Commonwealth of Virginia

Enterprise Technical Architecture (ETA)

Networking and Telecommunications Domain Report

Version 2.0, July 10, 2006

Prepared by:

Virginia Information Technologies Agency
ETA Networking and Telecommunications Domain Team

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The Networking and Telecommunications Domain team began its work by delineating the team's goals, objectives, and scope of work. Discussions included how the domain interfaces with other architecture domains, present and future directions, 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, research and deliberations are provided throughout this document.

Networking and Telecommunications Domain Report: Version History		
Revision	**Date**	**Description**
1.0	12-07-2001	Initial (Formally known as the Networking, Telecommunications and Cabling Standard)
1.1	04-22-2003	Addendum to add Cat 6 wiring specification
1.1	12-07-2001	Networking and Telecommunications Guideline
2.0	07-10-2006	Networking and Telecommunication Domain Report (replaces above three documents)

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

This document addresses networking and telecommunications architecture requirements, recommended practices and technology standards for agencies in the Commonwealth of Virginia. The networking and telecommunications domain is part of Virginia's Enterprise Technical Architecture (ETA). The ETA provides current state and future vision for the technical architecture that will meet agency business needs. It also provides requirements that will assist VITA-served agencies in meeting their needs while moving towards the future vision. For networking and telecommunications, the future vision for VITA-served agencies is simple. Future networks will be highly integrated, providing end-to-end services that coexist in a common infrastructure. Conceptually, the future network for VITA-served agencies will be one network. Institutions of higher education will strive for greater consistency and unity within the institutions with use of shared services across institutions when cost effective or when appropriate for meeting business needs.

The networking and telecommunications domain report represents the work and decisions of the 2005-2006 Network Domain Team, which was comprised of knowledgeable state, local, institutions of higher education, and contract personnel. The domain team identified two topics:

- Facilities Telecommunications Infrastructure (i.e., cable plant)
- Telecommunications
    - Local Area Networking (LANs)
    - Wide Area Networking (WANs)
    - Other Telecommunications Services (e.g., phone, data, multimedia)

In general, the document provides assistance to agencies in the following ways:

- Recommendations for actions that will improve future connectivity and services
- Descriptions of the current state of networking and telecommunications
- Overviews of the technical topics and technical trends
- A glossary of technical terms
- Web links for more information

Facilities telecommunications infrastructure addresses industry standards for build out and management of cabled networks. For telecommunications, the general approach recommended is: for LANs, use of switched Ethernet and IP addressing; for WANs, the service options presently available in the Commonwealth are discussed along with future directions, bandwidth, connectivity, and throughput issues; for other telecommunications services, the wide array of multimedia, voice, email, teleconferencing and additional services are addressed along with their impact on the future infrastructure and its management.

As requirements are implemented, agencies and central services will move towards:

- one common network designed and managed across participating agencies;

- an IP driven network;
- wired and wireless networks seamlessly integrated;
- roaming capabilities seamlessly provided;
- a network supporting LAN speeds and throughput for WAN connectivity;
- increases in carrier-based connectivity, management and services;
- security for wired and wireless LANs/WANs with carrier-provided and Commonwealth provided components;
- quality of service provided using a variety of tools to meet integrated voice, video and data needs transparently;
- 24x7 availability as standard;
- ever increasing reliability; management improvements; and
- remote provision of troubleshooting.

Overview

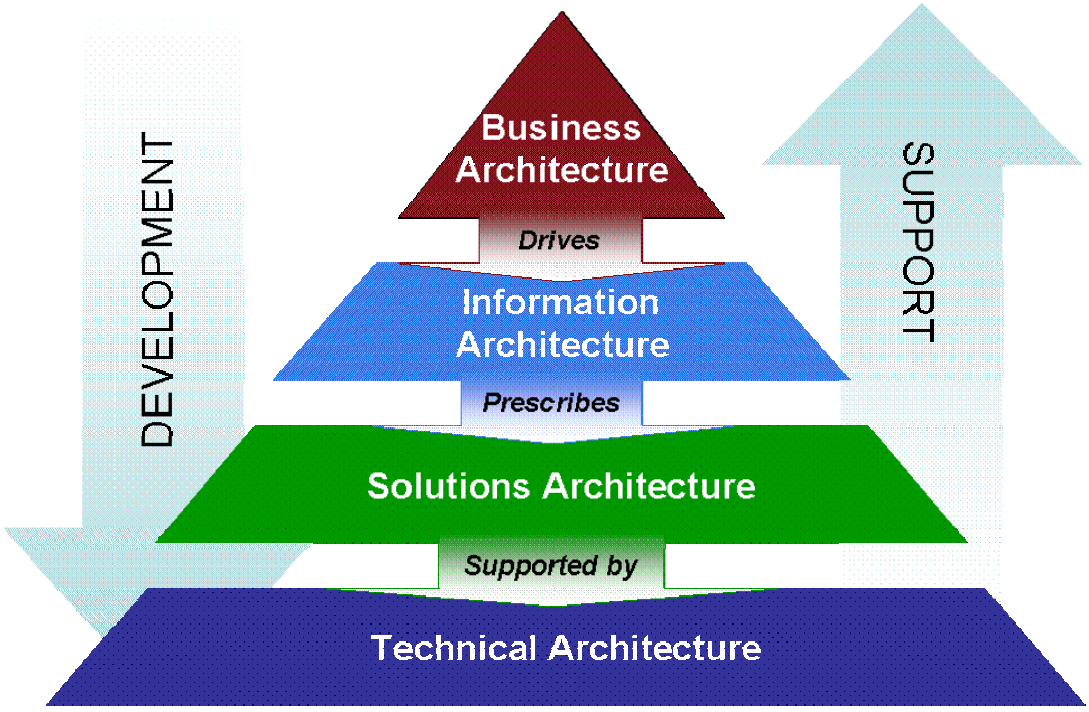
The Commonwealth's Enterprise Architecture is a strategic asset used to manage and align the Commonwealth's business processes and Information Technology (IT) infrastructure/solutions with the State's overall strategy.

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.

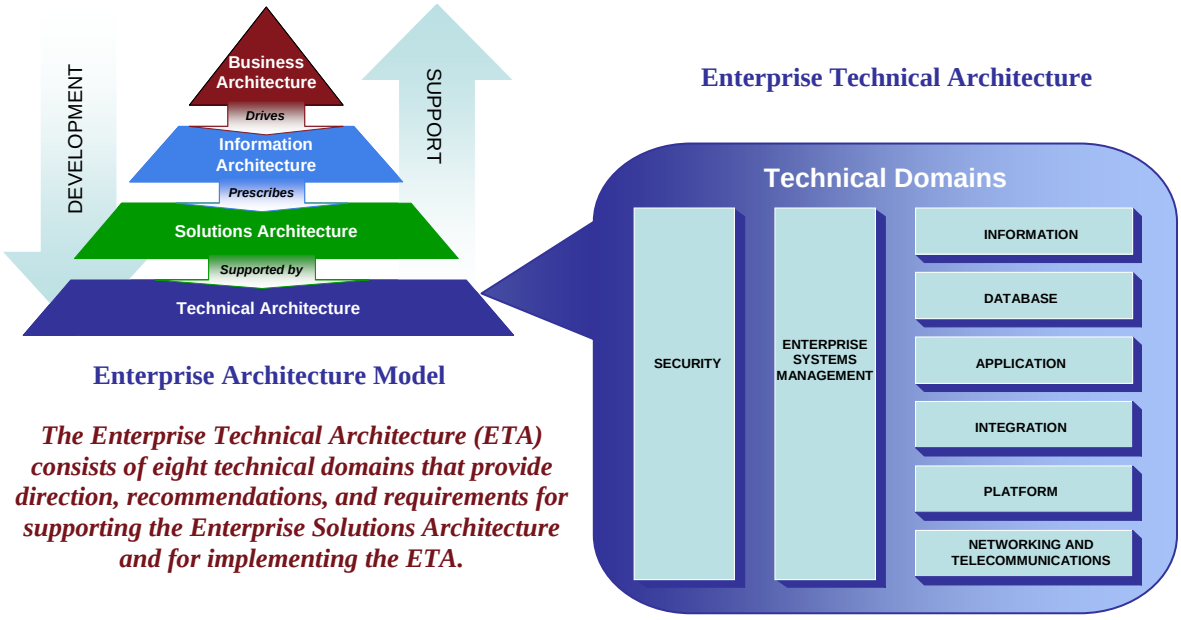
Figure 1
Commonwealth of Virginia Enterprise Architecture Model



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.

Figure 2
ETA Relationship to the Enterprise Architecture



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 Networking and Telecommunications Domain and includes requirements and recommended practices for Virginia's agencies[1, 2].

[1] 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.
[2]The 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 Networking and Telecommunications 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 Networking and Telecommunications 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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Networking and Telecommunications Domain Scope

The mission of the domain team was to define a networking and telecommunications model as a foundation for meeting the present and future business communications needs of the Commonwealth. The *Networking and Telecommunications Domain Report* provides guidance and requirements regarding connectivity and communications components (e.g., services and protocols used).

The audiences for the 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 the communications and connectivity in being responsive to changing business needs and services.

The domain report represents the work and decisions of the 2005-2006 Network Domain Team, which was comprised of knowledgeable state, local, higher education, and contract personnel. The domain team identified two topics:

- Facilities Telecommunications Infrastructure (i.e., cable plant)
- Telecommunications
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In general, the document provides assistance to agencies in the following ways:

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Methodology

The original domain team began its work by defining the networking and telecommunications portion of the ETA and by delineating the team's goals, objectives, and scope of work. Successive domain teams will consider the continuing relevance of the earlier efforts and recommend updates and improvements.

Networking and Telecommunications Domain Definition

The networking and telecommunications domain provides a communications infrastructure model for the Commonwealth. It defines the various technologies and services required to provide networking and telecommunications needed for addressing the business of state and local governments, their citizen customers, and their business sector constituents.

Objectives

The networking and telecommunications domain addresses communications related requirements implied by the Commonwealth's business strategies and methods. The domain team addressed the following objectives in its initial work and continued to do so during its review.

- promote simplicity across network solutions;
- promote interoperability (e.g., sharing information) among networks and networked services;
- provide a long-term vision with opportunities for short-term payoffs;
- enable the "leveraging of network infrastructure investments" by business users rather than just the "saving of money;"
- expand citizen/customer services by improving networking and telecommunications infrastructure and service functionality in the Commonwealth;
- improve decision making (through improved information flows) for all Commonwealth network users;
- help with technical decision making at the agency and Commonwealth levels;
- encourage acquisition patterns within and across agencies that will result in economies of scale;
- influence standards selection and development in areas such as wireless and mobile connectivity where ever standards are still evolving; and
- enable the convergence of voice, video, multimedia and data services in the Commonwealth over one, end-to-end network.

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As-Is and To-Be Architecture for Infrastructure and Services

As-Is Architecture

The data available for describing current networking and telecommunications in the Commonwealth is from information compiled for the 2005 due diligence effort in preparation for negotiating partnerships with several companies interested in helping the Commonwealth modernize its infrastructure. A small portion of the data that was collected for the due diligence effort is displayed here to provide a picture of networking and telecommunications in the Commonwealth.

Agencies as a whole have employees in every county and city in the Commonwealth. Most towns also have some state services. Nearly all of the state employees, who are spread across the Commonwealth, use local area and wide area networking services in addition to local and long distance telephone services. Local governments and schools also use the state-coordinated services.

Services provided over Commonwealth networks and through Commonwealth internal and external services include the following:

- Cabling plants
- LANs within each agency and in many local offices including LAN-based services (e.g., print services) and connectivity (e.g., email)
- WAN infrastructure and WAN connectivity including building to building connections, campus WANs, LAN to LAN connections
- LAN and WAN-based services including data transfer, connecting distributed applications, connecting business partners, and providing multimedia services including Internet connectivity, VoIP, audio and video conferencing, and more.

Some of the statistics from the 2005 due diligence effort may be used to describe the scope of government networking and telecommunications. These statistics do not include higher education agencies. Commonwealth networking supports the following persons, agencies, and infrastructure:

- Persons
    a. 60,000 executive branch customers (non-higher education agencies)
    b. 13,000 cell users
    c. 1,600 Centrex VoIP users
    d. 4,500 Premises VoIP users
- Agencies
    a. 60 non-higher education agencies
    b. 1,600 locations

c. 3,000 servers
d. 1,600 applications
e. 13 agencies using some VoIP

- Network Devices and Infrastructure
  a. 90,000 analog and digital phone lines (mainly Centrex)
  b. 4,700 WAN physical circuits (ATM, Frame Relay, FRASI, T1, etc.)
  c. 6,000 switch devices
  d. 1,500 wired hubs
  e. 2,500 routers
  f. 430 token ring network devices (e.g., MAUs, switches)
  g. 65 VoIP network devices (e.g., media servers and call managers)
  h. - Unknown number of wireless network devices

Although the Commonwealth's LANs are primarily switched Ethernet LANs at this time, there are still users and devices that are not switched. Also, two large agencies continue to operate significant token ring environments. These two agencies are slowly moving towards Ethernet solutions. One is now about 30 percent Ethernet. The other agency runs parallel Ethernet and token ring networks and will continue to do so until it can replace network printers and modify mission-critical applications, which rely on token ring connectivity for redundancy and mainframe access solutions. Both agencies have operations throughout the Commonwealth.

The majority of cabling in agency sites, whether used for token ring or Ethernet services, is still Category 5 twisted pair. Although some agencies have Category 5e or Category 6 capable cabling, these are the exception. Plant upgrades typically are the result of a facility move or a new application such as VoIP.

Most non-higher education agencies also have some Wi-Fi (IEEE 802.11) or Bluetooth (IEEE 802.15) wireless connectivity for conference rooms, laptops, Blackberries, or PDAs. Some also have infrared building to building connections. Cell services and other wireless networking connectivity (e.g., police communications, 2-way radios) are also used.

For higher education, little data is available centrally to describe the networking and telecommunications architectures that are in place. Like all colleges and universities, their infrastructures are massive with campus-wide and inter-campus connectivity. The public colleges support more than 300,000 students, 60,000 faculty and staff, and multiple campuses for 39 institutions.

To-Be Architecture

The future architecture envisions the unification of all networking, network management and network services. Future networks will be highly integrated, providing valuable end-to-end services that coexist in a common infrastructure. Conceptually, the future network for participating agencies will be one network. Premises lines will blur as carrier-

provided services move into LAN and MAN spaces. Wired and wireless services will merge as well, with a common management and security framework. As technical architecture requirements are implemented across the converging networks, agencies and central services will move towards:

- one common network designed and managed across participating agencies;
- an IP driven network;
- wired and wireless networks seamlessly integrated;
- roaming capabilities seamlessly provided;
- a network supporting LAN speeds and throughput for WAN connectivity;
- increases in carrier-based connectivity, management and services;
- security for wired and wireless LANs/WANs with carrier-provided and Commonwealth provided components;
- quality of service provided using a variety of tools to meet integrated voice, video and data needs transparently;
- 24x7 availability as standard;
- ever increasing reliability; management improvements; and
- remote provision of troubleshooting.

While it is not necessary to understand the inner-workings of future carrier-provided services, it may help to show the roadmap and to note agency cautions. See Table 1 below.

Table 1: Timeline and Typical LAN-WAN solutions

1980-2000	2001-2005	2006-2010	2011-2015
10 Mb Ethernet/ Cat 5 Token ring/Cat 5 Appletalk/Cat 5 Hubs/MAUs Frame Relay, T1 analog voice	100 Mb Ethernet/ Cat 5e, fiber Hubs and Switches Frame Relay, T1, ATM analog and digital voice; cellular VPN Limited wireless (typically 802.11b/g) IP based Site-based VoIP	GB+ Ethernet/ Cat 5e, 6, fiber Switches and Routers Carrier MPLS (Frame Relay and ATM, VPN) Analog and digital voice; cellular multitask with voice and email (smartphones) Site and Carrier VoIP; wired and wireless VoIP; cellular expansion with all services Pervasive wireless; mixed 802.11a/b/g designs; integration of wired and wireless management; some wireless only networks 3G and WiMAX Ratification of standards-based management (e.g., LWAPP)	GB+ Ethernet/ Cat 6a; fiber Buildings built and leased with comprehensive wired and wireless infrastructure Buildings designed for wireless Analog and digital voice; wireless phone roaming across cellular/VoIP/Other; multitasking voice devices Carrier Ethernet Line/LAN (Ethernet private line, Ethernet virtual private line) Carrier VoIP wireless pervasive Cellular and wireless pervasive Fully integrated wireless and wired pervasive Improved mobility solutions; carrier mobility
		Caution: building leases should include network and wiring closet service quality guarantees for wireless and wired LAN provision. Agency leases should include requirements for access to documentation and testing results for all cable plants. Agencies should be held harmless for expenses required for removing old cable to upgrade cabled services or electrical services. NEC requires removal of abandoned cable which also may have disposal costs due to lead.	Caution: must know bandwidth needs to the application level or risk overbuying highly scaled bandwidth services; must know security needs or risk overbuying.

Domain-wide Principles, Recommended Practices and Requirements

Domain-specific principles, recommended practices and requirements are presented for the network domain as a whole in this section. This section is then followed by a discussion of two technical topics along with recommended practices and requirements specific to each topic. The technical topics are facilities telecommunications infrastructure and telecommunications.

Principles are guiding beliefs. They are intended as guidance for the domain teams. They are less specific than recommended practices, which are intended to guide agency decisions. Requirements are those controls that will help the Commonwealth move towards it future vision for networking and telecommunications.

Domain-wide Principles

In addition to the principles identified in the "*Commonwealth of Virginia Enterprise Architecture – Conceptual Architecture*", the Networking and Telecommunications Domain team identified the following seven domain-specific principles:

NET-P-01: **Use of Industry Standards –** The networking and telecommunications ETA should be based on a set of industry standards.

NET-P-02: **Layered Protocols –** Standardization on layered protocols provides user transparency.

NET-P-03: **Network Integration –** The networking and telecommunications standards should support the use of networks for integrated voice, video, multimedia and data transmission.

NET-P-04: **Convergence of Voice and Data –** The Commonwealth must actively work on enabling the convergence of voice with data traffic over LANs and WANs. This convergence will require a quality of service level that approaches what is provided by the existing Public Switched Telephone Network (PSTN).

NET-P-05: **Service Quality –** The Commonwealth should seek to meet service quality guarantees within its networking and telecommunications ETA.

NET-P-06: **Affordable Interoperability –** The key to ensuring affordable interoperability is the promulgation of standards, and the adoption of these standards.

NET-P-07: **Planning –** Telecommunications infrastructure planning is an integral part of facilities planning, leasing, maintenance, construction, and renovation.

Domain-wide Recommended Practices

The following are two Domain-wide Recommended Practices for the Network and Telecommunications Domain:

NET-RP-01: **Network Planning and Application Changes.** State and local agencies should ensure that network planning is well integrated with applications design/acquisition and roll out. Agencies should have regularly scheduled meetings to review and document changes in each application's bandwidth requirements, real-time data flow needs, and expected system capacity changes over time.

NET-RP-02: **Strategic Planning.** State and local agency business leaders should review anticipated business changes with networking and telecommunications staff or service providers to ensure that implications are addressed in a timely manner. Changes in business volume, staffing levels, applications, or facilities (e.g., relocation, construction, or renovations) may affect networking and telecommunications services. Eighteen months lead time is often needed to ensure services availability.

Domain-wide Requirements

The following are the three domain-wide requirements identified for the Network and Telecommunications Domain:

NET-R-01: **Networking and Telecommunications Changes Due to Agency Facility Changes.** Networking and telecommunications infrastructure requirements must be an integral part of agency office change plans, whether the changes involve moving, expansion, construction, renovation, or lease changes. Agencies served by VITA that are planning changes must involve VITA in the early planning to determine the lead time required to ensure the availability of business critical telecommunications services. When state-owned or state-leased buildings are involved, agencies must also notify the Department of General Services, Division of Engineering and Buildings. To avoid delays and inflated expenses, agencies need to provide a six month advanced notice for minor changes and an eighteen month notice for major changes.

Rationale:
To ensure networking and telecommunications services availability to meet critical business needs, agencies must address infrastructure requirements as early as possible in the facility change planning process.

NET-R-02: **Inter-building Connections.** Agencies, except for institutions of higher education, which require network interconnections between two or more buildings, shall work with the Virginia Information Technologies Agency to determine a solution. The Department of General Services, Division of Engineering and Buildings shall be a participant in the discussion whenever Commonwealth owned or leased buildings are involved.

NET-R-03: **Single Pipeline Planning Data.** Agencies are required to report connectivity information and connection usage data when requested by the Commonwealth's Chief Information Officer (CIO). Such reporting requirements must have pre-defined, decision-based uses.

Rationale:
The future network vision for the Commonwealth includes reductions in state required connectivity costs for local governments, local government agencies, local branches of state courts, and branch offices for state agencies. The enterprise network redesign shall include considerations of a simplified design for required local connectivity, which is often referenced as a "single pipeline" between state and local government. To consider possible single pipeline solutions for the Commonwealth, requirements must be assessed.

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Networking and Telecommunications Domain Technical Topics

There are two topics within the networking and telecommunications domain: facilities telecommunications infrastructure and telecommunications. Facilities telecommunications infrastructure addresses the cabling, pathways and documentation that are tied to a physical location (e.g., building, office space, outdoor space, or campus of buildings). Facilities telecommunications infrastructure is currently limited to cabling plants and their documentation. In the future, wireless infrastructure may become a common part of the infrastructure which is typically provided as part of a facility lease and will remain with the facility at the termination of the lease.

Telecommunications addresses all other infrastructure and services, whether provided by the Commonwealth or by external service providers. Included in services are Local Area Networking (LAN), Wide Area Networking (WAN), and other telecommunications services (e.g., phone, data, multimedia).

A local area network or LAN is generally a private network. It is under the control of the owner and used by a set of related individuals and/or workgroups, typically within a single building or over a group of neighboring buildings.

A wide area network or WAN is a geographically dispersed telecommunications network. A wide area network may be privately owned or rented, but the term usually connotes the inclusion of public networks including the public telephone system.

Telecommunications are services or applications that run on local and wide area networks. Telecommunications services connect people, servers, security solutions, work groups, meeting participants, applications tiers, businesses and more.

Facilities Telecommunications Infrastructure

This topic addresses requirements for infrastructure that is typically used by an agency but not owned by the agency. When an agency is occupying a facility, it will have use of the building cabling, electrical systems, and access closets that together constitute much of the physical portion of the agency’s premises networking and telecommunications solution.

The cabling component of telecommunications infrastructure in the Commonwealth is typically under the control of individual agencies with the assistance of the Department of General Services (DGS) due to its being an integral part of the occupied buildings and grounds. DGS provides management of most state-owned facilities. The Department also oversees leasing of non-state-owned space.

For institutions of higher education, telecommunications infrastructure typically spans business, academic, residential, public safety, food service, public access, and recreational spaces, often across numerous buildings and multiple campuses. Non-higher education infrastructure may also span multiple buildings and may include connectivity to multiple locations within numerous localities. Spaces served by higher education and other agencies may extend beyond the walls of buildings into outdoor gathering areas most typically through wireless connectivity

The Commonwealth, to maximize its ability to provide low cost, high quality telecommunications services statewide to its agencies, localities, and higher education institutions must ensure that the telecommunications infrastructure is standards-based and capable of delivering certain throughput, speed, reliability, security and availability. The Commonwealth's future network is a statewide mesh of local and wide area networking. For this mesh to work as a unit, agencies must tighten their controls over facility providers and demand modern electrical and networking infrastructures that will support wired and wireless communications needs.

Individual agencies may obtain their LAN/WAN premises infrastructure via lease agreements, building plan specifications, or service contracts for premises modifications. These same leases, contracts and specifications should include requirements for standards-based cabling, electrical and documentation. Agencies should ensure that leases hold them harmless for removal and disposal of old cable and wiring.

Central availability of documentation of cable plants in a common format across agencies will enable estimation of the cost of new services that may be offered to agencies and estimation across agencies of the cost of making needed infrastructure changes. Such evaluations could be used to support a request to the General Assembly for state facilities upgrades based on volume discounts, for example. As the Commonwealth moves towards one network, central storage of and access to such documentation will become increasingly important.

At present, much work on cable plants is done by contracted contractors using a variety of methods for documentation. Only one tool is currently available that provides cable labeling with database entries and database interactions. Potentially, use of such a tool could provide more accurate and less costly documentation for the Commonwealth. Information on this tool, DOCU-MARK, may be accessed at http://www.graybar.com/documark/ .

Electrical and cooling plants in agency buildings must be adequate to support premises networking equipment and wireless implementations in addition to office space requirements. Often, agencies will find it convenient to address electrical and cooling deficiencies related to networking at the same time they are addressing modification or upgrade needs for the cable plant.

Central wiring closets and distributed service areas are important factors in determining the adequacy of space leased or occupied by agencies. As applications such as VoIP are implemented in the Commonwealth, air-conditioned, well-ventilated and highly accessible wiring closets become a necessity.

Reasons to Upgrade a Cable Plant

There are many good reasons to upgrade a cable plant. From and agency perspective, the following may support upgrading:

- Fire hazards
- Service outages for phones or networks related to the premises cabling
- Inadequate electrical service to offices
- Present network cable does not support Voice over IP (VoIP)
- Present network cable does not support switched Ethernet
- Future plans include videoconferencing to the desktop

- Gigabit Ethernet is required to meet future converged voice, video and data needs

The building owner may view cable plants from a building management perspective. The owner may envision:

- Remote management of systems problems
- Computer controlled HVAC, elevators, security, lighting
- Video security building-wide
- State of the art cabling as a selling point to customers
- Passing building inspections

Of course, upgrades must be worthwhile for business improvements, monetary return on investments, or improved customer satisfaction. When an agency is ready to make a change, experts should be consulted for determining a cost-effective design. It may be possible, for example, to share cable over high-density, low-speed applications such as meeting needs in a call center or a school setting. Typically, the agency will upgrade with the future in mind, and will consider Category 5e, Category 6 and higher cable plant implementations. The Department of General Services (DGS) can assist agencies with these issues. Also, agencies may wish to request upgrades through DGS as a group for funding by the General Assembly.

The state requirements (NET-R) and recommended practices (NET-RP) that will help agencies to meet the network infrastructure demands of the future are provided below.

Recommended Practices

Following are the four recommended practices for the Facilities Telecommunications Infrastructure Topic:

NET-RP-03: **Documentation Software and Hardware.** When modifying cable plants, agencies should encourage the use of integrated documentation software and hardware by their staff and contractors. Tools such as DOCU-MARK may facilitate infrastructure documentation and lower the cost of cable labeling.

NET-RP-04: **Electrical Service Upgrades.** Agencies should assess the adequacy of electrical infrastructure for networking and for application testing whenever considering modifications to their network cabling plants.

NET-RP-05: **Occupied Space Agreements.** When renegotiating space leases or space occupation agreements, agencies should consider networking needs for the term of the agreement.

NET-RP-06: **Telecommunication Rooms.** (e.g., Telecommunications Closets, Wiring Closets, and similar spaces). Whenever state and local agencies house networking, telecommunications, and related equipment within their facilities, the agencies should provide a secure, climate-controlled

telecommunications room for the equipment (e.g., switches, routers, etc.). Agencies are encouraged to use racks or cabinets to maximize the utility of space available and to ensure adequate space for easy access to the front and rear of the equipment. Telecommunications rooms and space considerations are addressed in TIA/EIA-569.

Requirements

Following are the three requirements for the Facilities Telecommunications Infrastructure Topic:

NET-R-04: **Cabling Requirements.** Agencies must ensure the availability of standards-based structured cabling systems for all agency telecommunications in agency occupied space. Agencies must ensure the deployment of ANSI/TIA/EIA standards-based designs, topologies, components, distances, installation methods, cable testing, and cable administration. All related minimum requirements or mandatory criteria that must be met (unless exceptions are noted in this document) are addressed in the following Commonwealth adopted international standards (ANSI/TIA/EIA standards):

- **ANSI/TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.** This standard addresses cabling infrastructure design, installation and field testing for horizontal cabling, backbone cabling, and work areas. It also covers requirements for telecommunications rooms, equipment rooms, and entrance facilities. This standard recommends the use of ANSI/TIA/EIA T568A, which specifies the wiring scheme to be used with the RJ-45 modular plug (8 position jack) and optionally allows use of T568B. The 568-B.1 standard is typically used in conjunction with the National Electric Code to provide an appropriate cable plant.

  Exceptions

  Agencies except for institutions of higher education shall ensure use of the ANSI/TIA/EIA T568A wiring scheme for RJ-45 modular plugs in agency occupied space and shall not use T568B. Agencies are required to use T568A consistently throughout their cabling plant. T568A provides backwards compatibility with both one-pair and two-pair USOC (Universal Service Order Code) wiring schemes.

  Institutions of higher education, which prior to 1991 cabled their entire campus using the T568B wiring scheme (pin pair assignment), may continue using T568B without an

exception. Other agencies require an exception for any new installation of cabling using T568B except when the installation is accommodating the needs of existing users.

Agencies that have mixed T568A and T568B cabling plants are required to carefully document (see ANSI/TIA/EIA-606-A) the mixture and have clear rules for adding or partially replacing cabling in a building. In addition, an agency with a mixed plant must have a plan for switching to T568A as building cabling is replaced.

When an agency is replacing all horizontal cabling, the agency is required to implement the T568A standard.

- **ANSI/TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted Pair Cabling Components.** Addresses specifications for horizontal four-pair cables and backbone multi-pair cables and components. All Category 6, Category 5e and Category 3 cable specifications and testing are addressed.

  Exception

  Agencies must ensure a minimum of certified Category 5e cable when installing new or replacement telecommunications horizontal cabling in agency occupied space.

- **ANSI/TIA/EIA 568-B.3, Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard.** Addresses multi-mode (50/125µm and 62.5/125µm) and single-mode fiber optic cabling components, transmission standards, and field testers.

  Exceptions

  Agencies shall use 50/125µm multi-mode fiber optic cable for all new and replacement backbone building runs. Even though 62.5/125µm multi-mode cabling is permitted in this standard, agencies shall not install this cable type in agency occupied space.

  For the devices connected to the backbone fiber system via 50/125µm multi-mode fiber, agencies shall provide a minimum of four fibers (two pairs) run to each device. This will enable the use of redundant connections for equipment that may be deemed critical at a later point (e.g., implementation of Voice over Internet Protocol, VoIP). Consideration should be given to having two dark fibers

(one pair) for every four active fibers (two pairs) installed, this will provide adequate backup for critical equipment if a problem occurs on one of the active pair.

- **ANSI/TIA/EIA 569-B, Commercial Building Standard for Telecommunications Pathways and Spaces.** This Standard addresses specific pathway and space design and construction practices in support of telecommunications media and equipment within buildings.

  Agencies are also required to implement all specifications in related addenda to ANSI/TIA/EIA 569-B for agency occupied office space that has an average office density (one office per 100 square feet). Pathway and room size requirements must be adjusted for higher and lower densities of telecommunications outlets or equipment than are expected in the average situation.

  Exception

  None

- **ANSI/TIA/EIA 606-A, Administration Standard for Commercial Telecommunications Infrastructure.** This standard specifies administration for a generic telecommunications cabling system that will support a multi-product, multi-vendor environment. It also provides information that may be used for design of administration products.

  Exception

  When an agency alters its cabling plant, the agency must develop/maintain cable plant documentation that meets the minimum requirements of ANSI/TIA/EIA-606-A Class 3 administration as indicated in Clause 7 of the standard. In addition, agencies shall provide all cable plant documentation to the Department of General Services (DGS) central repository for cable plant documentation (see NET-R-05) using the documentation format (e.g., data names, data elements, data tables, data types, and/or spreadsheet column order) as specified by NET-R-05 and NET-R-06 below.

- **J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.** The purpose of this standard is to enable the planning, design, and installation of a telecommunications grounding and bonding system

which supports a multi-vendor environment and implements various system installation practices.

Exception

None

NET-R-05: Department of General Services (DGS) Central Repository. DGS shall provide a central repository for agency cable plant documentation (see NET-R-04, ANSI/TIA/EIA-606-A documentation). The DGS repository must be accessible to the Virginia Information Technologies Agency for planning purposes.

NET-R-06: Cable Plant Data Formats. The Department of General Services (DGS), Division of Engineering and Buildings, in conjunction with the Virginia Information Technologies Agency, shall provide a spreadsheet template (flat file) and optional database schema for use by agencies in providing required data to the DGS central repository. (See related requirements in NET-R-04 ANSI/TIA/EIA 606-A and NET-R-05).

Rationale:

To ensure cable plant data can be aggregated across agencies for analysis.

Telecommunications

The Telecommunications topic includes the hardware, software, services, and documentation related to electronic transmissions of data, voice, and multimedia content for the purpose of conducting agency business. Components included in this topic are telecommunications protocols, wired and wireless services, switches, routers and similar items. Also included are applications that provide end to end telecommunications services such as Voice over Internet Protocol (VoIP).

In the late 1980's to middle 1990's, state agencies were installing their first local-area networks (LAN). Prior to this time, personal computers were used as stand-alone machines or were connected directly to mainframes and minicomputers for use as terminals. Printers were not shared. And, the Internet was a text-based service available to those who acquired their own onramp access. Along with LAN connectivity came an explosion of tools, services and shared devices, both internally and externally provided, that resulted in the present highly-interconnected, always-on, electronic workplace of today. It is no longer possible to draw clean lines between LANs and WANs. Today, LAN and WAN telecommunications services may be provided by internal or external means or by a combination.

Voice, data, and multimedia telecommunications services have been under central control in the Commonwealth for many years. Today, the network design and management is also under central control. In 2003, the General Assembly created VITA and placed much of the responsibility for platforms, platform services and networking under VITA. Table 2 provides a guide to the current breakout of responsibilities.

Table 2: Responsibilities for Networking and Telecommunications for VITA-served Agencies

Activity	VITA as Central Services	Higher Education Agencies	Executive Branch, not Higher Education	Other Agencies and Local Governments
Provide building cabling, plant documentation, and electrical connections (i.e., infrastructure that is part of a facility) through lease agreements, space occupation agreements or other methods		X	X	X
Provide wireless site surveys as part of building occupancy		X	X	X
Provide wireless site surveys and troubleshooting surveys intermittently as part of service delivery	X			
Provide business requirements for telecommunications services		X	X	X
Provide and manage routers, hubs, firewalls, bridges, interfaces, directors, switches, software stacks, and related network equipment	X	X		X
Provide and manage LAN services	X	X		X
Provide contracts for building cabling and wiring	X	X		
Provide volume-based service contracts and approve alternate contracts for LAN and WAN services including installation and management of wired and wireless, voice, data, and multimedia services (e.g., PSTN voice, Internet, packet, VoIP, cellular, etc.)	X			
Provide telecommunications help desk	X	X		X
Purchase from VITA telecommunications contracts or VITA approved contracts	X	X	X	X

Today many agencies are replacing, reconfiguring, or upgrading their LANs to:

- expand existing services;
- redesign services due to relocation;
- improve throughput, availability or reliability of services; or
- accommodate a new mix of applications and services (e.g., adding voice or multimedia applications or services).

To provide guidance appropriate to business needs in state and local agencies, this report focuses on the widely deployed LAN and WAN solutions, services that use these solutions, and options for improving them.

LANs use the cabled and wireless infrastructure in buildings or across campuses along with signaling and signal management services to provide the communications foundation for numerous practical office applications that rely on LANs. These services include providing Internet connections to the desktop, enabling the receiving and sending of emails, enabling the saving and backup of documents, supporting network printing, supporting certain types of information storage, providing Voice over Internet Protocol (VoIP) telephony, providing remote access, providing security and privacy of communications, enabling applications to work, and more.

WANs enable telecommunications across separate LANs and over greater distances. Wide area networking infrastructure may be privately owned (i.e., may belong to the Commonwealth), rented, or provided as part of a connectivity service. The term usually connotes the inclusion of public networks such as the public switched telephone system (PSTN) or public backbones for MPLS. In the past, WANs have often been referred to as a data services, T1 lines, packet services, etc. Some metropolitan area networks (MANs) employ LAN technologies (e.g., Gigabit Ethernet) to connect LANs to LANs and buildings to buildings. Other MANs employ WAN services (e.g., an MPLS VPN). Most agencies procure public WAN services through contracts developed by VITA. The services are scaled to meet the particular business needs of the agency for bandwidth, reliability, security and throughput.

The complexity of the communications infrastructure extends well beyond the simple LANs and purchased WAN connections of yesterday. Many common office services may require both WAN and LAN infrastructure to achieve end-to-end communications. Example services include VoIP, Internet, and desktop conferencing. Certain telecommunications services operate on infrastructure that is reserved for the particular connection. Examples include storage area networks (SANs) and certain police communications systems. Blade systems and wireless infrastructures further complicate the picture. In higher education, networks such as the national LambdaRail have specialized users and uses. A given agency will use most of these network subsytems to some degree.

A future vision of one network for VITA-served agencies and one network within each higher education organization does not mean one network to meet all needs. Instead, the concept includes centralizing and unifying as much as possible across users, uses and technologies. LambdaRail, for example, will always have restricted uses and users.

However, it may have centralized controls over uses and users or centralized usage tracking. An initial aspect of unification may be striving for centralized control and management of the unified network components. This could include common procedures, practices, protocol suites, documentation of systems, service level agreement measures, and controls of uses and users. 10 Gigabit Ethernet, IP, and switching are technical enablers of networking and telecommunications unification across agencies and across departments within an agency. The Commonwealth should leverage its statewide weight in numbers of users, bandwidth requirements, and infrastructure requirements to support cost-effective pursuit of both VITA and higher education network unification efforts.

WANs, LANs, PANs, MANs, SANs, WLANs, blade frames, and other networking systems should be considered part of a single infrastructure from a network documentation and management standpoint; however the tools to accomplish this are not be available today. Future questions may address whether it is reasonable to have a separate, dedicated infrastructure for storage that is managed apart from all other communications for example, or whether it is reasonable to permit server communications requirements to be separately managed by proprietary blade systems.

Many tools exist for unification and aggregation in the world of networks. It is now possible, to run 10GB Ethernet over copper for short distances (i.e., not yet approved category 6 augmented for 100 meters) and over fiber for longer distances. Arguments for needing more bandwidth than is available in the LAN infrastructure to handle storage in a switched GB Ethernet environment may not hold. Arguments for undocumented and separately managed extensions of the communications infrastructure that reside inside of blade frames may not outweigh the benefits of infrastructure unification.

Ethernet is today and will be for the foreseeable future the dominant networking technology for private and public communications infrastructure. Backplane Ethernet standards, wireless power-over-Ethernet (PoE) plus standards, carrier Ethernet-Line and other current and promised standards will strengthen Ethernet's hold on the future of networking. However, without unified planning, central documentation, and central management of bandwidth, throughput, quality/class of service, security, reliability, and other application needs at the application level, the business improvements and cost savings of the unified network will not be realized. As the Commonwealth makes future infrastructure decisions, it should keep in mind the benefits of one, unified network each step of the way.

The following requirements (NET-R) and recommended practices (NET-RP) address LAN, WAN and telecommunication services issues. Because the services of VITA may be used by local agencies and by branches of government other than the executive branch, some of the requirements may reference users of centrally provided services rather than the agencies of the executive branch.

Protocols

The following are three Requirements for the Protocols component of the Telecommunications topic.

Requirements

NET-R-07: **LAN Protocols.** Agencies modifying their LAN services must migrate to the minimum Virginia standard of IEEE 802.3 Fast Ethernet (100 Mbps Switched Ethernet) or to a higher bandwidth Ethernet service (802.3 Full duplex Fast Ethernet, 802.3ab Gigabit Ethernet over copper, 802.3ad, or 802.3z Gigabit Ethernet over fiber).

NET-R-08: **IP Access to LAN Nodes.** Agencies must ensure that each agency LAN node and LAN segment may be accessed using IP addressing. This mandatory requirement was to be met in December of 2003.

NET-R-09: **Routing.** Agencies must employ IP as the standard addressing protocol for all routed transmissions. Agencies establishing new and replacement connections to external business partners, local governments, and state agencies must employ IP addressing. If other protocols are used as a transitional strategy, when routed, these protocols must be tunneled through IP.

Switches, Routers and Similar Items

The following are two Recommended Practices and four Requirements for the Switches, Routers, and Similar Items component of the Telecommunications Topic:

Recommended Practices

NET-RP-07: **UPS.** VITA is strongly encouraged to use continuous inversion, uninterruptible power supply units (UPSs) with power conditioning for network-attached servers and networking equipment. The UPS units should provide 15 minutes of battery backup for most network equipment and 30 minutes for servers. UPS units that automatically shut down in a controlled manner are preferred for servers.

NET-RP-08: **Domain Name Systems (DNS).** VITA should provide a secondary DNS server for all served agencies, which resides on a separate network from agency primary DNS servers (required for domain registration). This will enable an agency's public-facing services to remain visible to users if the agency's network is down.

NET-RP-09: **Networking Devices.** If an agency or its network service provider has responsibility for procurement of network device types (e.g., a type of switch) that are acquired in large quantities but in numbers fewer than 500, that agency or service provider may benefit from having comparison price, quality, availability, service quality, reliability and support costs

data on a small number of a competitor's device to use in acquisition and maintenance negotiations. (See requirement NET-R-12.)

Requirements

NET-R-10: **Network Hardware.** Agencies acquiring new network hardware (i.e. firewalls, routers, switches, etc.) must ensure that the devices are SNMP-compliant (Simple Network Management Protocol compliant).

NET-R-11: **SNMP Use.** All agencies that manage networks must employ SNMP-compliant device management. SNMP is a protocol that enables management information for a network element such as a switch to be inspected by a remote manager.

NET-R-12: **Networking Devices.** Agencies and their network service providers who establish contracts for 500 or more of a single network device type (e.g., a particular router, switch or hub), must have validated performance and cost comparison data (e.g. price, quality, availability, service quality, reliability and support costs) for a second brand for the device type during a particular acquisition cycle. This data may be obtained from a small-dedicated network segment, a separate network, or from a third party (e.g. University, local government, etc.). The intent is that the Agencies or their service providers be able to use comparison results in acquisition and maintenance negotiations.

Rationale:

In networking, it is often desirable to use a single networking devices vendor across interacting communications equipment. When there is a problem, it may be resolved by contacting one vendor. However, this same situation leads to a monopoly with little leverage for price controls. The above requirement is not intended to force a mixed networking infrastructure, but instead is intended as a controlled comparison or evaluation opportunity.

NET-R-13: **IP Addresses in the Enterprise Network.** Agencies served by any portion of the VITA enterprise network shall acquire IPv4 address space from VITA or gain VITA approval for using its own address space. Any served agency with its own address space must notify VITA of the address space renewal date. No served agency may increase their use of RFC1918 addresses. Any served agency currently using the private address range (RFC1918) must record this use with VITA and prepare to discontinue this use when the served agency's network is integrated with other agencies' networks for the purpose of common management. Served agencies are required to only use registered IPv6 addresses assigned by

VITA when they switch to IPv6. Also, VITA reserves the right to revoke and reassign address space as dictated by future network designs.

Notes: An RFC is a document distributed as a request for comments. In many instances, RFCs are treated as industry standard recommendations. Many standards groups issue RFCs.

A Freedom of Information Act (FOIA) exception to the sharing of VITA recorded IP address information with anyone other than agency specified personnel shall be obtained prior to enforcing this requirement.

Served agencies are strongly encouraged to employ only registered IPv4 addresses when routing over COVANET and to eliminate all RFC1918 address space use as soon as practical.

Wired and Wireless Services

The following are ten Recommended Practices and the one Requirement for the Wired and Wireless Services component of the Telecommunications Topic:

Recommended Practices

NET-RP-10: **Planning for Voice, Video and Data Convergence.** When designing new networks, state and local agencies should design for voice, data, and multimedia traffic on the network. Designs should enable good management strategies for wired and wireless. Examples of other design components that will address future business needs and business solutions are Category 6e cabling and fiber, switched Ethernet service, layer three intelligent switches, building and campus wide planning; layer four bandwidth management facilities, and intelligent routers. Although x-Gigabit Ethernet is rarely provided to the desktop today, it will be in the near future and is in common use for LAN and WAN backbones at present.

NET-RP-11: **Wireless Site Surveys.** State and local agencies deploying new or redesigned wireless LAN/WAN services should conduct thorough site surveys including testing/inspection.

NET-RP-12: **Wireless Frequencies and Protocols:** In general, the WLANs using Industrial, Scientific, and Medical (ISM) unlicensed frequency bands (i.e., 802.11b and g) will experience greater interference than those using the Unlicensed National Information Infrastructure (U-NII) frequency bands (i.e., 802.11a). 802.11a also addresses coverage with its greater number of channels while 802.11b and g offer better range. Agencies may wish to consider

implementing 802.11a, b and g together if both coverage and capacity are issues.

NET-RP-13: **Planning for Wireless.** State and local agencies should implement wireless LANs in addition to existing wired LANs whenever they have good business reasons to do so. Wireless system design and redesign plans should never be based solely on an access point's coverage radius. Designs should take into account user densities, use types, use peaks, physical interference, electrical interference, electrical connectivity plans, and security requirements. Designers should also consider: useable throughputs rather than maximum protocol throughputs in calculations (e.g., 30Mbs instead of 54Mbs to accommodate overhead); continuous escalation in connectivity and bandwidth requirements as wireless access needs multiply over time; and downward adjustments in anticipated throughput whenever channels must be reused within a plan. For many new implementations, the IEEE 802.11a standard should be considered for taking advantage of the greater number of WLAN channels and decreased interference. Continued use of 802.11b and g along with 802.11a may help in meeting bandwidth requirements despite interference. (For more discussion of security issues see the security domain report.)

NET-RP-14: **Wireless Devices.** All devices used for wireless LANs should carry the Wi-Fi Alliance's interoperability certification. For a current list see: http://certifications.wi-fi.org/wbcs_certified_products.php

NET-RP-15: **Wireless Management.** State and local agencies deploying new wireless LAN/WAN services may want to consider implementing Cisco LWAPP-based management of LWAPP wireless access points (or Cisco LWAPP-based systems implemented by another company) to enhance security and improve services. While the IETF has not ratified LWAPP, it is currently considering the Cisco LWAPP design as a standard. Management needs for security purposes may outweigh the lack of ratification of a standard in this instance. At present, each company's device-management solution is proprietary and only able to manage its company's own access points. If LWAPP is ratified, all access points will be built to enable LWAPP management.

NET-RP-16: **Network Planning and Risk.** State and local agencies should allow security and risk planning decisions to drive decisions regarding network design for redundancy, fail-over, and disaster recovery.

NET-RP-17: **Test Environment.** State and local agencies should test the effects of new or modified applications on their networks using a test environment. The test environment should not exceed the requirements of the planned operational environment. An alternative to a test environment would be use of a controlled, measured implementation.

NET-RP-18: **LAN/WAN Redesign.** State and local agencies should redesign their local and wide area networks to meet changing business needs, reduce costs, integrate wireless, replace outdated equipment, and ready the environment for new applications (e.g., VoIP). The redesign should include central documentation of wired and wireless infrastructure across solutions from blades, to storage area networks (SANs), to power over Ethernet.

NET-RP-19: **State and Local Agency Interconnections for Telecommunications.** For all state and local agencies that need to communicate with one another, use of COVANET (and/or its successor) is strongly recommended as a cost-effective vehicle. Agencies may be responsible for providing the gateway between their network and COVANET. Institutions of higher education may have alternate school-to-school connections for distance education or research (e.g., Internet 2 or LambdaRail) that should be leveraged rather than using COVANET. Also, agencies may require redundant, independent pathways in addition to COVANET for increased availability of connectivity or risk reduction.

Requirement

NET-R-14: **VoIP.** Agencies implementing VoIP must provide well-ventilated and air-conditioned premises wiring closets to protect investments and to ensure services.

Rationale:

In the future, VoIP will be provided as a purchased service. Certain services such as VoIP will have components addressed by the network provider, the voice service provider and the premises space provider. In the case of VoIP, agencies and/or their lease holders are responsible for the premises space. Agencies may have wiring closets that are adequate to meet their current needs, but the addition of VoIP will change the wiring closet environment by adding significant heat and increasing electrical demands. VoIP will not work unless the demands of the service are addressed. Because agencies will be responsible for ensuring that their space can meet the required demands, they must plan for this premises cost when considering VoIP service savings.

Technology Component Standards

The technology component standard tables below provide strategic technology and service directions for agencies that are acquiring technical components or services for local area networking, wide area networking or other telecommunications. Agencies may acquire these components via purchasing, office space rental, leasing, facilities construction or modification, or other acquisition methods. Both wired and wireless components and services are addressed. Subtopics are noted in table headings.

Table NET-S-01: Wired Local Area Networks (LANs) Technology Component Standard
Strategic:
IEEE 802.3 Fast Ethernet (100 Mbps Switched Ethernet)
Higher bandwidth Ethernet service (802.3 Full duplex Fast Ethernet, 802.3ab Gigabit Ethernet over copper, 802.3ad, or 802.3z Gigabit Ethernet over fiber)
Note: Category 5e LAN is the minimum required for enabling VoIP
Emerging:
10 Gigabit Ethernet LAN (standard ratified; business use testing)
VoIP Centrex (The Commonwealth is beginning to use VoIP centrex solutions and is studying costs and amassing data.)
Transitional/Contained:
Ethernet 10Mbps (IEEE 802.3)
ATM 25 Mbps (LANE, an element of MPOA)
Note: Category 5 LAN cable is transitional because VoIP is not supported
Obsolescent/Rejected:
Token Ring (IEEE 802.4)
Appletalk
All Other Non-Strategic Protocols
Waiver History:

Table NET-S-02: Wireless Local Area Networks (WLANs) Technology Component Standard
Strategic:
Wi-Fi using Access Points Frequency Hopping Spread Spectrum (FHSS, IEEE 802.11) Direct Sequence Spread Spectrum (DSSS, IEEE 802.11 and 802.11b) Orthogonal Frequency Division Multiplexing (OFDM, IEEE, 802.11a used for Access Points)
Emerging:
WiMAX (802.16e)
Transitional/Contained:
Infrared (Point to Point, IEEE 802.11)
Obsolescent/Rejected:
Waiver History:

Table NET-S-03: Cabled Wide Area Networking (WAN) Technology Component Standard
Strategic:
Data and VoIP are example WANs Frame Relay T1 (128 Kbps-1.5 Mbps) ATM T1 (1.5 Mbps) with IMA (Inverse Multiplexing over ATM) Aggregated Frame Relay, i.e., 2, 3, or 4 T1s (3-6 Mbps) ATM DS3 (22-45 Mbps) ATM SONET (synchronous optical network) over OC3 (optical carrier) to OC12 (155-622+ Mbps) PoS (Packet over SONET) FRASI (FR to ATM Services Internetworking) xGB Ethernet (e.g., MAN, carrier backbone) LAN speed Ethernet interconnection over public backbone xDSL (128 Kbps—8 Mbps) Cable Modem (300 Kbps—10 Mbps) MPLS
Emerging:
VoIP VoIP Centrex (The Commonwealth is beginning to use VoIP centrex solutions and is studying costs and amassing data.)
Transitional/Contained:
Data WAN Frame Relay 56 Kbps ISDN—narrow band (64—128 Kbps) Frame Relay DS3
Obsolescent/Rejected:
Waiver History:

Table NET-S-04: Mobile and Remote Access to Local Area Networks (LANs) Technology Component Standard
Strategic:
Dial up (e.g., RAS) VPN (e.g., IP VPN) Blackberry Services Wi-Fi
Emerging:
Microsoft Exchange Direct Push Mail via SPS
Transitional/Contained:
Obsolescent/Rejected:
Waiver History:

Table NET-S-05: Wireless Telecommunications (Voice, Image, Data, Conference, and Other Multimedia) Technology Component Standard
Strategic:
VITA Negotiated Services (current and anticipated services provided below) VoIP Service (using MPLS) Digital Voice, Image, Data, Centrex and PBX Digital Cellular Service: 800 MHz, CDMA, WCDMA, CDMA 2000, CDMA EV-DO, GSM/GPRS PCS Service: (1900 MHz, personal communications services—Sprint, digital wireless) Ntelos Service: GSM/GPRS) this is not cellular but provides cell-type services at a different frequency; uses trimode phones (1900/800 MHz, analog and digital) Nextel Service: 800 MHz iDEN; wireless telephone service (note: this is not cellular but is Enhanced Specialized Mobile Radio (ESMR)—2 way radio) Analog Voice, Centrex, PBX (still strategic for some locations) Wi-Fi (802.11a,b,g)
Emerging:
VoIP Wireless (high mobility in building is a place to start—e.g., forensic lab, corrections, hospital) Video Conference over IP VoWLAN (802.11r) WiMAX (802.16e) WLAN (802.11n) High speed uplink and downlink, HSDPA QoS for voice/video 802.11e, WSM an WME Mesh Networks Wireless Video Conferencing Wireless PBX 200 Mbps WLAN links IP Multimedia, IMS and SIP Fixed mobile convergence service
Transitional/Contained:
CDPD Analog Cellular (AMPS) Mobitex is currently a Cingular packet data service that uses MASC protocol and has a limited service area (9.6—19.6 Kbps)
Obsolescent/Rejected:
Waiver History:

Glossary

Agency 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 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.

AMPS Analog Mobile Phone Service or AMPS is defined in EIA/TIA-553 standards. In 2006, AMPs is still the most extensive wireless coverage available for nationwide service in the US. However, in 2002, the FCC made the drastic decision to no longer require A and B carriers to support AMPS cellular service as of March 1, 2008. Since the AMPS standard is analog technology, it suffers from an inherently inefficient use of the frequency spectrum. All AMPS carriers have converted most of their consumer base to a digital standard such as CDMA or GSM and continue to do so at a rapid pace. Digital technologies such as CDMA support multiple voice calls on the same channel, superior call quality, enhanced features such as two-way text messaging, voicemail indicator, internet, and GPS services; whereas, AMPS can only support one call per channel and a basic one-way short message service.
AMPS cellular service operates in the 800 MHZ FM band. In 1989, the Federal Communications Commission granted carriers an expansion from the current 666 channels to the now 832 (416 per carrier). The additional frequency was available in the upper 800 MHz band which also was home to UHF channels 70-83. This meant that these UHF channels could no longer be used for UHF TV transmission as these frequencies were to be used for AMPS transmission.
(Adapted from Wikipedia.)

ANSI A voluntary non-profit organization that coordinates and supports the U.S. voluntary consensus standards for industry.

ARDIS A company that provides a cellular packet-switched radio data service in the U.S. Now completely owned by Motorola. (It used to be a joint venture with IBM.) Initially (1984), the network was designed by Motorola for IBM field service technicians. The radio protocol is proprietary (designed by IBM and Motorola). Has about 34,000 subscribers, about 10 times the number that RAM Mobile has. Data transmission is at 4,800 bits/s (using 240-byte packets, resulting in about 2,000 to 3,000 bits/s of user-data throughput) or

	19,200 bits/s (in larger U.S. centers) using 512-byte packets, resulting in up to 8,000 bits/s of user-data throughput. Usage charges are per kbyte of data transferred. Sometimes called Datatac. Competes with RAM Mobile Data's Mobitex system and CDPD. Ardis is at http://www.ardis.com/. (Taken from O'Reilly)
Asynchronous Transfer Mode (ATM)	A cell switching technology that transports data at high speeds in small, uniform cells (packets). ATM may be used in LAN and WAN communications.
ATM/SONET	Asynchronous Transfer Mode cells carried over Synchronous Optical Network packets.
Backbone	A high-speed computer network designed to interconnect lower-speed networks or clusters of dispersed user devices.
Backplane	A backplane is an electronic circuit board containing circuitry and sockets into which additional electronic devices on other circuit boards or card can be plugged.
Bandwidth	The carrying capacity of a circuit, usually measured in bits per second for digital circuits or hertz for analog circuits.
Bluetooth	Bluetooth is a telecommunications industry specification (IEEE 802.15) that describes how mobile phones, computers, and personal digital assistants (PDAs) can be easily interconnected using a short-range wireless connection. Using this technology, users of cellular phones, pagers, and personal digital assistants can 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 tranceiver 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 is provided. The technology got its unusual name in honor of Harald Bluetooth, king of Denmark in the mid-tenth century. (Adapted from Whatis.com.)

Cable Modem A cable modem provides variable speed transmission depending on the number of simultaneous users on the same cable.

Cat 5e Category 5e standard wiring.

CDMA Code division multiple access. A form of multiplexing where the transmitter encodes the signal using a pseudo-random sequence which the receiver also knows and can use to decode the received signal. Each different random sequence corresponds to a different communication channel. Motorola uses CDMA for digital cellular phones. Qualcomm pioneered the introduction of CDMA into wireless telephone services.

CDMA 2000 Code division multiple access (CDMA) version of the IMT-2000 standard developed by the International Telecommunication Union (ITU). The CDMA2000 is third-generation (3-G) mobile wireless technology that can provide mobile data communications at speeds ranging from 144 Kbps to 2 Mbps. Deployment is in the planning stages.

CDPD A wireless standard that provides two-way, 19.2 kbps packet data transmission over existing cellular telephone channels. A method proposed (1993) and developed by IBM and McCaw Cellular Communications, Inc. (now owned by AT&T) to more efficiently carry data on existing analog (AMPS) cellular radio systems. 138-byte packets of data are sent at 19,200 bits/s during gaps in conversations or on unused (no voice conversation established at that time) channels, using the full 30-kHz bandwidth of the channel. Voice always has priority. Actual air traffic consists of blocks of 63 (47 are information, 16 are forward error correction information) six-bit symbols, resulting in a user data rate of about 9,000 to 14,400 bits/s. The forward error correction can correct up to eight six-bit symbol errors. Advantages over Ardis and Mobitex include the following: use of the existing cellular radio infrastructure (CDPD overlays it), resulting in lower usage charges; built-in encryption and authentication; the land-line interface is TCP/IP; security, since the data for a conversation are carried over many cellular radio channels (according to whichever has spare capacity), so it would be difficult to monitor the communication; V.42bis data compression; multicasting (to subsets of users); and a full-duplex option. Will be an open specification that will compete with the proprietary systems from Ardis and Mobitex (RAM). Is a packet-oriented service, so the call setup time is fast (much faster than circuit-switched), charging is by the kilobyte of traffic carried, and it is best-suited to smaller transactions (up to 5 Kbytes of data--larger transfers are better handled by circuit-switched methods, such as analog cellular with modems). Promoted by five of the seven U.S. RBOCs and Motorola, Microcom, and some cable TV companies.

COTS	Council on Technology Services. An advisory group for Virginia's Secretary of Technology
COVANET	A comprehensive array of communications services - voice long distance, data, and Internet services to local and county governments, state agencies, universities, and quasi-government agencies.
DID	Direct Inward Dialing (DID) is a service of a local phone company (or local exchange carrier) that provides a block of telephone numbers for calling into a company's private branch exchange (PBX) system. Using DID, a company can offer its customers individual phone numbers for each person or workstation within the company without requiring a physical line into the PBX for each possible connection. For example, a company might rent 100 phone numbers from the phone company that could be called over eight physical telephone lines (these are called "trunk lines"). This would allow up to eight ongoing calls at a time; additional inbound calls would get a busy signal until one of the calls completed or be able to leave a voice mail message. The PBX automatically switches a call for a given phone number to the appropriate workstation in the company. A PBX switchboard operator is not involved. A DID system can be used for fax and voice mail as well as for live voice connections. Compared to regular PBX services, DID saves the cost of a switchboard operator, calls go through faster, and callers feel they are calling a person rather than a company.
DS3	A signal with a transmission rate of 44.736 Mbps (672 voice channels) provided over T3.
DSSS	Direct Sequence Spread Spectrum. A method of providing wireless connectivity as specified in IEEE 802.11b.
EIA	The Electronic Industries Alliance (EIA) is a non-profit organization that functions as an association of other organizations, one of which is TIA, EIA's communications arm. The EIA is certified by ANSI to develop standards. The EIA is well known for having produced certain electrical wiring and data transmission standards. Standards are just one part of the organization's mission, however. The EIA often jointly recommends standards with the Telecommunications Industry Association (TIA). An example standard put forth by both groups is EIA/TIA-232 (also known as EIA-232 and RS-232). This standard establishes how two devices communicate—for example, via the 9 and 25 pin connectors still commonly used on PCs along with USB connectors.
EoIP	Everything over IP.
ESMR	Enhanced Specialized Mobile Radio (ESMR) is a wireless communication system in which numerous mobile/portable

	transceivers are linked in a network of repeaters. Each repeater has a range of approximately 5 to 10 miles. Operating frequencies are in the UHF (ultra-high-frequency) range, that is, between approximately 300 MHz and 3 GHz. Usually, the working band is near 900 MHz. ESMR can function like its fundamentally simpler cousin, SMR, but it can also offer features similar to those of a cellular telephone network. The PTT (push-to-talk), half-duplex mode can be used; in this case the operation resembles communications between old style two-way radios. full-duplex mode can also be used, so either party can listen and talk at the same time. Interconnection with the telephone networks is commonly done. In addition to voice communication, an ESMR system can offer paging, wireless fax, and data transmission. ESMR systems use digital radio transmission. Spread-spectrum modes, such as frequency hopping, are common. In a well-designed ESMR system, connection is almost instantaneous, compared with the typical 15 to 20 seconds required to dial and set up a call in a public cellular network. The coverage of an ESMR system depends on the geographical distribution and needs of the users. Some systems are confined to single municipalities; others cover selected groups of metro areas; others operate over entire states or regions of a country. Examples of ESMR networks include Ericsson's EDACS (Enhanced Digital Access Communications System), Motorola's IDEN (Integrated Dispatch Enhanced Network), and the Sprint Nextel System. (Adapted from Whatis.com).
ETA	The Enterprise Architecture has business and technical components. All of the technical components taken together are called the Enterprise Technical Architecture.
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.
FHSS	Frequency Hopping Spread Spectrum. A method of providing wireless connectivity as specified in IEEE 802.11.
Frame Relay	A data communications interface that provides high speed transmission with minimum delay and efficient use of bandwidth. It does not have error detection or error control and it assumes that connections are reliable.
FRASI	Frame Relay to Asynchronous Transfer Mode (ATM) service internetworking
GPRS	General Packet Radio Services (GPRS) is a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and

computer users. The data rates will allow users to take part in video conferences and interact with multimedia Web sites and similar applications using mobile handheld devices as well as notebook computers. GPRS is based on Global System for Mobile (GSM) communication and will complement existing services such circuit-switched cellular phone connections and the Short Message Service (SMS).
In theory, GPRS packet-based service should cost users less than circuit-switched services since communication channels are being used on a shared-use, as-packets-are-needed basis rather than dedicated only to one user at a time. It should also be easier to make applications available to mobile users because the faster data rate means that middleware currently needed to adapt applications to the slower speed of wireless systems will no longer be needed. As GPRS becomes available, mobile users of a virtual private network (VPN) will be able to access the private network continuously rather than through a dial-up connection.
GPRS will also complement Bluetooth, a standard for replacing wired connections between devices with wireless radio connections. In addition to the Internet Protocol (IP), GPRS supports X.25, a packet-based protocol that is used mainly in Europe. GPRS is an evolutionary step toward Enhanced Data GSM Environment (EDGE) and Universal Mobile Telephone Service (UMTS). (Modified from Whatis.com)

GSM

1. *Groupe Spéciale Mobile*—the European standards group for wireless connectivity.
2. Digital cellular telephone standard developed by the European Telecommunications Standards Institute's (ETSI) *Groupe Spécial Mobile*. Also used in some Middle Eastern countries and parts of Australia. The frequencies allocated to the service are divided into 200-kHz blocks, each of which supports eight simultaneous users (by using a form of TDMA that lets a handset transmit a few bytes of data or digitized voice, 217 times per second).

HSDPA

High Speed Downlink Packet Access (HSDPA) is a UMTS packet-based broadband data service feature of the WCDMA standard. HSDPA provides an improved downlink for the UMTS data service. It improves speed and system capacity by making better use of the bandwidth. Data transmission speeds are up to 8-10 Mbps over a 5 MHz bandwidth or more than 20 Mbps for systems that use multiple transmitters and receivers (Multiple Input Multiple Output or MIMO systems (802.11n)). The high speeds of HSDPA are achieved through techniques including 16 Quadrature Amplitude Modulation, variable error coding, and incremental redundancy. HSDPA use requires technology upgrades to sending and receiving devices in UMTS networks. This broadband service is provided by Cingular in

	limited locations in 2006.
Hub	A LAN wiring concentrator that connects cables from numerous network devices. An intelligent hub can monitor and report on network activity, typically using SNMP.
IEEE	Institute of Electrical and Electronics Engineers, Inc. www.ieee.org
IMS	The IP Multimedia Subsystem (IMS) is a next-generation network for carriers from the 3GPP that uses the IP protocol as its foundation. IMS supports data, video, SIP-based voice over IP (VoIP) and non-SIP packetized voice, such as H.323 and MGCP. IMS was designed to integrate with the PSTN and provide traditional telephony services such as 800 numbers, caller ID and local number portability. (Adapted from PCMag.com).
Infrared	Electromagnetic waves in the frequency range just below visible light corresponding to radiated heat.
Integrated Services Digital Network (ISDN)	A set of communications standards allowing a single wire or optical fiber to carry voice, digital network services and video
International Telecommunication Union (ITU)	An intergovernmental organization through which public and private organizations develop telecommunications.
Internet	1. A wide area network connecting disparate networks world wide. 2. An international network of millions of web sites that uses TCP/IP.
Internet Engineering Task Force (IETF)	A large, open, international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. IETF is generally recognized as the standards organization for the Internet.
Internet Protocol (IP)	A communication protocol which routes packets of data from one node 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).
IPv4	Four octet 32 bit IP address in the form 255.255.255.255
IPv6	Sixteen octet 128 bit IP address. For a discussion and comparison with IPv4 see NCS http://www.ncs.gov/n6/content/tibs/html/tib97_1/sec5_0.htm.
ISM	Industrial, Scientific and Medical (IMS) radio spectrum bands can be

	used by anyone without a license. Multiple bands are set aside for this use. Some commonly used bands are 902 to 928MHz, 2.4 to 2.4835GHz, and 5.725 to 5.850GHz.
Local Area Network (LAN)	A private computer network generally on a user's premises and operated within a limited geographical area.
LWAPP	The Light Weight Access Point Protocol (LWAPP) is a yet-to-be ratified standard of the IETF that defines interactions between wireless termination points and wireless access controllers. Ratification is expected in mid-2006.
MAN	A Metropolitan Area Network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network). It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network. (Adapted from Whatis.com).
MAU	A multi-station Access Unit (MAU) is a central hub in a Token Ring local area network. (Adapted from PCMag.com).
Mobile Asynchronous Communications (MASC) protocol	The standard form of communicating between a Mobitex wireless data subscriber device and the computing platform. MASC allows applications developed on the computing device to provide high levels of control and management of the wireless modem. The MASC protocol is used when developing highly efficient, commercial wireless application software.
Mobitex	Ericsson's Eritel subsidiary's cellular land-radio-based packet-switched data communication system. Used by RAM mobile data. The raw data transmission bit rate was originally 8,000 bits/s (using 512-byte packets) for all installations, which provides a user data throughput of about 2.4 to 5 kbits/s, but this has been upgraded to 19,200 bits/s in some larger cities. Usage charges are per kilobyte. More open that the competing Ardis system, since all specifications are developed by the Mobitex Operators Association. Was designed by L.M. Ericsson and Swedish Telecom. Uses 896 to 901 MHz and 935 to 940 MHz. Cantel offers the service in Canada. Available in about 11 countries, but different frequencies are used, so roaming is complicated. L.M. Ericsson server is http://www.ericsson.nl/. (Taken from O'Reilly.)
Network	1. A configuration of data processing devices and software

	connected for information interchange. 2. A group of two or more computer systems linked together.
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).
Open System	A system whose characteristics comply with standards made available throughout the industry and therefore can be connected to other systems complying with the same standards.
OSI	Open System Interconnection.
Packet	A collection of payload data and transport information that is transmitted as a bundle across a network connection.
Packet Switching	The process of routing and transferring data by means of addressed packets so that a channel is occupied only during transmission of a packet. On completion of the transmission, the channel is made available for transfer of other packets.
PAN	A Personal Area Network (PAN) or Wireless Personal Area Network (WPAN) is the set of transmission technologies used by a person for interconnecting devices they use in a home, in a workplace, in the car, in the gym, or in a mobile setting. Typically, a wireless personal area network uses one or more technologies that permit communication within about 10 meters - in other words, a very short range. One such technology is Bluetooth, which is the basis for IEEE 802.15. A PAN could interconnect all the ordinary computing and communications devices that many people have on their desk or carry with them today - or it could serve a more specialized purpose such as allowing the surgeon and other team members to communicate during an operation. (Adapted from Whatis.com).
PBX	Private Branch Exchange – a premises voice switch.
PCS	Sprint’s Personal Communications Services. It operates in the 1.9 MHz band. It is not a cellular service. (600mhz, 900mhz)

PoE	Power-over-Ethernet is (PoE) is a technology for wired Ethernet LANs that allows the electrical current, necessary for the operation of each device, to be carried by the data cables rather than by power cords. For PoE to work, the electrical current must go into the data cable at the power-supply end, and come out at the device end, in such a way that the current is kept separate from the data signal so that neither interferes with the other. The current enters the cable by means of a component called an injector. If the device at the other end of the cable is PoE compatible, then that device will function properly without modification. If the device is not PoE compatible, then a component called a picker or tap must be installed to remove the current from the cable. This "picked-off" current is routed to the power jack. To minimize the possibility of damage to equipment in the event of a malfunction, the more sophisticated PoE systems employ fault protection. This feature shuts off the power supply if excessive current or a short circuit is detected. (Adapted from Whatis.com).
PSTN	The Public Switched Telephone Network (PSTN) is the worldwide voice communications system.
QoS	Quality of Service - The performance of a network service such as throughput, delay, and priority. Some protocols allow packets or streams to include QoS requirements (e.g., ATM).
RAM Mobile Data	A wireless service. A company jointly owned by RAM Broadcasting, Inc., Ericsson, and BellSouth Corp. that provides a cellular-radio-based packet data service called Mobitex. Competes with Ardis and CDPD. Ericsson encourages others to manufacture compatible equipment (people prefer an open standard). (Taken from O'Reilly.)
Router	1. An attaching device that connects two LAN segments, which use similar or different architectures, at the reference model network layer. 2. (IRM) The combination of hardware and software that links LANs and WANs together.
SAN	A Storage Area Network (SAN) is 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. The network communications for a SAN may include fibre channel, iSCSI, Ethernet or other technologies. The SAN also includes the storage management, storage device and storage access technologies.
Segment	1. vt. to isolate traffic on a LAN; 2. n., the LAN devices and media isolated.
Simple	A set of network communication specifications that cover all the

Network Management Protocol (SNMP)	basics of network management. It is a simple and expandable protocol designed to give the capability to remotely manage a computer network by polling, setting terminal values, and monitoring network events. It is comprised of three elements, an MIB, a manager, and the agents. The manager is located on the host computer on the network. Its role is to poll the agents and request information concerning the networks status. Agents run off each network node and collect network and terminal information as specified in the MIB.
SIP	Session Initiation Protocol (SIP) is a signaling protocol developed by the IETF. The SIP protocol has not yet been ratified as a standard. SIP is primarily used for voice over IP (VoIP) calls but also may be used for other communications including video, instant messaging, and gaming. SIP is a text-based protocol that is based on HTTP and MIME. SIP is used as one part of a protocol stack that is intended to provide seamless, continuous, end-to-end communications similar to what is provided by the PSTN. SIP is responsible for setting up and taking down the connection. SIP also provides services such as dialing a number, causing a phone to ring, and providing ring back tones or busy signals. SIP is included as part of the IMS subsystem.
Switch	1. n., a circuit switching hub. 2. vt., A communications paradigm in which a dedicated communication path is established between the sender and receiver along which all packets travel. The telephone system is an example of a circuit switched network. Also called connection-oriented.
Synchronous	Two or more processes that depend upon the occurrences of specific events such as common timing signals.
Synchronous Optical Network (SONET)	1. A new and growing body of standards that define all aspects of transporting and managing digital traffic over fiber-optic facilities in the public network. 2. A network communication technology offering fiber optic transmission system for high-speed digital traffic.
T1	An AT&T term for a digital carrier facility used to transmit a DS1 formatted digital signal at 1.544 megabits per second or a 24 analog line equivalent. T1 transmission uses a bipolar Return To Zero alternate mark inversion line coding schemes.
TCP	Transmission Control Protocol. An OSI layer 4 protocol
TDMA	Time Division Multiple Access
TIA	Telecommunications Industry Association. A standards body. An association that sets standards for communications cabling.

Token Ring	An IEEE 802.5 standard for media access. Conflicts in the transmission of messages are avoided by the granting of "tokens" which give permission to send.
U-NII	Unlicensed National Information Infrastructure bands (U-NII) are designated by the FCC to provide short-range, high-speed wireless networking communication at low cost. U-NII consists of three frequency bands of 100 MHz each in the 5 GHz band: 5.15-5.25GHz (for indoor use only), 5.25-5.35 GHz and 5.725-5.825GHz. The three frequency bands were set aside by the FCC in 1997 to help schools connect to the Internet without the need for hard wiring (Adapted from Wi-Fi Planet).
Wide Area Network (WAN)	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. 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. (IRM) A computer network that links multiple workstations and other devices across a large geographical area. A WAN typically consists of multiple LANs that are linked together.
VoIP	Voice over Internet Protocol (VoIP) is a service that permits voice connections and the transmission of voice conversations using IP packets that are sent over public and private cabled infrastructure. A set of equipment and protocols is required to accomplish quality voice communications using VoIP. A major advantage of VoIP and Internet telephony is that it avoids the tolls charged by ordinary telephone service. VoIP derives from the VoIP Forum, an effort by major equipment providers, including Cisco, VocalTec, 3Com, and Netspeak to promote the use of ITU-T H.323, the standard for sending voice (audio) and video using IP on the public Internet and within an intranet. The Forum also promotes the user of directory service standards so that users can locate other users and the use of touch-tone signals for automatic call distribution and voice mail. Using VoIP, an enterprise positions a "VoIP device" at a gateway. The gateway receives packetized voice transmissions from users within the company and then routes them to other parts of its intranet (local area or wide area network) or, using a T-carrier system or E-carrier interface, sends them over the public switched telephone network.
VoWLAN	Voice over Wireless LAN is an implementation of Voice over IP using wireless rather than wired infrastructure.

VPN	A Virtual Private Network (VPN) is a communications service that affords various levels of privacy over public or private infrastructure. Secure VPNs may use cryptographic tunneling protocols to preventing snooping, sender authentication to preventing identity spoofing, and message integrity (preventing message alteration) to achieve the privacy intended. Trusted VPNs do not use cryptographic tunneling. Instead, they rely on the security of a single provider's network to protect the traffic. Multi-protocol label switching (MPLS), layer 2 forwarding, and layer 2 tunneling are commonly used to build trusted VPNs.
WCDMA	Wide-band Code-Division Multiple Access (WCDMA) is a 3G technology that increases data transmission rates in GSM systems by using the CDMA air interface instead of TDMA. WCDMA is based on CDMA and is the technology used in UMTS. WCDMA was adopted as a standard by the ITU under the name "IMT-2000 direct spread". (Adapted from Wi-Fi Planet.)
Wi-Fi	Wi-Fi is a brand logo of the Wi-Fi Alliance used in their certification of products as compliant with the 802.11 wireless connectivity standards. The Wi-Fi Alliance was originally called WECA or the Wireless Ethernet Compatibility Alliance. The term Wi-Fi is widely used in common parlance to refer to all things wireless. Wi-Fi does not stand for Wireless Fidelity. (Adapted from Wikipedia).
WiMAX	WiMAX is an acronym for Worldwide Interoperability for Microwave Access. WiMAX is a logo used by the WiMAX Forum for certifying product compatibility with the IEEE 802.16 standard. The 802.16 working group of IEEE specializes in point-to-multipoint broadband wireless access. IEEE 802.16 or WiMAX is a standard for wireless technology that provides high-throughput broadband connections over long distances. WiMAX can be used for a number of applications, including "last mile" broadband connections, hotspots and cellular backhaul, and high-speed enterprise connectivity for business. (Adapted from Whatis.com).
WLAN	Wireless Local Area Network

Information provided in this Glossary was liberally borrowed from a number of Internet sources including the following highly recommended 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/trsrb/glossary.htm
- MobilInfo.Com Glossary http://www.mobileinfo.com/Glossary/
- Free Online Dictionary Of Computing http://foldoc.doc.ic.ac.uk/foldoc/index.html
- North Carolina ITS Glossary http://www.its.state.nc.us/Information/Glossary/GlossMain.asp
- U. of Colorado Computing Standards with Links http://itp-www.colorado.edu/~scig/std_glossary.html

Appendix A. 2006 Network Domain Team Analysis of Technology Trends

The 2006 network domain team identified nine critical technology trends that will shape networking in the future. These critical trends are as follows:

- Bandwidth needs will increase geometrically as data, voice and video converge to everything over IP (EoIP).
- Bandwidth needs will continue to exceed availability on average, thus driving the need for improved pathways between locations.
- Centralized management will change the way we design networks to meet business needs.
- The last mile of connectivity will continue to divide state and local agencies into those who have needs met and those who cannot afford needed connectivity.
- Wireless communications will escalate.
- The line between public and private communications will blur.
- Over time, the LAN will continue to decrease in importance and the WAN will take over more and more LAN functions.
- Mobile networking will increase and the workforce will expect anytime, anywhere connectivity.
- Networks will continue to be sources of business risk.
- Network service consolidation will continue as a vehicle for mitigating risks (e.g., one network with one Internet onramp).

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Appendix B. Previous Workgroup/Team Members

2001 Network Domain Team Members

John Eagle, Co-Chair ..... City of Hampton, Co-Chair
Bob Pontius, Co-Chair ..... Virginia Employment Commission
Ric Anderson ..... Department of Information Technology
Bethann Canada ..... Department of Education
Jay Epperson ..... Department of Education
Karen Hardwick ..... Department of Corrections
Gary Post ..... City of Alexandria
Bobby Wattlington ..... Department of Motor Vehicles
Diane Wresinski (Team Facilitator) ..... Department of Technology Planning
Paul Lubic ..... Department of Technology Planning, Enterprise Architecture Manager

2001 COTS Enterprise Architecture Workgroup

David Molchany, Co-Chair ..... Fairfax County
Local Government Representation

Murali Rao, Co-Chair ..... Department of Transportation
Secretariat of Transportation Representation

Tim Bass ..... Virginia Retirement System
Independent Agency Representative

Bethann Canada ..... Department of Education
Secretariat of Education Representative

Troy DeLung, ... Department of Environmental Quality
Secretariat of Natural Resources Representative

Linda Foster ..... Department of Taxation
Secretariat of Finance Representative

Bob Haugh ..... Department of Corrections
Secretariat of Public Safety & Large Agency Representative

Randy Horton ..... Department of Rehabilitative Services
Secretariat of Health and Human Services Representative

James Jokl ..... University of Virginia
Higher Education Representative

Ted McCormack ..... Commission on Local Government
Secretariat of Administration & Small Agency Representative

Bill Mize ..... Department of Information Technology
Secretariat of Technology Representative

Bob Pontius ..... Employment Commission
Secretariat of Commerce and Trade Representative

Diane Wresinski ..... Department of Technology Planning
Team Staff

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Appendix C. References, Links and Recommended Reading

General Networking and Telecommunications References:

Forrester:
http://www.forrester.com/my/1,,1-0,FF.html

Gartner Group:
http://www.gartner.com/

Government Computer News:

http://www.gcn.com/

Network World:
http://www.networkworld.com/

Techworld:
http://www.techworld.com/

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