
Commonwealth of Virginia

Enterprise Technical Architecture (ETA)

Platform Domain Report

Version 2.0, July 10, 2006

Prepared by:

[Virginia Information Technologies Agency](#)

ETA Platform Domain Team

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Platform Domain Creation and Review

In 2005-2006, three teams addressed updates for personal computing, servers, and utility services. The individuals on the teams were chosen by Agency Information Technology Representatives (AITRs) and others for their ability to research and update the domain report and the related policy, standard and guideline documents. The personal computing update team began its work in May, 2005. Two additional teams began work on server and utility topics in July, 2005. Work was discontinued in September due to other priorities and resumed in December, 2005 to produce requirements for all technical domains. Recommendations by the three teams were then incorporated into Version 2.0 of the Platform Domain Report. The team members who worked on this effort are as follows:

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Platform Domain Report: Version History		
Revision	Date	Description
1.0	3-3-2004	Initial (Formally known as the Platform Architecture Standard)
2.0	07-10-2006	Platform Domain Report

Review Process

Technology Strategy and Solutions Directorate Review

The domain report was reviewed and approved by Jerry Simonoff, Director and Paul Lubic, the Associate Director of Policy, Practices, and Architecture Division.

Online Review

Participation of all Executive Branch agencies was encouraged through a review and comment period via VITA’s Online Review and Comment Application (ORCA). Technology businesses and the general public were also actively encouraged to use ORCA to provide comments. All comments were considered and many resulted in modifications to the final document. Additionally, the Domain team provided the reviewers with responses to their comments.

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Executive Summary

The original domain team identified personal computers, servers, and storage as the most important topics to be included in the platform architecture domain scope and recommended the inclusion of printers as a topic for later consideration. The 2006 platform domain report is substantially broader in scope and provides the following:

- Overviews of three technical topics: personal computing, server, and utility services
- Information on the current situation or as-is architecture
- Requirements for executive branch agencies related to these topics
- Requirements related to centralization efforts for some executive branch agencies
- Rationales and background information related to the requirements
- Recommended practices for the topics
- A [Glossary](#) of technical terms (the Glossary precedes the Appendices)
- Web links provide additional information resources for selected technologies (these links are provided both in the glossary and throughout the document)

For personal computing devices, the general approach recommended is one of strong central control. Controls are proposed for the following areas: hardware acquisition, desktop display replacement, operating systems (OSs), [productivity software](#), printers, wireless services, and desktop management.

Also important to personal computing is improved use of metrics and continued assessment of costs, benefits, tool usage, and changes in agency business needs.¹ Especially in the area of changes to productivity software including word processing, spreadsheets, desktop databases, and presentation software, comprehensive Virginia government studies are recommended. The results of studies should be used both in price negotiations with Microsoft and in reconsidering the future directions for personal computing. Sun's Java Desktop is an example of one alternative environment that could be evaluated.

The report recommends continued use of Microsoft solutions for personal computing and a centrally controlled approach to providing desktops, notebooks, and all related services for those agencies served by the Virginia Information Technologies Agency, [VITA](#). The standardization proposed for personal computing is expected to lower costs, improve support, improve personal computing tool uniformity, and improve services availability

¹ The platform domain team's review of current legislation, agency budgets, and agency strategic IT plans indicated that there are no planned agency changes that would require major changes in the Business Architecture's list of business functions or delivery of services methods (as recorded in Version 1.0 of the Business Architecture). In other words, they expected that the agencies would collectively perform about the same set of business functions and would use about the same set of methods. Only emphasis would change.

for the Commonwealth's workforce. Accommodation of multiple device types is recommended for wireless access to services such as wireless email and personal management data (e.g., contacts and calendar).

Over time, the personal computing architecture in Virginia will evidence targeted changes as follows:

- Improved knowledge of user needs by job role
- Centralized purchasing of personal computing tools
- Greater standardization of desktop and laptop software and hardware
- Fewer desktop printers
- Software changes supported by a business case
- Greater availability and use of time-saving devices
- Greater use of wireless devices
- Life cycle standardization

For servers, the main thrust is consolidation and simplification across agencies served by VITA, within individual colleges, and within the community college system. As part of the consolidation and simplification, the platform architecture narrows the number of platform types by restricting operating systems to Microsoft Windows, Unix (HP-UX, AIX, Solaris, and [Linux](#)) and IBM z/OS. Also on the low-end, [appliances](#) are encouraged as options as are proven blade server solutions (if cost-effective) and high-density racks. For any application needing high-end performance, the report recommends that decision makers consider all in-architecture high-end platforms alternatives to promote competition among them when conducting cost and effectiveness analyses for a particular application.

[Virtual server](#) technology is expected to continue to play a significant role in Virginia's consolidation solutions. However, virtual servers should run only those operating systems that are in Virginia's architecture or that are past versions of them.

The ability to grant exceptions to operating systems standards will be critical, especially for servers that support business applications that cannot be moved cost-effectively. Also, when agencies wish to adopt proven applications developed for other states, the agency may need an exception if the application has been proven only on one out-of-architecture platform. Agencies should only migrate from existing platforms when it is cost-effective to do so or when the manufacturer has scheduled the existing platform for obsolescence (i.e., has eliminated support).

Over time, the server architecture in Virginia will evidence targeted changes as follows:

- Improved data on business and application related infrastructure data
- Fewer servers
- Fewer server locations

- Better services operated with fewer staff (e.g., for backup provision)
- More high-density solutions
- Increased reliance on telecommunications
- Movement of databases to separate platforms from the applications that use them or to separate partitions on the same platform
- Fewer operating systems across applications
- Increased use of [scale-up](#) and [scale-out](#) consolidation solutions
- Scalable server solutions for utilities including email, web page serving, and storage
- Use of virtual servers for development and some testing
- Use of virtual servers for accommodating multiple versions of an OS as a transition strategy for consolidation of a [network](#) function
- Use of appliances for functions including cache, storage, etc.
- Use of stored images for rapid provisioning changes to clusters
- Active consideration of more than one “within-architecture” platform alternative for all new and revised business applications
- Tracking of planned retirement dates for applications and for server hardware
- Increasing use of Linux
- Managed increases in uses of Solaris and HP-UX
- Decreasing use of Windows where Linux and Novell are used
- Managed decrease in the use of all platforms not in the architecture
- Managed increase in use of platforms in the strategic architecture
- Eventual use of Windows as a consolidation platform
- Continued use of commoditized hardware at the low and low-midrange server end
- More consistent product life-cycle management
- Continued acquisition of high-end platform capacity when it is needed (e.g., for processor activation, processor acquisition, etc.)
- Having lease lengths that match planned technology life
- More standardized technology lifecycles for hardware
- Movement to consolidation platforms only if cost effective (effectiveness assessments include consideration of the value of all benefits such as security improvements, more consistent backup and recovery provision, customer service improvements, and other consolidation benefits)

- Separate management of applications remaining on an “out-of -architecture” platform

The report also provides recommendations for standardized approaches to several utility services. Utility services are those networked activities that should be performed in a common way across all agencies for cost reduction and service improvement. The utilities addressed at this time include the following: Microsoft network related services; print, scan, fax and copy services; storage services; email and other messaging services; and Linux use across utilities.

The expected changes in the Commonwealth’s utility architecture include the following:

- Improved planning, capacity and usage data for all utilities by application
- Coordination of presentation, database, messaging, and storage options within and across in-architecture platforms and tiers
- Reductions in the number of utility servers
- Common deployment of utility servers
- Reductions in the number of file servers
- Increased use of shared storage systems
- A central directory for VITA served agencies
- A scalable, central email solution for VITA served agencies
- Improved services for print, fax, copy and scan needs for all employees who need these services
- Fewer printers, fax machines, and copiers
- More scanners (this will support paper storage reduction efforts)
- Increased use of Linux utilities when they provide a cost-effective alternative to Microsoft utilities
- More unified messaging
- Improved use of networks for supporting a multitude of services for every agency
- More unified networks that are better able to support a broad range of utility services

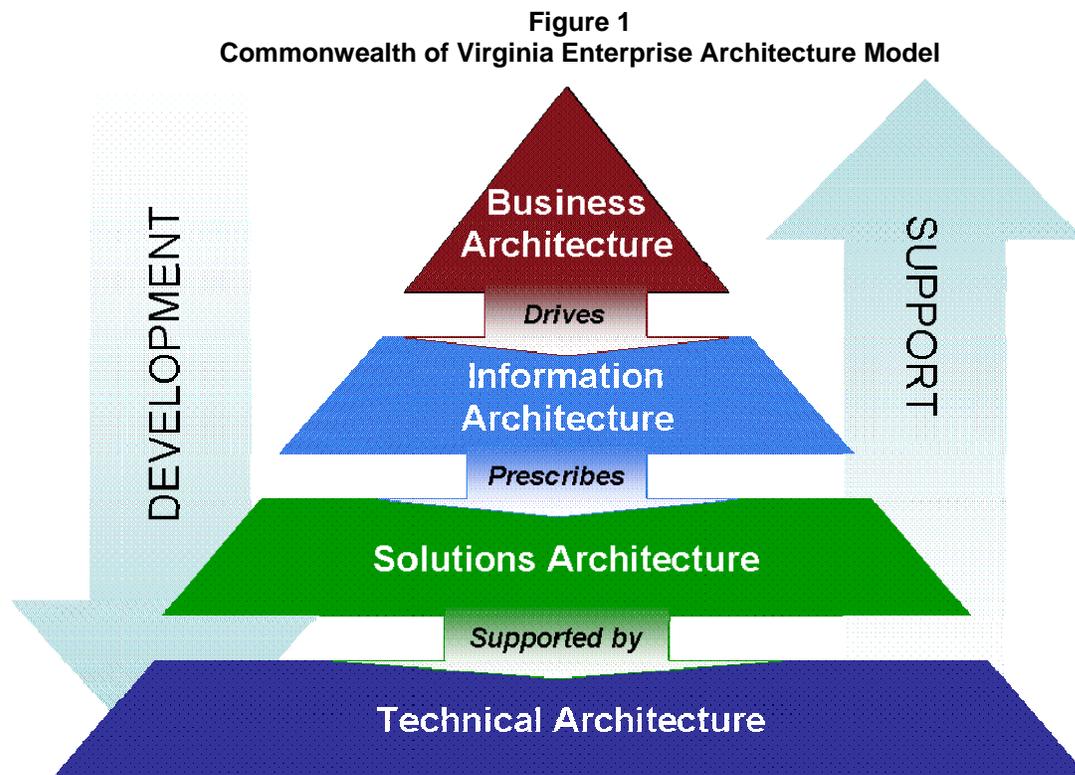
Overview

The Commonwealth's Enterprise Architecture is a strategic asset used to manage and align the Commonwealth's business processes and Information Technology (IT) infrastructure/solutions with the State's overall strategy.

The Enterprise Architecture is also a comprehensive framework and repository which defines:

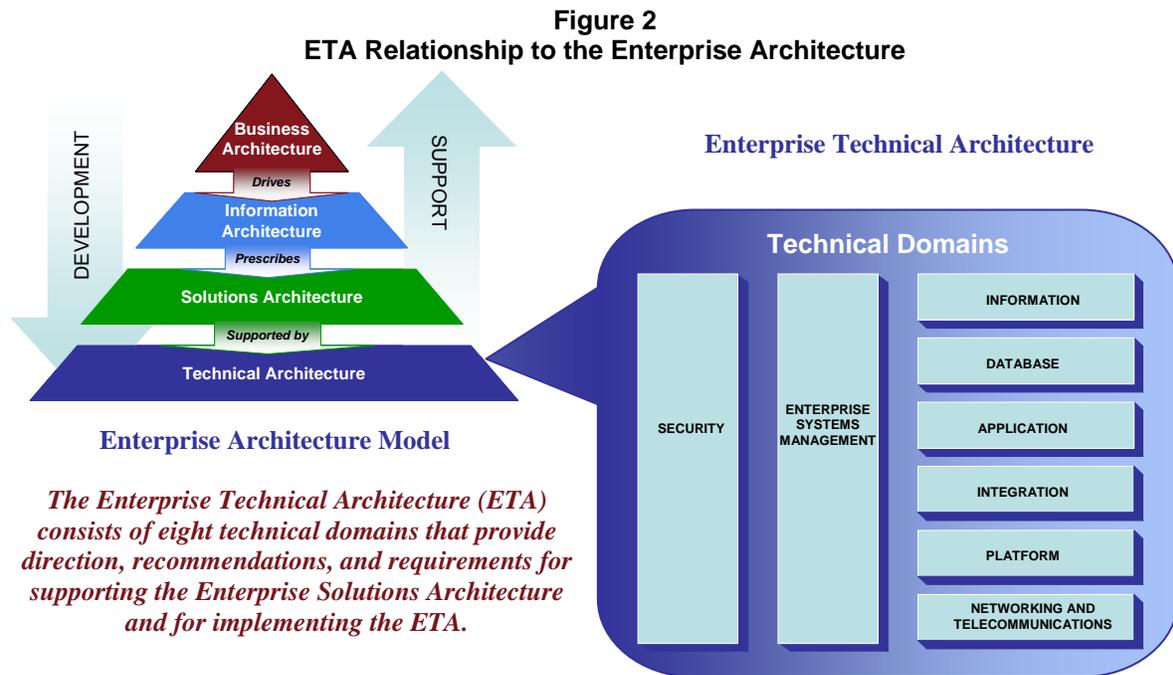
- the models that specify the current ("as-is") and target ("to-be") architecture environments,
- the information necessary to perform the Commonwealth's mission,
- the technologies necessary to perform that mission, and
- the processes necessary for implementing new technologies in response to the Commonwealth's changing business needs.

The Enterprise Architecture contains four components as shown in the model in Figure 1.



The Business Architecture drives the Information Architecture which prescribes the Solutions Architecture that is supported by the Technical (technology) Architecture.

The Enterprise Technical Architecture (ETA) shown in Figure 2 consists of eight technical domains that provide direction, recommendations and requirements for supporting the Solutions Architecture and for implementing the ETA. The ETA guides the development and support of an organization's information systems and technology infrastructure.



Each of the domains is a critical piece of the overall ETA. The Networking and Telecommunications and Platform Domains address the infrastructure base and provide the foundation for the distributed computing. The Enterprise Systems Management, Database, Applications, and Information Domains address the business functionality and management of the technical architecture. The Integration Domain addresses the interfacing of disparate platforms, systems, databases and applications in a distributed environment. The Security Domain addresses approaches for establishing, maintaining, and enhancing information security across the ETA.

This report addresses the Enterprise Technical Architecture Platform Domain and includes requirements and recommended practices for [Virginia's agencies](#)^{2,3}.

² This report provides hyperlinks to the domain report Glossary in the electronic version. In the electronic and printed versions, the hyperlinks will have the appearance established by the preferences set in the viewing/printing software (e.g., Word) and permitted by the printer. For example, the hyperlinks may be blue and underlined in the screen version and gray and underlined in the printed version.

³The Glossary entry for agency is critical to understanding ETA requirements and standards identified in this report and is repeated here. **State agency or agency** - Any agency, institution, board, bureau, commission, council, or instrumentality of state government in the executive branch listed in the appropriation act. ETA requirements/standards identified in this report are applicable to all agencies

This report was developed by the Platform Domain team, which was commissioned to identify domain related requirements and recommendations. Identified requirements and technology product standards from this domain report will be combined with requirements and technology product standards from other technical domain reports into a single ETA Standard for review and acceptance by the Information Technology Investment Board ([ITIB](#)).

Concerning local governments, courts, legislative agencies, and other public bodies, while they are not required to comply with a requirement unless the requirement is a prerequisite for using a VITA service or for participating in other state-provided connectivity and service programs, their consideration of relevant requirements is highly recommended. This architecture was designed with participation of local government and other public body representatives with the intent of encouraging its use in state and local interconnectivity efforts.

including the administrative functions (does not include instructional or research functions) of institutions of higher education, unless exempted by language contained in a specific requirement/standard.

Commonwealth of Virginia: To-Be ETA

The to-be Enterprise Technical Architecture envisioned for the Commonwealth will be one where the Commonwealth's citizens and other customers who wish to access Virginia services will do so by utilizing an Enterprise Portal via standard web browsers.

Where appropriate, these online government services will be developed, delivered and supported using a Service-Oriented Architecture (SOA) based on open and industry standard solutions. Selected legacy applications will be exposed to the SOA using web services.

The SOA will be supported by an Enterprise Service Bus that provides Orchestration and Choreography Services to the agencies.

Central integration and coordination will be managed by an Integration Competency Center (ICC) that supports agency needs such as: asynchronous message queuing and persistence.

Large complex *mission critical* applications that need to be reliable, scalable, secure and highly available will be n-tiered and will utilize business rule and workflow engines.

Enterprise application software for the core government administrative business functions will be consolidated and the underlying business processes modernized. An Application Management Center of Excellence will service and manage the new enterprise applications that replace existing legacy and silo-based applications.

Data will be exchanged among systems, agencies, institutions of higher learning, localities, the federal government, and partners using XML based standards such as the Global Justice XML Data Model and the National Information Exchange Model.

The number and types of software tools and products used by the Commonwealth will be decreased to reduce complexity. This will create the opportunity for agencies to refocus their current in-house IT resources to achieve higher levels of expertise on the fewer required products resulting in, among other benefits, a lower dependence on outside contractors.

Agency software applications and customer services will be delivered and supported by an IT infrastructure that will:

- Be responsive, agile, modular, scalable, reliable, secure, and highly available (24x7)
- Utilize ITIL (IT Infrastructure Library) best practices
- Have extensive and proactive technology refreshment
- Utilize a shared services model for technology delivery
- Have a single secure state-wide [network](#) and Intranet
- Have a state-of-the-art data center and back-up facility
- Consolidate agency servers in their most cost-effective locations

- Unify statewide electronic mail services
- Employ innovative procurements, supplier partnerships, and financing arrangements to fund, expedite, and ensure the performance of future initiatives
- Provide a statewide customer care center
- Improve the cost performance of IT utilized by the Commonwealth

Transition:

The Commonwealth will transition from silo-based, application centric and agency centric information technology investments to an enterprise approach where applications are designed to be flexible. This allows agencies to take advantage of shared and reusable components, facilitates the sharing and reuse of data where appropriate, and makes the best use of the technology infrastructure that is available.

The implementation of the to-be architecture will take some time. It is not the intent of the Commonwealth to force agencies to replace their existing systems. The migration to the to-be architecture will occur as Agencies consider new information technology investments or make major enhancements/replacements to their existing systems. It is important to note that the Commonwealth ETA is not static; it needs to continue to evolve to support changing business strategies and technology trends.

Rationale:

Agencies can achieve the following benefits resulting from the Commonwealth's implementation of the ETA:

- Better responsiveness to changing business needs and rapidly evolving information technologies.
- Greater ease of software application integration and application interfacing.
- Easier secure access to data and information to enable interagency collaboration and sharing.
- Increased levels of application interoperability within the Commonwealth, with other states and municipalities, and with the Federal government.
- Increased sharing and re-use of current information technology assets.
- Faster deployment of new applications.
- Reduction in costs required to develop, support and maintain agency applications.

Definition of Key Terms

All of the Platform Domain ETA standards and requirements considered to be critical components for implementing the Commonwealth's ETA are included in this report.

The report presents three forms of technical architecture guidance for agencies to consider when planning or when making changes or additions to their information technology:

- **Requirements** – mandatory enterprise technical architecture directions. All requirements are included within the ETA Standard.
- **Technology Component Standard Tables** - indicate what technologies or products that agencies may acquire at a particular point in time. These are mandatory when acquiring new or replacing existing technology or products. All technology component standard tables are included within the ETA Standard.
- **Recommended Practices** - provided as guidance to agencies in improving cost efficiencies, business value, operations quality, reliability, availability, decision inputs, risk avoidance or other similar value factors. Recommended Practices are optional.

The following terminology and definitions are applicable to the technology component standard tables presented in this report:

Strategic:

This technology is considered a strategic component of the Commonwealth's Enterprise Technical Architecture. It is acceptable for current deployments and shall be used for all future deployments.

Emerging:

This technology requires additional evaluation in government and university settings. This technology may be used for evaluative or pilot testing deployments or in a higher education research environment. Any use, deployment or procurement of this technology beyond higher education research environments requires an approved *Commonwealth Enterprise Technical Architecture Exception*. The results of an evaluation or pilot test deployment should be submitted to the **VITA Technology Strategy and Solutions: Policy, Practice and Architecture Division** for consideration in the next review of the Enterprise Technical Architecture for that technology.

Transitional/Contained:

This technology is not consistent with the Commonwealth's Enterprise Technical Architecture strategic direction. Agencies may use this technology only as a transitional strategy for moving to a strategic technology. Agencies currently using this technology should migrate to a strategic technology as soon as practical. A migration or replacement plan should be included as part of the Agency's IT Strategic Plan. New deployments or procurements of this technology require an approved *Commonwealth Enterprise Technical Architecture Exception*.

Obsolescent/Rejected:

This technology may be waning in use and support, and/or has been evaluated and found not to meet current Commonwealth Technical Architecture needs. Agencies shall not make any procurements or additional deployments of this technology. Agencies currently using this technology should plan for its replacement with strategic technology to avoid substantial risk. The migration or replacement plan should be included as part of the Agency's IT Strategic Plan.

Agency Exception Requests

Agencies that desire to deviate from the requirements or the technology component standards specified in this report shall request an exception for each desired deviation and receive an approved *Enterprise Technical Architecture Change/Exception Request Form* prior to developing, procuring, or deploying such technology or not complying with a requirement specified in this report. The instructions for completing and submitting an exception request are contained within the *Commonwealth Enterprise Architecture Policy*.

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Background

The Platform Domain Team's mission is to identify Commonwealth policies, standards, and recommended practices for personal computing, server, and utility platforms to meet the business needs of agencies. The team addresses a variety of hardware platforms, the productivity software needs of individuals and workgroups, and utility service provision.

The Platform Domain report addresses requirements and recommended practices that will assist agencies in meeting their needs while moving towards the future platform vision. For platforms, the future vision is a simplified architecture to support more uniform, higher quality, and more cost-effective services. Platform services may meet the needs of individual workers, centrally supported agencies, individual colleges, or centrally supported colleges. The document also defines obsolescent/rejected, transitional/contained, strategic, and emerging directions for technical platform components.

The audiences for the *Platform Domain report* are the business and technical leaders in state and local agencies (universities, colleges, and agencies from all branches of government) and those involved in centralization and consolidation activities. This information will assist those who make technical decisions related to platforms and platform services in being responsive to changing business needs and services.

In general, the document provides assistance to executive branch agencies and their platform service providers in the following ways:

- Overviews of three technical topics: personal computing, server, and utility services
- Information on the current situation or as-is architecture
- Requirements for executive branch agencies related to these topics
- Requirements related to centralization efforts for some executive branch agencies
- Rationales and background information related to the requirements
- Recommended practices for the topics
- A [Glossary](#) of technical terms (the Glossary precedes the Appendices)
- Web links provide additional information resources for selected technologies (these links are provided both in the glossary and throughout the document)

Requirements within this document are addressed to: agencies, agencies excluding higher education; or the Virginia Information Technologies Agency (VITA). The term "agency" is used to mean Commonwealth of Virginia executive branch agencies and institutions of higher education.

In 2003, when the General Assembly created VITA, it gave VITA considerable responsibility for computer infrastructure. Whenever VITA is referenced in a requirement, the requirement addresses a function for which VITA has been given responsibility such as server consolidation. Such services are provided to some executive

branch agencies and/or localities, but not to all. Only served agencies are affected by VITA requirements. In the instance of outsourced or partner-involved services, the outsourcer or partner must adhere to the requirement on behalf of VITA or other agencies.

Concerning local governments and other public bodies, while they are not required to comply with a requirement unless the requirement is a prerequisite for using a VITA service or for participating in other state-provided service programs, their consideration of relevant requirements is highly recommended. This architecture was designed with participation of local government and other public body representatives with the intent of encouraging its use in state and local service provision efforts.

Methodology

The platform domain team began its work by defining the platform domain, and by delineating the team's goals, objectives, and scope of work. Discussions included how the platform domain interfaces with other technical architecture domains, the present and future directions for platforms, and how often the information provided in this document is to be updated. The team also reviewed input from publications and individuals with specialized knowledge. The results of the team's efforts and deliberations are provided throughout this document.

Platform Domain Definition

The platform domain addresses personal and business computing hardware systems and related software. The hardware platforms include servers, storage systems, server appliances, personal computing devices (desktops, notebooks, and hand-held computing devices), and peripheral devices (e.g., printers). Software is limited to personal computing software, operating systems and utility system software used to meet basic platform infrastructure needs. Software examples include Windows operating system, word processing software, email server software, and server backup software. The platform domain addresses the hardware and software issues, requirements and recommended practices under three technical topics: personal computing, servers, and utility systems.

Objectives

The domain team has addressed the following objectives in its initial work and will continue to do so during periodic reviews.

- Provide comprehensive coverage of trends, topics, issues, and critical information needs for personal computing, servers, and utilities to guide VITA staff and agency decision makers.
- Support requirements that will simplify and standardize platform approaches in Commonwealth executive branch agencies with the following goals in mind.
 - Provide a long-term target architecture vision with opportunities for short-term payoffs.
 - Encourage platform acquisition practices within and across agencies that will result in a more homogeneous platform domain, improved support, and greater economies of scale.
 - Improve citizen/customer services by improving infrastructure and its management in the Commonwealth.
 - Influence standards-based requirements in areas such as solutions design, transmission interface selection, [mobile](#) computing technologies, where standards are evolving.
 - Enable cost-effective central location and/or central management options for platforms for participating agencies.

- Recommend best practices for IT decision making for Commonwealth-wide efforts and for those of the Commonwealth's state and local agencies.
 - Enable the convergence of voice, video, image and data services in the Commonwealth.
 - Encourage well-planned solutions within and across agencies that meet business needs while protecting investments and reducing future expenditure escalation.

Platform Domain Scope

The Platform Domain addresses three technical topics: personal computing, servers, and utility servers and services. This document will address these topics within the scope indicated below:

- Personal Computing Devices
 - Desktops–Hardware/OS/productivity software
 - Notebooks–Hardware/OS/productivity software
 - Handhelds–Hardware/OS/productivity software
 - Personal Printers–Hardware
- Servers
 - [High-end servers](#)–Mainframes/enterprise servers/OSs
 - [Midrange/low-end servers](#)–All other servers/OSs
 - Consolidation platforms
 - The Role of Linux
- Utility Servers and Services
 - Print, fax, copy and scan services
 - Network services
 - Network edge services (web cache–not middleware)
 - Email services
 - Storage, backup and recovery services

Within this document, some important areas will be touched on that are not in scope. When the area is in the scope of another technical domain (e.g., routers would be covered in the network and telecommunications domain and database standards in the database domain) this will be noted.

Definition: Personal Computing Devices

Personal computing devices include a variety of hardware and software components for desktop computers, notebooks, handhelds and peripherals. The following definitions and discussion provide specific examples of which components and topics may be included and which are excluded from discussions in the platform domain document.

Desktops, Notebooks, Peripherals and Productivity Software

Desktops include all non-mobile personal computer hardware, software, and peripherals that might be provided to most Commonwealth employees as networked desktops. Desktops may be fat or thin clients and may include versions of Macintosh, Windows, and [Linux](#) operating systems.

Notebooks include all computing devices that provide desktop functionality to a mobile worker in or out of the office. Laptops, pen tablets, and Tuffbook form factors are included in this category. Notebook discussions may cover any of the components in desktops when differences should be noted or mobile computing options that are not relevant to desktops (e.g., specially designed mobile [chipsets](#) that conserve battery power).

Hardware for desktops and notebooks includes the CPU, [I/O](#) ports, network interfaces, communications buses, memory, storage, power supply, graphics, audio, and controller components.

Productivity software is considered to be an integral part of the government worker's desktop or notebook computer. Productivity software discussed may include office suite, browser, plug-ins, calendaring, scheduling, email client, help desk client, network client, and related software.

Personal computing peripherals discussed here include monitors, printers and media read/write devices. Removable media is also discussed. Personal printers are small, general use printers that are direct-attached to one personal computer. Personal printers are not typically shared. Other personal computing peripherals are considered to be of lesser enterprise importance at this time.

Handhelds

Handhelds include all computing devices typically used by government workers that provide less functionality than a notebook or specialized functionality. Typical devices include personal digital assistants ([PDAs](#)), cell phone/PDAs, and smartphones. Limited function devices (e.g., inventory/tracking computers) are not covered. Devices specifically excluded from consideration in this category are voice-only devices including single purpose telephones, cell phones, and communication radios.

Definition: Servers

Servers include the full range of devices from mainframe computers to small single-processor computers, which might function as single service-providers on a client-server network (e.g., file/print server, application server, database server, or web server). Excluded are hardware devices that function as both client and a server in a peer-to-peer network, bridges, and routers. A server solution may include single servers, [virtual servers](#), [clusters](#), farms, frames of server blades (e.g., a blade chassis), and n-tier applications solutions. Server configuration capabilities, management options, and shared use options are important considerations in the discussion of servers. Servers may also be appliances or specially configured, single purpose devices. Servers include hardware and software as follows: operating systems, CPUs, I/O ports/interfaces, communications buses, memory, storage, power, controller components, frames, and racks.

Definition: Shared Utility Platforms

Shared utility platforms include platform solutions that provide general technical services including printing, faxing, scanning, domain name services (and other network services), storage, backup, archiving, email and other similar solutions centrally. Utility services are

defined in this report to support centralization and common handling of services that are currently implemented in many different ways using different practices across the served entities. The ideas are intended to be useful to VITA, VCCS, or individual colleges and universities. The services addressed are those services requiring the least specific knowledge of agency business and providing the greatest opportunity for efficiencies and improved practices. The following shared utility services are addressed:

- Storage, archiving, backup and recovery devices and services
- Output servers and devices—print, fax, scan and copy servers and devices
- Messaging/email services (networked, mobile, audio, video, and data)
- Network control services

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Domain-wide Principles, Recommended Practices and Requirements

The following principles, recommended practices, and requirements pertain to all components, in all situations and activities related to the platform domain. Component specific principles, recommended practices, and requirements are discussed below in the “Platform Domain Technical Topics” section.

Principles

Principles are guiding beliefs adopted as part of the enterprise architecture development methodology. Principles describe the desired future architecture in global terms. They are intended as guidance for the domain teams. They are less specific than best practices, which are intended to guide agency and central service actions and decisions.

In addition to the principles identified in the “[Commonwealth of Virginia Enterprise Architecture – Conceptual Architecture](#)”, the platform domain team identified the following eight domain-wide principles:

- PLA-P-01: Platforms based on standards** – Platform choices will be based on technical standards that have been formally adopted by standards groups whenever possible.
- PLA-P-02: Design to meet business needs** – The design of platforms will meet business needs for availability, reliability, speed, scalability, fault tolerance, and business continuity.
- PLA-P-03: Use TCO metrics** – The use of total cost-of-ownership metrics is one of several important factors in making platform acquisition decisions.
- PLA-P-04: Balance uniformity with efficiency** – Solutions will balance platform uniformity goals with platform business efficiency and effectiveness goals.
- PLA-P-05: Centralize platform utilities** – Platform utilities are identified and centralized whenever it is practical and cost effective to do so.
- PLA-P-06: Use of outsourced and in-sourced solution** – The Platform Domain should enable the comparison of outsourced and in-sourced solutions for platform acquisition and management.
- PLA-P-07: Security as a Platform Decision Factor** – Security is an integral part of platform design and acquisition decisions.
- PLA-P-08: Business continuity** – Solutions design will address business continuity needs.

Recommended Practices

The following domain-wide recommend practice applies to all platforms.

- PLA-RP-01: Government-wide Technology Clearinghouse:** VITA should explore agency interest in sharing information technology business applicability, surveys, technology test results, test facilities, test plans, testing opportunities, test uses, and lessons learned. This sharing to promote reuse could be in the form of a clearinghouse. Coordination and communications could include all branches of state government. Possible homes for the Clearinghouse might be VITA, a university, a large agency (other than a university), or the Council on Technology Services (COTS). A university may be an especially appropriate host due to their education role, their ability to apply successfully for external funds, their own interest in publicizing internal research and development efforts, and their access to special test facilities. VITA may wish to request that COTS consider exploring these possibilities.

Requirements

The following two domain-wide requirements apply to all platforms.

- PLA-R-01: Security as a Platform Decision Factor:** VITA shall consider business security requirements up front when making decisions for all platforms from personal computing devices to enterprise servers.
- PLA-R-02: Remote Administration of Platforms.** Agencies shall acquire platforms designed for ease of remote administration, diagnosis, and systems management.

Platform Domain Technical Topics

In this section, the personal computing, server, and shared utility platforms technical topics are discussed in detail. Available data are used to describe the current architecture in Commonwealth's executive branch agencies and to describe recent changes in the architecture. Also described are component technologies, strategic practices, critical issues, requirements and recommended practices.

Throughout this report, one underlying theme is the transition of the Commonwealth from the distributed information technology islands of today to a more integrated system with greater deployment of shared, centrally managed utility services⁴ in the future. Virginia Information Technologies Agency, or VITA, will play a central role in orchestrating this transition for many executive branch agencies.

A second theme of the report is the need to simplify the overall platform domain (e.g., reduce the number of platform types). A simplified architecture enables the Commonwealth to more effectively leverage enterprise volumes when making purchases and to take advantage of the cost savings related to support simplification, skills transfer, and training.

A third theme is the need to ensure that alternatives are considered. The Commonwealth and its agencies should always leverage viable alternatives when negotiating solutions and selecting technologies. For example, one major de facto standard in Virginia is Microsoft operating systems. In Virginia, this is true for desktops and low-end servers. Regardless of what the main choice is, Virginia needs to study the costs and benefits of switching to an alternative choice to have a sense of reasonable prices for its main choice. This information is very useful in price negotiations and critical for maintaining a big-picture perspective.

VITA's purview in matters that control staffing and reinvestments of savings is generally limited to executive branch agencies excluding higher education. The ETA, however, may also address requirements for higher education. These requirements generally focus only on administrative computing activities of higher education agencies. Both VITA and the ETA attempt to provide solutions that can be of use to agency application providers, local governments, local schools, and other branches of government.

To create cost effective central platform resources, certain other services must be in place—namely, network connections, privacy guarantees, [authentication](#) services, access services, help desks, services management, and service metrics. Because this report focuses on the platform component, these other services may be mentioned throughout this report, but will not be dealt with in depth. Other technical domain teams will take the lead on fleshing out requirements, standards and recommended practices for Systems Management, Networking and Telecommunications, Integration, and Security. However, as the domain team presents its discussions of personal computing, server, and shared utility platforms, it must make certain assumptions regarding the existence of foundation

⁴ A utility is a portion of information technology work that may be provided without having significant knowledge of the business. An example would be web site hosting. You can provide server space and accessibility levels without knowing the business of the agency or the information content of the website.

services that will be provided to support its conclusions. These foundation services are as follows:

- The Commonwealth will provide help desk services for the central and sourced utilities.
- The Commonwealth will create regional islands of utility services if cost effective.
- The Commonwealth will create cost-effective connectivity options between agencies and central services.
- The Commonwealth will provide access to central services for geographically remote areas if cost effective.
- The Commonwealth will ensure adequate throughput, availability, reliability and security.
- The Commonwealth will offer adequate messaging privacy and security to meet agency application needs.
- The Commonwealth will mandate specific utility applications such as common email services.
- The Commonwealth will provide the staff and systems needed to ensure quantitative and qualitative data requirements are met for central services planning and management.
- The Commonwealth will enable remote management of managed devices.

Many different technologies will be used in the process of constructing workable solutions to meet the different needs of agencies. These technologies will involve networking, platform, and security solutions. Example technologies that may be used include Multiprotocol Label Switching ([MPLS](#)) WAN services, LAN protocol WANs/MANs (e.g., [GB Ethernet](#)), branch office box ([BOB](#))⁵ appliance services, wide area file services [WAFS](#), and WAN optimization controllers ([WOCs](#)). These technologies will bridge the gap across utility services and across PC and server technologies enabling end-to-end connectivity, communications, security, and application functionality.

⁵ BOBs, WAFS, and WOCs are discussed in greater detail in the following: Juniper Networks, *The evolution of WAFS: Toward Transparent Comprehensive WAN Optimization*, March 2006, http://www.juniper.net/solutions/literature/white_papers/200173.pdf; Info World, *The dumb remote office*, Leon Erlanger, July 18, 2005, www.infoworld.com/article/05/07/18/29FEintelnetremote_1.html?TRAFFIC%M20MANAGEMENT ; Network World, *Bringing LAN-like file delivery to WANs*, Deni Connor, <http://www.networkworld.com/news/2005/080805-wafs.html>; NetworkWorld, *Application acceleration market topped \$1 billion in 2005*, Denise Dubie, April 13, 2006 www.networkworld.com/newsletters/accel/2006/0410netop2.html; Gartner, *Two new ways to build a high-performance branch office*, Joe Skorupa, John Enck, David A. Willis, February 8, 2006, ID Number: G00137102.

Personal Computing Devices

Personal computing devices include primary personal computers (desktop or notebook), handheld computers, and certain peripheral devices. The current and target architectures for these devices are addressed below.

Principles

The following four principles are identified for the Personal Computing technology topic.

- PLA-P-09: Use of High Quality Productivity Tools** – Uniform, high-quality productivity tools will be utilized to meet the business needs of the agencies and employees of the Commonwealth.
- PLA-P-10: Standards Based Mobile Clients** – Mobile clients will use standards-based communications interfaces whenever possible.
- PLA-P-11: Risk Averse Platforms** – Personal computing decisions should not add excessive risk to enterprise data and networks
- PLA-P-12: Integration of PC Hardware and Software Strategies** – Personal computer hardware and software selection strategies should be integrated to maximize cost savings opportunities.

As-Is Architecture for Personal Computing Devices

In the 2003 version of the Platform Domain Report, 2002 data collected for due diligence planning for the creation of VITA was available to describe the then current state of personal computing. In 2005, the data gathered from agencies for the purpose of providing a VITA inventory of software and hardware is available for analysis. However, no new information is available to describe higher education personal computing. Both the 2002 and the 2005 information is presented below to show changes that have occurred. Also, information on printing is provided.

Personal Computing Data

Executive branch agencies in the Commonwealth, excluding higher education agencies and independent agencies, report that they use nearly 67,000 personal computing devices⁶. As is the case across public and private sector businesses, the use of notebooks is increasing and the use of PDAs is likely leveling off. Most of the agencies report that they are using Microsoft operating systems and Microsoft office suite software on nearly all of their computers. Agencies report using 1,755⁷ handheld devices in fiscal year 2005 (handhelds include smartphones and personal digital assistants or PDAs), about 54,000 desktops, and about 11,000 notebooks. Tablet PCs are used in only a few instances, and

⁶ VITA Inventory Database, FY 2006.

⁷ Includes 1,660 reported in inventory in FY2005 plus 95 devices for VITA from the cell phone billing list.

they have been reported inconsistently as either handheld devices or as notebooks in the inventory system.

The type of software deployed on personal computers is fairly consistent over time with the exception of increasing use of specialized security tools or hand writing identification software. In addition to the office suite software that is typically present on most Commonwealth desktops and notebooks, Internet Explorer, Norton/Symantec Antivirus, and Adobe's Acrobat Reader are commonly deployed⁸. Desktops and those notebooks used as an individual's primary computer also usually have network and systems management client software. Notebook form factors often have remote [LAN](#) access and [virtual private network \(VPN\)](#) software as well.

The main operating systems and other software recorded in the fiscal years 2002 and 2005 are presented in Tables 1 and 2 below. Table 1 shows operating systems presently in use within executive branch agencies separately for higher education agencies (academic and users) and non-higher education executive branch agencies for fiscal year 2002 but no data are available for higher education for 2005.

It is very likely that most computers in use by non-higher education agencies in 2005 use Windows 2000 or Windows XP. When questioning one agency that accounted for most other operating systems, the domain team staff discovered that the agency's inventory practices recorded a device's first operating system but did not track changes in operating systems due to re-imaging. Adjusting for this practice, the Table 1 percentage of computers with the two most recent operating systems would be closer to 95% than to the 88% that is reported.

Table 1: Personal Computing Operating Systems in FY2002 and FY2005

Agency Type	PC OS Versions In Use in FY 2002	Percentage of OSs Reported	
		FY2003	FY2005
Executive Branch Agencies (not Higher Education)	Windows XP	0.0%	32.5%
	Windows 2000	8.2%	55.6%
	Windows 98	45.3%	2.6%
	Windows 95	22.7%	2.3%
	Windows NT	17.7%	1.9%
	Windows for Workgroups	0.8%	0.0%
	Windows Unknown	0.0%	4.0%
	Windows ME	0.1%	<0.1%
	LINUX	0.1%	<0.1%
	DOS	<0.1%	0.8%
	OS2	<0.1%	<0.1%
	W3.1	<0.1%	<0.1%
	Other	5.1%	0.3%
Higher Education Agencies	Windows XP	0.0%	Unknown

⁸ Software data from the Due Diligence Database for FY 2002 and the VITA Inventory Database for FY 2006.

Agency Type	PC OS Versions In Use in FY 2002	Percentage of OSs Reported
	Windows 2000	0.0% Unknown
	Windows 98	64.0% Unknown
	Windows NT	13.8% Unknown
	Macintosh	7.2% Unknown
	Windows 2000	7.2% Unknown
	Windows 95	6.7% Unknown
	Unix	0.5% Unknown
	Windows for Workgroups	0.3% Unknown
	OS9	0.3% Unknown
	LINUX	0.1% Unknown
	DOS	<0.1% Unknown

Table 2 presents prevalent software types for non-higher education executive branch agencies.⁹ Comparable data are not available to describe the business side of higher education agencies. Table 2 clearly shows that Microsoft products are used on greater percentages of desktops and notebooks in nearly every category of software. In fact, the Commonwealth is highly dependent on Microsoft for both operating systems and productivity software.

For productivity software, the tendency for most agencies is to acquire and install bundled office suite software. Recent changes in licensing by Microsoft make it necessary to reconsider this approach. Because relatively few knowledge workers really need database software and are able to use it effectively, it may be worthwhile for agencies to consider buying and installing Microsoft Access separately. Competing tools might be considered for meeting the needs of non-technical data gathers and reporters.

Table 2: Personal Computing Software Prevalent in August, FY 2006¹⁰

Software Type	Software and Its Relative Prevalence		Included in a Typical System
Office Software for Executive Branch Agencies	Microsoft Office Professional Bundle	Most Prevalent	Yes
	Microsoft Office Bundle	Second	Yes
Antivirus	Norton (Symantec)	Most Prevalent	Yes (a solution appropriate to the prescribed security program for desktops and servers)
Calendaring/Scheduling/ Mail Client	Microsoft Outlook	Most Prevalent	Yes
	Novell GroupWise	Second	--

⁹ The FY 2006 VITA Inventory Database did not provide consistent software version information.

¹⁰ Better information is needed on not only what software is present on personal computing devices but also what software is really used by the workforce and how it is used.

Software Type	Software and Its Relative Prevalence		Included in a Typical System
Email Service	Microsoft Exchange	Most Prevalent	Yes
	Novell GroupWise	Second	--
Document Authoring	Adobe Acrobat	Most Prevalent	--
Web Browser	Internet Explorer	Most Prevalent	Yes
	Netscape	Second	--
Browser Plug-in	Adobe Acrobat Reader	Most Prevalent	Yes
Project Management	Microsoft Project	Most Prevalent	--
Flowcharting	Microsoft Visio	Most Prevalent	--
Web Authoring & Management	Macromedia Dreamweaver	Most Prevalent	--
	Microsoft FrontPage	Second	--
Desktop Publishing	Adobe (Acrobat; PageMaker; Illustrator; QuarkXpress)	Most Prevalent	--

In July 2003, desktop computing moved under VITA. In FY 2006, hardware and software provision is still handled partly by acquisition and partly by service contracts. Negotiations are presently underway, which may replace the present methods for all personal computing in executive branch agencies served through VITA.

Replacement of desktops and notebooks by agencies has generally resulted in the following changes.

- Operating systems, software, and hardware upgrades that are compatible with one of the latest Windows operating systems on the market
- Appropriate software upgrades
- Middle priced hardware capable of supporting both the newly acquired software and another upgrade of the software
- Between FY 2002 and FY 2006, increasing replacement of desktops by docked notebooks for selected personnel

Table 3 presents the acquisition year for both leased and purchased desktops and notebooks that were in service in August of FY 2006. These data show that the life cycle length of a personal computer in the Commonwealth varies considerably across agencies. Since 2003, the Platform Domain has recommended that personal computers be used for a minimum of four years, but has not set a maximum lifecycle length. If a four year lifecycle were enforced by each agency, the percentage of units replaced in each of the last three full years would be nearer to 25% (calendar years 2002 through 2004). The “overall percentage” displayed in Table 3 for calendar years 2002 through 2004 indicates a greater than 4-year lifecycle on average (percentages increased from 16.2% to 20.9% over the three years). For notebooks, Table 3 shows that more notebooks in service in August 2005 were purchased in calendar year 2004 than in any prior year. At 11,038 units, the number of notebooks was just over 17%.

Across agencies, desktop hardware replacement appears to occur about once every six years. This is moving towards a five year replacement cycle. Agencies typically range between four and six years in their replacement cycles for desktops and between four and five years for notebooks. However, some agencies do have three-year replacement cycles.

Table 3: Personal Computer Hardware in Service in August of 2005

Agency Type	Acquisition Calendar Year	Laptop Percentages (n=11,038*)	Desktop Percentages (n=53,720*)	Overall Personal Computer Percentages (n=64,758*)
Executive Branch Agencies (not Higher Education)	1999 or earlier	6.0%	10.1%	8.5%
	2000	10.0%	15.2%	13.0%
	2001	7.8%	13.2%	11.1%
	2002	13.5%	17.6%	16.2%
	2003	22.0%	17.0%	18.9%
	2004	29.4%	17.3%	20.9%
	2005 (half year)	11.3%	9.6%	11.4%

* These data have errors including the underreporting of seat-managed units in two agencies. Full reporting would likely result in a somewhat longer lifecycle estimate and somewhat greater laptop use.

VITA’s inventory also has operating system and year acquired for PDAs and other handheld devices. No detailed information was available for PDAs in 2002. The information for August 2005 is provided in Tables 4 and 5 below.

In FY 2003, an estimated 1,350 PDAs were in use. This number has increased by 30 percent to 1,755 devices in 2005 (see Table 4). Such devices are used by about three percent of the workforce in non-higher education executive branch agencies. Even though the sale of PDAs is declining in the marketplace, acquisition in state government continues at about the same level as was reported for prior biennia. As smartphones come down in price, a switch to these devices is anticipated.

Even though in 2003, the platform domain recommended use of [Blackberry](#) type devices for wireless email, this recommendation was clearly not followed across agencies. Most agencies continued to deploy Palm Pilot devices and Microsoft devices in greater numbers than BlackBerrys. All of these devices are on state contract.

Table 4: Operating Systems for PDAs Use in August 2005

Agency Type	Operating Systems	Number in Use	%
Executive Branch Agencies (not Higher Education)	Palm	663	39.9%
	MS PocketPC*	334	20.1%
	RIM**	284	11.4%
	MS Windows CE	73	4.4%
	MS Windows Mobile 5.0*	56	3.4%
	Blank or Unknown	345	20.8%
	Total		1755

*Windows Mobile 5.0 is the new name for the Microsoft PocketPC OS.

**The number of RIM devices may be about 10 % higher based on cell billing for October 2005

Table 5: Year Acquired for PDAs Use in August 2005

Agency Type	Calendar Year Acquired	%
Executive Branch Agencies (not Higher Education)	1999 or earlier	1.1%
	2000	10.5%
	2001	22.2%
	2002	14.5%
	2003	22.6%
	2004	19.5%
	2005	9.5%

Personal computing acquisition, management and support is now centralized in the Commonwealth under VITA, but the personnel served are widely dispersed throughout the state. Figure 3 provides a graphic illustration of the dispersion of supported desktops using zip codes of the nearly 54,000 desktops in use in August 2005. Virginia uses 1,256 zip codes. Most localities have only one or two zip codes, but a locality such as Richmond City has 53 within the city limits alone. Executive branch desktops are located in a little less than half of the of the zip code areas across the state (535 zip code areas). Although the state workforce achieves substantial concentrations in metropolitan tidewater, northern Virginia, metropolitan Richmond, Staunton, Lynchburg, and Roanoke (see Table 6 below), personnel are clearly spread across every locality in the state.

Figure 3: Geographic Dispersion of Desktops across the Commonwealth

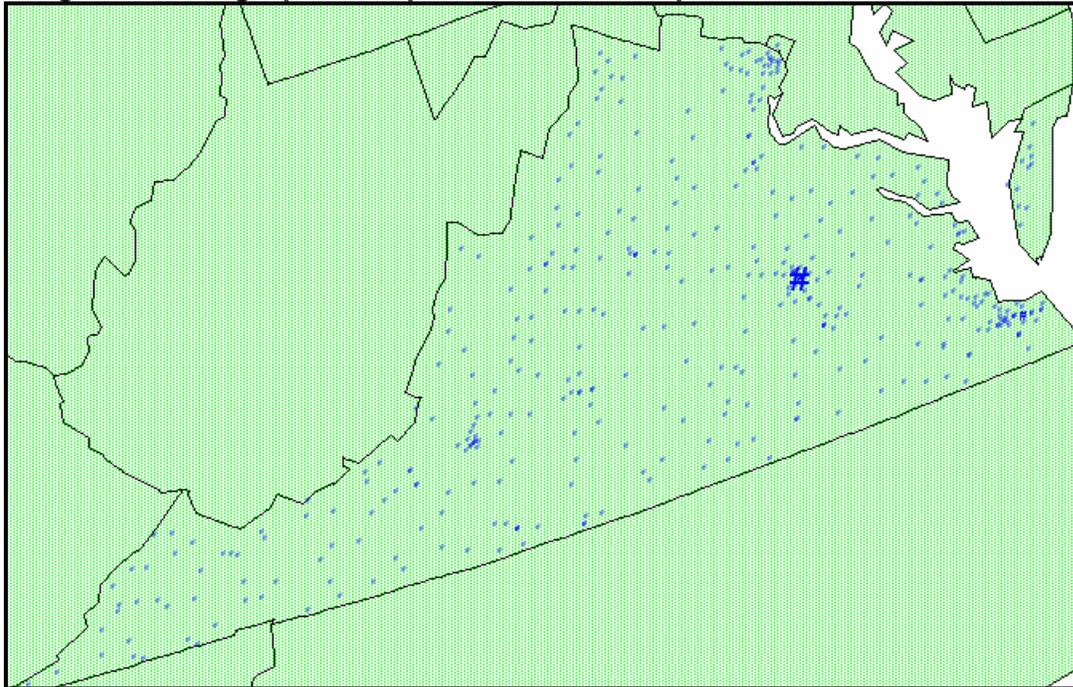


Figure 3 Map Notation

Number of Desktops in a zip code area	Number of Zip Code Locations with a Desktop Count in this Range	Map Notation
11001-12000	1	#
2001-11000	0	#
1001-2000	5*	#
901-1000	1	.
801-900	2	.
701-800	0	.
601-700	3	.
501-600	4	.
401-500	5	.
301-400	20	.
201-300	16	.
101-200	52	.
76-100	24	.
51-75	43	.
26-50	58	.
11-25	50	.
1-10	251	.

*Four in Richmond and one in VA Beach

Table 6: Desktop Concentrations in 2005

Agency Type	Virginia Location	Desktops in Area
Executive Branch Agencies (not Higher Education)	Richmond	21749
	Tidewater	8532
	Northern VA	3249
	Staunton	1139
	Roanoke	902
	Lynchburg	803
	Jarratt	578
	Charlottesville	571
	Salem	514
	Marion	507
	Bristol	449

Printers: PC Peripheral Devices and Shared Network Devices

Commonwealth executive branch agencies excluding higher education have more than 32,000 printers, not counting the printers in corrections centers, hospitals and learning centers. About half of these printers are small printers that are peripheral to desktops. The information in Table 7 provides comparative data for 2003 and 2005.

In this report, commentary regarding desktop single user printers and shared printing, faxing, scanning and copying devices will be addressed in different sections. Desktop single user printers are addressed as peripheral devices under the Personal Computing technical topic and shared printers are addressed under the Shared Utility Services technical topic. Data for both are presented together in this section.

Table 7: Printers, Scanners and Fax Machines Reported in 2003 and 2005

Agency Type	Document Processor Type*	2003**	2005
Executive Branch Agencies Excluding Institutions (not Higher Education)	Printer	-	3705
	Network	17728	10721
	Network - Color	-	332
	Network - Multifunction	639	35
	Slave	**	16390
	Slave - Label	**	191
	Slave - Multifunction	**	791
	Scanner	1016	1177
	Network Fax	-	65

* Networked printers are addressed in the Shared Utility Services technical topic (#3).

**Data reported for network shared devices only in 2003

Commonwealth’s Goals for the Personal Computing Architecture

The Commonwealth’s goals in selecting, acquiring, refreshing, deploying, and supporting personal computing devices are as follows.

- Meeting workforce business needs for four or more years with each acquisition of personal computing tools

- Providing office application tools that enable workers to use shared applications and to share documents, mail, and data with most customers regardless of the software product or version used by the customer
- Providing effective within-agency and across agency workgroup tools (e.g., scheduling)
- Promoting greater consistency in vendors, versions, images, and tool sets to reduce acquisition and support costs without eliminating competition advantages
- Having personal computing solutions that have sufficient penetration in the marketplace to ensure support staff availability
- Using a standardized methodology to minimize costs and maximize benefits when selecting from among alternative technology and support options (e.g., when comparing partnering versus outsourcing versus in-sourcing for personal computing)
- Setting life cycle length to maximize useful life while controlling escalation of support and other costs
- Considering the effect of change on staff productivity
- Ensuring that maximum customer value results from centralization of acquisition, support and architectural controls

Issues/Challenges

Some problems and concerns related to selecting, deploying, and managing personal computing devices in the Commonwealth are as follows:

- Concern about the escalation of support and management costs for providing adequate security, privacy, and risk controls
- Concern about vendor options determining what is deployed rather than business needs (e.g., in the Microsoft Enterprise Agreements, free training for engineers is unrelated to how well the software meets business needs but may influence engineer recommendations regarding the value of the software)
- Concern about the difficulty of exploring alternatives when doing so requires data that are not available. Obtaining support to deploy studies of business needs, staff training requirements, and other costs associated with transitioning from a de facto standard to a new architectural option (e.g., determining costs of retraining the workforce, developers, and support staff if the Commonwealth were to change from Microsoft solutions to a different OS and/or personal productivity suite)
- Concern about whether marketed “business” personal computing platforms are built for actual business needs (e.g., performance features may be more appropriate for gaming than for office systems)
- Concern about the cost-effectiveness of acquiring desktop computers with monitors (e.g., monitor’s replacement life cycle is two to three times as long as

that of the computer, but the monitor is usually replaced when the computer is replaced)

- Concern that how long an agency or a business unit within an agency keeps computers often reflects fund sources available (e.g., federal program funds) more than business needs
- Inability to maintain consistency in the computing environment due to constant marketplace changes that are often unrelated to business needs (e.g., changes in software versions and OS versions that sometimes have little business enhancement value)
- Concern about support cost escalation for PDAs and associated services due to having to support multiple PDA types and increasing numbers of form factors (e.g., smartphones)
- Concern about challenges resulting from geographic spread of personnel and computing equipment throughout the Commonwealth and beyond and having geographically equitable services

Business Trends

Even though one would not expect the functions performed by a state government to change drastically from one biennium to another, in early FY 2006, there were no mechanisms in place for assessing and reporting on business changes. The first Business Architecture was created and validated by agencies in FY 2005. Because it was so new, there had been no opportunities to assess the typical rate of change in business functions and methods.

In FY 2006, the platform domain update team was interested in considering whether any changes in business functions that had occurred were likely to affect the personal computing tool-set needs of employees. To make this determination, the team members reviewed documents that would highlight recent or planned changes; these documents included agency strategic planning documents, Secretariat planning documents, major legislative and budget changes, agency information technology project documentation, and central IT initiatives. Team members considered these changes in light of the agency's recently reported business architecture. They explored the following questions: 1) whether the changes represented doing more of an existing recorded function (e.g., adding new grants to manage in the same way old grants were managed) or adding new functions that had never been performed by Virginia government before, and 2) what affect any business changes found would have on how personal computing tools would be used in the future.

The results of their reviews were as follows:

- No obvious changes to the business or service areas were identified
- Existing agency services seemed to be expanding
- How services were delivered seemed to be changing more than what services were delivered

- New, large capital outlay projects were being undertaken

VITA's high priority project reports for 2005 and other enterprise initiatives also provided team members with insights regarding current and anticipated future changes in the means of providing services. Examples follow:

- Growing use of partnerships
 - Agency PPEAs: e.g., Social Services Delivery System
 - State PPEAs: e.g., statewide information security system
- Growing emphasis on enhancing ROI by creating centrally provided services or service bureaus
 - Enterprise Applications PPEA: e.g., for financials, [human resources](#), etc.
 - Creating central applications that can be modified to address agency specific needs: e.g., for licensing

One additional area that was explored was whether telecommuting was increasing and whether standards were needed for providing telecommuter service options. There has been recent emphasis by the General Assembly and others on the need to increase telecommuting by employees. Supporting telecommuting is thought to be both less costly than providing the full overhead of one office setup per person and good for the environment. However, telecommuters have different needs than office based workers or itinerant workers. Although the team did not see evidence in the represented agencies that telecommuting was on the increase, they did feel that this is one area where suggested configuration options and total costs of options would be useful to agencies in the future if telecommuting were to increase.

The platform domain team's review of current legislation, agency budgets, and agency strategic IT plans indicated that there are no planned agency changes that would require major changes in the Business Architecture's list of business functions or delivery of services methods (as recorded in Version 1.0 of the Business Architecture). In other words, the domain team expects that the agencies will collectively perform about the same set of business functions and will use about the same set of methods in addressing these functions.

Environmental Trends

Environmental issues include networking, security, and other societal and Commonwealth restraints on personal computing decisions. Societal trends that are driving factors include: changes in connectivity and messaging; and an increased emphasis on security world-wide—often beyond what would be recommended from a business risk perspective.

For networking, of particular importance is the ubiquity of wireless access and its affect on personal computing for in-office, mobile office, and remote office solutions. In rural areas, broadband connectivity options are increasing and thus increasing tool choices.

In the area of network management, increased security requirements are having an effect on computer base images. Security requirements and available solutions tend to make

personal computing more costly, primarily through the addition of software, hardware, and connectivity restraints. Examples of added expenses are spyware, personal firewalls, antivirus solutions, biometric access devices, and VPNs.

Discussions of Conclusions

Conclusions in the form of requirements, standards, and recommended practices for personal computing are provided in the next section. They are grouped together in one place in this document for all of personal computing. The following discussions provide background information for the specific conclusions in the next section by topic.

Review Process

The team recommended that the Commonwealth have a defined review process in place. The review process should reestablish a domain team of 8 to 12 persons, study new personal computing issues and costs, and recommend revised components at least annually. Although this is a governance issue for enterprise architecture, it is noted here due to having a more frequent update requirement in the previous platform domain report.

Personal Computing Technologies—Generally

Personal computer desktops are the platform acquired in the greatest quantity by the Commonwealth. For executive branch agencies, the total cost of ownership for personal computing was studied and was found to be just slightly less than Gartner estimates due to lower salaries of staff. The total cost of ownership at that time (i.e., FY 2002) for 64,000 users exceeded \$0.5 billion annually. Due to salary increases offsetting hardware price decreases, current estimates would be even higher, perhaps reaching \$.54 billion. These estimates are calculated using a three year lifecycle and must be adjusted downward for a four or more year life cycle (recommended).

If VITA and other agencies that provide desktops are able to reduce complexity in desktop images and hardware and are able to standardize management and support, they may be able to reduce per user costs for *direct and indirect operations and administration* as much as 20 to 30 percent. This would translate to approximately 7 to 22 percent of the total costs of ownership or \$38 to \$120 million per year. Total savings for the Commonwealth as a whole could be even greater if cost savings strategies recommended in this document were to have significance for local governments, K-12 schools, and other branches of government. The savings may be small from the viewpoint of government-wide operations, but from a technology reinvestment viewpoint, savings of this magnitude could provide significant opportunities for improving business processes using information technology.

Without investment in improved metrics, it is difficult to tell whether the executive branch is making desired inroads in reducing total costs of ownership across agencies. As a result, recommendations in this report also address the need for better data in addition to more standardized strategies.

Personal Computer Operating Systems

Technology component tables at the end of this section indicate that for personal computers including desktops and notebooks, the domain team selected only the

Windows XP Pro operating system (strategic) as the target desktop architecture. This decision was based on the prevalence of Windows OSs across agencies, the improvements in Windows XP Pro OS, and the potential for decreasing support costs by decreasing the number of OSs in use. If acceptable licensing costs cannot be reached in negotiations with Microsoft, other OSs including Linux, Solaris, and Macintosh OS X (emerging) could be reconsidered for the Commonwealth. However, a thorough cost study would be needed to support a change to an alternate OS from the de facto standard in the Commonwealth. Also, for Linux¹¹, there are still some risks related to the SCO Unix lawsuits that must be considered.

Even though some suggest that Linux can be explored as an alternative to Windows for use by staff members who perform only data entry type tasks, there are also reasons why one OS is preferable to two. The complications of having two desktop OSs can easily outweigh the cost savings for data entry. One example is that selected agency-wide applications based commercial off-the-shelf packages may not be designed to work with more than one client OS.

In experimenting with Unix desktops, engineers in the Virginia Department of Health discovered that they needed Windows for software such as Visio and for interfacing with hand-held devices including Palm and Blackberry. Also, they found that some application systems used between business units or between VDH and external customers required either Microsoft Windows or application redevelopment to work with Linux, FreeBSD, SuSE or another Unix variant.

When the 2003 version of the platform domain report was written, Microsoft's anticipated release date for the next version of the Windows operating system, then code named Longhorn, was 2004. This operating system is now called Windows Vista. The present anticipated release date is the fourth quarter of 2006 for corporate customers and later for consumers. Articles by Gartner and others are not very positive about the benefits of the new OS¹². Microsoft has also changed its policy to allow for 2 years of full support beyond the release date of the replacement.

Displays

Technology component tables at the end of this section provide standards for a 17 inch minimum size for desktop displays and a recommendation that flat panels be the standard replacement display. Keeping the display for its entire lifecycle is also recommended.

For computer displays, there are two opportunities for small savings for the Commonwealth. One is related to the type of display acquired for desktops and the other to the planned life of the display. LCDs tend to be a good value and a customer pleaser when replacements are made, but a particular user may require the benefits of a CRT, which include flexible resolution, better color, better responsiveness for video, and much cheaper purchase price (about half the cost in 2005 for a 17 inch). The LCD display's value relies on longevity cost savings, small footprint, and modest energy savings.

¹¹ See Gartner's article, *Management Update: Recommendations About SCO's Suit Against IBM*, May 4, 2005, George J. Weiss (G00127632). While this article recommends caution, Gartner and Forrester consultants have indicated that SCO is unlikely to have an outright win.

¹² See Gartner's article, *Ten Reasons You Should and Shouldn't Care About Microsoft's Windows Vista Client*, Neil MacDonald and Michael A. Silver, November 10, 2005, ID Number G00131711.

The present tendency in state agencies continues to be replacing desktop monitors at the end of the PCs lifecycle. Gartner and others suggest that the lifecycle of a desktop CRT is up to ten years and that the life of a flat panel can be even longer (according to one study, the flat panel could last an average of 13.4 years¹³ if the backlight does not fail).

Lifecycles used in Commonwealth agencies for PCs range from 3 to 6 years. In 2003, the Commonwealth had an opportunity to realize a small savings by delaying the replacement of CRT displays that would continue to meet business needs and performance requirements of users. A number of agencies chose this route and realized the savings for both not acquiring the CRT replacement and for paying a reduced price once the delayed replacement with a flat panel. Since 2003, the cost of flat panels has declined by one-third, and so the window of opportunity for realizing cost savings from a price decline is now closing.

Over the past two years, some agencies implemented break/fix policies for monitors and others did not. In part, this was due to the way contracts and procurement vehicles are implemented and in part, it may be due to a lack of tangible benefits. For example, seat management contracts may not have permitted this option, and procurement vehicles may have made it difficult to decline a new display. Presently, some brands on state contract do not permit the removal of the monitor as an option on their website.

Another display procurement issue has been that unless an agency used an APR for acquiring their replacement displays, they may not have been aware of the opportunities for savings. The awareness problem should lessen with centralized procurement of desktops for most executive branch agencies.

Colleges and universities tend not to differentiate between administrative use and academic use in the acquisition of desktop hardware. They do, however, differentiate in setup images for various labs and other uses including libraries and administrative offices. Across university uses, displays will have different life spans due to varying usage levels.

For both higher education and other executive branch agencies, a continued policy of using LCDs and CRTs until display performance has declined¹⁴ will result in a small savings. For LCDs, the life may be extended from as little as four years for some brands to more than 13 years by field replacement of the backlight. If necessary and cost-effective, providers may wish to arrange for technician training for the field replacement of LCD backlights. Providers should check on the backlight life for displays recently acquired and establish a break/replace or break/fix policy for them based on cost analyses of alternatives.

¹³ <http://www.epa.gov/oppt/dfe/pubs/comp-dic/lca/Ch2.pdf> or for the whole document and appendices, see <http://www.epa.gov/oppt/dfe/pubs/comp-dic/lca/> The EPA compares 15" LCD and 17" CRT monitor on lifecycle related issues in Chapter 2. Backlights may fail between 4.0 and 13.4 years depending on the manufacturer, but they are field replaceable. These data are fairly old but more recent data are not available. In the report, discussions with Dell officials indicate that most of their LCD backlights have the 50,000 hour life or a life that exceeds the 13.4 years.

¹⁴ CRTs typically do not die. What happens is that the brightness of the display decreases over a period of years, the number of which depends on how many hours per day it is in use. A monitor is considered to be at end of life when the display brightness decreases by 50 percent.

PC Processors, Chipsets and Supported Interfaces

Typically, the components of a computer are determined by the manufacturer with little choice on the part of the purchaser unless units are custom built. For personal computers, the Intel processors and chipsets dominate the market, but AMD and others offer equivalent hardware, often at a lower price. At present, most available processors and chipsets include features that exceed the needs of the typical office worker given the software they use and the way they work. Examples of rarely needed features include:

- Dual core processors
- Hyperthreading
- 64 bit addressing
- [PCI Express](#)

A dual core processor may be helpful to users who have numerous applications running at the same time. However, for users who rely heavily on email and browser-based applications, the dual core processor may hinder more than help because those applications are not multi-threaded and cannot make use of a dual processor. Most of the chipsets and processors currently on the market have some of the unneeded features and most are also adequate to run operating system and productivity software. Workforce needs tend to be well met by most processors and chipsets that are on the market. However, some caution purchasers that the low-end items such as Intel's Celeron and AMD's Sempron, while they may meet business needs, may not actually be significantly cheaper due to price competition. For both AMD and Intel, there are mobile processor and chipset offerings that have special features to reduced power consumption and extend battery life. These are a necessity and they tend to be used by most notebook manufacturers.

Designers of mobile chipsets are now bundling more into their solution package. For example, Intel's [Centrino](#) brand name requires that notebook manufacturers bundle in a wireless chip for connectivity with reduced power consumption, and a built in antenna. These features are required to use the Centrino name on the resulting notebook.

Because the providers of computers often have exclusive partnerships with parts manufacturers, the quality and price of competing companies may not even have a chance to enter into the equation. Recent conflicts between Intel and AMD¹⁵ punctuate the cut-throat nature of parts competition. Unfortunately, the future price of computing may be adversely affected by deals that remove consumer choice from the design and building of computers. Large purchasers may be able to have an affect on this situation, but procurement practices in the Commonwealth have not supported parts competition.

¹⁵ Internetnews.com, Enterprise, Dell to Reveal Documents in AMD vs. Intel Suit, September 8, 2005, David Needle. <http://www.internetnews.com/ent-news/article.php/3547371> ; PCWorld Magazine, Does Intel's Dominance Hurt Consumers? AMD's suit against Intel alleges antitrust violations that lead to higher PC prices. October 2005, Carla Thornton, <http://www.pcworld.com/news/article/0,aid,122249,00.asp> .

Read/Write Devices

The devices addressed here are desktop and notebook devices that read from and write to transportable external media. “Writable” media for desktops and notebooks include floppies, CDs, DVDs, and USB devices with numerous names (e.g., USB keys, jump drives, flash drives, and USB drives).

The Commonwealth’s workforce tends to use CD and DVD devices mainly for reading and floppies for occasional writing. Also, a small percentage of users benefit from the advantages of using USB devices to transport data, documents and presentations securely to remote locations. Some mobile workers use USB devices for providing document backups. Writing to external media is rarely done by most workers due to the ease of using email and shared drives for transferring and accessing files. Even though external media is rarely used by the workforce, new computers tend to have multiple methods available for writing. Because all writing methods and media have been used to some degree, narrowing future directions for the state will be problematic for some. Meeting the reading and writing needs of those who most use external media is an important decision factor but providing some capabilities to all is also required.

Of the available writing options, USB devices have the best secure data transport solution for those needing security and they require no special software. Also, USB devices have come down in price to about half what they cost only three years ago but devices with security are a little more expensive.

Because CD/DVD read capabilities are especially useful to workers, adding the CD write capability makes some sense as a means of providing a file transport capability to all. However, support personnel indicate that most workers do not know how to use the CD write capabilities and that this is the reason they cling to floppies when file sizes permit this. The cost of the CD option is mostly in training the workforce to use the device (a statewide email could achieve this).

DVD write standards have not solidified. Several camps (i.e., two for high definition video and two for all other information) are proponents of the methods that are competing to be the standard. Many feel that a single standard will never exist. If DVDs were used extensively as an alternate storage, there would be some potential for loss of data or costly conversion if the methods supported by one or more camps were to fall by the wayside. For example, using DVDs to offload rarely used files could have negative consequences if the write method used were discontinued and drive manufacturers drop reading capabilities for that method from the list of methods supported.

Floppies and floppy drives are still available in nearly every office, but more and more, the users of floppies will have files that exceed the capacity of the disks. For this reason, floppies do not have much longevity as a useful output medium for the future. The capacity limits are especially problematic when the writer needs a medium to substitute for email when files are too large for the email system of the sender or receiver.

There is little cost-benefit to preventing users from having floppy drives. However, they will surely disappear in the near future. Because of this, agencies should ensure that those who need to write to removable media know how to write to a CD or USB drive.

Personnel should also be taught how to use the security features available with certain USB drives.

Printers

Some agencies tend to use large numbers of desktop-attached printers. In some cases, this usage pattern is because of continuous printing of confidential information or printing forms that require an ink signature from the customer who is in the worker's office. Others are used because a worker's job requires label printing or special document printing (e.g., certificates). As many as half of the printers presently in use within agencies are desktop attached. Agencies may want to reduce this practice as much as possible to achieve cost savings. Costs of desktop printers are high due to:

- Higher per page printing costs (two to four times as expensive)
- Increasing costs of supplies as the printers age
- Frequency of ordering supplies due to small sizes (more staff time)
- Buying desktop printers singly rather than in bulk (supporting numerous brands and models and not getting price advantages when printers are needed)
- High hand-holding support costs (changing cartridges, fixing paper jams)
- Fixing broken printers when they are out of warranty instead of replacing them (high support costs associated with repairs)

If agency personnel only occasionally need to print confidential documents, agency use of workgroup printers that enable security passwords for the printing of selected documents may be a viable alternative to permitting desktop printers.

Because the Commonwealth uses as many as 17,000 desktop printers, cost savings, although small, could be significant. The following estimate of \$4.6 million in savings is intended as a rough approximation.

- 2500 copies times 17000 printers time \$0.02 savings per copy for printing costs is \$850,000
- Purchasing printers at \$60 per year of use is \$1,020,000 (A good quality, quiet, fast, desktop laser printer with a \$.02 per copy cost can be purchased for \$180. An example is Brother HL-5140 which was recommended by Consumer Reports).
- Ordering printing supplies twice annually at 2 hours at \$15.00 per hour times 17000 printers is \$510,000
- Supporting printers with IT staff at 1 hour per year at \$30 per hour times 17000 is \$510,000
- Unpacking, setting up, and installing printers and cartridges at 1 hour per year times \$30 per hour times 17000 printers is \$510,000
- Trying to diagnose broken printers at 1 hour of staff time and 1 hour of IT time once every 3 years is $\$15 + \30 times 17000 divided by 3 or \$255,000

- Cost of buying single printers and cartridges of many brands \$15 per year per printer or \$255,000
- Cost of supporting numerous brands and models (add 50% to support staff costs above \$637,500
- Total Added Cost: \$4.6 million.

Agencies should reduce desktop printer usage as much as possible. Whenever a business case can be made for desktop printers, black and white laser printers should be used. Ink jet printers are appropriate for mobile users only and generally should not be used in offices.

Wireless Connectivity Devices

Although use of wireless technologies for mouse and keyboard connections is becoming more popular, the typical wireless connections in Commonwealth offices are for notebook connections to the local area network in conference rooms, PDA/smartphone connections to desktops, and Blackberry connections.

Several technologies support device interfaces with networks including modems, [infrared connections \(IrDA\)](#), [Bluetooth \(IEEE 802.15\)](#), and wireless [network interface cards](#) or chipsets (IEEE [802.11](#) or [WiFi](#)). Bluetooth personal area network (PAN) interface technologies (radio frequency, 10 meter) are expected to eventually replace infrared (optical, half meter) connections because of the relative improvements in speed, distance interference, and flexibility. The use of Bluetooth has increased drastically in recent months, and is especially popular in headset implementations for phones and other devices. Alternative technologies including ultrawideband (UWB) may replace Bluetooth. Bluetooth version 1.2 is designed to accommodate some of the conflicts between WiFi (IEEE 802.11) and Bluetooth, which use the same frequencies.

IEEE 802.11 a, b and g products are now available in one card or as an embedded chip both singly and in combinations (e.g., one card provides a, b and g frequencies and transmission methods) for providing wireless connectivity. Network Interface Cards (NICs) and embedded chips should accommodate all three WiFi standards due to the need to access multiple networks and to constant changes in wireless networks to improve capacity or availability. A given wireless network could use all three standards.

Because of the increase in wireless services, especially in public places including hotel, conference rooms, etc., the mobile worker now can benefit from wireless connectivity even if the office does not provide a wireless LAN. With a move towards anywhere connectivity wireless interfaces have become a necessity. Agencies should introduce wireless use policies appropriate for their business¹⁶ that address wireless connectivity. For example, the agency may want the user to send emails using encryption on wired connections but may encourage the free use of public Internet access with a personal firewall installed.

Wireless security is beyond the scope of the Platform Domain, but agencies that choose to deploy wireless personal computing devices must consider the business needs and

¹⁶ See the Security Architecture Report and associated policies, standard, and guidelines on the VITA website, <http://www.vita.virginia.gov/cots/ea/library/index.cfm>.

available security. In some instances this will require discussions with wireless service providers and in other instances, with agency or VITA security personnel.

Wireless security issues for 802.11 networks are addressed by the 802.11i (ratified June 24, 2004) standard which adds the Advanced Encryption Standard (AES) security protocol to the standard for wireless LANs. AES is a stronger level of security than found in the old Wi-Fi Protected Access security standard¹⁷. Bluetooth security and vulnerability issues are also a concern. Policies within agencies may be especially important for those permitting Bluetooth access to networks.¹⁸

The numbers and types of devices using wireless connectivity is growing at a fast rate and will continue to do so as newer standards address security, distance, degradation, multimedia requirements and other issues. The cost of wireless computing is decreasing as use spreads making it very likely that wireless PANs, LANs and MANs will dominate future connectivity. For personal computing, this will mean wireless keyboards, monitors, mice, headsets, computers, and speakers in every office and wireless management of devices and software. For the mobile worker, everything but power will be wireless.

Microsoft or Alternatives—OS and Productivity Software Decisions

Virginia is not alone in having a de facto Microsoft standard for personal computer operating systems and productivity software. Governments and businesses are predominantly Microsoft worldwide. However, businesses throughout the world continue to seek alternatives due to concerns arising from the monopoly Microsoft enjoys, Microsoft licensing practices, and hidden Microsoft dependencies and costs.

Microsoft software meets non-higher education executive branch business needs well, but it is likely that other similar products would meet business needs too. Regardless, Virginia has two important issues to address regarding its use of office software. One issue is which office software provides the best long-term return on investment (ROI) and the other is whether installing periodic upgrades is worthwhile. To date, experience and research in other sectors points to the advisability of continuing to use Microsoft products rather than alternatives and of not upgrading to new versions within the life of the hardware.

To date, Virginia has considered only the data from other businesses and non-Virginia studies to make its decisions regarding office software selection. Some of the questions that Virginia needs to address regarding Microsoft are:

- how much is too much to pay for Microsoft systems;
- how does using Microsoft limit Virginia's other choices;
- what viable alternatives the Commonwealth has; and
- what attached Microsoft products or business applications should be in or out of the comparison equation for office software (e.g., where should a centrally-based decisions draw the line).

¹⁷IEEE set to ratify 802.11i standard, Tom Krazit, IDG News Service, June 24, 2004, <http://www.computerworld.idg.com.au/index.php/id:1691519598;fp:2;fpid:1>

¹⁸High-Trust Environments Require Improved Bluetooth Security, June 17, 2005, Peter Firstbrook and John Girard. Gartner 00127843.

Cost issues are different for higher education than for other executive branch agencies because of price breaks given to education by productivity software companies. For other agencies, there are no good studies at this time showing any conclusive evidence of a cost-effective alternative to using Microsoft suite products. Growth for alternatives is happening more in expanding markets such as China rather than in markets where the mainstream compatibility requirements are to be compatible with Microsoft users. Even in Asian markets, Microsoft piracy provides stiff competition to free products. In the United States, even if the open office software meets all general business needs well, Microsoft and Windows users still have problems with Linux/Unix interfaces and/or with the lack of driver support for the numerous devices users employ.

One frequently cited argument for not switching from de facto Microsoft standards is the training costs affiliated with making a change (i.e., training for users, programmers, and technical support staff). However, because each new version of Microsoft Office requires retraining or self training, a change to a different product may not require much more.

Conclusive answers can be found only in a Virginia study of alternatives and their costs and benefits. The Commonwealth can use its own studies to make a case for continuing with all or some of the Microsoft products used by agencies, switching to alternatives in one or more instances, or leveraging options in negotiating prices with Microsoft and others. Simply accepting the de facto standards for software and operating systems however, may not benefit Virginia as fully as exploring effective and efficient alternatives.

One important factor in exploring relative costs is determining which agencies and to what extent agencies use current suite tools in providing interfaces to or outputs from business systems. These agencies and their workers would be affected to a much greater extent by any changes in suite tools, and these interface costs would have to be considered in an examination of alternatives.

Because the desktop suite decision cannot be completely separated from the network and the business applications (e.g., email, Internet) that support the desktop user, a cost analysis comparing suite alternatives should also compare any options under consideration for operating systems, email, workgroup software, or business systems interfaces. Here, the effect of version-to-version changes should be compared with the effect of brand-to-brand changes. Also, product interaction issues should be addressed.

Microsoft has good products, but good alternatives do exist. For Windows, Macintosh's OS X and Sun's Solaris are good Unix-based operating system alternatives. Linux could also become a desktop OS alternative to be considered once lawsuits are settled. Office software such as Sun's StarOffice, Corel's Office Suite, and browsers including Netscape are strong products even though their market share is small. Linux OS, OpenOffice productivity software, and the [Mozilla](#) FireFox browser are examples of free, open source products that are being used by some who have switched from Microsoft. The Commonwealth preference is to employ supported software; however, some complain that companies such as Red Hat provide too little value add for supported versions of free products.¹⁹

¹⁹*Red Hat ES 3.0 vs. SuSE Server8.0: Battle for the Enterprise*, <http://www.devx.com/opensource/Article/20840>.

According to Gartner and others, changing from one office productivity suite to another will result in costs related to training for the workforce and support staff and opportunity costs related to time lost during the learning curve that can outweigh any likely savings that might be gained from making a switch. Still others indicate a total cost of ownership for open systems that is 25 to 50 percent less than that of Microsoft—plenty of room to absorb any one time retraining and refitting costs. A compromise view suggests that using open office solutions for the low-end users has promise. When calculating costs, the Commonwealth should look at user types and should look beyond the point of change and include differences in costs incurred over time due to relative frequency of product changes (e.g., patches and upgrades) across companies.

There are quite a few examples of countries and governments making the switch from Microsoft. While over time these efforts may provide additional data that either counters or provide credence to naysayer claims, Virginia should still conduct its own studies using costs appropriate for a large state government to ensure valid data for decision makers. Virginia's study should use Virginia's salaries, Virginia's software license negotiation results, Virginia's retraining requirements based on its staff competencies, Virginia's hardware and software refresh rates, etc.

In recent years, Virginia's procurement officials have joined with other state governments or other universities nationwide to negotiate Microsoft prices as a group. Although some doubt the ability of consortiums to have a significant impact by combining forces, the occurrence of conversion activities (e.g., conversion to open and other alternatives) worldwide may serve to increase the effectiveness of these negotiating groups.

Target OS and Productivity Software

OS and productivity software should be standardized for the majority of knowledge workers and support staff across executive branch personal computers for a variety of reasons including opportunities for reduced licensing costs for non-higher education agencies and lower support costs. Having standardized clients on standardized networks also helps those providing systems management to manage centrally and to select effective solutions.

Commonwealth agencies presently employ several Microsoft products in sufficient numbers for Microsoft to be the de facto standard. Until data are available from Commonwealth studies to support a change from the present direction, the Enterprise Technical Architecture should reflect this de facto trend and should also encourage more complete standardization on any de facto office productivity and security software used by most agencies. Broad availability of device drivers and client software through Microsoft is also a consideration.

Until information recommending a software solution is obtained from studies of alternatives, the Commonwealth should select software from Table 2 above to be included in the target architecture for desktops and when appropriate, notebooks, and other personal computing devices. The selections should include the operating system, word processing, presentation, spreadsheet, antivirus, and accessories (e.g., calculator and media player). The decision for database, project management, flowcharting and similar high-end tools should be made separately and should not be included in a standard [base image](#). Full product installs are preferred for products that are in the base image. For

higher education, there are benefits to having word processing software in common with other executive branch agencies. However, in higher education, administrative offices may wish to also have more options than one to accommodate the variability in customer software across students and faculty. Their base images should include Microsoft but may also include Corel, StarOffice, or other alternatives.

For non-developer databases and report-writers, alternatives to Access may be considered, but agencies should note their agency's interoperability requirements and should carefully test the difficulty of importing and exporting data between database programs while retaining the data structure. Access is a good choice, but not the only option.

Beyond office software, future base images should include recommended software for connectivity, antivirus, central management, device support, and help desk solutions. The following recommendations address information needs and the target software architecture selections prior to having available the results of any Virginia studies of alternatives.

To maximize the standardizing of base images and modules for desktops and notebooks, the Commonwealth will have to arrive at standards for the entire computing environment including areas that are beyond the scope of the platform domain. Important areas for consideration include email, security, remote management, help desk, databases, and [internetworking](#). Some of these decisions are beyond the scope of the platform domain.

Mobile Workers

There has been an increase push towards telecommuting in businesses such as Capital One as a way of decreasing costs. Even though the Commonwealth has had past encouragement to use telecommuting as a way of decreasing costs, agency management has not adopted or encouraged this alternative. Telecommuting is significantly cheaper as long as the individual does not have a work office too. There are also environmental benefits, roadway cost benefits, and traffic congestion decrease benefits for telecommuting. Technology can offset some of the negative aspects of telecommuting enabling virtual meetings, LAN connections, and more.

Clearly, one enabler of telecommuting would be having a standard package or toolset for the telecommuting knowledge worker and a standard in-office setup. These options should also have example cost ranges associated with them. The standard options should have the following components.

- Home or hotel-type remote office providing
 - Desk and Chair allowance
 - Notebook
 - Notebook docking and peripherals
 - Printer and supplies (discourage use with limit)
 - Media options to encourage avoiding printing (CDs, USB drives,
 - High speed connection (modem or DSL) via VPN to LAN/Internet if available

- Local and long distance voice for mobile workers (e.g., cell phone or in the future, roaming phone)
- Access toolsets for mobile workers (email, calendar, contact, internet and other access from region served)
- Software setup to address productivity, security, remote access, local (in office) access, and other connectivity
- Backup and recovery procedure if high speed connection to LAN is not available
- Software updates procedure or service (e.g., antivirus)
- Local (in office) hotel-type office
- Multimedia accessory access as needed (projector, MP3 for audio training in car for example, etc)

These requirements should be compared to what is provided on average for the in-office worker including building space, utilities, and overhead.

Security Devices

A variety of security devices are available to enhance network security or data security via improving authentication or access requirements by adding another layer. This is especially useful with mobile devices that are easily lost or that are targeted for theft.

[Key fobs](#), [biometrics](#) and [smartcards](#) are used increasingly in state government for adding an authentication security layer for accessing both networked servers and personal computers. Smartcard and biometric methods typically require a reader that attaches to the personal computing platform in the form of a keyboard/reader combination or a separate reader. IBM recently added biometric readers to several of its laptop offerings. Key fobs are usually key ring or medallion objects and smartcards are in credit card form. Some key fobs provide pin accessible password tokens that are keyed into the system or application, some signal to a radio frequency (RF) reader that may be attached to an RS232 interface on the PC or server, and others are inserted into a USB port and read by software.

Because fob readers tend to be costly unless included in a keyboard, the USB port option has cost advantages as long as accessing the port does not require crawling under a desk with a flashlight. Newer computers and displays tend to include easily accessible USB ports (e.g., on the front of the tower or the back/side of the display). This makes use of a USB port device far more practical.

Personal computer attached security device readers may be included in personal computing specifications on the advice of security program designers but will not be required as part of the platform domain.

PDAs and Smartphones

Personal Digital Assistants or PDAs and smartphones offer an increasing variety of valuable business functions (see Table 8), but little is known about what specific functions the Commonwealth's workforce needs or the extent to which such devices are

deployed to all who need them. Even though a simple PDA is a relatively low cost item requiring minimal support beyond initial training and connectivity, the costs for supporting the most complex PDA/smartphones with [push email](#), radio connections, and cameras can be staggering. Support cost estimates for PDAs made in 2002 range from \$100 to \$3,700 per year²⁰, with the simple low-end, desktop-synchronized, personal information devices being the least costly and the server-synchronized devices with wireless push email being the highest.

²⁰ Wireless PDA Costs \$3000 per year, June 24, 2002, 3G, <http://www.3g.co.uk/PR/June2002/3597.htm>; PDA TCO Sticker Shock, Jack Gold, September 5, 2002, ZDNet Tech Update, <http://www.3g.co.uk/PR/June2002/3597.htm>.

Table 8: Typical Business Functions for Four Types of PDAs

	Simple PDA with Wireless Synchroni- zation	PDA plus Wireless Email	PDA plus Phone	PDA plus Wireless Email and Phone
Personal Information Management (Calendar, Contacts, Tasks to Do). Synchronization of calendar, email, etc.	X	X	X	X
Applications (e.g., MS Office)	X	X	X	X
Shelf/Custom Business Applications	X	X	X	X
Display options (color, size)	X	X	X	X
Audio/Video storage and play	X	X	X	X
Reference Data Access	X	X	X	X
Data input, output, storage and transport (USB and other)	X	X	X	X
Voice Memos		X	X	X
Internet Connectivity		X	X	X
Paging		X	X	X
Wireless services (wide variety available –e.g., legislation updates)		X	X	X
Authentication, Secure Transmission, Email Push Service		X		X
Camera/ image Capture			X	X
Image phone transmission			X	X
Voicemail			X	X
Text Messaging			X	X
Voice and Data Communications via multiple methods and services			X	X

Current competition from Microsoft's Exchange SP2 will bring down significantly the costs of push email from Blackberry and others as Microsoft services become accessible via more and more device OSs²¹.

²¹ Microsoft Targets RIM Blackberry with Price, Network Computing, Feb 14, 2006 - By Antone Gonsalves, <http://www.networkcomputing.com/channels/wireless/showArticle.jhtml?articleID=180201443> ; Exchange ActiveSync - Not Just for Windows Mobile Anymore, Jack, posted Thursday, Feb. 9th, 2006, http://mobilitytoday.com/news/006137/mobility_DataViz_RoadSync_exchange_Active%20Sync .

The number of PDA-type synchronization connections in agencies is likely to grow as smartphone use increases and software capabilities improve. Currently, only 8,851 cell phones (222 + 8629) are used by executive branch employees and an additional 2,157 (57 + 2100) connections through VITA are used by higher education institutions.

Table 9: Wireless Service Usage in October, 2005

Agency Type	BlackBerry Service Only	BlackBerry and Cell Service	Cell Service Only	Total Wireless Services*
Executive Branch Agencies excluding Higher Education	93	222	8,629	9,166
Higher Education with service through VITA	90	57	2,100	2,304

*Totals do not include Verizon, e-rate, and direct billed customers

Because of the high cost of PDA/smartphone devices with multiple wireless services (e.g., push email, Internet, phone and other reference services), the Commonwealth should provide guidelines for agencies for the type of user for whom the devices are most cost-beneficial. For example, an agency may wish to restrict the high-end devices to those executives who spend most days away from the office or to those who can eliminate the need for a laptop by using the device. Other types of users who could benefit greatly from high-end devices are itinerant information technology support staff, critical systems and services managers, and security support staff. Also, high-paid staff who typically have one or more meetings every day and who need to remain accessible to managers under them could be cost effective users of these tools.

While agencies may wish to limit the use of expensive services, agencies should enable the simple PDA-type synchronization services for all staff members who have their own devices. The market for simple PDAs is no longer growing, but the number of staff members who have PDA synchronization capabilities through their cell phones is growing rapidly. The Commonwealth’s future services should be designed to enable staff access to their own calendar and contacts without limitation as long as security issues are addressed. Email synchronization should be addressed as well. Outlawing the use of employee owned devices is not a good strategy. This would result in agencies having to purchase and support replacement devices and in employee dissatisfaction regarding having to carry multiple devices or regarding the waste of their purchases.

Table 10 below illustrates a possible future scenario for changes in the Commonwealth’s usage levels for various PDA and phone devices and services between 2005 and 2010. This table illustrates an expected move from PDAs to Smartphones and an expected move from a BlackBerry solution to a Microsoft solution for mobile push email.

Table 10: Anticipated Usage for Cell Phones, PDAs and Smartphones in the Commonwealth's Executive Branch Agencies

	Percent of Workforce			
	2005	2006	2008	2010
PDAs: Office Synchronization	* 6.0%	*4.0%	* 2.0%	* 1.0%
Cell Phones	15.0%	12.0%	9.0%	6.0%
PDA Smartphones: Cell phone with PDA and Office Synchronization	* 7.5%	*10.0%	* 20.0%	* 30.0%
Push Email PDAs: Office Synchronization and Email	0.2%	0.2%	0.1%	0.0%
Push Email Smartphones: PDA with Office Synchronization, Push Email and Cell Phone	0.4%	0.6%	2.5%	5.0%
Likely Push Email Service	BlackBerry Server	BlackBerry Server	Microsoft Exchange	Microsoft Exchange

*Presently, as many as half of the PDA devices in use belong to the employees. This may switch to PDA functions on employee-owned smartphones.

Currently, BlackBerry holds the market lead for push email provision and Symbian holds the lead for smartphones. Together, smartphones that are BlackBerry with Symbian Connect dominate the smartphone push-email market. Microsoft provided competition to Blackberry in 2005 through a push email modification to Exchange Server 2003 via SP2. Already, Microsoft has executed licensing deals with Palm, Symbian, and many others to compete with BlackBerry/RIM's dominance in the push email arena. If the Commonwealth continues to use Microsoft Exchange for email, it is highly likely that it will become more cost-effective to move from Blackberry to Exchange for push email as the devices currently in use near end of life.

The Process used in Selecting Hardware Components

The domain team used an approach to computer component selection taken from a ZDNet article²² and other research²³ when writing the original advice for developing contracts. This same approach, one of judging the business appropriateness of options, continues to be useful today. Please note that advice is geared to the computer needs of most state knowledge workers and is not intended for all users.

The process described below provides a roadmap for decision making for personal computing hardware. This type of thought process can be modified from year to year as

²² ZDNet Technology Update, *Intel: Beyond Gigahertz*, Steve Kleynhans, December 18, 2002.

²³ Current references include advice provided by: Metagroup's Meta Practice, 2005 PC Purchasing Recommendations, March 10, 2005; Gartner Group's Desktop Recommended Configurations, June 2005 G00129034; Gartner Group's Predicts 2005—PC Technologies Due for Transition, G00123855; and Gartner Group's Recommended Configurations for Notebooks, June 2005 G00129251.

the component options change. The decisions would typically be made by procurement officials or service provision partners establishing agency options. Example steps follow:

- Determine the OS and productivity software first (this information will be used in creating the base image for the average worker and will determine standard hardware needs based on vendor specifications and commentary of others). Consider the resource requirements of the current software versions and the manufacturer's historical pattern for resource usage increases accompanying version changes if they are permitted. Microsoft Windows Vista and Office 12 will require larger memory footprints for new features provided.
- From a list of currently supported chipsets, either specify the lowest acceptable components or choose all chipsets that meet your minimums (the parts discussed below may be integrated into one chipset across brands).
 - Permit currently manufactured Intel, AMD, and comparable processors chipset series to be contenders for the base contract; do not permit Power Mac G5 and other similar processors/chipsets for the base contract unless the Commonwealth is undertaking a total change in directions.²⁴
 - Do not specify the highest available processor clock speed as a minimum. The clock speeds of all chipsets on the market are adequate.
 - Select a chipset with a lower speed processor with more cache rather than the one with a higher speed and less cache as the minimum (the cache, which is specified as part of the chipset, will provide speed enhancements more noticeable to the user than those provided by processor speed).
 - Do not set a cache minimum that inadvertently eliminates a chipset from contention (e.g., the amount of cache will vary by brand, so choose the minimum from the brand with the lowest acceptable cache (e.g., P4s have 512K cache that is roughly equivalent to the 384K cache in the [Athlon](#) XP so select 384K as the minimum acceptable cache).
 - For [PCI](#) support, select the lowest standard in a currently supported chipset as the minimum (e.g., PCI Express).
 - Require the minimum USB standard currently manufactured or higher (higher versions are backwards compatible for ensuring peripheral connectivity).
 - Require [serial ATA](#). Also consider external USB drives for mobile backup when high-speed connections to LANs are not available.
- The memory requirements are determined by the operating system, software and software use patterns. Information is generally available regarding the expected base memory requirements for software upgrades, if any, that are anticipated during the life cycle of the computer. The memory acquired with the hardware should exceed the base requirements for any anticipated upgrades. An upgrade

²⁴ For information on processor trends see: Tom's Hardware, <http://mikeshardware.co.uk/CPUPricesAMD.htm>; Willis' History of the PC, <http://www.willus.com/archive/timeline.shtml> ; Endian, <http://endian.net/>.

- option is necessary for a small percentage of high-end users of databases, spreadsheets, analyses, multimedia applications, and numerous open applications and windows.
- Low-end, integrated video cards are adequate for meeting most business needs.
 - Choose the hard drive that has faster access and lower capacity (e.g., 40-80 GB or the lowest available) as a minimum (business users store information on a networked server and do not need a drive larger than one adequate to hold software and provide virtual memory).
 - Integrated audio is an adequate minimum for good sound on a business unit.
 - The network adapter may be separate or built in to the motherboard, and should be 10/100/1000 Mbps. The Commonwealth should acquire 10/100/1000 Mbps cards of good quality even though use of Gigabit (1000 Mbps) connections are still rare.
 - A cost analysis may be needed to determine when it is acceptable to eliminate requirements for older PS/2 and parallel connections. After they are eliminated, it would be necessary to provide converters to the few remaining people who need the ports.
 - Headphones are a necessity in the open office environments and should be an option or an alternative to speakers.
 - Business machines are rarely expanded during their lifecycle. Providing for 1 to 2 open PCI slots, although often recommended, is usually a waste. The Commonwealth should encourage the acquisition of small form factor computers with no expansion slots.
 - Embedded graphics are all that is needed for business uses (PCI Express).
 - CD RW and DVD ROM capabilities are a good idea. A standard base unit should not have DVD write capabilities at this time.
 - Examine all new advances for their acceptability for use (e.g., whether they are useful for government business, whether they use adopted technical standards, whether they have moved beyond “bleeding edge,” and whether they are proven or require further testing).
 - Ensure specialized mobile energy saving and weight reduction features are incorporated.
 - Ensure that wireless access needs are addressed.

Life Cycle for Computing Hardware

Average life-cycle advice for computing hardware ranges greatly depending primarily on software upgrade policies and normal levels of equipment abuse. The lifecycle policies of the Commonwealth should include a full complement of policies and procedures that will result in same day or next day availability of computing hardware and software to all

workers that use computers on a daily basis. The policies need to include procurement, deployment, management/replacement, and disposal²⁵.

Establishing an average number of years for desktops and notebooks (a range of years) that is acceptable for general refresh permits the design of a multi-year cycle that will allow for budgeting of hardware and deployment cost. The chosen number in no way affects whether the individual's specific needs are met. It simply enables a periodic refresh for all users who have no specific refresh requirement.

The recommended life cycle *range* for desktops is set at four to five years and for notebooks at three and one half to five years. However, those notebook users who are mobile must have special maintenance and replacement options that are available only to the mobile workforce²⁶. Gartner recommends having an available pool of 2 percent of the notebooks in use by mobile workers available for express shipping to the mobile worker to ensure next day availability to meet the needs of the mobile worker. After receiving the replacement, the mobile worker can then use the same shipping materials to return the problem notebook for central repair or replacement. Gartner cautions that this same notebook pool should not be used for loans to those desktop users who need a notebook for a short period of time. Notebooks that remain in a docking station most of the time are the ones that would be slated for the longer replacement cycle.

Life Cycle for Software

Currently, many agencies refresh operating systems and/or productivity suites frequently during the lifecycle of the computer. There are some good reasons for doing this in an agency centric support environment but the reasons may not hold for a Commonwealth-centric environment. Individual agencies that are small enough to have limited support staff can use updates to keep current and reduce support complexity. However, in an environment where large support teams may serve several agencies, there may not be a compelling business or cost reason to upgrade. In these instances, it is more cost effective to skip upgrades of office software whenever there is no compelling business reason to upgrade. The savings are the costs of making the upgrade and the more substantial costs to employees to set the software up and learn the multitude of superficial changes that slow work progress.

Because future licensing costs and requirements are an unknown, the Commonwealth cannot easily calculate a cost savings from eliminating upgrades. In fact, the costs and benefits of lifecycle policies should be examined each year. Given present costs, if Microsoft Enterprise Agreements are used, there may be no additional software cost for performing an upgrade, but there will be other costs. In this instance, it is the testing costs, costs related to relearning time for both users and support staffs, and the deployment costs that are most significant. Both technical and business staff should have input into the decision of whether to upgrade. There are important issues on both business and technical fronts. However, it is the business staff who should make the upgrade

²⁵ Gartner, Best Practices in PC Life Cycle Services, 16 March 2006, Leslie Fiering, ID Number: G00138551.

²⁶ Gartner, Best Practices for Notebook Hardware Maintenance, 15 March 2006, Leslie Fiering, ID Number: G00138283.

decisions based on the total costs and benefits and not the technical staff because the productivity software is for meeting business needs. The technical staff must provide accurate information for the technical alternatives and their costs.

In its analysis of the business benefits of upgrading from Microsoft Office XP to Office 2003, the platform domain team did not find sufficient general business value to warrant the recommendation of a Commonwealth-wide upgrade. On the other hand, the team did indicate that Microsoft was offering a couple of interesting auxiliary products that interact with the Office 2003 including the Infopath XML data collection form module and the SharePoint Portal server and might have benefit for a limited number of users. They felt that because these products could have utility for some agencies, they could be a catalyst for spurring individual upgrades or business unit upgrades to Office 2003.

One add on service is SharePoint portal. Early versions of SharePoint (prior to the 2003 version) were not well received by reviewers and were not adopted widely by intended users. Even when portals were put in place as tools for workgroups, the workers tended to avoid using them. The current version seems to be more popular and is spurring some individual agencies to consider the upgrade. Some of the complaints about the new SharePoint include the following:

- costs associated with Web-facing uses,
- inability of non-Microsoft users to access and interact with SharePoint portal sites,
- poor representation of the site on non-Microsoft browsers,
- “authentication not working with Internet Explorer for the Macintosh or Mozilla prior to version 1.7.2. In addition, SharePoint pages look different in FireFox, Mozilla, and Netscape Navigator than they look in Internet Explorer. (Users of these other platforms can still get to the files, but they can't really take advantage of SharePoint's integration and management features.).”²⁷

The InfoPath data gathering tool has been used by some as a reason to upgrade because it can be used without additional charge under Microsoft enterprise licensing. It is certainly not free, however; for a single InfoPath 2003 form to be used by all employees in an agency, every employee must be upgraded to Office 2003. This causes its use for just one application in the agency to be the driving factor for Office upgrade policy. Unless the business use is so valuable that it offsets all of the retraining costs to every employee and the cost of supporting the upgrade, it is not likely to be a good reason for upgrading. InfoPath enables the production of forms in conjunction with an Access Database or a SQL Server database. The forms are XML Schema, and when filled out, are XML data repositories that can be sent to respondents for offline data entry and submission via email. InfoPath is just a new database front-end in the much the same way that Access forms are a database front end. To use the form in conjunction with Access, you must first design a relational database in Access and then create the form in Access by binding it to the relational tables that have been created. InfoPath does not have its own analysis tools, does not have any report generation capabilities, cannot do date arithmetic, cannot

²⁷ Applied Innovations, Q11019 - FAQ: What's SharePoint Not Good For?
<http://support.appliedi.net/article.aspx?id=11019&cNode=8F206E>

encrypt passwords, and is considered to be too light-weight to be a developer's tool. But, InfoPath also cannot be used by non-developers very easily. The form developer needs to be comfortable with a database tool and know how to use the tool to produce reports.^{28, 29} Also, according to Microsoft²⁴, InfoPath will not support important data types such as Access Memo, hyperlink, and other long data types. This makes it of questionable worth for conducting qualitative research with open-ended questions. Its value is that it produces an XML schema which may be used as forms. Its downfall is that it takes a quasi-developer or information systems professional to understand what that means and how to use it. Clearly, Microsoft is trying to produce modular tools that are recognizable as extensions to its databases and that bridge the object-oriented world with the relational world. Unfortunately, the tool is not well integrated with Office (e.g., cannot use spell check or grammar check during development) and does not have sufficient backwards compatibility. (See the footnote for a more detailed analysis.³⁰)

The next version of Office, currently called Office 12, has not been analyzed extensively at this point. Gartner³¹ has noted that because of the file format change to XML (default), it will be a costly upgrade and a "painful migration" requiring significant conversions in the workplace. Also, even though Microsoft is switching to a more "open" format, the conversion will cause many incompatibilities throughout enterprises that depend on interoperability previously built into other software. Before upgrading, existing Microsoft Office users will have to install file conversion software so that old versions of Office can accept files from users of the new Office 12. One analyst recommends early analysis of planned characteristics of Office 12 by using Microsoft enterprise agreements to get an advance list of the characteristics under a non-disclosure agreement.

Software Support Issues Including Operating Systems Upgrades

The architecture does not recommend the upgrading of software during the life of the computer for either operating systems or office productivity. The basic assumption is that you are buying a tool that is to meet business needs for the life of the hardware. The less you touch the tool, the less it costs to own and maintain. Of course, anytime business demands additional functionality and that functionality is cost-effective, it should be added. However, the cost to all users and all operations must be considered. No change that affects everyone should be permitted without a thorough analysis. The cost of adding a piece of software to one user's machine and the cost of upgrading an office suite are two entirely different issues.

Domain team participants considered many issues related to office productivity upgrading. One interesting question was "What is the meaning of going on expanded support for Office software, or support beyond the five years of full support provided by

²⁸ Microsoft on InfoPath, Access, and SQLServer: <http://office.microsoft.com/en-us/assistance/HA011032471033.aspx>

²⁹ Raj Chaudhuri, August 25, 2004, <http://discuss.fogcreek.com/joelonsoftware5/default.asp?cmd=show&ixPost=179536>

³⁰ Leading Edge, Projecting InfoPath, A Form-Focused, Information-Gathering Tool for Smart Client Applications, Peter O'Kelly. <http://www.okellyinc.com/Publications/ProjectingInfoPath.pdf>

³¹ Office 12 File Format Will Bring XML Benefits, Migration Pain; June 2005, Michael A. Silver and Rita E. Knox. ID Number: G00128241.

Microsoft.” The answer to this question, which is often given as a reason for upgrading, was relatively hard to find. Microsoft representatives at the COVITS conference offered the following explanation. If an agency is on expanded support, which lasts from year six until two years after the release of the next upgrade, the agency will have to pay for any requested fixing of bugs that may be necessary for a particular agency application development effort. However, if a security patch is needed, Microsoft will provide it as part of expanded support. In essence, expanded support means that Microsoft has moved its development team over to the new product. This means that there is little or no risk with going on expanded support. If an agency really needs to upgrade to develop an internal application, they can do this at any time.

For operating systems, an upgrade is intertwined with internal hardware, peripherals, new functionality, and other considerations. Because of this, the old computer and peripheral configuration is generally best left to the old OS and the newly acquired configuration would move to the new OS. The change-over will generally take the same period of time as the life cycle of the hardware.

An example of new hardware functionality tied to the operating system is LaGrande technology³², which embeds hardware security into the chipset. This technology was announced by Intel in 2002, but is tied to the release of the next Microsoft OS beyond Windows XP Pro. Both the new chipset and the new OS are required to get the proposed feature.

Surge Protection

All computers should have some form of power surge protection when they are plugged in to electrical, cable, network or phone wiring. Service entrance surge protection does not take the place of point of use surge protection. A surge can originate inside the building if lightning hits the building wiring or if other appliances cause a surge. Alternate energy sources also do not eliminate the need. The following list of caveats is not comprehensive. More information can be found on the State Farm Insurance web site at the following listing: <http://www.statefarm.com/consumer/vhouse/articles/surgprot.htm>

Some important considerations are as follows:

- A surge protector must be UL 1449, second edition rated, which means that it meets current Underwriter Laboratory's requirements for surge protector safety³³.
- A surge protector should be grounded and should never be used with a non-grounded extension cord
- A surge protector that no longer conducts electricity if its protection capabilities have been destroyed by too many surges is recommended. A light typically only means that electricity is being conducted and not that the surge protection works. Surge protectors can wear out.

³² LaGrande Technology tutorial. See <http://www.hardwaresecrets.com/article/264>.

³³ UL1449 has basic safety tests no different from most UL standards for safety. These tests include leakage current, dielectric withstand, insulation resistance, temperature rise and mechanical integrity tests such as impact, drop, crush and mold stress relief distortion for plastics among others. <http://www.leviton.com/sections/prodinfo/surge/ul1449.htm>

- You must use the jacks for phone and other electrical input to have full protection. No electrical input should go directly into your computer.
- The surge protector must have input and output for the connectivity you use. For example, different recommended jacks (RJ specifications) are used for phone (POTS), ISDN, DSL, T1, etc. (e.g., RJ11, RJ45, RJ48).
- Buy a surge protector with a warrantee and keep the warrantee.
- Remember to use a surge protector on your laptop. Laptop surge protectors are often small and have retractable phone or data line connection cords.
- The newer your equipment, the more sensitive it is likely to be to surges.

Outsourcing

The value of outsourcing desktop and notebook solutions should be reevaluated annually, even if multi-year seat management or partner contracts have been negotiated. The market place is constantly changing, and the value of outsourcing changes with it. A change of the desktop and laptop refresh lifecycle and corresponding support that enables the recommended minimums and maximums for life cycles should be reflected in any outsourcing or partnering contracts.

Emerging Technologies Generally

The Platform Domain team typically limits its scope to research and discussion of individual devices and technologies, their potential business utility for agencies generally, related benefits and risks, and their future place in the Commonwealth's to-be technical architecture. Actual deployment of the devices and technologies may involve assessment of agency-specific needs and testing for agency-specific risks, problems, benefits and compatibilities. This testing may be done in a laboratory setting or an agency setting. It may involve additional, agency business related research, consideration of uses in other states, published commentary from other states, or perhaps studies of the agency's deployment environment. The Commonwealth's agencies may be able to benefit greatly from sharing resources, facilities, test results and lessons learned from such testing and deployment efforts conducted by other agencies. To promote sharing of resources and reuse of results, a clearinghouse may be beneficial.

A clearinghouse for information could rest with an interested agency, the Council on Technology Services, VITA Communications, a metropolitan Richmond college or university, or any number of other groups. Making this type of coordination happen does not require endorsement by the ITIB or coordination by VITA, but certainly, an architectural recommendation as a best practice may provide some impetus to such an effort. These types of efforts including the General Assembly's funding of test labs and dedicated staffing were proposed by the personal computing domain team but are clearly broader in scope than either personal computing or platform architecture. The issue is being addressed here, because the current technical architecture framework does not have a venue for cross-domain technical architecture best practice recommendations.

Personal Computing Recommendations and Requirements

Personal computing addresses hardware, operating systems and/or productivity software for desktops, notebooks, handheld devices (e.g., personal digital assistants and smartphones), and personal peripherals (e.g., personal printers). Productivity software includes common office software (e.g., word processing) and utilities (e.g., pdf file readers). Recommendations and requirements for personal computing are provided below as requirement statements, Recommended Practice Statements, and Technology Component Standards tables.

Recommended Practices

The following eleven recommended practices are identified for the Personal Computing technology topic.

- PLA-RP-02: Desktop-Attached Print, Copy, Fax and Scan Devices –** Agencies that decide to continue use of high-cost desktop printers, faxes, scanners and copiers should establish a policy for their acquisition, use, maintenance and replacement. To reduce costs, they should employ quiet black and white laser printers with a low cost per page and a high consumer rating in most instances. If Agencies support the devices internally, they should use technicians or clerical staff who have had additional training in the devices and not use high-paid IT staff.

- PLA-RP-03: Wireless Enhancements –** Executive branch agencies involved in procuring computers should equip the standard mobile notebook computer with a wireless interface (e.g., IEEE 802.11a, b, or g card or embedded capability) to enable state workers to take advantage of wireless connectivity provided in public spaces.

- PLA-RP-04: Default Disabling of Wireless Devices –** Agencies should disable wireless connectivity capabilities by default and only enabled them at time of use. This will minimize the unnecessary wireless poll signals as well as save on DHCP issued IP addresses.

- PLA-RP-05: Studies of Personal Computing Needs, Costs, and Benefits –** Virginia should know what its best alternatives would be if it were to change from present personal computing architectures. The set of alternatives should be based on research conducted in government settings. For example, the research might address the best alternative to Microsoft productivity products and the costs associated with changing. Information could be used to establish reasonable cost targets

for future Microsoft product negotiations or reasonable alternatives if Microsoft prices were prohibitive.

- PLA-RP-06: Browsers** – At this time, not all Internet applications perform acceptably on Internet Explorer. Because of this, VITA and institutions of higher education should try to accommodate two browsers securely.
- PLA-RP-07: Hard Drive Encryption** – Some agencies have a need to provide enhanced security to their mobile worker's computing devices. Hard drive encryption software may be particularly useful in meeting the needs of workers who store medical and personal information on their notebooks and PDAs.
- PLA-RP-08: USB Ports** – Desktop units and/or monitors on state contract should have front facing USB ports or easily accessible USB ports. Easily accessible USB ports are an enabler for using USB key fobs for authentication, USB devices for storage, and other USB peripherals.
- PLA-RP-09: Guidance for Cost-Effective Matching of Toolsets to Workers** – VITA should provide guidelines to agencies for cost-effective pairing of workers and high-cost personal computing devices and services including notebooks, push email devices (Blackberries), smartphones, and projectors.
- PLA-RP-10: Push Email** – There will soon be stronger and possibly more cost-effective options for push email. VITA should study the alternatives in the 2006-2007 timeframe. Change to a new system could be phased in as devices are replaced.
- PLA-RP-11: Office 12** – VITA should begin an analysis of Office 12 immediately (in 2006) using its early access to information that is available as part of Enterprise Agreements and should report on the pros and cons of upgrading, the impact of upgrading, the costs associated with upgrading, costs associated with not upgrading, and the timing related issues involved in upgrading.
- PLA-RP-12: Surge Protection for Office Workers:** Agencies should provide surge protection for personal computers and should protect against surges for all electrical inputs. A two stage surge protection is best. Protect both at the service entrance and at the point of use.

Requirements

The following fourteen requirements are identified for the Personal Computing technology topic.

- PLA-R-03: Centralized Personal Computing Decisions** – For agencies supported by VITA, VITA shall centralize personal computing decisions regarding what shall be procured, how frequently devices may be refreshed, how agency support is to be provided, what security methods are acceptable, and what methods of access (e.g., wireless push email systems for PDAs) may be used.
- PLA-R-04: Personal Computing Security Software** – VITA shall establish the minimum requirements or the starting point for the base image to be used on personal computers that access VITA-controlled networks. Agencies will add to these images to meet agency-specific security needs. The VITA base image shall contain VITA-approved security software such as antivirus software.
- Agencies that operate on networks not controlled by VITA must establish minimum personal computing security software for the business they conduct and the networks they use. This software must be provided as part of the agency's base image.
- PLA-R-05: Location-based Personal Computing Support** – VITA shall provide location-based personal computing support options for geographically dispersed agency groups when central services are inadequate to meet customer needs. Costs and benefits of various location-based service options must be evaluated.
- PLA-R-06: Personal Computing Desktop Displays** – Because desktop displays have a longer lifecycle than the computers they support, their replacement shall not be automatic at the time of a desktop replacement. Display replacement decisions for all agencies including administrative units of higher education must be based on customer business needs, support considerations, cost-of-ownership data, and hardware compatibility considerations. VITA and other agencies that provide for display acquisition shall ensure separate display acquisition pricing that is equivalent to joint display and tower acquisition pricing.

- PLA-R-07: Personal Computing Processors** – When establishing minimum specifications for bids for low-end personal computing acquisitions or seats to be used by the majority of the workforce, executive branch agencies involved in acquisitions and contracts shall require: the lowest of currently available Intel, AMD, or comparable chipsets and components that will cost-effectively meet anticipated processing needs for the proposed productivity software, typical business needs, special needs of the mobile worker, and/or needs related to lifecycle requirements such as future availability of various memory options.
- PLA-R-08: Personal Computing Optical Drives** – When establishing minimum bid specifications for personal computers, executive branch agencies involved in procurements and contracts shall include a CD/DVD reader with CD write capabilities. DVD writers are not permitted. Any acquired DVD reader must read multiple formats. Floppy drives shall remain an option but their acquisition shall be discouraged.
- PLA-R-09: Personal Computer Base Images** – VITA shall develop starting point, typical base images for the most commonly needed desktop and notebook computer configurations to reduce setup decision making and costs for agencies VITA supports. This shall include standard software setup and system lockdown policies. Typically, agencies will add to these base images to accommodate agency-specific requirements.
- PLA-R-10: Productivity Software Needs** – VITA shall assess the productivity software needs for agencies it supports (e.g., percentage of the workforce that requires various combinations of the individual office software offerings including word processing, presentation, spreadsheet, and database software based on a workforce sample).
- Needs information shall be gathered with the assistance of agencies and shall be used in estimating the costs of state-level personal computing alternatives (e.g., licensing with or without Access). The information shall be available to agencies for use in assessing the costs of modifying the desktop base image for those groups needing additional personal or agency-wide functionality.
- PLA-R-11: Minimum Productivity Software for Meeting Knowledge Worker Needs** – The Commonwealth’s target personal computing software architecture for new desktops and

notebooks for all agencies including administrative units of higher education shall include: Microsoft Office (XP or 2003), Internet Explorer, and Adobe Acrobat Reader. (Note that Access is not to be included in the minimum base image for most workers.)

- PLA-R-12: Software Support for PDA Access** – VITA shall ensure that personal productivity software calendar information, tasks, contacts, and user files shall be accessible by using Personal Digital Assistant (PDA) capabilities on various communications devices used by employees. VITA shall accommodate standard access methods.
- PLA-R-13: Lifecycle for Personal Computers** – For replacement of personal computers, agencies including the administrative units of higher education shall use a lifecycle range of four to five years for desktop computers and three and one-half to five years for notebook computers.
- PLA-R-14: Software Upgrades** – Agencies shall not upgrade operating systems software or office productivity software during the life of the computer unless they document a compelling business reason to do so or a compelling return-on-investment that offsets all hard and soft costs for making the change.

Implications:

One concern about using this approach is that support staff may have to support two or three versions. This can be an issue for small agencies but is not an important issue for a large, Commonwealth-wide support service. The organizing of personal computer support teams by OS/software version combinations rather than by agency can easily mitigate the effects of this problem. Dedicated teams also facilitate the tracking of problems by version of software and year of hardware and software.

- PLA-R-15: Surge Protection for Field Workers** – To protect computing equipment used by field workers and to protect the data stored on their equipment, agencies responsible for purchasing these computers and peripheral devices shall provide a surge protector to the employee that protects from surges through all electrical inputs including network, telephone and power lines. Printers and other peripheral devices may also be protected through surge protectors. The term, “field workers” includes telecommuters, roadway inspectors, park rangers and similar workers who work outside of a networked office building. Workers who are in networked offices have the needed data protection, data backups, and uninterrupted power provided through file server protection.

PLA-R-16 **Telecommuting Tools** – For any telecommuting employee, a minimum toolset must enable the employee to do his or her job well. If needed for the specific job and person, the following personal computing tools shall be provided, as appropriate, for use in a home office, a hoteling space, or when working from a mobile office:

- mobile notebook,
- docking station with a separate display,
- keyboard and mouse,
- surge protector for mobile use and/or docking station,
- secure, high-speed connectivity to agency's LAN,
- file backup,
- email,
- voice and web conferencing,
- training,
- Internet services; and
- local and long distance voice services.

Technology Component Standards

The following seven technology component standards are identified for the Personal Computing technology topic.

Table PLA-S-01: PC Operating Systems Technology Component Standard	
Strategic:	Windows XP Pro (with tested Service Packs)
Emerging:	<p>Unix alternatives as a replacement to Windows as a Commonwealth solution could be studied.</p> <ul style="list-style-type: none"> Linux (kernel 2.6.13 on 9-8-05)³⁴ (Note: Commonwealth liabilities may be an issue depending on SCO Unix lawsuit outcomes.) Macintosh OS X Solaris <p>Windows Vista (formerly code name Longhorn, anticipated in the last quarter of 2006)³⁵</p>
Transitional/Contained:	<p>Windows 2000 Professional</p> <p>Macintosh OS 9</p>
Obsolescent/Rejected:	<p>Windows earlier than Windows 2000</p> <p>Any home version of Windows</p>
Exception History:	

Table PLA-S-02: Displays Technology Component Standard	
Strategic:	<p>Minimum of 17" CRT or flat panel for desktops (Note: The solution is to be used for its full life.)</p> <p>Flat panel is the standard recommended replacement for desktops</p> <p>CRT is the optional special use display</p>
Emerging:	<p>OLED displays</p> <p>FOLED displays (roll-up OLEDs for transporting presentations)</p>
Transitional/Contained:	<p>Less than 17" CRT or 17" flat panel for desktops</p>
Obsolescent/Rejected:	
Exception History:	

³⁴ See www.kernel.org for latest kernel.

³⁵ Inside Gartner Top View, September 28, 2005. ID Number: G00131334

Table PLA-S-03: Read/Write Devices Technology Component Standard	
Strategic:	<p>USB Keys (Many names are used including Jump Drives, USB Drives, and Flash Drives). These drives can include security options. With security, these drives are the preferred choice for transport of sensitive files and information.</p> <p>CD RW/ DVD ROM Combo Drive is the preferred device (installation on standard PC is recommended); other options including separate DVD ROM and separate CD ROM or CD RW are not recommended but also are not prohibited.</p> <p>External USB Hard Drive (an option to CDs and USB Jump Drives for mobile worker backups)</p>
Emerging:	<p>DVD³⁶: no single standards agreed to for DVD authoring; no single standard anticipated; DVD writer not recommended for PC installation. Blue and red laser write methods from competing camps are as follows:</p> <p>DVD Forum camp (current DVD, blue laser) Recordable: DVD-R; DVD-R(G); DVD-R(A). Rewritable: DVD-RAM; DVD-RW</p> <p>DVD+RW Alliance camp(current DVD, blue laser) Recordable: DVD+R; DVD+R DL. Rewritable: DVD+RW; DVD+MRW.</p> <p>Blu-ray camp (movie industry and future DVD, red laser) BD-R, BD-RW</p> <p>HD-DVD camp (movie industry and future DVD, red laser) HD DVD-R, HD DVD-RW</p> <p>(For enterprise storage use of DVDs, see utility services technical topic)</p>
Transitional/Contained:	<p>Jaz Drive (Iomega successor to Zip Drive)</p> <p>Floppy Drive (3.5") it is recommended that floppy drives not be installed as a base option for any standard PCs but purchase is not prohibited.</p>
Obsolescent/Rejected:	<p>Zip Drive (Iomega) 5 ¼ Floppy</p>
Exception History:	

³⁶ DVD technology explanations and competition commentary: <http://www-i4.informatik.rwth-aachen.de/~jakobs/Interop/Gauch.pdf> or a news listing such as PC World (see items marked news on the left), http://www.pcworld.com/resource/browse/0_cat,1114_sortIdx,1_pg,1_00.asp .

Table PLA-S-04: Desktop Attached Printing Technology Component Standard	
Strategic:	Laser printing devices are required for non-mobile black and white printing uses in situations where a desktop attached black and white printer must be used (Note: Desktop attached printers are strongly discouraged for most workers. See discussion in Utilities section.)
Emerging:	
Transitional/Contained:	Desktop attached (non-mobile) ink-jet printers for black and white printing are to be phased out (Note: Desktop attached printers are strongly discouraged for most workers. See discussion in Utilities section.)
Obsolescent/Rejected:	
Exception History:	

Table PLA-S-05: Miscellaneous Mobile Components Technology Component Standard	
Strategic:	<p>Modems (V.90, V.92³⁷)</p> <p>Receivers/transmitters for LAN, PAN and mobile devices</p> <ul style="list-style-type: none"> IrDA—infrared Bluetooth devices (1Mbps, FHSS, 2.4 GHz) may have a short life; version 1.2 or higher <p>PC Cards (PCMCIA) and internal devices (e.g., embedded in chipsets)</p> <ul style="list-style-type: none"> Bandwidth combination devices for 802.11 (a+b+g) <p>Lithium Ion Battery</p>
Emerging:	<p>Devices supporting new wireless standards and those in development</p> <ul style="list-style-type: none"> 802.11e ratified in September 2005 adds quality of service to 802.11a and b. 802.11i ratified in June 2004 adds security enhancements to wireless a, b and g transmissions 802.11n for next generation wireless with reduced distance degradation and better multimedia streaming at higher speeds (100 Mbs) UWB—high speed PAN solution and synchronization solution WiMAX Mobile³⁸ —portable high speed wireless for MAN (or last mile technology) in development (802.16e enables mobile device connections); to be adopted by digital peripheral makers; throughput and battery life are still issues. 802.16a WANs currently provide 70 Mbps over 31 miles using TDM/TDMA, between the 2GHz and 11GHz (licensed and unlicensed) frequency ranges) <p>Micro Fuel Cells³⁹ —a new technology to replace batteries</p>
Transitional/Contained:	<p>Modems (V.34 and earlier)</p> <p>PC Cards (also called PCMCIA cards) and internal devices (e.g., embedded in chipsets) not receiving 802.11 a, b and g (to maximize wireless network design possibilities)</p> <p>Bluetooth devices, less than version 1.2 (interference issues are greater)</p>
Obsolescent/Rejected:	
Exception History:	

³⁷ V.92 supports quick connect, modem on hold, and 48K upstream transmission.

³⁸ Uses orthogonal frequency division multiplexing access (OFDMA) with subcarrier spectrum divisions using QAM or QPSK. Several Gartner articles address the place of WiMAX in future mobile networking: WiMAX will Complement Not Kill Wireless Fidelity, Robin Simpson and Ian Keene (addresses throughput and battery life issues); How Vendors are Approaching WiMAX, January 13,2005, Jouni Foursman, Ian Keene, Jason Chapman, and Bettina Tratz-Ryan; Hype Cycle for Wireless, July 19, 2005, G00127662.

³⁹ Have the potential to provide ten times the energy capacity of lithium ion batteries. According to Gartner: Hype Cycle for Wireless, July 19, 2005, G00127622, working prototypes are now available. Commercialization is expected between 2005 and 2007.

Table PLA-S-06: Miscellaneous PC Components Technology Component Standard	
Strategic:	
	Cardbus type PC Cards with parallel interface, DMA, and 32 bit path
Emerging:	
	ExpressCard ⁴⁰ —PCMCIA Cardbus replacement that provides high speed serial access embracing USB 2.0 and PCI-Express
Transitional/Contained:	
	PC Card with parallel interface and 16 bit path
Obsolescent/Rejected:	
Exception History:	

Table PLA-S-07: Productivity/Management Software Technology Component Standard	
Strategic:	
	Microsoft Office XP, 2003 Internet Explorer (highest); encourage exploratory use of a second browser such as FireFox Outlook (2002 with 2004 update or 2003) Adobe Acrobat Reader (and plug in—latest) Microsoft Access XP, 2003
Emerging:	
	Corel WordPerfect Office X3; Corel Central StarOffice 7.0 (Beta 8.0) ; StarSuite 7.0 Microsoft Office 12 (Mac and Windows expected after mid 2006) Mozilla FireFox (Note: FireFox is pre-approved for pilot projects or research purposes. Exception requests are not required for pilot use.) Open Source Browsers (e.g., Opera) Centrally managed services clients; centrally selected antivirus software for VITA-served agencies (when initial selection and later changes have been announced)
Transitional/Contained:	
	Microsoft Office 2001 with Outlook Express 5 (Mac) Microsoft Office '97 with Outlook WinZip (compression now in Windows XP) Microsoft Office 2000 (expanded support ends June 27, 2009) Access 2000 (expanded support ends June 27, 2009)
Obsolescent/Rejected:	
	Microsoft Office '95 with Outlook

⁴⁰ This technology is just now gaining a foothold in the market place. It is listed as emerging because it is so new. As it becomes available, agencies should test its viability for their business uses.

Table PLA-S-07: Productivity/Management Software Technology Component Standard
Exception History:

Servers

Servers include the full range of computing devices from mainframe computers to small single-processor computers. Servers may provide file and print controls, business applications, databases, Internet presence, voice communications, email and other important functions for the enterprise. Most servers are part of a network. A server solution may include single servers, virtual servers, clusters, farms, frames of server blades (e.g., servers in a blade chassis), server appliances, or n-tier applications solutions. Server and server solution capabilities, scalability, reliability, management options, and shared use options are important factors in decisions regarding servers. Server hardware and software include operating systems, processors, ports, interfaces, communications buses, memory, storage, power, and controller components.

As-Is Architecture for Servers

For fiscal year 2002, Virginia’s executive branch agencies excluding higher education reported having 2,997⁴¹ servers. Fewer than 80 of the 2,997 servers appeared to fit the Commonwealth’s high-end server definition, and only three of these were mainframes. The data used for this analysis were updated in 2003 and then replaced by a VITA inventory system thereafter. The 2005 VITA inventory data provide summary information that may be used to look at changes since 2003 (see Table 11). Because no operating system information was provided for about 12 percent of servers in 2003, little can be said about changes. However, agency reports of servers purchased in the three years from January 2003 through July 2005 indicate that 81% of purchases were Windows servers and 13% Unix servers. This would seem to indicate a small increase in Windows and a decrease in Unix units. Purchase information is provided in Figure 4. No information is available on the number of applications housed on each type of server. Also, no information is available for higher education servers.

Table 11: Operating Systems Percentages in the 2005

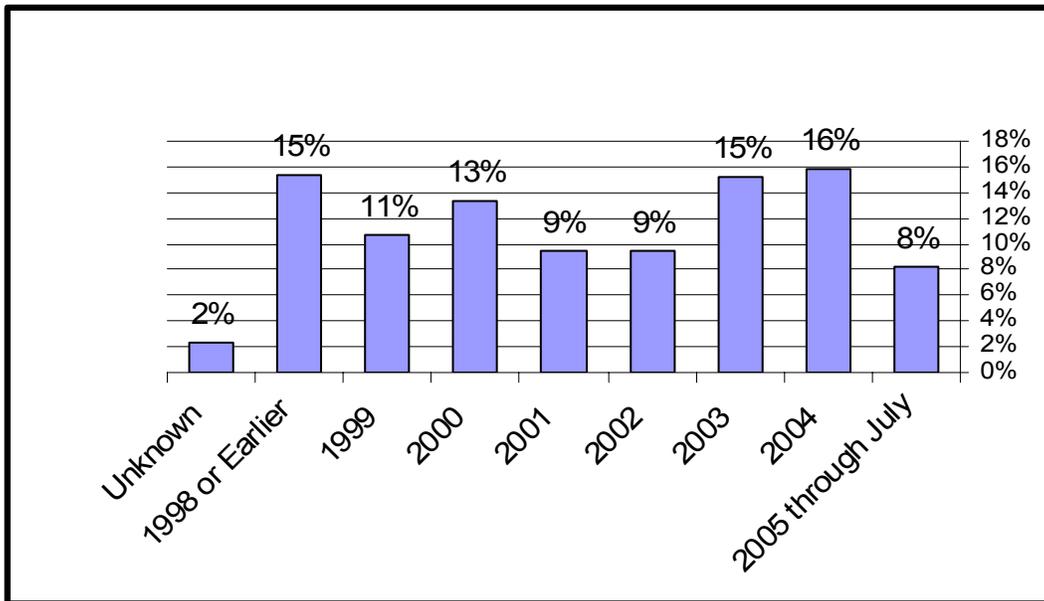
OS	FY 2003	FY 2006
DOS/Windows OS		
DOS		75
Windows NT		253
Windows Unknown		183
Windows 2000 Advanced		50
Windows 2000		1426
Windows 2003 Enterprise		5
Windows 2003		394

⁴¹ Four of the servers reported as single servers were 100 blade frames. Fewer than one hundred of the 2,997 are “high-end” servers.

OS	FY 2003	FY 2006
Microsoft Servers	65%	76%
Unix OS		
AIX		24
HP-UX		30
Linux		42
Linux, Red Hat		54
Solaris		335
Unix		34
OSX Server		1
Unix Servers	12%	17%
Other OSs		
MPE		7
Netware		152
OS/400		1
OS2 WARPSVR		6
VMS		4
Unknown		25
None		32
Other, Unknown & No OS Servers	13%	7%
Grand Total (All Servers)	2997	3133

The “Other” category in Table 11 includes mainframe platforms supported by agencies and centrally. The Commonwealth supports both an IBM z/OS mainframe and a Unisys HMP OS2000.

Figure 4: Purchase Year for Production Servers in the 2005 VITA Inventory



Commonwealth’s Goals for the Server Architecture

In the past, most server solutions have been proposed agency by agency across the executive branch or department by department within colleges. Now, agency solutions

can be addressed from the perspective of the agency and the Commonwealth as a whole. This practice was common only for certain Commonwealth data center solutions, in some universities and in the community college system (VCCS) prior to the creation of VITA. Today, for agencies served by VITA and for colleges, universities and central college services, greater consideration of consolidation options are possible. Even though needs of the business and the business applications remain the number one concern, VITA and its partners can focus on server solutions that make greater use of strategies that may cross agencies, departments and schools.

A Commonwealth-wide perspective would focus on the following enterprise goals and strategies:

- Achieving cost-reductions across agencies while maintaining or improving service quality for each agency
- Providing a full range of platform capabilities to meet business needs
- Consolidation of storage, backup and recovery to reduce storage costs and reduce the risk of data loss
- Considering platforms as application, data and presentation consolidation vehicles
- Considering more homogeneous server solutions across agencies (e.g., reducing the number of OSs, images, manufacturers, management solutions, etc.)
- Considering opportunities for reuse of software, hardware, and server images across agencies
- Considering virtualization strategies
- Considering alternate organizational and staffing arrangements to reduce costs and improve service consistency and quality
- Considering outsourcing or central in-sourcing opportunities for all IT services
- Considering server sizing tradeoffs and scaling opportunities

When a server's size (or committed resources in the case of virtual servers) is just right, this will increase the likelihood of high server configuration costs and server resource monitoring costs. Having a server that is too large might decrease monitoring costs while wasting resources and limiting future opportunities to enhance server performance by acquiring improved technologies. Having a scalable server or server cluster may provide a cost-effective balance.

- Considering expectations and metrics for the total solution
 - Ensuring adequate reliability
 - Ensuring adequate availability
 - Controlling costs for the application and its future maintenance
 - Providing temporary transitional opportunities for moving applications from old hardware to new while planning for timely application porting

to a more modern operating systems (e.g., virtual NT moving to Windows 2003)

- Involving agency security and network personnel in solution decisions from the beginning
- Providing quality, standardized backup and recovery to meet agency business needs

Issues/Challenges

There are a number of issues and challenges that must be dealt with in providing good application-based, centralized, and outsourced server solutions. Some of these are noted below.

- Estimating solution risks for platform alternatives
- Estimating costs and benefits for platform alternatives
- Ensuring fair and equitable charge-back mechanisms for multi-agency platforms and related services
- Providing for competition while controlling overall architectural complexity
- Defining models for allocating these costs across the systems and services that use them

Some cost-effective consolidation solutions require up-front expenditures to ensure solution opportunities (e.g., acquisition of a consolidation platform) or related services (e.g., authentication, access, connectivity, management software, bandwidth, help desk services, and operating metrics). Whenever these services are shared across consolidation opportunities, a method of using part rather than all of the costs in an alternative comparison will provide a better assessment of the consolidation opportunity.

- Promoting the benefits of having a platform architecture through customer communications
- Ensuring that architecture recommendations have an impact on procurements and solutions

Server Consolidation

Consolidation is one strategy that will be used by VITA, its partner, colleges, and the VCCS to control costs in certain instances, to provide scalability, to attain greater simplification and to provide more consistent backup and recovery. Not all consolidation vehicles have the same benefits, costs and risks, however. The following discussion addresses some of the pros and cons.

There are several approaches to server consolidation. Gartner suggests there are three approaches (consolidation types are in italics and basic definitions are from Gartner). Others use similar classifications.

- The first type of consolidation, *logical consolidation*, leaves servers where they are and manages them centrally. The management software used for remote administration must handle well the types of servers in the current and envisioned future architecture.
- The second type, *physical consolidation*, requires moving agency server hardware to one or more central locations to be managed across groups of agencies or co-locating replacement hardware as existing servers become obsolete. In Virginia, this consolidation solution would also require good telecommunications for getting the data and functions to the users (including tier components) in addition to a good central management strategy.
- The third type of consolidation, *rationalized consolidation*, requires using scale-up and scale-out consolidation platforms for the co-location of applications, databases, general storage, network functions, and utility functions (e.g., network, application, or database functions that are handled commonly across agencies). Collocation of such applications might involve using provisioning blades, server clusters, server partitions, virtual servers, etc.

Rationalized consolidation might include bringing together many different applications to one platform (e.g., Oracle databases) or consolidating multiple instances of the same utility application such as email. This type of consolidation is the most risky and, therefore, requires particular attention to assessing risks and costs for the alternatives being compared.

Future Architecture

The Commonwealth's present server architecture is predominantly Microsoft and Unix, with Unix being used primarily for applications that require higher-end server capabilities. This will not change in the near future. The server architecture will continue to include Microsoft, Unix (including HP-UX, AIX, Solaris and Linux) and the IBM z/OS mainframe. Over time, the target server architecture changes in Virginia will result in:

- Fewer servers
- Fewer server locations
- Better services operated with fewer staff (e.g., for backup provision)
- More high-density solutions
- Increased reliance on telecommunications
- Movement of databases to separate platforms from the applications that use them or to separate partitions on the same platform
- Fewer operating systems
- Increased use of scale-up and scale-out consolidation solutions
- Scalable server solutions for utilities including email, web page serving, and storage
- Use of virtual servers for development and some testing
- Use of virtual servers for accommodating multiple versions of an OS as a transition strategy for consolidation of a network function

- Use of appliances for functions including cache, storage, etc.
- Use of stored images for rapid provisioning changes to clusters
- Active consideration of more than one “within-architecture” platform alternative for all new and revised business applications
- Tracking of planned retirement dates for applications and for server hardware
- Increasing use of Linux
- Managed increases in uses of Solaris and HP-UX
- Decreasing use of Windows where Linux and Novell are used
- Managed decrease in the use of all platforms not in the architecture
- Managed increase in use of platforms in the strategic architecture
- Eventual use of Windows as a consolidation platform
- Continued use of commoditized hardware at the low and low-midrange server end
- More consistent product life-cycle management
- Continued acquisition of high-end platform capacity when it is needed (e.g., for processor activation, processor acquisition, etc.)
- Having lease lengths that match planned technology life
- More standard technology lifecycles
- Movement to consolidation platforms only if cost effective (effectiveness assessments include consideration of the value of all benefits such as security improvements, more consistent backup and recovery provision, customer service improvements, and other consolidation benefits)
- Coordination of presentation, database, messaging, and storage options within and across in-architecture platforms and tiers
- Separate management of applications remaining on an “out-of -architecture” platform

Linux

Linux is not used a great deal across executive branch agencies that are served by VITA. However, use of Linux is expected to increase, perhaps for certain utility services (discussed later in this report) and for databases. At present, Linux and Unix users are concerned about the possible affect of the SCO Unix lawsuits against IBM and others and what affect they might have. The main lawsuit filed by SCO claims violation of its intellectual property rights in Unix. A legal victory for SCO may affect Unix and Linux business applications, customer communications, and other server functions in the Commonwealth. Gartner has provided a consultation to the Commonwealth on this topic (February 7, 2006) and has indicated that the risk is relatively low. The Commonwealth currently has contracts with Fujitsu, IBM, HP-UX, and some additional small server providers but does not have contracts with all in-architecture Linux and Unix server providers. Existing Commonwealth contracts require suppliers to provide some level of indemnification. However, if SCO were to prevail in the courts, the Commonwealth may incur costs associated with replacement of infringing products with non-infringing ones. For future applications, agencies should consider whether their risk could be further decreased by taking steps such as those outlined in the following Gartner article: *SCO's Suit Against IBM: An Update and Recommendations*, ID Number G00127209.

Principles

The following three principles are identified for the Server technology topic.

- PLA-P-13: Server Selection Flexibility** - The Platform domain should recognize the importance of permitting server selection flexibility in addressing requirements for many large-scale enterprise business problems.
- PLA-P-14: Efficient Consolidation** - The Platform Domain should enable efficient server consolidation.
- PLA-P-15: Reducing complexity** - The Platform Domain should reduce server complexity without jeopardizing competition

Recommended Practices

The following eleven recommended practices are identified for the Server technology topic.

- PLA-RP-13: Planning for Workload Types** – VITA should define platform consolidation strategies by workload type, e.g. email, database, applications, etc.
- PLA-RP-14: Staff Planning for Servers** – For in-house staff and operations, to ensure continuous support of the Commonwealth’s information technology infrastructure, VITA should track data on staffing, staff retirement plans, staff skills and staff retraining interests.
- PLA-RP-15: Platform Lifecycle Management** – To improve Commonwealth infrastructure planning, agencies responsible for infrastructure should manage all platform lifecycles and track appropriate data.
- PLA-RP-16: Consider Application Total Costs** – When conducting cost-benefit analyses for an application, owning agencies should consider full costs of alternatives and not just up-front costs.
- PLA-RP-17: Leverage Volumes across State and Local Government and Beyond** – VITA should leverage its business volumes and its central control to pursue the costs savings and benefits of simplification in platform procurement and scaling decisions. Acquisitions of a hardware type (servers, appliances, blades, etc.) and related hardware or software should be restricted to no more than two brands by competition every one to two years. The competition should be based on the most procured size and type of server for an in-architecture operating system,

but the award should extend to variations within the class (commodity class or low-end, scalable class or midrange). Support, reliability, performance, and other needed qualities should be weighed appropriately. The advantage of having two selections is continued competition for performance and price during the one to two year contract. At a minimum, this type of procedure should be followed whenever cost saving or other benefits will exceed the cost of the competitive process costs by one million dollars over the one to two year period. Areas of greatest savings should be addressed first.

- PLA-RP-18: Planning for the Common Good** – Individual agencies that provide server infrastructure and VITA should consider the agency's goals, the Commonwealth's goals, and Enterprise Architecture guidance when selecting among server solutions.
- PLA-RP-19: Maintenance Options and Business Needs** – Individual agencies that provide server infrastructure should ensure that the maintenance support response-time is in line with business needs for all applications on each specific server.
- PLA-RP-20: Considering Server OS Manufacturer Best Practices** – Individual agencies that provide servers should follow the OS manufacturer's specific systems setup policies and best practices.
- PLA-RP-21: Rack Mounted Servers** – Rack mounted servers are the preferred form factor whenever their use is possible. Blades may be more appropriate in some instances but should be considered application by application due to the higher costs and the importance of applications benefiting from shared services to offset the costs. Also, concerns about the proliferation of proprietary management systems should be weighed in the decision.
- PLA-RP-22: Server Capacity** – Agencies that provide servers should consider growth requirements over the server life to enable minimizing costs and reducing wasted capacity. Specifically, planning may enable acquisition of a small number of large capacity memory modules instead of a large number of smaller modules and may enable avoiding excess and underused server capacity.
- PLA-RP-23: Supported Linux** – The Commonwealth should avoid the use of unsupported, open source distributions of Linux.

Requirements

The following three requirements are identified for the Server technology topic.

- PLA-R-17: Maintenance Agreements** – All agencies shall ensure that servers which support production are under a maintenance agreement for the planned life of the server. For x86 architecture, the planned life shall be a minimum of five years. Operating systems replacement plans and service level agreements for the applications supported by a server are important factors in establishing the server's planned life.
- PLA-R-18: File Servers** – All agencies shall examine consolidated storage alternatives whenever considering acquisitions of file servers and shall select the consolidation option when it is cost effective.
- PLA-R-19: OEM (Original Equipment Manufacturer) Operating Systems** – Agencies shall use volume licensing agreements in place of OEM provided options for operating systems acquisitions for X86 server hardware.

Note: OEM operating systems offer no upgrade path, and in the case of Windows, each OEM license is tied to the hardware with which it was purchased

Technology Component Standards

Servers with Different Capabilities

The following Technology Component Standards are presented in Tables. The table headings indicate the particular server type. The terms high-end servers and midrange to low-end servers are used to describe types. High-end servers are defined as servers that may scale to more than 16 processors in size. These servers typically cost more than \$250,000 and have greater capabilities in areas including scalability, reliability, availability, serviceability, security, privacy, business continuity provision, management consistency, and risk reduction. Midrange to low-end servers typically cost \$50,000 or less. These servers would usually have one to four processors, but could scale to 8 or 16 processors. When a midrange computer is a scaled-down version of a high-end server, it may cost substantially more than \$50,000, but it will also have many of the high-end platform capabilities. Over time, the gap between the high-end solutions and the midrange to low end solutions will continue to decrease.

Table PLA-S-08: High-End Servers Technology Component Standard	
Strategic:	
Software	<ul style="list-style-type: none"> z/OS Solaris HP-UX AIX Windows Linux in virtual partitions Virtual Server OSs (e.g., zVM, VMware, strategic only for: <ul style="list-style-type: none"> supporting OSs that are in the desired future architecture (e.g., Linux, Windows 2003, HP-UX and Solaris) use in building test environments
Hardware	<p>IBM, Sun, and HP platforms are strategic. Hardware alternatives to these platforms may be considered if they are fully compatible for running applications designed for strategic systems, provide equal or better performance for all application and architectural requirements, and introduce no problems to the Virginia architecture other than those that may be cost-effectively resolved. (Fujitsu, for example, is a proven alternative to Sun for the Solaris OS)</p>
Emerging:	
Software	<ul style="list-style-type: none"> Windows Virtual Server R2
Transitional/Contained:	
Software	<ul style="list-style-type: none"> MVS OS 390 Unisys OS2200 VMS OS/400 (library OS) Unix other than Solaris, AIX and HP-UX
Hardware	<ul style="list-style-type: none"> IBM ES9000 (9221) Virtual Server OSs used to support older versions of a strategic OS in cost-effective consolidation transitional plans
Obsolescent/Rejected:	
Software	<ul style="list-style-type: none"> MVS XA MPE
Exception History:	

Table PLA-S-09: Midrange/Low-end Servers Technology Component Standard	
Strategic:	<p>Software</p> <ul style="list-style-type: none"> Windows Server 2003 family Unix (Solaris, AIX, HP-UX and Linux) Virtual Server OSs (e.g., VMware and zVM) <p>Software Examples</p> <p>Windows Server 2003 family is especially appropriate for utility services including domain controller, file, print, email, etc.</p> <p>Linux may be an alternative for Web, database, and utility services</p> <p>Virtual servers and virtual machines aid in providing test environment setup</p> <p>Hardware</p> <p>Numerous manufacturers compete for low- to midrange-server hardware; narrowing the variety used by the Commonwealth at a point in time is important to reducing acquisition, maintenance and support across agency solutions.</p>
Emerging:	<p>Software</p> <ul style="list-style-type: none"> Windows Server 2003 family (64 bit applications) Xen Virtual Hypervisor
Transitional/Contained:	<p>Software</p> <ul style="list-style-type: none"> Windows 2000 family (by June 2007, agencies should move off this version) Virtual Server OSs (e.g., VMware hypervisor, Integrity Virtual Machines, and in some cases, Windows Virtual Server R2) enable transition strategies for multiple versions of the same OS such as Windows NT through 2003 when used for one application OS10 Server may have use as a transitional OS. OS10 can be used with greater ease by staff who are transitioning from Windows responsibilities to Unix. OS10 has a Windows-like graphical interface instead of a command-line interface, which is typical for Unix servers.
Obsolescent/Rejected:	<p>Software</p> <ul style="list-style-type: none"> NT Novell OSX
Exception History:	

Consolidation Platforms

Some servers and server solutions are used as consolidation platforms. A consolidation platform is typically a single high-end platform or a large aggregation of midrange or low-end platforms. Consolidation platforms are used to accomplish the following types of work more cost-effectively with improved backup, recovery, security, management, and business solution quality:

- Centralizing a distributed information resource such as GIS data, library digital documents for universities, customer data, library holdings, or other data. The centralized data are often of enterprise significance and/or reusable resources. The data are often duplicated multiple times across the enterprise prior to consolidation.
- Centralizing an application that is implemented in a duplicative rather than in a distributed manner such as centralizing numerous separate instances of email services (e.g., Exchange) and related directories (e.g., Active Directories).
- Centralizing a function that is implemented in many ways (numerous different applications) across agencies such as license provision, federal grant management, or hospital information systems.
- Providing one server that can be partitioned for running many applications for many agencies with limited and definable risk.
- Providing one server that runs many applications for a single large agency.
- Providing a central utility or service that does not require significant knowledge of the business but that can be tailored in checklist fashion to meet each agency's business needs such as storage, [mirroring](#), backup and recovery, sign on, network management, etc.

The tables below address servers only relative to consolidation efforts.

Table PLA-S-10: Consolidate by aggregation on midrange to high-end platforms Technology Component Standard	
Strategic:	<p>Software</p> <ul style="list-style-type: none"> Unix (HP-UX, Solaris, AIX and Linux) z/OS Windows 2003 Server Family (Windows 2003 may not scale sufficiently depending on the use.) <p>Consolidation Examples: Appropriate for critical application and database tiers that require exceptional scaling, speed, transaction processing, reliability, etc.</p> <p>Hardware</p> <ul style="list-style-type: none"> Exceptional partitioning and workload management are required for the server solution. Example platforms include but are not limited to: IBM Mainframe, IBM POWER5, Sun/Fujitsu SPARC/UltraSPARC, Fujitsu/HP Itanium 2 (64) and AMD Opteron (64).
Emerging:	
Transitional/Contained:	
Obsolescent/Rejected:	<p>Software</p> <ul style="list-style-type: none"> MPE MVS OS 390 Unisys OS2200 VMS OS/400 IBM ES9000 (9221)
Exception History:	

Table PLA-S-11: Consolidate by Scaling Out Technology Component Standard	
Strategic:	
Software	<ul style="list-style-type: none"> Windows Server 2003 Solaris HP-UX AIX Linux
Examples	<p>Clusters are appropriate for MS Exchange Server (e.g., an email farm): clustered low-end to low midrange solution on Windows Server 2003.</p> <p>Appropriate as a tier for single large or mirrored databases—e.g., Oracle real application clusters (RAC) running on HP-UX, AIX, Windows or Linux.</p> <p>Appropriate for Web hosting: (e.g., on Windows Server 2003, HP-UX, Solaris, AIX or Linux)</p>
Hardware	<p>Typical solutions include farms/clusters using blades or servers in racks. Commodity servers are commonly employed. Other options are possible.</p>
Emerging:	
Transitional/Contained:	
Software	<ul style="list-style-type: none"> Permit Windows 2000 as a transitional strategy through June 2009)
Obsolescent/Rejected:	
Software	<ul style="list-style-type: none"> Windows NT
Exception History:	

Table PLA-S-12: Consolidate using virtual tools Technology Component Standard	
Strategic:	
Software	Virtual Servers (via *Hypervisors, or Virtual Machine Software) zVM or VMware Permit virtual Windows, Solaris, AIX, HP-UX, or Linux machines or servers in scale-out solutions provided via zVM or VMware
Hardware	Typical solutions include low-end to high-end servers whose resources are divided and shared among the virtual servers which run natively within the multiple partitions. A *hypervisor is a controlling operating system or virtualization manager for the multiple virtual servers. The hypervisor enables the division of resources for a particular processor architecture. Each server partition may be running identical or different operating systems.
Emerging:	
Software	Windows Virtual Server (current version, R2, still lacks scalability needed for scale-out applications)
Hardware	Intel and others are working to improve sub-processor partitioning capabilities
Transitional/Contained:	
Software	Permit virtual servers of older versions of supported OSs in transitional efforts (may have some use here)
Obsolescent/Rejected:	
Exception History:	

Shared Utility Services

Utility services are defined in this report to support centralization and common handling of networked services that are currently implemented in many different ways using different practices across the served entities. The requirements and recommended practices are intended to be useful to VITA, VCCS, or individual colleges and universities. The services addressed are those services requiring the least specific knowledge of agency business and providing the greatest opportunity for efficiencies and improved practices. Not all possible utilities are addressed here. The included shared utility services were chosen to be implemented first because they are expected to result in the best cost savings, service improvement and other benefits of possible candidates.

Virginia government is, primarily, a Microsoft enterprise. This fact provides a solid architectural starting point for consideration of both backward facing (e.g., consolidations) and forward facing (e.g., new approaches for the future) efforts to improve efficiency and effectiveness of services. UNIX, Novell and other operating systems are on a relatively small portion of servers, even though they may be providing important, business critical application and services.

Microsoft provides considerable well-tested guidance⁴² for architecting and managing Microsoft environments. In part, this is the reason for Microsoft's popularity. In the area of utility services, Microsoft provides guidance for reducing risks, reducing costs, and providing better management of resources. Virginia's recent centralization of hardware and utility services through VITA provides opportunities for considering Microsoft's strong points for enterprise-wide efforts and tools provided by Microsoft's partners. Examples of general opportunities and areas where Microsoft tools may help are:

- Improving availability and security while cutting server management staff as much as half by implementing management best practices across the enterprise (Microsoft tools for patch management and service monitoring plus ITIL best practices integration) beginning with utility servers
- Improving interoperability and common utility service, especially file and print serving, across operating system including UNIX and Novell by using tools provided by Microsoft to do so (e.g., for storage, considering the usefulness of Microsoft tools such as Windows 2003 Virtual Disk Service (VDS) in the overall solution)
- Reducing the number of servers through performance gains by upgrading those utility servers that are using obsolete or transitional OSs
- Simplifying the environment by consolidating domains within and across agencies
- Taking advantage of utility consolidation opportunities permitted by newer products (e.g., the last two upgrades of IIS, SQL Server or Exchange) such as the

⁴² A good example of Microsoft's guidance may be found in this older, but still relevant audio/slide presentation
<http://www.microsoft.com/seminar/shared/asp/view.asp?url=/Seminar/en/20030424vcon85/manifest.xml> .

ability to have multiple instances of IIS on a single server, multiple databases on a single server, or offloading storage on new versions of Exchange

- Taking advantage of opportunities to combine like workloads and provide better server processing utilization

Microsoft includes file, print, database (mainly SQL Server), network attached storage, messaging (Exchange), domain controllers, network services (DNS, DHCP, WINS), security services (e.g., firewalls) and web servers (mainly IIS) in its discussions of best practices for what may be considered utility services. The degree to which standardizing on Microsoft utility best practices will provide benefit to the Commonwealth depends partly on whether the best practices are currently being implemented across agencies and partly on the costs and benefits of those that are not widely implemented. Also, even though agencies may have implemented strong practices from a single agency perspective, they may not have considered how utilities would be supported in a multiagency scenario or beyond the local area network. In these instances, Microsoft ideas may require supplementing and modification to address latency and other issues associated with transmitting LAN protocols over WAN connections. To address these issues, it may be necessary to use BOB concepts to move utility servers out of agencies and into the data center.

Some larger agencies including VITA may have gained the benefit possible in several utility areas already. Nevertheless, the age of servers, the opportunities providing services across agencies within a building or in adjoining buildings, and the multiple instances of email service provision in neighboring agencies indicate that opportunities still exist. Knowing the extent to which these opportunities exist requires additional surveys, data analysis, and studies of costs, benefits, and risks that have not been conducted to date. Without the additional information, only the agency reported numbers of servers offering a service can be used to rank order opportunities. This additional data collection is critical to identifying the level of benefits that may be attained. The current opportunity ranking based on numbers of servers is:

1. Database Servers
2. File Servers
3. Web Servers
4. Domain Controllers
5. Print Servers (plus print, fax, copy, and scan devices)
6. Email

Of course, general (e.g., [NAS](#), [SAN](#), and DAS) storage for databases, files, web pages, email, and other archived information is a major opportunity that should be planned and designed together with all other utility services.

The utilities defined and addressed here are as follows:

- Storage services—including devices and services for general storage, archiving, backup and recovery

- Output servers and devices—including print, fax, scan and copy servers and devices
- Messaging with and initial focus on email services that could later be expanded to include other networked, mobile, audio, video, and data messaging
- Network control services—including initially server based network utilities and foundation services such as DHCP and DNS servers

Because utility services use various parts of the technical architecture, their inclusion in platform architecture is somewhat arbitrary. To address the potential overlap with other domains such as the application, systems management, networking, security and database domains, a dividing line has been established for each service. For each function, the main consideration is consistency of the platform solution and the ability to provide a platform roadmap. For example, the database domain would establish the database tool selection and related requirements, but the platform architecture might recommend platforms and how they may be used to improve the efficiency and effectiveness of database implementations within and across agencies.

Platform controls for networked utility services and devices, which may be provided in a common manner across agencies, will enable:

- service consolidations,
- creation of more cost-effective services,
- simplification of the overall architecture across technical domains,
- easier provision of qualified platform and services staffs, and
- improved customer access to quality services.

As-Is Architecture for Utility Services

The data available to describe the as-is architecture for utility services includes agency reported server uses from 2003 and printer data from 2002 and 2005 (presented earlier with desktop printer data) and storage information. These data do not include higher education. Current utility services in the Commonwealth set a foundation for selecting the most beneficial utilities and for considering future architecture improvements. The available data for describing the current situation is fairly weak.

Tables 12 and 13 below provide known information on utility service platforms in the Commonwealth from 2003. This older data is likely to be representative of current patterns and permits the consideration of location. Some important points from this data, which does not include higher education, are the following:

- For most server functions, Microsoft is the overwhelmingly the OS of choice across agencies
- A focus on Windows services provides the best opportunity for quickly improving efficiencies, performance, management, messaging, throughput, security, and service access
- A relatively large percentage of all servers are in the Richmond metropolitan area

Table 12: FY 2003 Reported Uses* of Servers by Operating System Type

Service Type	Operating System				Service Use Totals	Microsoft Percentage of Uses
	Novell	Other/None	UNIX	Micro soft		
Application/General	17	74	184	974	1249	78%
Database	14	63	167	657	901	73%
Storage/File	47	67	12	720	846	85%
Print	23	49	94	529	695	76%
Presentation/Web Servers	3	21	107	425	556	76%
Network/Controller	3	11	4	352	370	95%
Other (One or more uses noted)	7	109	31	175	322	54%
Communications/E mail	22	28	15	119	184	65%
Network DHCP	4	3	2	80	89	90%
Storage/Backup	3	7	8	70	88	80%
Application Test/Development	0	4	11	52	67	78%
Network DNS (Naming)	1	4	7	52	64	81%
Network Security Services	4	6	17	37	64	58%
Thin Client Application	0	4	0	58	62	94%
GIS Application	1	2	7	16	26	62%
Application Spare/Standby	1	2	0	3	6	50%
Use Totals	150	454	666	4319	5589	77%

* 5,589 uses are specified for 2,643 servers

Table 13 shows that a significant proportion of the Microsoft services are provided on Richmond metropolitan area servers. Services that are “low hanging fruit” for more cost-effective provision are highlighted (gray background). Richmond area services and servers also provide a special opportunity for quick improvements.

Table 13: FY 2003 Reported Use* and Location for Microsoft Servers

Service Use	Metropolitan Richmond Microsoft Uses	Total Microsoft Uses	Richmond % of Total
Application	444	974	46%
Database	241**	657	37%
File	227	720	32%
Web Server	175	425	41%
Domain Controller	159	352	45%
Print	153	529	29%
Other	123	175	70%
Email	81	119	68%
Thin-client server (e.g., Citrix, MS Terminal Server)	45	58	78%
Test and/or Development	32	52	62%
DHCP Services	30	80	38%
Security (e.g., Firewall, Anti- virus, Network Intrusion)	26	37	70%
Domain Name Services (DNS)	25	52	48%
Backup Server	22	70	31%
GIS	10	16	63%
Spare/Standby	2	3	67%
Use Totals	1795	4319	42%

* 4,319 uses are specified for 2386 servers. Use and location data are not reported for all servers.

** Gray areas are candidates for utility services

Output devices that are networked are another possible utility service. Information for printers for 2003 and 2005 are provided in Table 8 in the personal computing section of this report. Table 8 shows that the Commonwealth currently supports more than 16,000 shared output devices.

For storage, little is known to provide a picture of what the Commonwealth is presently doing or what amounts and types of storage are presently provided. The data in Table 13 for databases and file servers provide an indication of the magnitude of storage as an

issue. Data on storage needs, storage use, storage trends, backup requirements, bandwidth needs, and more must be collected centrally.

What is known is more anecdotal than quantitative. The following general descriptions can be provided:

- Most storage supports applications and utilities on Microsoft servers
- Storage needs are escalating rapidly
- Agencies have inadequate planning data (use and trend data for storage needs and capacity)
- Agencies tend to add to storage capacity at the last minute when capacity gets low rather than planning for storage provision
- Storage is designed application by application and not across applications
- Application funding dictates cooperation that would promote agency-wide planning for storage
- Cooperation across agencies for storage planning and use would have to be imposed from above the business units (e.g., by the agency head, the Secretary, VITA, the Governor, or the General Assembly)
- Large agencies may have SANS
- A few agencies use NAS
- File servers, application controlled storage, and DAS are the main storage for most agencies
- Many different backup systems may be used within an agency
- Much storage must remain local unless affordable bandwidth and throughput can be paid for by storage savings
- In the Commonwealth's data center, storage solutions are typically designed and acquired to meet the needs of each centrally managed application separately (this is beginning to change)
- Web site storage is more likely to be planned across an agency
- Mainframe computer storage is planned at the agency level and solutions are designed across all agencies
- At the data center, storage solutions are being examined for across platform management and use capabilities

Recommendations for Improving Information about Storage

Appendix A provides a sample questionnaire for interviewing several small, medium and large agencies to provide a better as-is view of how storage is handled across agency applications and utilities. This is intended as a starting point for establishing agency data collection. It addresses storage complexity, amount, planning, growth, [WAN](#) storage and mobile worker storage.

PPEA 2005 Data

Some additional data gathered and analyzed as part of the PPEA due diligence activities in 2005 is available for describing Commonwealth equipment and services, primarily for telecommunications. These data are not by location and do not have as much detail on server usage.

Utilities Generally

The utilities addressed in this document are the best starting point for standardizing those networked services that are important enablers of an agency doing its business in the electronic workplace of today. Over time, additional utility provision opportunities will be developed, some for the Commonwealth as a whole, some for VITA-served agencies, and others for colleges and universities. In higher education, utilities such as central electronic reference services across institutions and other internal central services may be provided. Initially, general requirements address only the VITA centralization of networked services. Principles

Principles

The following two principles are identified for shared utility platforms.

- PLA-P-16: Roadmaps for Planning** – The Platform Domain should provide roadmaps for planning and transitioning in highly volatile and rapidly changing technology areas such as enterprise storage planning and network perimeter protection.
- PLA-P-17: Viable Utilities** – The Platform Domain should facilitate viable centralization, consolidation, access levels, and/or simplification for utility services including storage, firewall platforms, web servers, output servers, output devices, and related hardware and software.

Requirements

The following two requirements are identified for shared utility platforms.

- PLA-R-20 Utilities Generally** – VITA shall standardize the deployment and management methods used for Local Area Network (LAN) and other utility services (e.g., storage, communications, printing, and copying) across agencies it serves.
- PLA-R-21 Microsoft Utilities** – Most utility services that have been deployed within VITA-supported agencies are Microsoft Windows services. VITA shall consider Microsoft best practices as guides for standardizing these services across agencies until alternative utility services are studied and alternative methods are put into place. This requirement should not be construed to mean that only Microsoft Windows solutions shall be deployed for utilities, or that only Microsoft

best practices should be used. Because Microsoft utility solutions are de facto standards in the Commonwealth, any alternatives considered should be analyzed using Microsoft utilities and Microsoft deployment recommendations as the base service to which alternatives may be compared. For example, the majority of web server deployments may use Windows IIS Servers and may follow Microsoft best practices for their deployment. The uses listed below may have general benefit for agencies, but should be compared in cost and benefit analyses with other in-architecture options before proceeding:

- Linux as a database OS (e.g., ESRI; Oracle [RAC](#) clusters on Linux)
- Linux for selected utilities including web hosting running on low-end servers or in soft partitions on midrange or high-end servers
- Linux for selected business applications proven on this platform
- Apache servers on Linux instead of IIS servers on Windows

Storage Utilities

Two important ways that agencies can meet business needs while reducing IT expenditures are implementing controls to reduce storage escalation and planning for the least costly storage solution for meeting each of several levels of business storage needs. For VITA, providing appropriate storage and backup alternatives is a core element of providing centralized server support. Storage provision must be approached as a utility service designed to decrease costs and reduce risks while maintaining or improving performance and availability. Comparing options requires combining the costs and benefits of changing from the current solution to a new service offering with the costs and benefits of the needed telecommunications, security, storage and backup solutions.

The term “storage system” will be used here to encompass the hardware, software, communications, networking, media, media controllers and management tools required to record data somewhere other than in local memory (e.g., RAM) and to index the data in a manner that allows it to be retrieved at a later time. Storage systems are not platforms, but they are the main user of platform hardware, communications interfaces, and storage media. Much of the opportunity available within the platform domain for cost reduction depends on careful design and deployment of storage systems. Other enterprise technical domains will address what management tools should be used (Systems Management Domain), what types of networking and protocols are restricted (Network Domain), what security tools are appropriate (Security Domain), and what middleware tools (Middleware Domain) might be involved.

There are several models of storage provision that are commonly referenced. Appendix B discusses storage models including Network Attached Storage ([NAS](#)), Storage Area Networks ([SAN](#)), DAS storage, hierarchical storage and various storage media. Storage media, managers, and hardware components are also covered in Appendix B.

The rapid and escalating growth of storage has driven down costs of options and has created marketplace opportunities for finding new and better solutions. The earlier approaches to storage employed server operating systems, file management software, database management software, or perhaps backup and recovery software as storage managers. Also, the typical application had its own, separate storage solution. Today's storage solutions include the historic DAS and file server solutions and more complex storage models such as SAN and NAS models that service multiple platform types. The solutions also enable centralized management regardless of geography.

Present day storage options include a variety of different access channels, platforms and storage media (e.g., tape, disk, CD, DVD⁴³). For transporting the data, today's solutions sometimes use the existing LAN or WAN and sometimes use dedicated paths or separate networks (e.g., SANs) for moving the data. Also, many different protocols and interfaces (e.g., [Ethernet](#), FC, [ESCON](#), [FC-AL](#), [iSCSI](#) (IP), [SCSI](#)) are used in the transmission of stored information from the source to the storage medium.

Commonwealth's Goals for a Storage Architecture

The Commonwealth's vision for storage is to have both local and central storage systems that are well planned, appropriately implemented and well managed. By conducting storage planning and identifying agency-wide storage needs, an agency will be better able to select appropriate options to meet its varied storage needs. For VITA and other agencies that provide central storage, having planning data available centrally, will improve the design of solutions. Ultimately, the local and central solutions should better meet risk reduction, throughput, and cost requirements. The following are example agency and Commonwealth goals for improving storage systems.

- Increase storage reliability (e.g., address data availability and redundancy).
- Improve storage scalability (e.g., implement a solution that will overcome present software and solution limits).
- Improve service levels (e.g., improve response time and speed).
- Increase utilization rates (e.g., lower storage costs by using a greater percentage of available capacity and implementing systems that can be managed with fewer human resources).
- Reduce the need for planned outages (e.g., enable hot-swapping, remove storage traffic from the LAN).
- Improve backup systems or disaster recovery (e.g., by central management and control of options).

⁴³ For a good discussion of RAID and CD solutions, see http://www.mosaic-sys.co.uk/html/nf100_qa.html#2. For a discussion of tape issues and tape roadmaps see http://it-div-ds.web.cern.ch/it-div-ds/HO/pasta_tape02.html.

- Improve file-serving speed (NAS).
- Improve block-servicing speeds.
- Decrease I/O burden on [hosts](#).
- Improve network availability (e.g., create a separate storage infrastructure (SAN)).
- Meet write-once, read many times ([WORM](#)) media needs of some legal documents (e.g., CDs may be a good option for meeting these needs).
- Accommodate distance requirements.
- Reuse skills of existing staff in providing systems improvements (e.g., NAS models can be implemented with existing network staff).
- Reduce management time.
- Take advantage of management capabilities of more advanced systems and software (e.g., storage management software may provide environment management, [virtual storage](#), metrics, off-site tape tracking, etc.).
- Take advantage of automation opportunities (e.g., server-less backup, business continuation volumes, data warehouse input, [synchronous](#) or [asynchronous mirroring](#), [snap shot](#), etc.).

Storage Planning

In the Commonwealth, there is very little storage planning outside of the data center. Storage planning metrics and reporting are very important for building services to meet agency needs across the many customer units (e.g., agencies for VITA, departments for universities, colleges for the VCCS) and locations. Good planning requires looking at storage needs from both unit and enterprise perspectives. Every agency or other unit, small or large, needs to consider the following.

- Special needs of each business application or utility service (e.g., email) including permissible risks, performance, security, privacy, availability requirements, etc.
- Changing needs of applications (e.g., over time)
- Whether backup and disaster recovery systems are adequate
- How well storage traffic is being handled and will be handled in the future by the involved networks, connections, and network services used in transmitting data (e.g., local area networks (LANs), SCSI connections, wide area services ([WANs](#)) or special storage networks (SANs))
- Costs and benefits of storage, backup and recovery alternatives

Improving storage handling across an enterprise is difficult because of the complexity of decisions and the number of decision makers. Although storage needs must be assessed at the application and service level, solutions and alternatives should be designed with the entire enterprise in mind.

Storage Parameters

Many factors come into play in choosing among storage solutions: present storage needs, anticipated storage growth, server locations, user locations, transmission needs, specialized service needs, and more. In Virginia, storage planning also requires joint consideration of aggregate needs and Commonwealth-wide opportunities for improving services or reducing service costs through central solutions.

Data Types and Uses

Much of storage solution planning should be done by data type and data use patterns. Solution options may vary for different data types. Example data types include real-time databases used by widely distributed users, static data used by users in only one location, indexed image data accessed via the Internet, email, email attachments, web pages accessed via the Internet, static online library reference systems. These data types require different approaches to storage and to backup and recovery. For example, static data may require offsite, accessible copies but may not require periodic backup.

Unneeded Data

In agencies, one major contributor to the growth of storage is the failure to delete what is no longer needed. Although the Library of Virginia provides regulations and guidance pertaining to record keeping, this guidance is not used systematically by all agencies to delete unneeded information from computer stores. Keeping unneeded information can have risks and liabilities associated with it. For example, if you have 15 years of email and if a court or a [Freedom of Information Act \(FOIA\)](#) request requires that you produce all email pertaining to a particular topic, you must search the entire 15 years accumulation if you have it.

Modern storage management software permits policy-driven archiving. This type of mechanism provides interesting possibilities for reducing storage systematically. For example, if all email systems were centrally controlled, it might be possible to set a policy to delete all email and attachments after 3 years except for email of agency heads, acting heads, and others, whose historically significant communications must be retained permanently by law. VITA and other providers of central storage should provide services for helping agencies, departments and other units to decrease the amount of stored data they maintain.

Storage Solution Types

Each storage solution type may be very appropriate for certain situation. Every store should not be migrated to a central SAN. The following generalization illustrates some possibilities.

If central storage options are prohibitively expensive, a small agency with modest storage needs might benefit from LAN resident file servers and occasional SCSI attached DAS. In this instance, a central service might assist by providing remote management, standardizing the agency's backup and recovery, or by offering a canned NAS system as an alternative.

In a medium agency with high storage volumes, mixed application servers (e.g., UNIX and Windows), or a need to share files across a mixed environment, a central service

might encourage use of NAS instead of file servers. Such an agency may effectively use a combination of file servers, DAS and NAS in their environment, but simplification may be beneficial. Agencies with large web-hosted applications requiring cache, large volumes of email, or databases that are accessed frequently may also benefit from NAS and NAS/DAS combined solutions. Agencies of any size that have already met their needs with DAS solutions will likely continue with this model until performance and affordability become issues.

Agencies with very large databases, heavy transaction processing, many data producing applications, many employees, and/or over-committed network resources may need to entertain the installation of SANs or unified NAS/SAN options.

If telecommunications are affordable, many agencies will benefit by using consolidated storage options. Multi-agency storage consolidations in locations of varying distances from the users, presentation servers, and application servers are now more cost effective and workable than they have been in recent years. Solutions such as MPLS VPNs and WAFS enable transmissions of data across WANS without suffering delays that are often inherent in WAN but not in LAN solutions.

Storage from a Central Perspective

The following are some possible areas for achieving cost savings in the provision of storage alternatives that meet business needs.

- Having common central planning data across agencies and applications
- Consideration of Microsoft tools and Microsoft best practices where feasible given the overwhelming use of Microsoft for both applications and databases
- Strategic choice of storage platform solutions (e.g., appropriate use of NAS devices, blades, and tapes)
- Ensuring that storage management software has specialized handling capabilities for storage associated with selected services with escalating storage needs such as email services or databases.
- Centralizing or regionalizing data storage for data that is currently stored many times across the executive branch (e.g., certain map data, accident report data, customer data, or library reference data)
- Providing cost-saving options for customer that enable the customer to reduce costs based on business needs (e.g., storage options with levels of services such as backup frequency alternatives to accommodate data that changes only once annually versus data that changes every day)
- Providing well planned backup and recovery services as a utility
- Ensuring good tool set integration between management tools used
- Providing agencies with the information, reporting and tools they need to establish policy and feedback mechanisms for storage controls to the fiscal unit level if possible.
- Good storage management and provisioning.

Storage Problems from Central Service Customer Perspective

The following are some indicators of growing storage problems from the perspective of agencies, colleges, departments or other business units. These are the kinds of problems that might encourage an individual agency to actively plan for a new way of addressing storage in the future.

- Agency application and/or email storage needs are growing by leaps and bounds
- Storage is the main reason the agency has been buying new servers or expanding server usage.
- The agency has dozens of separate storage units that require individual backup solutions.
- Storage traffic is interfering with agency LAN traffic.
- The window of opportunity for completing agency backups has become too narrow.
- The agency wants greater control of storage for security/privacy reasons.
- State or federal laws require agencies to have greater control over storage of items such as email.
- The agency wants to consider decreasing storage costs by implementing hierarchical storage management or policy driven storage management.
- The agency wants to move to more paper free solutions and increase the use of user managed storage.

Recommended Practices

The following three recommended practices are identified for the Storage Systems.

- PLA-RP-24: Matching Storage Alternatives to Needs** – Individual agencies that control storage, including administrative units of higher education and central storage planners (e.g., VITA), should consider the full range of storage alternatives. NAS, SAN, DAS, file servers, NAS/SAN combinations may all be appropriate depending on storage volumes, LAN bandwidths, connectivity requirements, and other factors.
- PLA-RP-25: Storage Reduction Assistance** – VITA should consider offering workshops or coordinating other assistance to help agencies plan for and implement storage reduction programs.
- PLA-RP-26: Linux for Storage** – Agencies that provide storage services should evaluate Linux roles (e.g., in solutions such as backup). Linux is opportune because of anticipated cost savings and because it is being explored worldwide as an alternative to Windows for selected uses. Any evaluation may

require factoring in possible risks related SCO Unix lawsuits (e.g., cost of exit strategies).

Requirements

The following eleven requirements are identified for the Storage Systems.

- PLA-R-22: Storage and Capacity Planning Data** – VITA shall require that agencies it supports provide periodic capacity planning and storage planning data. Agencies not supported by VITA shall also perform capacity planning and storage planning. The availability of planning data will improve storage, backup, and disaster recovery solutions for the Commonwealth.
- PLA-R-23: Agency Assistance for Capacity and Storage Planning** – VITA shall offer capacity planning and storage planning services to assist agencies in determining their present and future requirements.
- PLA-R-24: Storage and Capacity Planning Scope** – Agencies shall consider all of their applications jointly when conducting capacity planning and when developing a storage plan.
- PLA-R-25: Consolidated Server Storage Planning** – For servers used by multiple applications within an agency, by multiple agencies, or managed as a group across agencies and applications, the agency managing the storage consolidation shall design storage solutions across the servers within adequately networked locations.
- PLA-R-26: Storage Consolidation** – Agencies shall use consolidated, single and multi-agency, networked storage solutions whenever the consolidated solution shows cost-effectiveness across an agency's applications (i.e., meets business needs at an equal or lower total cost for the agency). For example, if the agency adds a small application that could use dedicated storage more cheaply than consolidated storage, the dedicated storage may not be used unless the agency-wide storage plan shows dedicated storage to be more cost-effective than consolidated storage.
- PLA-R-27: Policy-Based Storage Reduction Focus** – VITA shall work with the Library of Virginia to simplify retention requirements for electronically stored data such that automated, policy-based methods may be used to control storage growth. Specifically, efforts should simplify the deletion of stored files, emails (except emails from agency heads and Governor's staffs), and other data that are not of historic value. Efforts

would specifically enable the creation of VITA services for the deletion of old data, unused data, and data with no owner for agencies.

- PLA-R-28: Storage Reduction Preceding Migration** – When an agency changes its storage from application-based stores to central or consolidated stores, it must first consider what may be deleted prior to moving the remaining stores. This effort must be jointly conducted by the data-owning agencies and the centralization project staff.
- PLA-R-29: Backup Consolidation and Simplification** – VITA shall consider the value of improved backup and recovery management, reduced backup and recovery costs, and improved backup and recovery service levels when developing server management and storage management plans and costs for agencies. This very important benefit of server and storage consolidation must be included in cost comparisons.
- PLA-R-30: Applications Offering Storage Consolidation Opportunities** – To reduce escalating storage costs, VITA shall consider the cost-effectiveness of alternate storage consolidation and storage reduction (e.g., policy deletion options for stored data) opportunities. When considering new utility services for central handling, VITA shall separately address storage consolidation and reduction for the service. Examples of utility services that would have large storage needs and/or growing storage needs are email services, backup, and Web hosting services.
- PLA-R-31: Connectivity and Consolidated Storage** – When designing consolidated storage solutions, agencies shall include assessments of connectivity needs and options for the customer base. A consolidated solution often requires added connectivity. This connectivity may both increase costs and degrade throughput. For many agencies, the distance to the consolidation system and the costs of connectivity are critical factors. Solutions including iSCSI, MPLS VPNs, WAFS, blade chassis, and SAS are among the tools that may be beneficial in reducing total storage costs.
- PLA-R-32: Storage Location Considerations** – When designing consolidated storage solutions, agencies shall include assessments of storage location. If central remote storage is cost-prohibitive, agencies providing storage must evaluate the

cost-effectiveness of locally consolidated storage options for the physically co-located servers under their control.

Technology Component Standards

The following three technology component standards address Storage Systems.

Table PLA-S-13: Storage Interfaces Technology Component Standard	
Strategic:	FIBRE Channel -FC, FC-AL (fiber channel arbitrated loop) FICON SCSI 10/100/Gb Ethernet; 10/100/2Gb Ethernet iSCSI PCI Express FC-IP 10GigE SAS (Serial Attached SCSI)
Emerging:	4x InfiniBand (IB) 4Gb/sec FICON
Transitional/Contained:	10/100 Ethernet
Obsolescent/Rejected:	ESCON, 17 Mbps (Mainframe) Block/Parallel (distance limits and speed problems) 4.5 Mbps (Mainframe)
Exception History:	

Table PLA-S-14: Disk Storage Hardware Technology Component Standard	
Strategic:	<p>External Controller-based RAID ATA Disks; SATA Disks Disks CDs (archive quality)</p>
Emerging:	<p>DVD (awaiting write standards) No DVD write option is being recommended for the Commonwealth at this time. MEMS (microelectrico-mechanical system) probe device MAID</p>
Transitional/Contained:	
Obsolescent/Rejected:	
Exception History:	

Table PLA-S-15: Tape Technology Component Standard	
Strategic:	<p>LTO (linear tape open) SDLT (super digital linear tape) Virtual Tape (Disk) Magstar (IBM 3590; STK 9x40)</p>
Emerging:	<p>Terabyte tapes</p>
Transitional/Contained:	<p>36 track DLT (digital linear tape) AIT (advanced intelligent tape)</p>
Obsolescent/Rejected:	<p>9 track, 18 track</p>
Exception History:	

Print, Fax, Scan and Copy Devices

For networked print, fax, scan and copy services, the standardizing of hardware, software, supplies, deployment, management, and staff training all offer high potential savings. This can be done while meeting customer needs for service types and service availability at better than current levels. For example, the Commonwealth can improve services to employees and agencies by providing better color printing, faster printing, more available printing, more accessible scan and fax services, and better agency-level reporting of service usage for improved policy setting. While it is important on the one hand to have the services needed, it is also important to have controls. Policies within agencies and other units served by centrally managed input and output services are a very critical part of controlling escalating and unnecessary output production. To control costs, both proper availability of services and judicious use of services are important. Also important is having solid alternative practices and tools including use of CDs for storing reference material, the use of scanners to capture and distribute copies electronically, the use of CDs, jump drives and wireless connections for transporting information to meetings, providing presentations online following a meeting instead of paper copies, and using color only when it adds business value. Ideas such as these must be part of an agency’s culture and policy.

In the personal computing section of this document, there is a discussion of the need to move away from desktop printers and toward shared devices. This section of the report is focused on the shared devices and agency policy regarding their use.

In recent years, network print, fax, copy and scan devices have become more capable, more multifunctional, and more cost effective. Color printing is more affordable and presents a great business tool for reaching customers and others with whom agencies communicate. In most offices, sharing workgroup devices is now considered to be common and desirable. For some business units, having access to high-speed printers and copiers that can collate and staple large numbers of documents when necessary is considered to be a necessity.

Estimates of savings from increased control and standardization of print, fax, scan and copy devices are based on industry data that has been modified to address differences between government and businesses. Across the agencies served by VITA, Virginia may save 1 to 3 million (1 million from use reduction) dollars annually by:

- investing in newer multifunctional devices,
- carefully tailoring device acquisitions more closely to business needs using standards,
- simplifying the types and brands of devices used in the environment, and
- instituting agency/business unit-based use policies.

Because the enterprise is so large and geographically distributed, savings from management improvements may be lower than industry expectations and savings from price negotiations on equipment or supplies, higher. The following, more detailed estimates of savings are generally lower than estimates provided by vendors⁴⁴. If Virginia's devices are older than in an average business, savings may be higher. Also, these estimates do not address policy savings.

- Reducing printing support costs 5-10 percent
- Reducing related help desk costs 30-40 percent
- Reducing repair costs 10-15 percent
- Reducing consumables 15-25 percent
- Reducing equipment costs 5-10 percent by leveraging buying power on selected devices and by buying fewer, more capable devices

Minimum Service Levels

Recommendations presented here address minimum service levels including distance to service centers from individual offices and work stations, minimum on-site availability of services, and duplication of services when devices fail. These levels are proposed as best practices based on vendor recommendations, industry practices, and perceived needs of

⁴⁴ For example, see the fast facts table provided by Hewlett Packard on page 2 of *How to effectively deploy printing and imaging assets, An HP Planner*,

knowledge-worker. Agencies and other customer groups may wish to modify these levels up or down based on actual work done or policies for use reduction.

Example Target Configurations for a Location

The following table provides a count of Commonwealth executive branch agency locations by size. Higher education agencies are not included. This information is used to provide a rough estimate of the numbers of document handling devices that would be appropriate for a typical office setting based on the number of employees. Needs based on unusual office layouts and other special requirements are not considered. One special device such as a plotter is allotted based on employee counts, however. The purpose of providing this estimate of needs is to provide a simple starting point that can be used as a gauge the potential for cost savings. Actual studies of needs may indicate that a higher level of device provision should be established. The only data available with location information is 2003 due diligence data. This data is considered to be sufficient for providing a rough estimate.

The following is an example of a bare minimum 5 devices (plus optional special device) configuration for a one floor office with three centrally located device stations for 61-80 employees:

- One High Speed Black and White Laser Printer/Copier
- One Medium Speed Color Laser
- Three Medium Speed Multifunctional Black and White Printers with Fax and Scan
- Zero to One Possible Specialty Device such as a Plotter, Label Printer, or Large Format Scanner (or an additional regular device)

In the example case above, the special needs device could be replaced by another multifunction due to higher agency usage data or due to the location not permitting central location of the devices.

Table 14: Number of Locations Requiring Print/Copy/Fax/Scan Support With Device Count Estimates

Number of Desktops per Location	Locations of this Size in 2003	Estimated Number of Networked Shared Devices Needed	VITA supported Desktop Printers (very small sites)	Estimate of Specialty Printers & Plotters Needed	Ratio of Desktop Computers to Printers**
1001-1200	2	146		4	15:1
801-1000	3	180		6	15:1
601-800	3	141		6	14:1
401-600	7	231		14	14:1
201-400	18	360		36	14:1
101-200	39	390		78	13:1
81-100	12	72		24	11:1
61-80	18	90		9	13:1
41-60	33	99		16	14:1
21-40	81	162		40	12:1

Number of Desktops per Location	Locations of this Size in 2003	Estimated Number of Networked Shared Devices Needed	VITA supported Desktop Printers (very small sites)	Estimate of Specialty Printers & Plotters Needed	Ratio of Desktop Computers to Printers**
11-20	150	150	150		8:1
2-10	436	0	436		5:1
1	37	0	37		1:1
	839*	6407	623	144	

* Does not include needs for the DSS remote locations with 9,107 desktops and associated printers in approximately 250 localities. These desktop devices are often locally supported with local desktop and/or network printing capabilities. Due to the confidential nature of documents printed, personal desktop printers are frequently required.

** Hewlett Packard recommends a 10 to 1 ratio. The estimates in this table are intended as an absolute minimum for most locations based on an assumption that sites may vary considerably with respect to need. Sites with fewer than 20 people may or may not be networked. Fewer printers may be possible in small sites when networked with adequate bandwidth.

The above minimum estimate of devices needed shows a considerable discrepancy between the current 16,000 plus devices in use and the 7,000 plus devices proposed in Table 14. Even if these figures are underestimates of need, they show substantial room for cost cutting when compared to present levels even if the estimates are doubled. Also, these newer devices will provide significant service improvements for employees in quality, performance, choice (e.g., color and double sided copying), and improved availability of faxing and scanning. These counts do not even include savings possible if agencies wish to eliminate the numerous desktop devices in use (these savings would go directly to agencies and would be partly used to acquire networked devices).

Much of the advice provided in this section was developed using the excellent free materials provided by Hewlett Packard (HP), Dell, Gartner and others on their websites. The minimum levels of printers recommended herein are lower than levels recommended by HP. Nevertheless, these recommended levels are a good starting point for agencies that want to be thrifty and yet still provide some excellent options to their workforce. Initial layouts can be designed with expansion in mind to allow for later adjustments based on needs when adequate usage and unmet needs data are available. Movement away from paper escalation is another possible goal to add to design parameters that supports establishing lower base configurations.

Writings by HP, Dell, IDC, Gartner and others support the value of the multifunction printer. These devices do more than fax, scan, print and copy. They also have the ability to scan to email, for example. This particular capability can help to do away with the high costs of sending, receiving, and distributing incoming faxes, using postal delivery options, and using messengers, but staffs must be encouraged to use this feature. Some of the most useful articles consulted are footnoted.⁴⁵

⁴⁵ How to effectively deploy printing and imaging assets, An HP Planner http://h30046.www3.hp.com/united-states/public/assets/research/T5C_planner.pdf ; If its not broke, why fix it? http://h30046.www3.hp.com/united-states/public/assets/research/T4B_WP.pdf ; Printer Total Cost of

Recommended Practices

The following ten recommended practices are identified for Print, Fax, Scan and Copy Devices.

- PLA-RP-27: Employee Access to Print, Fax and Scan Services:** Agency employees should have access to networked print, fax, and scan services within 100 feet of their office.
- PLA-RP-28: Employee Access to Printing Services:** Agency employees should have office access to laser color printing, laser black and white printing, collating with stapling, and two-sided printing at a minimum in any office larger than 20 people. In small offices, business needs may dictate using services rather than having all capabilities in house.
- PLA-RP-29: Multifunction Document Handling Devices:** Agencies should employ one or more multifunction document handling devices in most offices.
- PLA-RP-30: Replacement of Document Handling Devices:** Agencies should replace document handling devices more often than five years whenever it is cost-effective to do so. Employee inconvenience and work time lost estimates due to device downtime should be used in the replacement decision.
- PLA-RP-31: Location Plans for Print, Fax, Scan and Copy Devices:** VITA and other agencies that support print, fax, scan and copy devices should implement a minimum service plan for networked document handling devices for all customer sites with options for customer additions and deletions. The actual implementations should include consideration of whether a network exists in the location, whether high or low volumes of documents are handled due to business differences, whether extra devices are required to reduce distances, whether savings on services will cover office reconfiguration, and other local considerations.
- PLA-RP-32: Standard Set of Document Handling Devices:** The Commonwealth should standardize on document handling devices purchased during a particular year or other appropriate time period to increase volume purchasing discounts for equipment and supplies, reduce employee learning time and reduce internal support costs.

Ownership Assessment White Paper, Quality Logic for Dell,
<http://www.dell.com/downloads/global/vectors/Total%20Cost%20of%20Printing.pdf> ; Cost of Printing, Dell website comparison of HP and Dell,
http://www1.us.dell.com/content/topics/global.aspx/solutions/en/print_solutions?c=us&l=en&s=gen&~page=2&~tab=2 ;

- PLA-RP-33: Agency-based Practices and Policies for Output Reduction:** Agencies should establish practices and policies to help control the escalation of printed output. For example, the agency could address personal printer use, track and post printing growth, post color versus black and white price differentials, provide print-on-demand web libraries as an alternative to printing extra copies of documents and storing them, or encourage employee use of personal CD libraries of non-critical reference materials to reduce printing escalation and costs.
- PLA-RP-34: Copy and Printing Supplies:** VITA should control the acquisition of copy and print supplies to reduce costs. When output device supplies are proprietary, better prices may be negotiated as part of the acquisition contract. Certainly, these highly variable costs should be included in the TCO of any equipment acquisition decision.
- PLA-RP-35: Security and Privacy Options for Scanners and Printers:** VITA should provide secure printing and scanning options to agencies that need these options when they are cost-effective alternatives to agency use of desktop printers.
- PLA-RP-36: Specialty Devices:** VITA should track the need for specialized input and output devices including plotters and photo-capable printers for potential cost savings opportunities.

Requirements

The following requirement is identified for Print, Fax, Scan and Copy Devices.

- PLA-R-33: Print, Fax, Scan and Copy Devices and Managing Servers.** VITA shall deploy and manage all customer-oriented input and output devices that are deployed as networked devices and which serve VITA-supported agencies. These devices include document scanners, fax machines, copiers, and printers along with the servers that support them. These devices shall be deployed in a consistent manner across all VITA-supported agencies.

Email Utilities and Related Communications and Coordination Services

At VITA's inception, email and other communications, coordination, and personal organization services were provided, mostly, agency by agency. Sometimes, the agencies used more than one product to address the email, calendaring and related needs. The solution decisions were made by agencies at different points in time. Typically, the decisions were not made from an enterprise-wide perspective, did not consider enterprise scaling issues, and were not futuristic in scope considerations. As VITA and other

agencies that control these communications tools and services move into the future, comprehensive, unified messaging and communications plans will become increasingly crucial. Some elements that should be considered include the following:

- Email, Multimedia Attachments, and Hygiene (virus, spam, etc.)
- IM/SMS, RSS
- Calendar with Sharing
- Scheduling and Multimedia Attachments
- VoIP
- Voicemail
- Push Mail
- Secure Mail
- Unified Communications
- Policy Management
- Audio/Video Conferencing, Training and Customer Interface

Most agencies have deployed or used Microsoft Exchange as an email solution. Others solutions used include Lotus/Domino, Sun One, and Sendmail.

Microsoft is the de facto standard for email across non-higher education agencies. Until a comprehensive messaging and communications plan is in place, the Commonwealth should continue to standardize on Microsoft solutions. The Commonwealth should also require that other solutions remaining in place within any executive branch agency be able to access a central directory and identity management service. Having a central identity management service in place⁴⁶, will be a significant enabler of a good communications solution for VITA-served agencies. The same identity service will facilitate the future participation of non-VITA agencies in various aspects of centralized or decentralized solutions that are put into place. Central identity management will also provide a foundation for other centrally supported utilities including security services and recovery operations.

Microsoft Exchange, in addition to being widely used throughout the Commonwealth, is a market leader along with IBM with its Lotus/Domino. Upcoming enhancements⁴⁷ from both Microsoft and IBM and will focus on filtering and message management.

Novell and Mirapoint are also significant players. Mirapoint offers low cost email without the broader functionality available with Exchange. Because most state workers are knowledge workers, the broader functionality of calendars, integrated scheduling, and

⁴⁶ See also IP services and directories in the network domain, LDAP directories in the integration domain, and discussions of authentication and authorization in the security domain.

⁴⁷ Following its release of SP2 modifications to Exchange last year, Microsoft will release Exchange 12 in 2006. IBM will release Hannover in 2007. See Gartner's "Microsoft Finally Wakes Up to Unified Communications, Matthew W. Cain and Bern Elliot, February 9, 2006, ID Number G00137739.

more are crucial. With Mirapoint, the Commonwealth would have to use multiple service modules from a variety of providers to get the full complement of needed services.

Novell is trying to provide the ultimate Linux, open-source alternative with both email and workgroup functionality in its Hula/Maui product. If it succeeds, it will be a front-runner for Commonwealth consideration in the future. Of course, the cost of switching would be a significant issue in any comparison⁴⁸.

According to Gartner, companies are considering all of their options at upgrade time and competition is heating up. To profit from negotiations, the Commonwealth must seriously entertain options to Microsoft Exchange and know exactly what its planning options are for future management of messaging and communications. In addition, the Commonwealth must aggressively plan for message storage and message management (see storage for additional discussion of message escalation).

While future needs are being solidified and a roadmap put forth, the Commonwealth must still continue to provide voice, email, push mail, calendaring, contacts, and other services that the workforce considers to be a necessity. The best solution is always the defacto solution, unless serious problems exist or costs are prohibitive. However, for the Commonwealth, it is also important that the defacto solutions be challenged periodically.

The Commonwealth also needs to have a much more complete understanding of the needs of the workforce for each of the messaging and communications tools. This information will be important for establishing plans and putting a long-range roadmap be put in place to guide changes. If there are significant segments of the workforce that need some messaging but do not need the full functionality provided by Exchange, this too should be factored into plans.

The following requirements (PLA-R) and recommended practices (PLA_RP) address email and other communications utilities for the Commonwealth.

Recommended Practices

The following recommended practice is identified for email.

PLA-RP-37: Unified Communications. VITA should gather data on current and projected communication needs of the workforce and use this information to establish a plan for unified communications across all served agencies.

Requirements

The following requirement is identified for email.

PLA-R-34: Enterprise-wide vs. Agency-centric Email Solution Analyses. VITA shall examine the feasibility, costs, and benefits of standardizing on Exchange as the future enterprise email solution. The study shall consider whether centralizing email is cost effective and whether standardizing on Microsoft

⁴⁸ Gartner article: *Market Scope for E-Mail Systems*, February 1, 2006, Matthew W. Cain, ID Number G00136445.

Exchange or other enterprise solutions is cost effective. Until this study is conducted, Microsoft Exchange will be the solution VITA-served agencies shall employ when making changes.

Technology Component Standards

The following technology component standard is identified for email.

Table PLA-S-16: Email Technology Component Standard	
Strategic:	
	32 bit Exchange Server 2003
Emerging:	
	64 bit Exchange Server; All other solutions that are appropriate for Commonwealth-wide services (e.g., solutions that should be evaluated).
Transitional/Contained:	
	Exchange Server 2000; Unsupported open source implementations.
Obsolescent/Rejected:	
	Exchange Server 5.5 and earlier
Exception History:	

VITA Network (LAN/WAN) Control Utilities

Most requirements for networks are provided in the network domain. Network utilities, which are addressed here, are those recurring network control services that should be managed as a common service across all agencies served by VITA. Examples of network utility services are secondary Domain Name System (DNS) services, directory services, and Dynamic Host Configuration Protocol (DHCP) servers. As networks are combined across agencies to create one centrally managed network, the centralizing and standardizing of important look up and control services will become increasingly important.

The network domain envisions a unified future network for the Commonwealth. To enable that end, the platform domain establishes Microsoft Windows as the operating system for network control. The network domain also establishes IP as the critical network routing protocol and places VITA in charge of avoiding IP conflicts in routed communications. In addition, the network domain requires that VITA provide a DNS server on a separate network to be referenced when in-network DNS servers fail. Central utilities are viewed as the platform control vehicles that VITA may use to ensure that these central network controls come about.

Recommended Practices

The following recommended practice is identified for LAN/WAN Control Utilities.

- PLA-RP-38: Establishing Network-wide LAN/WAN Utility Practices:** VITA should initiate common management and configuration practices for network utilities beginning with the key controls (e.g., IP address management, central directories) and then expanding to LAN/WAN services implemented on the greatest numbers of servers.

Requirements

The following requirement is identified for LAN/WAN Control Utilities.

- PLA-R-35: Operating Systems for LAN/WAN Control Services:** Servers in VITA supported agencies that provide network-wide control services (e.g., domain design, secondary DNS provision, IP ([Internet Protocol](#)) addressing, and directory services) must use the same operating system to facilitate central management and central consolidation. Microsoft Windows is the target architecture standard for LAN/WAN control services for all VITA controlled networks.

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Glossary

Following are Glossary entries pertaining to the Platform Domain and required to support this document. Additional glossary definitions can be found in the [ITRM](#) Technology Management Glossary located on the VITA website here:

<http://www.vita.virginia.gov/projects/cpm/glossary.cfm>.

10GigE	10 Gigabit Ethernet Service
8-, 16-, 32-, and 64-Bit Architectures	A CPU is designed to carry out instructions on data that is in memory. The way it does this is significantly different for 8 bit and 64 bit architectures. The greater the number of bits, the more options there are that must be considered for how instructions are handled. Options include the complexity of the instruction set, the width of the data path, the number of registers, and the number of instructions that may execute per clock cycle. A program written for a 64-bit architecture may not be as fast as one written for a 32-bit architecture, but it may provide other advantages.
802.11a card	Wireless interface that provides up to 54 Mbps service using an Orthogonal Frequency Division Multiplexing (OFDM) modulation technique for signal transmission in the 5.5 GHz spectrum
802.11b card	Wireless interface that provides up to 11 Mbps service using Frequency Hopping Spread Spectrum (FHSS) modulation technique for signal transmission in the 2.4 GHz spectrum; also called WiFi. Interference from cordless phones and microwave ovens may be a problem.
802.11g cards	Wireless interface that provides up to 54 Mbps service using an Orthogonal Frequency Division Multiplexing (OFDM) modulation technique for signal transmission in the 2.4 GHz spectrum. Backwards compatibility is maintained with 802.11b. Interference from cordless phones and microwave ovens may be a problem
Advanced Intelligent Tape (AIT)	A form of magnetic tape and drive using AME developed by Sony for storing large amounts of data. An AIT can store over 50 gigabytes and transfer data at six megabytes/second (in February 1999). AIT features high-speed file access, long head and media life, the ALDC compression algorithm, and a MIC chip. (FOLDOC)
Agency	Means executive branch agency, which includes higher education agencies. ITRM policies, standards and guidelines apply to all executive branch agencies including higher education agencies. FY 2005 changes in the <i>Code of Virginia</i> , enable certain institutions of higher education to be self-governing with respect to meeting selected requirements but do not alter the scope of the requirements.

VITA's scope of control with respect to infrastructure provision is sometimes confused with the scope of control imposed by ITRM policies and standards. VITA "in-scope" agencies are a subset of those affected by ITRM policies and standards. Tabled technology acquisition and use requirements in this report apply to all executive branch agencies including the administrative units of higher education. All recommended requirement statements that address agencies apply to higher education administrative units unless they are specifically directed only to VITA operations

- AMD Opteron** The AMD 8131 chipset, which improves connection speeds by employing two independent, high-performance PCI-X bus bridges, integrated with a high-speed HyperTransport technology tunnel. The tunnel function provides connection capability to other downstream HyperTransport technology devices, allowing greater system flexibility. (www.AMD.com)
- Appliance** Server hardware configured with server software and optimized for simple functions such as Web page serving.
- Asynchronous Mirroring** Data to be stored are written synchronously (with acknowledgement to the application) to a cache resource and then written asynchronously (without acknowledgement) to a primary store and a mirrored (copy of the primary) store.
- Asynchronous Transfer Mode (ATM)** ATM (asynchronous transfer mode) is a dedicated-connection switching technology that organizes digital data into 53-byte cell units and transmits them over a physical medium using digital signal technology. Individually, a cell is processed asynchronously relative to other related cells and is queued before being multiplexed over the transmission path. Because ATM is designed to be easily implemented by hardware (rather than software), faster processing and switch speeds are possible. The pre-specified bit rates are either 155.520 Mbps or 622.080 Mbps. Speeds on ATM networks can reach 10 Gbps. (searchNetworking.com)
- ATA Disk – ATA (Advanced Technology Attachment)** Is the official name that American National Standards Institute group X3T10 uses for what the computer industry calls Integrated Drive Electronics (IDE). An ATA disk is a serial drive used for data storage, which may be used in a disk array. It is cheaper than the technology typically used in RAID. Also, a type of drive controller.
- Athlon Chipset** AMD microprocessor, delivered in mid-1999, was the first to support a 200 MHz bus. In March 2000, AMD announced the first 1 gigahertz PC microprocessor in a newer version of the Athlon. The current AMD Athlon XP 3000+ performs better than the Intel Pentium 4 3.06 GHz chip in office productivity (PWC audit).
- Authentication** Authentication is the process of determining whether someone or

something is, in fact, who or what it is declared to be. In private and public computer networks (including the Internet), authentication is commonly done through the use of logon passwords. Knowledge of the password is assumed to guarantee that the user is authentic. Logically, authentication precedes authorization (although they may often seem to be combined). (searchSecurity.com)

Base Image

This term is used in this report to indicate a starting point for a hard disk image that may be used as is or further modified to meet agency user needs with users placed in as large a group as possible based on commonality of requirements. All secretaries may have one base image and all programmers, another. The image is a copy of the configured operating system and software on the desktop, laptop or other device. Microsoft provides instructions for establishing, compressing and distributing such images:

“Some organizations deploy a complete user system at one time, including Microsoft® Windows® software, device drivers, Microsoft Office 2003 applications, and custom settings. In this scenario, you install the entire system onto a test computer, and then you create an image of the hard disk to copy to users' computers. Installing Office with a complete user system is almost as fast as installing Office by itself. It is a particularly efficient way to configure new computers or to restore a computer to its original state. When you distribute the hard disk image to users, everything on the computer is replaced by your custom configuration, so users must back up any documents or other files they want to keep”

Biometrics

The science and technology of measuring and statistically analyzing biological data. In information technology, biometrics usually refers to technologies for measuring and analyzing human body characteristics such as fingerprints, eye retinas and irises, voice patterns, facial patterns, and hand measurements, especially for authentication purposes. Fingerprint and other biometric devices consist of a reader or scanning device, software that converts the scanned information into digital form, and wherever the data is to be analyzed, a database that stores the biometric data for comparison with previous records. When converting the biometric input, the software identifies specific points of data as match points. The match points are processed using an algorithm into a value that can be compared with biometric data scanned when a user tries to gain access.

Blackberry

A brand of personal digital assistant hardware; an email service; or the company that offers the hardware and service. The hardware/OS, which was originally a RIM product, is called a Blackberry and comes in a variety of form factors. Most notably, the Blackberry has

a small keyboard for data input and offers standard personal information management capabilities. The Blackberry service is a live push email service, which may be controlled by a local server or a Blackberry company server.

Block Service A block is the unit in which data is stored and retrieved on disk and tape devices. Blocks are the atomic unit of data recognition (through a preamble and block header). A block service is the process of storing and retrieving blocks of data (as opposed to files).

Bluetooth A computing and telecommunications industry specification that describes how mobile phones, computers, and personal digital assistants (PDAs) can easily interconnect with each other and with home and business phones and computers using a short-range wireless connection. Using this technology, users of cellular phones, pagers, and personal digital assistants such as the PalmPilot will be able to buy a three-in-one phone that can double as a portable phone at home or in the office, get quickly synchronized with information in a desktop or notebook computer, initiate the sending or receiving of a fax, initiate a print-out, and, in general, have all mobile and fixed computer devices be totally coordinated. Bluetooth requires that a low-cost transceiver chip be included in each device. The transceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification are provided. (serachMobileComputing.com)

BOB A Branch Office Box (BOB) is a server appliance that is optimized to provide distributed office support for simple utility functions that are required locally but difficult to provide over a WAN. [BOB](#) deployment is an alternative to having more complex servers and support provided locally for all needed utility application such as: email, printing, and file serving/caching, DNS, DHCP, HTML/XML, and encryption/decryption (e.g., HTTPS). When WAN connections are unreliable, a BOB may be used as part of a local business continuation solution. When WAN connections are reliable, a BOB may not be a cost-effective alternative to using protocol wrapping solutions (e.g., MPLS) to address WAN latency. BOBs are usually optimized for the type of protocol traffic the business uses most in communicating with its central office or data center and the type of

persistent service needed locally in the event of a WAN disruption.

- Chipset** A group of microchips designed to work together and which are sold as a unit. Colloquially, chipsets are referenced by brand name and version (e.g., Pentium 4). Example components are the bus controller (USB, PCI, etc.) and the processor (CPU).
- CISC** Complex instruction set computer. A processor type in which each instruction can perform several low-level operations such as memory access, arithmetic operations or address calculations. For example, the Intel Pentium is a CISC design. (Modified from www.FOLDOC.org)
- Cluster**
- 1) In a computer system, a cluster is a group of servers and other resources that act like a single system and enable high availability and, in some cases, load balancing and parallel processing. See clustering. [Clustering has been available since the 1980's with VAX and is called [Sysplex](#) in the IBM S/390 world.]
 - 2) In personal computer storage technology, a cluster is the logical unit of file storage on a hard disk; it's managed by the computer's operating system. Any file stored on a hard disk takes up one or more clusters of storage. A file's clusters can be scattered among different locations on the hard disk. The clusters associated with a file are kept track of in the hard disk's file allocation table (FAT). When you read a file, the entire file is obtained for you and you aren't aware of the clusters it is stored in. (Whatis.com)
- Common Internet File System (CIFS)** Is a proposed standard protocol that lets programs make requests for files and services on remote computers on the Internet. CIFS uses the client/server-programming model. A client program makes a request of a server program (usually in another computer) for access to a file or to pass a message to a program that runs in the server computer. The server takes the requested action and returns a response. CIFS is a public or open variation of the Server Message Block Protocol ([SMB](#)) developed and used by Microsoft. The SMB Protocol is widely used in today's local area networks for server file access and printing. Like the SMB protocol, CIFS runs at a higher level than and uses the Internet's TCP/IP protocol. CIFS is viewed as a complement to the existing Internet application protocols such as the File Transfer Protocol ([FTP](#)) and the Hypertext Transfer Protocol (HTTP). CIFS lets you:
- Get access to files that are local to the server and read and write to them
 - Share files with other clients using special locks
 - Restore connections automatically in case of network failure
 - Use Unicode file names

In general, CIFS gives the client user better control of files than the

File Transfer Protocol. It provides a potentially more direct interface to server programs than currently available through the Web browser and its use of the HTTP protocol.

CIFS is an Open Group standard, X/Open CAE Specification C209, and has been proposed to the Internet Engineering Task Force (IETF) as an Internet application standard. (Whatis.com)

Digital Linear Tape (DLT)

Is a form of magnetic tape and drive system used for computer data storage and archiving. A special compression algorithm, known as Digital Lempel Ziv 1 (DLZ1), facilitates storage and retrieval of data at high speeds and in large quantities. In the DLT drive, data is written on the tape in dozens of straight-line (linear) tracks, usually 128 or 208. Some cartridges can hold 70 gigabytes (GB) of data when compression is used. A variant of DLT technology, called SuperDLT, makes it possible to store upwards of 100 GB on a single cartridge. The SuperDLT drive can transfer data at speeds of up to 10 megabytes per second (Mbps). (searchStorage.com)

DASD

Direct Access Storage Device

EPIC

Explicitly Parallel Instruction Computing. Intel's Itanium 2 processor uses this instruction set rather than CISC.

ESCON (Enterprise Systems Connection)

Is a marketing name for a set of IBM and vendor products that interconnect S/390 computers with each other and with attached storage, locally attached workstations, and other devices using optical fiber technology and dynamically modifiable switches called ESCON Directors. In IBM mainframes, the local interconnection of hardware units is known as channel connection (and sometimes as local connection to distinguish it from remote or telecommunication connection). ESCON's fiber optic cabling can extend this local-to-the-mainframe network up to 60 kilometers (37.3 miles) with chained Directors. The data rate on the link itself is up to 200 Mbps (million bits per second) and somewhat less when adapted to the channel interface. Vendor enhancements may provide additional distance and higher amounts of throughput. ESCON may be used for a SAN. (search390.com)

Ethernet

A local-area network (LAN) protocol that is specified in IEEE 802.3 and that uses CSMA-CD to provide 10 Mbps service over copper. Switched Ethernet provides faster service (e.g., 100 Mbps Ethernet, 10GigE). Gigabit (GB) and 10 GB Ethernet service are now possible. GB Ethernet is used mainly for backbone services and wide area networking.

eVA

Electronic Government Virginia. The name for the procurement system used in Virginia government.

ETA (Enterprise Technical Architecture)	Enterprise Architecture has business and technical components. All of the technical components taken together are called the Enterprise Technical Architecture. In Virginia, the technical architecture is divided into eight domains, one of which is the platform domain.
Fabric	A term used to reference a switching system such as a SAN system, and ATM system or a Frame Relay system. The term, fabric, is used to indicate the complex interplay of hardware and software in the switching process that may involve numerous paths.
FICON (Fiber Connectivity)	<p>Is a high-speed input/output (I/O) interface for mainframe computer connections to storage devices. As part of IBM's S/390 server, FICON channels increase I/O capacity through the combination of a new architecture and faster physical link rates to make them up to eight times as efficient as ESCON (Enterprise System Connection), IBM's previous fiber optic channel standard. FICON channel features include:</p> <ul style="list-style-type: none">○ A mapping layer based on the ANSI standard Fibre Channel-Physical and Signaling Interface (FC-PH), which specifies the signal, cabling, and transmission speeds○ 100 Mbps bi-directional link rates at distances of up to twenty kilometers, compared to the 3Mbps rate of ESCON channels at distances of up to three kilometers.○ More flexibility in terms of network layout, because of the greater distances○ Compatibility with any installed channel types on any S/390 G5 server○ Bridge feature, which enables support of existing ESCON control units○ Requires only one channel address○ Support for full-duplex data transfer, which enables simultaneous reading and writing of data over a single link-multiplexing, which enables small data transfers to be transmitted with larger ones, rather than having to wait until the larger transaction is finished (searchStorage.com)
Fiber Channel Arbitrated Loop (FC-AL)	<p>A fast serial bus interface standard intended to replace SCSI on high-end servers. FC-AL has a number of advantages over SCSI. It offers higher speed: the base speed is 100 megabytes per second, with 200, 400, and 800 planned. Many devices are dual ported, i.e., can be accessed through two independent ports, which doubles speed and increases fault tolerance. Cables can be as long as 30 m (coaxial) or 10 km (optical). FC-AL enables self-configuring and hot swapping and the maximum number of devices on a single port is 126. Finally, it provides software compatibility with SCSI.</p>

Despite all these features FC-AL is unlikely to appear on desktops

anytime soon, partly because its price, partly because typical desktop computers would not take advantage of many of the advanced features. On these systems FireWire has more potential. (FOLDOC)

FireWire	A high performance serial bus(or IEEE 1394). FireWire is a 1995 Macintosh/IBM PC serial bus interface standard offering high-speed communications and isochronous real-time data services. 1394 can transfer data between a computer and its peripherals at 100, 200, or 400 Mbps, with a planed increase to 2 Gbps. Cable length is limited to 4.5 m but up to 16 cables can be daisy-chained yielding a total length of 72 m. It can daisy chain together up to 63 peripherals in a tree-like structure (as opposed to SCSI's linear structure). It allows peer-to-peer device communication, such as communication between a scanner and a printer, to take place without using system memory or the CPU. It is designed to support plug-and-play and hot swapping. Its six-wire cable is not only more convenient than SCSI cables but can supply up to 60 watts of power, allowing low-consumption devices to operate without a separate power cord. Some expensive camcorders have included this bus since autumn 1995. It is expected to be used to carry SCSI, with possible application to home automation using repeaters. (FOLDOC)
FC-IP	Fibre Channel Internet Protocol, a Fibre Channel Block wrapped in an IP packet.
File Service	The process of storing and retrieving files (as opposed to blocks of data).
File Transfer Protocol (FTP)	A client-server protocol that allows a user on one computer to transfer files to and from another computer over a TCP/IP network. Also, used to reference the client program that the user executes to transfer files. It is defined in STD 9, RFC 959. (FOLDOC)
Flash Memory	A non-volatile memory device that retains its data after the power is removed. (www.crucial.com)
Freedom of Information Act (FOIA)	A chapter of the Code of Virginia. 2.2-3700 , which addresses a citizen's right to access state government information.
GB	Gigabit
High-end Servers	In this report, defined as servers with a greater than 16 processor scale-up limit and typically costing more than \$250,000.
Host	The term "host" is used in several contexts, in each of which it has a slightly different meaning: 1) In Internet protocol specifications, the term "host" means any computer that has full two-way access to other computers on the Internet. A host has a specific "local or host number" that, together

with the network number, forms its unique IP address. If you use Point-to-Point Protocol to get access to your access provider, you have a unique IP address for the duration of any connection you make to the Internet and your computer is a host for that period. In this context, a "host" is a node in a network.

2) For companies or individuals with a Web site, a host is a computer with a Web server that serves the pages for one or more Web sites. A host can also be the company that provides that service, which is known as hosting.

3) In IBM and perhaps other mainframe computer environments, a host is a mainframe computer (which is now usually referred to as a "large server"). In this context, the mainframe has intelligent or "dumb" terminals (or emulation) attached to it that use it as a host provider of services. (The server/client relationship is a programming model independent of this contextual usage of "host.")

4) In other contexts, the term generally means a device or program that provides services to some smaller or less capable device or program. (Whatis.com)

**Human
Resources
(HR, DHRM)**

This term has four meanings as used in this report.

- 1.) Person hours available to perform work on an information technology project
- 2.) Data systems that specialize in employee related information and functions
- 3.) The department or office within an agency or an enterprise that deals with employee information, performance, hiring, firing, benefits, EEO, training and related functions
- 4.) DHRM is the state agency in Virginia, Department of Human Resource Management.

**Hyper-
threading**

A term used by Intel to describe multithreading functionality in a chipset that may be turned on and off. Some argue that an enterprise should turn the capability off until they are able to determine whether it results in a performance boost or drop for the type of processing they need. The following definition is from Intel:

Hyper-Threading Technology allows two threads (or parts of a software program) to execute simultaneously on a single Pentium 4 processor. A Hyper-Threading Technology-aware operating system such as Microsoft Windows* XP Professional "sees" two virtual processors, instead of a single physical Pentium 4 processor. By using resources that might otherwise sit idle, the Pentium 4 Processor with Hyper-Threading Technology delivers noticeable performance increases over current software in a multitasking environment, no code modifications needed.

IEEE

Institute of Electrical and Electronics Engineers, Inc. – A standards

group for communications. www.ieee.org

InfiniBand (IB)

An emerging standard intended as an interconnect for processor and I/O systems and devices (see the InfiniBand Trade Association web site at <http://www.InfiniBandta.org> for details). IP is one type of traffic (and a very important one) that could use this interconnect. InfiniBand would benefit greatly from a standardized method of handling IP traffic on IB fabrics. It is also important to be able to manage InfiniBand devices in a common way. The InfiniBand working group (<http://www.ietf.org/html.charters/ipoib-charter.html>) has two tasks:

- Specify the protocols and encapsulations to transport IPv4/v6 over an InfiniBand fabric.
- Specify a set of management information base or MIB objects to allow management of the InfiniBand fabric itself.

Infrared

Electromagnetic waves in the frequency range just below visible light corresponding to radiated heat.

I/O

Input/Output

Intel Centrino

Centrino is a technology package from Intel that provides built-in wireless support for laptop computers while making it possible to run a laptop all day (up to seven hours) without a battery recharge. Through Centrino, Intel hopes to encourage corporations and users to replace their current notebooks with a newer, more mobile version. Analysts suggest that a more mobile laptop may in time replace the desktop computer as well. The Centrino package consists of:

- The Pentium M processor
- The 855 chipset Family
- The PRO/Wireless network connection

In addition to a 400 MHz system bus and a 1 MB L2 cache, the M processor has the ability to use only the voltage that applications demand. The 855 Chipset supports up to 2 GB of double data rate (DDR) memory and USB 2.0 for faster data transfer. The PR/Wireless connection supports WiFi (802.11b) and power functions designed to maximize battery life.

Intel Itanium Chipset

Itanium is Intel's first microprocessor that is based on the 64-bit architecture known as IA-64. Developed under the code name of Merced, Itanium and its underlying architecture are expected to provide a foundation for the next-generation of software for the server and high-end workstation markets. Intel plans to follow Itanium with additional IA-64 microprocessors, which have the code names of McKinley, Madison, and Deerfield. In addition to supporting a 64-bit processor bus and a set of 28 registers, the 64-bit design allows access to a very large memory (VLM). In addition, the architecture exploits features in Explicitly Parallel Instruction

Computing (EPIC), a joint Intel and Hewlett-Packard development effort. These provide advances in the parallel processing handling of computer instructions known as predication and speculation. An additional Itanium feature includes a Level 3 (L3) cache memory, to supplement the current L1 and L2 cache memories found in most of today's microcomputers. Most applications in use today are based on a 32-bit microprocessor architecture, and are designed for up to 4 gigabytes of memory. However, with application access to ever-larger databases becoming more important, many of the leading software and hardware suppliers in the computer industry have already begun to develop systems and applications for the Itanium and its ability to handle 64-bit address space. One feature of Itanium is its use of a "smart compiler" to optimize how instructions are sent to the processor. This approach allows Itanium and future IA-64 microprocessors to process more instructions per clock cycle (IPCs). (IPCs can be used along with clock speed in terms of megahertz (MHz) to indicate a microprocessor's overall performance.) (Whatis.com)

Intel XEON The Intel® Xeon™ processor MP family is designed specifically for mid-tier servers performing key business functions such as collaboration, application serving, enterprise resource planning, and business intelligence. The Intel Xeon processor MP features [Hyper-Threading](#) technology, Integrated Three-Level cache architecture and Intel® NetBurst™ microarchitecture. The Intel® Xeon™ Processor is designed for dual-processor server and workstation platforms. It does not have the three-level cache.

Internet Protocol (IP) a communications protocol, which routes packets of data from one address on the Internet to another. IPv4 routes each packet based on a 32-bit destination address called an IP address (e.g., 123.122.211.111).

Internet-working A term used by Cisco, BBN, and other providers of network products and services as a comprehensive term for all the concepts, technologies, and generic devices that allow people and their computers to communicate across different kinds of networks. (searchNetworking.com)

IrDA Infrared Data Association – is an industry-sponsored organization set up in 1993 to create international standards for the hardware and software used in infrared communication links. An IrDA port is an infrared port. In this special form of radio transmission, a focused ray of light in the infrared frequency spectrum, measured in terahertz, or trillions of hertz (cycles per second), is modulated with information and sent from a transmitter to a receiver over a relatively short distance. Infrared radiation (IR) is the same technology used to control a TV set with a remote control. Infrared data communication

is playing an important role in wireless data communication due to the popularity of laptop computers, personal digital assistants (PDAs), digital cameras, mobile telephones, pagers, and other devices. Infrared communication involves a transceiver (a combination transmitter and receiver) in both devices that communicate. IR can be also be used for somewhat longer interconnections and is a possibility for interconnections within local area networks. The maximum effective distance is somewhat less than 1.5 miles and the maximum projected bandwidth is 16 megabits per second. Since IR is line-of-sight light transmission, it is sensitive to fog and other atmospheric conditions.

(searchMobileComputing.com)

- iSCSI** Internet Small Computer System Interface – a protocol for transmitting a SCSI block wrapped in an IP packet.
- ITIB** Information Technology Investment Board – created by the General Assembly to perform “agency head” roles for the Virginia Information Technologies Agency.
- ITRM** Information Technology Resource Management – identifier used to indicate official IT policies, standards, and guidelines permitted by the Virginia General Assembly for the control and management of IT resources in the Commonwealth.
- Jaz Drive –** Iomega Corporation's drive, which takes removable one or two gigabyte disk cartridges that contain conventional hard disks.
- Just a Bunch of Disks (JBODS)** A storage subsystems using multiple independent disk drives, as opposed to one form of RAID or another.
- Key Fob** A type of security token: a small hardware device with built-in authentication mechanisms. Just as the keys held on an ordinary real-world key chain or fob control access to the owner's home or car, the mechanisms in the key fob control access to network services and information. The key fob (and similar devices, such as [smart cards](#)) provide two-factor authentication: the user has a personal identification number (PIN), which authenticates them as the device's owner; after the user correctly enters their PIN, the device displays a number which allows them to log on to the network. Because a key fob is a physical object, it is easy for the owner to know if it has been stolen. In comparison, a password can be stolen (or guessed) and used for an extended period before -- if ever -- the theft is detected. (searchSecurity.com)
- Linear Tape Open (LTO)** An open standard for a backup tape system, which provides formats for both fast data access and high storage capacity, developed jointly by Hewlett-Packard, IBM, and Seagate. IBM released the first LTO

products in August, 2000. Like existing tape systems, LTO uses a linear multi-channel bi-directional format. LTO adds to existing technologies timing-based servo (a device that automates a process of error correction for a mechanism), hardware data compression, enhanced track layouts, and efficient error correction code. LTO was developed in two different formats - one for fast data access and another for greater storage capacity. The Accelis format uses 8mm-wide tape on a two-reel cartridge that loads at the mid-point of the tape to provide fast data access, specifically for read-intensive applications, such as online searches and retrieval functions. The Ultrium format uses a single reel of half-inch wide tape to maximize storage capacity, specifically for write-intensive applications, such as archival and backup functions. Early products using the Accelis format offer a 25 gigabyte capacity for uncompressed data, while Ultrium based-products offer a 100 gigabyte capacity. Both formats provide transfer rates of 10 - 20 Mbps. While these figures are not unheard of in other technologies, LTO specifications include plans for expected increases that will double current rates with each of the next three generations of products.

Linux – a UNIX-like operating system that was designed to provide personal computer users a free or very low-cost operating system comparable to traditional and usually more expensive UNIX systems. Linux has a reputation as a very efficient and fast-performing system. Linux's kernel (the central part of the operating system) was developed by Linus Torvalds at the University of Helsinki in Finland. To complete the operating system, Torvalds and other team members made use of system components developed by members of the Free Software Foundation for the GNU Project. Linux is a remarkably complete operating system, including a graphical user interface, an X Window System, TCP/IP, the Emacs editor, and other components usually found in a comprehensive UNIX system. Although copyrights are held by various creators of Linux's components, Linux is distributed using the Free Software Foundation's copyleft stipulations that mean any modified version that is redistributed must in turn be freely available. (searchEnterpriseLinux.com)

Local Area Network (LAN) A private computer network generally on a user's premises and operated within a limited geographical area.

MagStar A family of IBM proprietary tape equipment and products.

Metropolitan Area Network (MAN) A private wide area network that addresses the needs of a city — typically of dark fiber, that may be lit with public services or Gigabit Ethernet.

Midrange to In this report, servers costing \$50, 000 or less are typical midrange to

Low-end Servers	low-end servers. These servers would usually have one to four processors, but could have as many as 8 or 16 processors. When the midrange computer is a scaled-down version of a high-end server, it may cost substantially more.
Mirroring	Writing the same data in two locations.
Mobile	The ability to move around, it also refers to anything that can be moved around (or transported) and still functioning properly. It usually describes handheld devices, such as PDAs and cell phones (that is, mobile phones), but it can also refer to notebooks or other portable devices. (netlingo.com)
Mozilla	Mozilla was the original code name for the product that came to be known as Netscape Navigator, and later, Netscape Communicator. Later, it came to be the name of Netscape Communications Corporation's dinosaur-like mascot. Netscape Communications Corporation holds trademarks on the names Netscape, Navigator, and Communicator; it has not yet been decided what, if any, restrictions Netscape will place on the use of those names. Now, they use the name "Mozilla" as the principal trademark representing the Foundation and the official releases of internet client software developed through our open source project. This organization produced Firefox, Bugzilla, Camino (Mac browser), Thunderbird (email), Mozilla Suite, and is also working on a Calendaring solution. (adapted from Mozilla.org)
MPLS	Multiprotocol Label Switching (MPLS) is a communications technology for speeding up wide-area network traffic flow and making it easier to manage. This technology is typically a backbone technology provided by a carrier. MPLS involves setting up a specific path for a given sequence of packets, identified by a label put in each packet, thus saving the time needed for a router to look up the address to the next node for packet forwarding. MPLS is called multiprotocol because it works with the Internet Protocol (IP), Asynchronous Transport Mode (ATM), and frame relay network protocols. With reference to the standard model for a network (the Open Systems Interconnection, or OSI model), MPLS allows most packets to be forwarded at the layer 2 (switching) level rather than at the layer 3 (routing) level. In addition to moving traffic faster overall, MPLS makes it easy to manage a network for quality of service (QoS). (Adapted from Whatis.com).
NAS Engine	The controller portion as opposed to the storage portion of a NAS system.
NAS Head	A NAS engine
NAS Gateway	A NAS engine

Network	<ol style="list-style-type: none">1) A configuration of data processing devices and software connected for information interchange.2) A group of two or more computer systems linked together.
Network Attached Storage (NAS)	Hard disk storage that is set up with its own network address rather than being attached to the department computer that is serving applications to a network's workstation users. File requests are mapped by the main server to the NAS file server.
Network File System (NFS)	A client/server application that lets a computer user view and optionally store and update file on a remote computer as though they were on the user's own computer. The user's system needs to have an NFS client and the other computer needs the NFS server. Both of them require that you also have TCP/IP installed since the NFS server and client use TCP/IP as the program that sends the files and updates back and forth. (However, the User Datagram Protocol, UDP, which comes with TCP/IP, is used instead of TCP with earlier versions of NFS.) NFS was developed by Sun Microsystems and has been designated a file server standard. Its protocol uses the Remote Procedure Call (RPC) method of communication between computers. NFS has been extended to the Internet with WebNFS, a product and proposed standard that is now part of Netscape's Communicator browser. WebNFS offers what Sun believes is a faster way to access Web pages and other Internet files.
NIC	Network Interface Card – A hardware device used to connect computers to a wired or wireless network.
Nonvolatile Memory	A memory that retains information if power is removed and then reapplied. SRAM or static random access memory and flash memory are examples of nonvolatile memory (www.crucial.com)
OLED Displays	Organic Light-Emitting Diode – Monochrome and color display with no backlight and thus more power efficient. is a display technology, pioneered and patented by Kodak, based on the use of organic polymer material as the semiconductor material in light-emitting diodes (LEDs). A polymer can be a natural or synthetic substance and macro or micro in size. Examples of organic polymers include proteins and DNA. OLED displays are used in cellular phones, digital video cameras, digital versatile disc (DVD) players, personal digital assistants (PDAs), notebooks, car stereos, and televisions. OLED displays are thinner and weigh less because they do not require backlighting. OLED displays also have a wide viewing angle up to 160 degrees even in bright light, and they use only two to ten volts to operate. New technologies that build on the OLED include FOLED (flexible organic light-emitting display), which promises to make highly portable, roll-up displays possible within the next few years.
PC Card	PCMCIA device or slot.

PCI	Peripheral Component Interconnect – A standard for connecting peripherals to a personal computer or components within a computer, designed by Intel and released in 1993. PCI is supported by most major manufacturers. The technology is usually called a bus but is in fact a bridge.
PCI Express (PCI X)	Developed by the PCI-SIG industry group to extend the PCI bus to meet the present and future computing and communications interconnect requirements, PCI Express is suitable for both chip-to-chip and add-in card implementations. The packetized protocol and layered architecture of the standard enables attachment to copper, optical, or emerging physical signaling media.
PCMCIA	Personal Computer Memory Card International Association – A PC Card. An international trade association and the standards they have developed for devices, such as modems and external hard disk drives that can be plugged into notebook computers. A PCMCIA card is about the size of a credit card.
PDA	Personal Digital Assistant – A small hand-held computer typically providing calendar, contacts, and note-taking applications but may include other applications, for example a web browser and media player. Small keyboards and pen-based input systems are most commonly used for user input.
Productivity Software	Software typically used by business professionals such as word processing, spreadsheets, presentation slides, web browsers, and plug ins. Also includes lesser used software such as personal database software, flowcharting, project management.
Push Email	Email service that sends new email to a device when it is received rather than waiting for the user to request store and forward email.
RAC (Real Application Cluster)	A component of the Oracle 9i database product that allows a database to be installed across multiple servers. According to Oracle, RAC's shared disk method of clustering databases: increases scalability because servers can easily be added or subtracted to meet current needs, lowers costs because companies don't have to buy high-end servers, and improves availability because if one server fails, another can assume its workload. RAC's shared disk architecture is an unusual approach to database clustering. Most competing database products (such as Microsoft's SQL Server and IBM's DB2 for Windows and Unix environments) use the alternative, which is known as "shared nothing" architecture. Shared nothing architecture partitions data and only gives each server access to its own disk subsystem, while shared disk architecture gives all servers access to the entire database. This adds failover capacity to the database, because all servers have access to the whole database. Proponents claim that this capacity increases 9i's reliability and availability

significantly. British Telecom, for example, reported that deploying the product enabled them to cut their failover time from a typical 20 minutes to between 10-60 seconds.

RAID	Redundant Array of Independent Disks – A method of organizing small format disk devices to drastically increase I/O bandwidth and improve data availability.
Scale-up server solution	<ol style="list-style-type: none">1) From an application perspective, a scale-up solution is one that permits the adding of more resources to the application by adding resources from within a single platform and without increasing the number of operating systems used in supporting the application.2) For the consolidation of multiple applications, the scale-up solutions will provide the ability to add resources to more than one application from within the platform without increasing the number of operating systems used in supporting the application.
Scale-out server solution	from an application standpoint (e.g., email), the scale-out solution increases resources to the application by adding servers to the cluster of real or virtual servers. The addition of servers increases the number of operating systems supporting the solution.
SCSI	Small Computer System Interface
Secure Digital (SD)	A tiny memory card used to make storage portable among various devices, such as car navigation systems, cellular phones, eBooks, PDAs, smartphones, digital cameras, music players, camcorders, and personal computers. An SD card features a high data transfer rate and low battery consumption, both primary considerations for portable devices. It uses flash memory to provide nonvolatile storage, which means that a power source is not required to retain stored data. An SD card is about the size of a postage stamp and weighs approximately two grams. It is similar in size to a MultiMediaCard (MMC), but smaller than older memory card types such as the SmartMedia card and the CompactFlash card. Both MMC and SD cards provide encryption capabilities for protected content to ensure secure distribution of copyrighted material, such as digital music, video, and eBooks, but SD cards are available with storage capacities as high as 128MB, with a 512MB SD card expected to be available by late 2002. SD cards are more rugged than traditional storage media. They have an operating shock rating (basically, the height you can drop them from and still have them work) of 2,000 Gs, compared to a 100-200 G rating for the mechanical drive of the typical portable computing device. This translates to a drop to the floor from 10 feet, as compared to a single foot for the mechanical disk drive. Both MMC and SD cards use metal connector contacts, instead of the traditional pins-and-plugs, so they aren't as prone to damage during handling. The SD card was jointly developed by Matsushita,

SanDisk, and Toshiba.

Serial ATA device

Serial Advanced Technology Attachment – A new standard for connecting hard drives into computer systems that is based on serial signaling technology, unlike current IDE (Integrated Drive Electronics) hard drives that use parallel signaling. SATA has several practical advantages over the parallel signaling (also called Parallel ATA or PATA) that has been used in hard drives since the 1980s. SATA cables are more flexible, thinner, and less massive than the ribbon cables required for conventional PATA hard drives. SATA cables can be considerably longer than PATA ribbon cables, allowing the designer more latitude in the physical layout of a system. Because there are fewer conductors (only 7 in SATA as compared with 40 in PATA), crosstalk and electromagnetic interference (EMI) are less likely to be troublesome. The signal voltage is much lower as well (250 mV for SATA as compared with 5 V for PATA). SATA creates a point-to-point connection between devices. Transfer rates for SATA begin at 150MBps. One of the main design advantages of Serial ATA is that the thinner serial cables facilitate more efficient airflow inside a form factor and also allow for smaller chassis designs. In contrast, IDE cables used in parallel ATA systems are bulkier than Serial ATA cables and can only extend to 40cm long, while Serial ATA cables can extend up to one meter. (Combined from Whatis.com and www.techimo.com definitions)

SMB

Server Message Block – Message protocol used by DOS and Windows to share files, directories and devices. (webopedia.com)

Smartcard, also Smart Card

A small electronic device about the size of a credit card that contains electronic memory, and possibly an embedded integrated circuit (IC). Smart cards containing an IC are sometimes called Integrated Circuit Cards (ICCs). Smart cards are used for a variety of purposes, including:

- Storing a patient's medical records
- Storing digital cash
- Generating network IDs (similar to a token)

To use a smart card, either to pull information from it or add data to it, you need a smart card reader, a small device into which you insert the smart card. (webopedia.com)

SMT

Simultaneous Multithreading – Simultaneous multithreading is a processor design that combines hardware multithreading with superscalar processor technology to allow multiple threads to issue instructions each cycle. Unlike other hardware multithreaded architectures (such as the Tera MTA), in which only a single hardware context (i.e., thread) is active on any given cycle, SMT permits all thread contexts to simultaneously compete for and share processor resources. Unlike conventional superscalar processors,

which suffer from a lack of per-thread instruction-level parallelism, simultaneous multithreading uses multiple threads to compensate for low single-thread ILP. The performance consequence is significantly higher instruction throughput and program speedups on a variety of workloads that include commercial databases, web servers and scientific applications in both multiprogrammed and parallel environments.

(<http://www.cs.washington.edu/research/smt/index.htm>)

SmartMedia

A card (originally called a solid-state floppy disk card, or SSFDC) is a memory card developed by Toshiba that uses flash memory to store data and to make it portable among devices, such as digital cameras, personal digital assistants (PDAs), and other handheld devices. At 45 X 37 mm and less than 1 mm thick (about as big as a matchbook), SmartMedia is similar in size to the CompactFlash card (although significantly thinner), but larger than the newer, postage stamp-sized alternatives, MultiMediaCard and [Secure Digital](#) (SD card). SmartMedia cards are available with storage capacities ranging up to 128MB, with higher capacities corresponding to higher prices. Unlike CompactFlash, SmartMedia doesn't have an on-board controller. Compliant devices have a controller built into the units' slots. The main advantage that SmartMedia cards have over the other memory cards is that because they read, write, and erase memory in small blocks of data (256 or 512 bytes at a time), you can more precisely select what data you want to save. However, SmartMedia cards aren't as sturdy as the other formats, and so require more careful handling and storage.

Snapshot

A backup facility provided by several companies. For example:

1.) A function of Tivoli Storage Management (TSM) that backs up the entire TSM database to media that can be taken off-site. The database snapshot does not interrupt any database backup series and cannot have incremental database backups associated with it. (Tivoli.com)

2.) SNAZ InstaView™ is optional Snapshot Software available with SNAZ SVA. SNAZ InstaView provides point-in-time volume imaging and presents a virtually unlimited number of views of the data. Each view can be individually allocated, on a read only or read/write basis, to any server. Data replication and data rollback are also offered as part of SNAZ InstaView functionality. Key benefits of SVA InstaView include:

- Backup and operations can be completed in background while volumes remain on-line
- Multiple views can be created and accessed simultaneously without copying data. There is no need to replicate data for each view, saving significant amount of storage and improving performance

- Ability to maintain several versions of data
- Ability to run several applications in parallel, using the same data
- Ability to create a view of the data at any specific time for later use (www.snia.org)

SONET	Synchronous Optical Network – A standard format for transporting a wide range of digital telecommunications services over optical fiber. SONET is characterized by standard line rates, optical interfaces, and signal formats.
SAN	Storage Area Network – A storage model typically characterized by a use of switching and transmission facilities that are separate from the local area network where the server of data to be stored and retrieved resides. As IP and Ethernet protocols become used in SANs, the model and/or name may change.
SDLT	Super Digital Linear Tape – A variant of DLT technology, called SuperDLT, makes it possible to store upwards of 100 GB on a single cartridge. The SuperDLT drive can transfer data at speeds of up to 10 megabytes per second (Mbps). (searchStorage.com)
Switch	Network device that filters, forwards, and floods frames based on the destination address of each frame. The switch operates at the data link layer of the OSI model. A fabric switch may have significant management and security functionality in addition to switching protocol choices. (modified Cisco definition)
Synchronous	This term has two distinct meanings in networking: 1.) a network communication, which requires a reply for completion or 2.) a type of network transmission that uses start and stop bits to establish precise clocking.
Sysplex (from System and Complex)	A computer image that consists of the multiple computers (the systems) that make up the complex. A sysplex is designed to be a solution for business needs involving any or all of the following: parallel processing; online transaction processing (OLTP); very high transaction volumes; very numerous small work units - online transactions, for example (or large work units that can be broken up into multiple small work units); or applications running simultaneously on separate systems that must be able to update to a single database without compromising data integrity. According to IBM, the Parallel Sysplex is the end result of IBM large systems' developments over the years, from the single system uniprocessor, to tightly-coupled multiprocessors, to loosely-coupled configurations, to the sysplex, and finally to the Parallel Sysplex. A single system uniprocessor consists of a single central processor complex (CPC) - which consists of a single central processor (CP) and all associated system hardware and software, controlled by a single copy of the

operating system. Tightly coupled multiprocessors consist of a number of CPs added to a CPC that share central storage and a single copy of the operating system. Work is assigned to an available CP by the operating system and can be rerouted to another if the first CP fails. A loosely coupled configuration has multiple CPCs (which may be tightly coupled multiprocessors) with separate storage areas, managed by more than one copy of the operating system and connected by channel-to-channel communications. A sysplex is similar to a loosely coupled configuration, but differs in that it has a standard communication mechanism (the cross-system coupling facility, or XCF) for MVS system applications that enables communication between application programs on one or multiple computers. The sysplex is made up of a number of CPCs that collaborate, through specialized hardware and software, to process a work load. This is what a large computer system does in general; a sysplex, through XCF, increases the number of processing units and operating systems that can be connected. The Parallel Sysplex, IBM's latest method of configuration for CPCs, is a clustering architecture that has improved communication capabilities and supports more connected CPCs and more copies of the operating system. There are several areas of improvement over the base sysplex. The Parallel Sysplex Coupling Facility is a new processor that stores crucial system information, usually configured on a separate device. Use of the coupling facility increases the capacity for data sharing among systems and subsystems. Because it is used through both systems and subsystems, it also ensures data integrity and consistency throughout the sysplex. Another feature of the new technology is the Workload Manager (WLM), part of OS/390 that is in each system in a Parallel Sysplex configuration. WLM manages resources more responsively than the earlier schedule-based methods through dynamic workload balancing and prioritization according to user-set criteria. The data-sharing capability enables simultaneous, multiple-system access to data. (Whatis.com)

System Image	The current contents of memory, which includes the operating system and running programs. For effective management, a cluster of computer systems may be organized as a single system image, in which all systems appear as one. See virtual server and Sysplex.
Tape Library, Automated (ATL)	A robotic media handler capable of storing multiple pieces of removable media and loading and unloading them from one or more drives in arbitrary order.
Tape Silo	Tape Library, Automated
Utility Service	In this report, the term is used to connote a function or activity typically provided by an IT unit, which may be separated from IT work requiring business knowledge, and which may be provided by a

central enterprise service (in-sourced) or by an external business (outsourced). An example would be web site hosting. You can provide hosting and WC3 accessibility levels without knowing the business of the agency or understanding the content of the website.

Virtual Machine

A software emulation of a physical computing environment. The term gave rise to the name of IBM's VM operating system whose task is to provide one or more simultaneous execution environments in which operating systems or other programs may execute as though they were running "on the bare iron", that is, without an enveloping Control Program. A major use of VM is the running of both outdated and current versions of the same operating system on a single CPU complex for the purpose of system migration, thereby obviating the need for a second processor. (FOLDOC)

VPN

A virtual private network (VPN) is a network that uses a public telecommunication infrastructure, such as the Internet, to provide remote offices or individual users with secure access to their organization's network via layer two tunneling protocols (L2TP).

Virtual Host

1) On the Web, a server that contains multiple Web sites, each with its own domain name. As of the first version of the Web protocol (HTTP 1.0), each Web site on a [virtual host](#) must be assigned a unique IP address. HTTP Version 1.1 eliminates this requirement. See also virtual server.

Virtual Server

1a) Same as virtual host. (<http://content.techweb.com/encyclopedia/>)
1b) 3. A configuration of a World-Wide Web server that appears to clients as an independent server but which is actually running on a computer that is shared by any number of other virtual servers. Each virtual server can be configured as an independent web site, with its own hostname, content, and security settings. The Domain Name System or DNS maps the hostnames of all virtual servers on one physical server to its IP address. The web server software then uses the "Host" header in the HTTP request to determine which virtual server the request was for, and then processes the request using that virtual server's configuration. (foldoc.org) 2) Multiple servers that appear as one server, or one [system image](#), to the operating system or for network administration. (<http://content.techweb.com/encyclopedia/>)

Virtual Storage

The storage space that may be regarded as addressable main storage by the user of a computer system in which virtual addresses are mapped into real addresses. The size of virtual storage is limited by the addressing scheme of the computer system and by the amount of auxiliary storage available, not by the actual number of main storage locations. (www.ibm.com)

Virtual Tape

Virtual tape is the use of a special storage device that manages less-

frequently needed data so that it appears to be stored entirely on tape cartridges when some parts of it may actually be located in faster, hard disk storage. The programming for a virtual tape system is sometimes called a virtual tape server (VTS). Virtual tape can be used with a hierarchical storage management (HSM) system in which data is moved as it falls through various usage thresholds to slower but less costly forms of storage media. Virtual tape may also be used as part of a storage area network (SAN) where less-frequently used or archived data can be managed by a single virtual tape server for a number of networked computers. A virtual tape system offloads from the main computer the processing involved in deciding whether data should be available in the faster disk cache or written onto a tape cartridge. The virtual tape system also can manage data so that more of the space on a tape cartridge is actually used. (searchStorage.com) IBM and Storage Technology are well-established vendors of virtual tape systems. Sutmyn Storage sells a product that provides a virtual interface to existing IBM and other systems.

VITA	Virginia Information Technologies Agency – a merged technology agency created by Virginia’s 2003 General Assembly.
WAFS	Wide Area File Services – A storage tool for improving central data access speeds over WANs and the Internet.
WAN	Wide Area Network –1) A network that provides communication services to a geographic area larger than that served by a local area network or a metropolitan area network, and that may use or provide public communication facilities. A WAN typically consists of multiple LANs that are linked together. 2) A data communications network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. 3) A computer network that links multiple workstations and other devices across a large geographical area.
WiFi	Wireless Fidelity – a protocol specified in 802.11b from the Institute of Electrical and Electronics Engineers (IEEE), which is part of a series of wireless specifications together with 802.11, 802.11a, and 802.11g. WiFi refers to an over-the-air connection with a wireless client and a base station or between two wireless clients.
WOC	A WAN optimization controller was recently called a WOC by Gartner.
WORM	Write Once Read Many times medium.

Glossary Acknowledgements

The domain team would like to thank their counterparts in the many states and federal government agencies whose excellent work preceded this. We couldn't have completed this report as quickly as it was done without the tireless energies obviously expended to complete their ETA documents. We also hope that other states will find this document useful in the design and updating of their own Enterprise Architecture. Significant contributions, references, and insights were derived from the following documents and web sites.

Information provided in Virginia's Enterprise Architecture Glossaries are liberally borrowed from a number of Internet sources including the following highly recommended general sources:

- O'Reilly's (search box at the bottom of the page)
<http://www.oreilly.com/reference/dictionary/tsearch.cgi>
- What Is? <http://whatis.techtarget.com/>
- Cisco's Glossary of LAN terms
<http://www.cisco.com/univercd/cc/td/doc/product/lan/trsr/b/glossary.htm>
- MobilInfo.Com Glossary <http://www.mobileinfo.com/Glossary/>
- Free Online Dictionary Of Computing
<http://foldoc.doc.ic.ac.uk/foldoc/index.html>
- TechWeb's Encyclopedia <http://content.techweb.com/encyclopedia/>

Numerous other authoritative sources have been referenced because of their special expertise in specific areas of technology.

Appendix A: Interview Schedule for Storage

Date _____

Interviewer _____

Persons Interviewed _____

Agency Number _____

Agency Name _____

Interview Script

We have selected several small, medium and large agencies to get a sense about how agencies presently handle storage. Agency answers don't have to be exact.

Approximations are fine. The questions are about how complex your storage is, the amount you have, mobile workers, WANs, and planning.

In some agencies, we have to talk to more than one person because one person handles UNIX storage and another, Windows, for example. At any time you can refer me to someone else regarding a particular question or some portion of your storage. (*NOTE—use a separate questionnaire for each interview if there are two or more different storage environments like UNIX and Windows*).

Our records indicate that you have ____ server locations. Do you have storage in this many locations? Yes No If no, about how many? _____

Our records indicate that ____ percent of servers that support your agency are Microsoft. Is this about right? Yes No If no, about what percentage _____

Question 1: Complexity of Storage

This question asks how many of your locations that have storage are simple versus complex on a 5 point scale. For the storage complexity question, the two end points are 5 is COMPLEX and 1 is SIMPLE. The middle point, 3, is MODERATELY COMPLEX. I will read several bullets that describe what we mean by these labels. Then I will ask you to tell me about how many of your **locations** you would place in categories 5, 4, 3, 2, and 1. Let me read all three types first and then I can repeat them if you like.

- A. Read the first set of bullets, by saying "*Locations that are complex would have most of these characteristics*" ...etc.

- B. Then provide this prompt. *“How many of your locations would you say are 5 or Complex?”*
- C. Then, read the bullets for number 1 and prompt *“How many locations are 1 or Simple?”*
- D. For 2, 3, and 4 ask *“If they are in between, how many locations would you place at 2, 3, or 4?”*
- E. Then, total the responses and see if they match the numbers of locations agreed to above.

5. Complex

5. _____

- SAN is currently in place
- High LAN use made SAN solutions viable for a location
- Use of iSCSI or Fibre Channel (FC) connections to servers
- There are multiple storage options for any new application
- One solution can accommodate multiple OSs
- Can provide cross OS backups

4. Between Moderately Complex and Complex

4. _____

3. Moderately Complex

3. _____

- Some LAN-based storage
- Use of some VLANs or segmentation for storage
- Use of NAS
- Use of iSCSI
- Shared backup tools
- Shared storage capacity among servers
- Sharing mostly between servers with like OSs

2. Between Simple and Moderately Complex

2. _____

1. Simple

1. _____

- Server-based storage
- Server-based tape backup
- No sharing of storage capacity between servers
- No way to reallocate storage among servers
- Multiple stand-alone tape backup solutions exist (unless only one server)
- Only one or two server operating systems
- No NAS or SAN solutions—all storage is direct attach
- Storage is not LAN-based

Total Locations _____

Question 2: Amount

About how many terabytes of storage do you have in your agency? _____TB to _____TB

(for small agencies, report in GB if that is how they buy storage)

Write down detail if they prefer to say something like 100-200 GB at 50 small locations and 10-20 TB centrally

Question 3: Planning

Do you have agency-wide storage planning? **Yes** **No**

Do you have agency-wide storage projections? **Yes** **No**

Based on your projections or on the last two years, how much change would you expect in the next two years? Circle + - _____ **Percent**

(They can answer in “percent increase/decrease” or by saying double (=200%), triple (=300%), etc.)

Question 4: WAN

Do you share files over a WAN (wide area network—excluding the Internet)? **Yes** **No**

Question 5: Mobile Workers

How many mobile workers do you have? _____ **Mobile Workers**

If any, do you provide storage services for them? **Yes, Locally** _____

Yes, Locally and Centrally _____

No _____

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Appendix B: Storage

Storage Services Overview

One defining factor for storage models is that storage requests are of two types, [block service](#) requests and [file service](#) requests. Personal computer clients on a network usually request files—document files. Web clients usually request files—web page files. Large database servers, email servers, and other applications, on the other hand, usually deal in blocks of data.

File server and NAS solutions provide file services and typically rely on local area networks (LANs) when interacting with the applications requesting storage. DAS and SAN solutions usually provide block services that do not use the LAN but instead use a separate storage connection and transit medium. Examples of combinations that provide block services are Fibre Channel (FC) SANs and SCSI DAS. Table 15 provides expanded definitions for DAS, SAN and NAS storage types.

Table 15: DAS, NAS, and SAN

Storage Type	Definitions*
Direct Attached Storage (DAS)	DAS is a storage model that involves a physical connection between a server and a storage resource. DAS is easy to implement compared to NAS and SAN. The storage system that is directly attached to the server is usually an array of disks but could also be a tape subsystem or other resource. Some call DAS disk array solutions a “SAN in a Can,” because the disk provides its own controller. In most DAS implementations, the server is a single point of failure. This is an issue with small servers but not with mainframes, which are more robust.
Storage Area Network (SAN)	<p>A SAN is a high-speed special-purpose network (or subnetwork) that interconnects different kinds of data storage devices with their associated data servers.</p> <p>Typically, a SAN is part of the overall network of computing resources for an enterprise. A SAN is usually in close proximity to other computing resources but may also extend to remote locations for backup and archival storage, using wide area network carrier technologies such as asynchronous transfer mode (ATM) or Synchronous Optical Networks (SONET).</p> <p>A SAN may use communication technology such as IBM's optical fiber ESCON or Fibre Channel technology. Some SAN system integrators liken the SAN to the common storage bus (flow of data) in a personal computer that is shared by different kinds of storage devices such as a hard disk or a CD-ROM player. SANs can incorporate sub-networks with NAS systems.</p>

Storage Type	Definitions*
Network Attached Storage (NAS)	<p>Network-attached storage (NAS) is often disk storage that is set up with its own network address rather than being attached to an application or database server. By removing storage access and its management from the server, the server can run applications or perform functions faster because these uses are not competing for the processor resources with the storage and retrieval functions. The NAS file server and storage are attached to a local area network (typically, an Ethernet network) and assigned an IP address. The main network server maps file requests to the NAS file server. Network-attached storage usually consists of hard disk storage, including ATA disks and multi-disk RAID systems. NAS also has software for configuring and mapping file locations to the network-attached device. Network-attached storage can be included as part of a SAN.</p> <p>Network support personnel often have the right mix of skills to successfully implement and manage a NAS system. NAS systems are like file servers with pared down operating systems and beefed up storage management features.</p> <p>NAS software can usually handle a number of network file protocols. Configuration, including the setting of user access priorities, is usually possible to do using a Web browser.</p>

* These definitions are modified from WhatIs.com

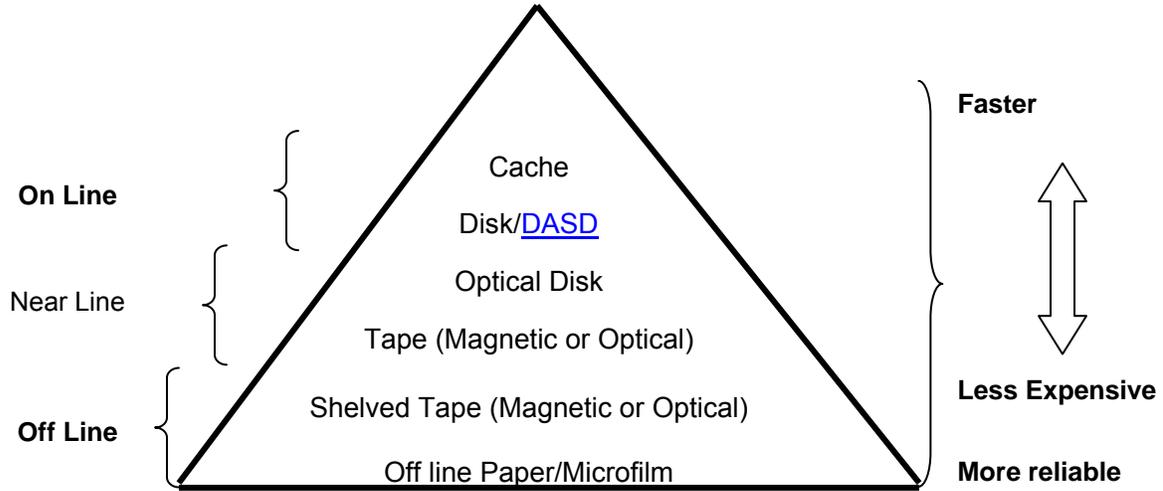
Mixed models may try to provide both files and blocks to the requesting applications. A [NAS Gateway](#) is one term that may be used for a mixed solution broker. The mixed model may have NAS, SAN, and DAS components.

On the destination end of a storage solution are the actual storage systems and media. The media might be disks, tapes, or optical storage with internal and external management utilities and control systems (e.g., tape library management software or enterprise storage management software).

Storage media are often described in a hierarchy that is based on relative accessibility, reliability and cost. In the past, cost differences across the hierarchy were enormous. Now the differences have decreased considerably.

Figure 5 provides one view of a storage hierarchy. The accessibility, cost and reliability dimensions portrayed in Figure 5 are not hard and fast. These qualities depend on the total solution design including the interface, the network/bus, the controllers, the management software, and the transmission protocol used to access data stored on the medium.

Figure 5: Storage Media Hierarchy



The costs range for media is illustrated in Table 16 below. Because costs change rapidly and amounts of storage on disk escalate geometrically, the costs will not be accurate. What will remain consistent over the next several years is the enormous spread in costs per GB.

Table 16: Cost of Media in 2004-2005

Media Type	TCO per GB* (Dollars per GB) Calculated for a terabyte system based on media, hardware, software, environmental, administration, and hardware	Media Cost used in TCO** (Dollars per GB)	Street Price of Media (Dollars per GB)
Solid state disk			2000.00 to 5000.00
Enterprise Disk (FICON, ESCON, FC, SCSI)			40.00 to 70.00
Midrange Disk (SCSI, FC)			15.00 to 35.00
Optical Disk Blue Laser			15.00 to 35.00
Economy Disk	8.76	.90	3.00 to 15.00
Automated Tape	4.30	.50	0.50 to 3.00

*Source: http://www.storagetek.com/upload/whitepaper/SUNintTT0008B_ValueOfTape_WP.pdf

**Source: discounted price based on acquisition of one terabyte of storage
http://www.storagetek.com/upload/whitepaper/TT0010A_TCOtape_WP.pdf

The management systems that control media access and other functions have varying capabilities for supporting important business needs including backup, recovery, and redundancy, for example. The management features of a storage system can reside in the storage server’s operating system, a switch, the medium itself, or in separate software that manages part or all of the storage needs for an enterprise.

Table 17 below summarizes some of the storage control features that might be available through a solution’s media controller. Table 18 provides examples of specialized services that are available in high-end bundled solutions, mainframe storage management modules, or add-on third party enterprise storage management software.

Table 17: Built-in Storage Management Services

Storage Type	Media Controller	Possible Media Controller Services
Cache	Server OS, Business Application	Access speed improvement
Disks (Arrays, Optical, DASD)	Built-in Management Software for Disk Array Controller or Disk Tower	RAID protection levels 1-5; multi-pathing with path failover; synchronous mirroring and asynchronous mirroring ; data warehouse input
Tape (Magnetic or Optical)	Built-in Management Software for Tape Drive, Library, or Autoloader	Automated backup and restore; 24x7 automated library access; auto inventory

Table 18 lists examples of special services provided through Mainframe Storage Modules or Third Party Storage Management Software.

Table 18: Examples of Storage Services

<p>Hierarchical storage management solutions (i.e., moving infrequently used data to cheaper, less available media)</p> <p>Automation of storage services by application (for provisioning, resource management, back up and recovery, and the archiving of data)</p> <p>Snapshot, replicate, and archive services</p> <p>Policy-based control for the storage environment (including archiving to read-only media for legal reasons)</p> <p>Separation of email from attachments for improved email archiving solutions</p> <p>Aids for establishing recovery priorities</p> <p>Aids for sharing tape hardware and software across a variety of heterogeneous disk systems (e.g., backup for a multi-vendor SAN)</p> <p>Aids for managing backup, recovery, restore across an entire distributed storage system</p> <p>Enablers of multi-pathing and path failover</p>

Other Storage Components

Storage models have several component hardware and software parts that support the physical connections between the storage user and the storage device, the communications and transmissions, and the setup and monitoring of systems and services. The components involve several technologies, some of which have been changing considerably in recent years. Example components and their purposes are provided below.

- **Interfaces**

The interfaces connect the hardware on the requesting end with the hardware on the receiving end, typically by attaching to a physical network. The interfaces determine the method and format of the communication so that both ends are speaking the same language. This also determines whether files or blocks are transmitted. The server's OS determines the type of file format supported for a file server, whereas with a NAS server, multiple file types (e.g., [NFS](#) and [CIFS](#)) would be supported. Example interfaces are FC, ATA, SCSI, iSCSI, FCIP, and Ethernet. iSCSI, when adopted, will permit a SAN to use LANs, WANs and the Internet as transmission vehicles.
- **Transmission medium**

The transition medium is usually a fiber or copper wire physical connection for communications among components of the storage system and servers that use it.
- **Controllers**

The controllers for the storage system may include a variety of hardware and software components. Simple systems rely on simple controllers built into operating systems or storage media. In more complex systems, which manage large amounts of storage, there are several points of control. Often, highly capable management software coordinates across the many components. Example controllers are a RAID controller, a server OS, a [NAS engine](#), a [NAS Gateway](#), a SAN-attached database server, a SAN [Fabric](#) Switch, and storage management software. Adequate remote management and control is an important issue for storage systems.
- **A variety of media and media systems**

The media and media systems store the data. Examples are redundant arrays of independent disks (RAID), [just a bunch of disks \(JBODs\)](#), NAS appliances, optical systems including CD towers, magnetic and optical tape cartridges/systems, tape silos, and [tape library systems](#). In hierarchical systems (see appendix A), tape remains the most cost effective option for archiving. Tape systems still cost about half of what a lower-end magnetic disk system costs. (See Table 16 below for media and TCO cost comparisons for 2004-2005 time frame).
- **Canned systems or bundled solutions.**

Canned systems provide end-to-end solutions targeted to a specific market. One example is the Prostore Backup Appliance—a plug-and-play ATA-based NAS backup system with an 8-cartridge digital linear tape autoloader system and backup and recovery software, all of which can be managed remotely.