data replication |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | ADSM | CH Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Backup Exec 8.5 |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Data replication; SANS | SANS- and network-attached storage (NAS) backup systems |

**Implications and Dependencies**

**Industry Position:** Current technologies include hierarchical storage management systems (HSMs), optical jukeboxes with capacities approaching terabyte (1,000+ GB) capacity, and DVD systems with capacities of 10 GB to 20 GB per disk. High-volume data objects (video, graphics, sound, etc.) are driving the need for high-capacity storage, along with off-line archival data of e-mail systems. Data replication and SANS and NAS are becoming standard in the industry.

## Security – Transport and Network

Proactive security mechanisms implemented to monitor data transmission.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ CISCO PIX firewall<br>▪ Dynamic IP-address management with DHCP and dynamic DNS | ▪ Network encryption<br>▪ System- and network-based intrusion detection and prevention | ▪ Network encryption<br>▪ System- and network-based intrusion detection and prevention |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | | Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Dynamic IP-address management; firewall |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | CSPP | |

**Implications and Dependencies**

**Industry Position:** No widespread standards exist. Numerous proprietary products are available. Firewall technology is less helpful in the multiple-points-of-access environment, and it cannot offer any intrusion protection or monitoring against non-CH entities with legitimate access to the network. Software add-ons are improving capabilities. Capabilities are not keeping up with Internet-based access demands. Security attack methods are increasingly sophisticated.

## Security – Application Services

Mechanisms to assure appropriate user access to network-based applications.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Operating system-level; Application-level | PKI initiative; Single sign-on; Novell BorderManager Authentication | Security based on client and server OS; Application-level firewalls; Single sign-on effective for all applications |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | Application-level security; PKI | Password prompting; X.500 | Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Novell BorderManager Authentication; Operating system-level; Application Level |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Novell NetWare NDS | |

**Implications and Dependencies**

**Industry Position:**
The rapid adoption by knowledge workers of remote access and handheld devices presents a new level of risk. These devices have weak or no security, and the physical asset is often owned by the end-user, although their electronic contents belong to the organization. This constitutes a new vulnerability and a complex issue that are yet to be addressed either by technology controls or by the risk assessments and security policies of many user organizations.

.

## Security – Datalink and Encryption

Systems to secure data during transmission.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Password protected | PKI; SecureICA; Novell BorderManager Authentication – DES; RSA | Little or no clear-text transmission; encrypted file system |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| Triple DES; RSA | Triple DES; RSA; SecureICA; IP Secure; S-HTTP, SSL | Triple DES; RSA; X.500 | Novell BorderManager Authentication - DES; RSA; CH Cyber Security Program Plan (CSPP) |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Password protected |

| **Containment Target(s)** | **Feasibility Target(s)** | **Emerging Technologies** |
|---|---|---|
| | SecureICA; Virtual private network (VPN); Smartcard; BioMatrix | |

**Implications and Dependencies**

**Industry Position:** Data is always at risk; encryption reduces but does not eliminate the risk. DES and RSA are the industry standards. DES is still the only Federally mandated standard. There are issues with U.S. *vs*. international RSA encryption schemes. International data transmission encryption must be limited to a less secure level by U.S. export law. Decryption algorithms continue to evolve. Increasing processing capabilities help security schemes and hackers alike. Smartcard technology employs encryption schemes and can augment encryption-only security.

## Enterprise Services – Document and Multimedia Management

Hardware and software for storage, indexing, location, and retrieval of multiple types of user-generated data files, including documents, presentations, graphics, scanned images, recordings, and similar document, audio, and visuals files.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ PC DOCS<br>▪ Windows "Fast Find" for indexing | ▪ Network-based and intranet-based document management with interface to SQL-based data;<br>▪ Multi-platform image access and cross-platform image file types;<br>▪ Multimedia conversion utilities;<br>▪ Multimedia authoring toolset | ▪ Web-enabled open document management services, including image management and multimedia document types |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | ODMA | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |
| Non-cross-platform image file types (e.g., PICT, PCX) | PC DOCS; Windows "Fast Find" for indexing |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | PC DOCS | Scalable vector graphics (SVG) |

**Implications and Dependencies**

**Industry Position:** The leading vendors have created proprietary products and are now working to incorporate open standards (Java, XML). FileNET, SAROS, PC DOCS, Open Text Corp., and Documentum are leaders at the middle and high end of product offerings. Web-enablement of vendors' products is still emerging. Adobe document type PDF is in widespread use in the government and provides some document management capabilities, but it is a proprietary and one-way technology that has no published standard.
Image processing is no longer considered an independent data management function. Well established standards include TIFF, JPEG, and MPEG (full-motion video) formats, and the World Wide Web Consortium also offers provisional support for SVG, WebCGM, and PNG.

CH must consider image processing in conjunction with collaborative services, workflow services and document management. Data storage, processing power, video display, and bandwidth all have high end requirements when image processing is embraced as a key method for data management.

## Enterprise Services – Decision Support Systems

Automated search of enterprise data with what-if scenario capabilities.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| | | Decision support systems, business intelligence, and data mining facilities |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | | Business Object<br>COGNOS |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support** |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** Increasing vendor entry into the Business Intelligence, Data Warehousing, and Data Mining fields provides a vast array of products from specifically oriented products, to products like Oracle.

## Enterprise Services – Disaster Recovery

Hardware, software, and services for maintaining IM operations in the face of major disasters or destruction of normal-use facilities.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| ▪ Scheduled network backups<br>▪ User-discretion desktop backups<br>▪ UPS and fire-defense<br>▪ Locked server rooms | ▪ SANS recovery options<br>▪ Off-site data redundancy<br>▪ Disaster recovery operations | |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Scheduled network backups; User-discretion desktop backups; Novell NetWare clustering and LBS |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | SANS-based redundancy for all data systems; Hardware/software outsourcing options | Novell NetWare Cluster Services, SANS Fiber Channel; Remote vaulting and mobile vaulting |

**Implications and Dependencies**

**Industry Position:** As in years past, data storage requirements are projected to increase to six times the current level in the next two years. Data storage and data recovery options will have to be moved offsite and operate on a 24x7 basis, to assure that CH organizations can recover from a disaster. The industry is moving toward network-attached storage that operates over high-speed WAN linkages to provide both data redundancy and the ability to restore operations, should a site be shut down by a disaster.

## Enterprise Network – Hardware – Servers

Mid-range computers providing network-based services for files, applications, database management, Web hosting, and other functions.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • 500+ MHz 32-bit dual-processor Intel CPU;<br>• Compaq systems (with SmartStart set-up management);<br>• 256+ MB RAM;<br>• 1+ TB Fiber-Channel clustering and RAID disk storage systems (capacity of all servers taken together);<br>• 100 Mbps Ethernet connectivity;<br>• Multiple ports (parallel, serial) and CD-ROM drive;<br>• Remote server-management functions | • 1+ GHz 32-bit CPU;<br>• 1+ GB high-performance RAM;<br>• 2+ TB hot-swappable fault-tolerant data storage;<br>• ACPI compliance;<br>• Intel 840 chipset and PCI bus;<br>• Multiple ports (parallel, serial, USB, SCSI) and DVD drive;<br>• Full remote server-management functions with Windows 2000 | • 2+ GHz 64-bit multiprocessor CPU with high-capacity on-board cache;<br>• 64-bit bus with hot-swappable PCI slots;<br>• Multi-gigabyte high-performance RAM;<br>• Multi-terabyte storage;<br>• 1+ Gbps network connectivity;<br>• Multiple standard ports;<br>• Hot-swappable power supplies and cooling systems |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | Intel CPU | Compaq/Intel CPU |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>500+ MHz 32-bit dual-processor Intel CPU; Compaq systems (with SmartStart set-up management); 256+ MB RAM; 1+ TB Fiber-Channel clustering and RAID disk storage systems (capacity of all servers taken together); 100 Mbps Ethernet connectivity; Multiple ports (parallel, serial) and CD-ROM drive; Remote server-management functions |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Multiprocessor on single chip | |

| Implications and Dependencies |
|---|

**Industry Position:** The rapid advance in CPU clock speeds continues to offer the technological “edge” to anyone willing to buy. The progress of electronic nano-engineering shows no sign of abating, and 32-bit processors running at 1 GHz (1000 MHz) were released to market early in 2000, and 1.5 GHz (1500 MHz) prototypes were demonstrated at the same time. Higher chip speeds mean not merely faster core processing.
Each of these auxiliary systems must be improved within the server machine, or else the benefits of a high-speed CPU are negated. While CPU speed is generally touted as a solution to 3-D graphics and speech recognition problems, in servers it is important to handle large volumes of data and transactions efficiently. In addition, the continuing rush toward handheld interface devices, cell phones, notebook computers, and other remote-access devices drives the need for a robust back-end infrastructure that will support internal data access, extensive application emulation, and remote communication, all carried on with multiple devices per user.

The revamped architecture of future chips also modifies the traditional concept of symmetric multiprocessing (SMP). New offerings will soon sport two discrete CPUs on a single chip. New architectures also mean new chip sets to support them. The technologies of copper and 0.18-micron specifications further impact CPU manufacture.

This branch of IT has advanced much more rapidly in the past year than analysts had predicted. The demonstration of operational 1.5 GHz chips, along with plans for 64-bit architectures, clearly shows the road ahead, namely that the market will see 2 GHz or 3 GHz speeds within the next two years, together with speed increases in other areas, producing some very fast infrastructure hardware.

## Enterprise Network – Physical Network – Switches and Routers

Hardware for interconnection of workstations to the network and of multiple network segments.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • 100 Mbps Ethernet to the desktop<br>• Modular multi-protocol switches<br>• Virtual LANs (VLANs) | • VPNs<br>• Redundant links between switches<br>• Server Clustering<br>• Multicasting support | 1 Gbps bandwidth backbone with continuing 100 Mbps to the desktop |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| | | Cisco network equipment; Compaq servers | Cisco network equipment; Compaq servers |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>100 Mbps Ethernet to the desktop; Modular multi-protocol switches; VLANs |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | Redundant links between switches; Server Clusters | VPNs |

**Implications and Dependencies**

**Industry Position:** New, large data-types are creating high-bandwidth requirements, which drive new protocols designed to efficiently facilitate transmission of data. Multi-protocol switches are designed to provide flexible, cost-effective support of data transmission, supporting industry standard protocols. Category 5 wiring is rated to 155 Mbps maximum.

## Enterprise Network – Physical Network – Wiring

Physical media providing network connections.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| Category 5 wiring; Fiber optic cable | Category 6 wiring; Fiber optic cable | Category 6 wiring; Fiber optic cable |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| TIA/EIA; IEEE | TIA/EIA; IEEE | | Category 6 wiring; Fiber optic cable |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>Category 5 & 6 wiring; Fiber optic cable; |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | |

**Implications and Dependencies**

**Industry Position:** Category 5 wiring and fiber cabling are designed to support 100 Mbps or higher. Enhanced Category 5 provides for improved technical functionality over ordinary Category 5, with its standards nearing finalization. Category 6 wiring standards are in development.

## Enterprise Network – Wide Area Transport

Data transport protocols and technologies at the network level.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| • ATM<br>• ISDN<br>• IPX/SPX<br>• IP | • ISDN DOE-wide (nationally) | • OC3 |

| Standards | | | |
|---|---|---|---|
| **International, National** | **Industry** | **DOE** | **CH** |
| ANSI; IEEE | ANSI; IEEE | | |

| Execution | |
|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>ATM; ISDN, IPX/SPX, IP |

| Containment Target(s) | Feasibility Target(s) | Emerging Technologies |
|---|---|---|
| | | Optical wave-division multiplexing (WDM) |

**Implications and Dependencies**

**Industry Position:** Upcoming application and data requirements are growing extremely rapidly, which necessitates high-bandwidth data transmissions at the desktop level. The growth of technologies that require high bandwidth, such as video, audio, push technology, network conferencing, remote access requirements, and interactive n-tier database systems, is a major motivation to keep the transmission capacity apace with these functionalities. Office desktop requirements, as listed in the TPS "Enterprise Network – Physical Network – Switches/Routers" above, will move to 2+ Gbps in the five-year time frame.

## Database Management – Enterprise DBMS

High-performance network-based database management system in a multi-tier system.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| SQL Server 6.5 and 7.0 | ▪ MS SQL Server 2000; online analytical processing (OLAP);<br>▪ Oracle based object-relational DBMS (Internet databases) | Oracle based object-relational DBMS (Internet databases) |

| Standards | | | |
|---|---|---|---|
| **International or National** | **Industry** | **DOE** | **CH** |
| ANSI SQL X3.135-1992 (R1998);<br>ISO SQL 9075:1992/Cor 3:1999 | Structured Query Language (SQL) | | SQL Server 6.5 and 7.0, Oracle |

| Execution | | |
|---|---|---|
| **Retirement Target(s)** | **Mainstream Support**<br>SQL Server 6.5 and 7.0, Oracle | |
| **Containment Target(s)**<br>MS SQL 6.5 | **Feasibility Target(s)**<br>XML; OLAP | **Emerging Technologies**<br>Incorporation of Java in the kernel; English-language queries |

**Implications and Dependencies**

**Industry Position:** Oracle 8i, Informix Centaur, and IBM DB2 Universal databases are products that compete at the enterprise level. The Informix products were designed first for a Unix platform. Porting to NT has resulted in measurable performance degradation. General issues affecting CH implementation include server clustering, fault-tolerance, and database replication. All vendors are working to extend the object-relational and "universal" aspects to become more Internet-capable. Oracle incorporates the *interMedia* technology previously sold as an option for storing multimedia data types, and adds Java technology to the kernel. Informix will add Java technology as well as ActiveX/COM.

## Database Management – Workgroup DBMS

Workstation-based (often stand-alone) database system used by small groups.

| Vision | | |
|---|---|---|
| **Current Environment** | **Tactical Deployment**<br>3-27 Months | **Strategic Direction**<br>2-5 Years |
| MS Access 97 | Lotus Notes Application Development; SQL-based workgroup DBMS; Oracle-based workgroup DBMS | ▪ Oracle-based workgroup DBMS<br>▪ Lotus Notes Application Development; |

| Standards | | | |
|---|---|---|---|
| **International or National** | **Industry** | **DOE** | **CH** |
| | Structured Query Language (SQL) | | MS Access 97 |

| Execution | | |
|---|---|---|
| **Retirement Target(s)** | **Mainstream Support** | |
| **Containment Target(s)**<br>X-base systems; MS Access 97 | **Feasibility Target(s)** | **Emerging Technologies** |

**Implications and Dependencies**

**Industry Position:** Mobile and remote-access computing and database synchronization requires technical expertise that is expensive for non-IT department budgets. These issues will grow and force even workgroup database services into the management umbrella of the IM function. Only rudimentary services such as mail-list creation or limited decision-support analysis will stay within the workgroup. The effect is that strategic directions show effectively no differences from tactical goals.

# Appendix II: CH Technology Projects Planned for FY2000

The pages here summarize the proposed CH Technology Projects. Each project is represented by the project name and a brief description. Further details such as estimates of cost and schedule, dependencies on other technologies and technology projects, and associated issues, will be detailed later by CH-IAS. This listing of projects functions as a preliminary map for tactical planning in the coming fiscal years. A more detailed listing of these projects with proposed schedules is available from the Strategic Planning and Architecture team of CH-IAS.

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## Summary List of Proposed Technology Projects

1. Document Management – This project defines and pilots efforts to support CH with document management and supports ties to Federal Records Management capabilities.
2. Workflow – This projects defines requirements and pilots an effort to evaluate various needs in workflow in Business processes within CH
3. Office Automation – This project is an annual Level of Effort for increasing capabilities to the end user to facilitate increased productivity
4. Information Management – This project provides a foundation of capabilities to support the IAS organization to produce software and support
5. MS Exchange Rollout – This project puts MS Outlook on the CH Users desktop and connects the Outlook client to the MS Exchange server for all CH Mail functions.
6. Rollout of MS Office 2000 – This project upgrades CH Users office suite to MS Office 2000. This upgrades MS Word, Excel, PowerPoint, and MS Access.
7. Rollout of Lotus Notes (Application Development)– This is a pilot program to evaluate the capabilities of Lotus Notes for evaluation for compatibility, interoperability, and sharing of capabilities with the CH Infrastructure.
8. Rollout of Windows 2000 for the desktop operating system – This project upgrades the CH Users desktop operating system to MS Windows 2000 Professional.
9. Remote Access project – This project facilitates remote access to CH Mail, applications, and network storage via communications technologies.
10. Novell BorderManager Rollout – Implementation of Cyber Security Plan products.
11. Netscape Upgrade – This project upgrades the CH User to a current version browser capability.
12. Dragon Naturally Speaking Rollout – A pilot rollout to evaluate requirements for speech recognition with CH Desktop applications.

## Priority and Sequencing of Technology Projects

The technology projects identified above provide capabilities and functionality for CH. Some of these capabilities are directly related to the applications defined in the Applications Architecture while others are pilot projects to further evaluate products or infrastructure needs and capabilities. The information below provides some of the linkages between the Technology Projects and their justifications, relationships, and dependencies.

| Technology Project Name | Justification | Dependency |
|---|---|---|
| **Document Management** | This project is a key infrastructure project for the storage and tracking of information within CH. It will serve as a repository of information produced at CH, and received from outside CH. This repository will provide a baseline capability for integration into a searchable repository, such as an Information Portal, similar to the Office of Science Intranet Portal (SCIP) project. | Capabilities in several applications require a document management function. These applications could include Budget Formulation Application, Contract/Financial Assistance Application, Financial Tracking Application (Budget Execution), Human Resources Application, Information Management Application, Intellectual Property Information Tracking Application, Laboratory Project Management Application, Office Automation Application, Oversight Application, Performance Management Application, Program/Project Management Tracking Application, and the Regulatory Compliance Application. |
| **Workflow** | This project is a second infrastructure project that will provide a cross cutting capability that will provide value to both applications being implemented and day to day office requirements associated with the Office Automation Technology Project | There are no current dependencies with this project, but as the applications in the architecture are further defined, the need to have a routing and tracking capability will be identified. Examples of where Workflow may develop into dependant projects include both Budget Formulation and Budget Execution. |
| **Office Automation** | Office automation in CH provides the end users of CH with tools and capabilities to increase their ability to do their job by giving them better, more advanced tools to work with. The initial task in this annual project will be to identify the current situation and work with the end user community to validate that the tools in use today are adequate. Mapping these to needs and identifying where opportunities can be exploited will be key in this | This project has dependencies of most other projects within CH. The basis of an office suite of tools and standard image software provides a foundation. This foundation may become a key integration with applications within the architecture, but is not known at this time. |

| | | |
|---|---|---|
| | project. | |
| **Information Management** | This project supports the Information Management team, IAS. Supporting the IAS team with the cradle to grave management of applications development, engineering, testing, integration and production support. This project will be the adoption of a Software Development Life Cycle (SDLC) and tools to support it. | All projects and applications are dependent on IAS having a robust SDLC and appropriate processes in place. |
| **MS Exchange Rollout** | This project will implement a common robust server based mail system that is compatible with CH infrastructure and mail in terms of attachments, scheduling, etc. This project is an advancement from the current cc mail system and will provide additional security and virus protection over current systems. | Several projects may have links into functionality and compatibility with MS Exchange, but these are not identified at this time. |
| **MS Office 2000 Rollout** | MS Office 2000 provides increased capabilities in an office suite. Upgrading to MS Office 2000 will enable users to take advantage of having more advanced tools and increases their productivity and effectiveness in their positions. | Several projects may have links into functionality and compatibility with MS Office, but these are not identified at this time. MS Office is also compatible with other infrastructures within CH. |
| **Lotus Notes Application Development** | This is an experimental pilot. | This is not dependent on any other projects. |
| **Windows 2000 Desktop OS** | This is an upgrade to the standard image for end users operating systems. This will provide better security, more infrastructure capabilities from the OS, and advanced features from the existing desktop OS. | This project will provide additional security and infrastructure capabilities that may provide infrastructure for other projects not known at this time. |
| **Remote Access Project** | This project is a necessary addition to the CH infrastructure since the previous solution has been eliminated. This solution will allow users to access their working information from remote. | The infrastructure required by this project will create dependencies on security and infrastructure projects in addition to applications that are required to be accessible remotely. |
| **Novell BorderManager** | This is a security infrastructure project that is required in the Cyber Security Plan. | Other projects like Office Automation will be dependent on this project for interoperability. |
| **Netscape Update** | This upgrade is necessary to facilitate advanced capabilities within the internet and intranet developed applications. | The development infrastructure may require this to be implemented, but this is net known at this time. |
| **Dragon Naturally Speaking** | This is a pilot effort to gather additional requirements for a task relevant to Office Automation. | Office 2000 and Windows 2000 Rollout are predecessors to this project. |

**Sequencing of Technology Projects**

The technology projects are aligned as depicted on the following page in the PERT chart. Priority is based on Top to bottom and left to right.