VIRGINIA IT AGENCY

Commonwealth of Virginia

Enterprise Technical Architecture [ETA]

Networking and Telecommunications Domain Requirements

vita.virginia.gov

April 28, 2023

Networking and Telecommunications Domain Requirements: Version History

Revision	Date	Description
1.0	12-07-2001	Initial document (Formally known known as the Networking, Telecommunications and Cabling Standard)
1.1	04-22-2003	Addendum to add Cat 6 wiring specification
2.0	07-10-2006	Networking and Telecommunication Domain Report (replaces above three documents)
2.1	10-01-2008	Networking and Telecommunication Domain Report updated
2.1	04-28-2023	Administrative update for accessibility

Review Process
This requirements document was posted on VITA's Online Review and Comment Application (ORCA). All agencies, stakeholders, and the public were encouraged to provide their comments through ORCA. All comments were evaluated and individual commenters were notified of action(s) taken.

Standards and Agency Exceptions
These standards are incorporated within the COV Enterprise Architecture Standard (EA-225), and the requirements defined within this document are mandatory for Executive Branch agencies. Agencies deviating from these requirements must request an exception for each desired deviation, and receive an approved *Enterprise Architecture Exception* via Archer, prior to developing, procuring, or deploying such technology, or not complying with a requirement specified in this document.

Glossary
As appropriate, terms and definitions used in this document are in the COV ITRM IT Glossary. The COV ITRM IT Glossary is available on the ITRM Policies, Standards, and Guidelines web page at the VITA website: https://www.vita.virginia.gov/it-governance/glossary/cov-itrm-glossary/

Contents

Purpose

The intent of these requirements is to guide the purchase, design, implementation, and on-going operation of COV IT services and utilized technologies. For further information on the perspectives, please reference the most recent version of the Enterprise Technical Architecture (ETA) Requirements document.

Authority

- Code of Virginia, §2.2-2007. Powers of the CIO
- Code of Virginia, §2.2-2007.1. Additional duties of the CIO relating to information technology planning and budgeting
- Code of Virginia, §2.2-2009(A). Additional duties of the CIO relating to security of government information
- Code of Virginia, §2.2-2012(A). Additional powers and duties related to the procurement of information technology

Scope

This standard is applicable to all Executive Branch state agencies (hereinafter collectively referred to as "agencies") that are responsible for the management, development, purchase and use of information technology resources in the Commonwealth of Virginia. This standard does not apply to research projects, research initiatives, or instructional programs at public institutions of higher education.
In addition to the requirements below all COV IT technology solutions comply with the standards found on the VITA Policies Standards & Guidelines page.

Executive Summary

This document addresses networking and telecommunications 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 2006-2008 Network Domain Team, which was comprised of knowledgeable state, local, higher education institution, 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)
    - Wireless Considerations
    - Other Telecommunications Services (e.g., phone, data, multimedia)

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

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

Facilities telecommunications infrastructure addresses industry standards for build out and management of cabled and wireless networks. Telecommunications addresses a variety of business needs and services. The general approach to telecommunications is to move towards common practices and services. LANs and WANs across agencies should be integrated and managed centrally. This can be accomplished by focusing on common protocols, documentation, upgrade paths, services and management. The Commonwealth's LANs are typically switched Ethernet with IP (internet Protocol) addressing. Although the IP addressing makes some use of the private address space at an agency level, the WAN routing for these agencies is able to keep these local addresses hidden by wrapping packets in a label switching protocol. WAN services newly deployed in the Commonwealth at this time are usually Multiprotocol Label Switching (MPLS) networks and MPLS Virtual Private Networks (VPNs). MPLS may also be used to wrap older Asynchronous Transfer Mode (ATM) and Frame Relay cells and packets. Facility cabling typically follows international standards with minor deviations. Wireless connectivity is growing in importance to agencies attempting to improve business processes and has become an expectation of the workforce. Improved mobility and interoperability of networks encountered by the mobile workforce will be the next great challenge.

In this document, the telecommunications and networking service options presently available in the Commonwealth are discussed along with bandwidth, connectivity, throughput, and issues of future capabilities. The document also addresses a wide array of business-critical multimedia, voice, email, teleconferencing and other services along with their impact on the future infrastructure and its management.

As networking and telecommunications services are implemented across agencies, across remote offices and telework settings, and within/across universities, the Commonwealth will move toward:

- common networks designed and managed across all agencies that participate in central network services, across university departments; and across universities for cooperative state, local and national ventures.
- Internet Protocol or IP driven networks and services;
- wired and wireless networks seamlessly integrated;
- roaming capabilities seamlessly provided;
- a network supporting LAN speeds and LAN quality throughput for WAN connectivity;
- increases in carrier-based connectivity, management and services;
- adequate security for wired and wireless LANs/WANs whether components are carrier-provided or Commonwealth-provided;
- quality of service provided using a variety of tools to meet integrated voice, video and data needs transparently;
- 24x7 availability with continuous connectivity for all;
- ever increasing service reliability, quality, and throughput performance;
- remote provision of quality troubleshooting and service problem resolution, and
- network services that allow and promote connectivity between local government and state government resources.

New and modified requirements and recommendations for Networking and Telecommunications are noted in this document by a line in the left margin or the word “Updated” in requirement tables. The requirements as revised following approval by the Information Technology Investment Board will be revised both in this document and in the *Enterprise Technical Architecture Standard*, ITRM Standard EA225-02.

Overview

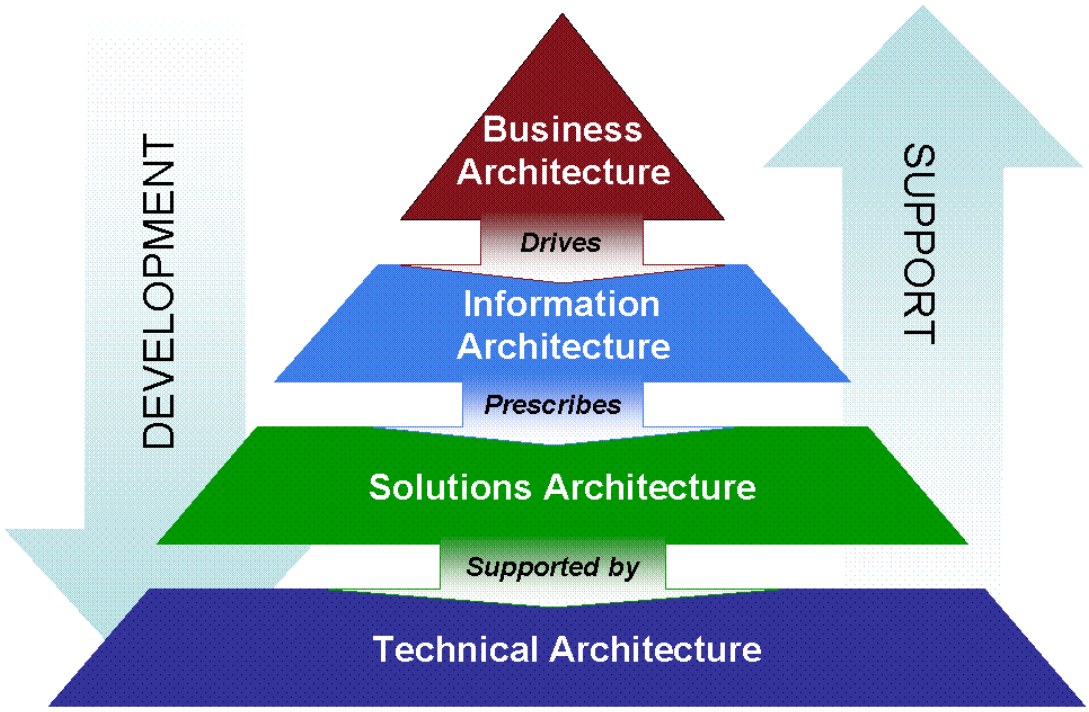
The Commonwealth's Enterprise Architecture is a strategic asset used to manage and align the Commonwealth's business processes and Information Technology (IT) infrastructure/solutions with the State's overall strategy.

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.

[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. This glossary entry 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 team are 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.

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). This guidance supplements and repeats the Networking and Telecommunications standards that are reported in the Enterprise Technical Architecture Standard, which is published separately and includes all technical domains.

The audiences for this domain report are the business and technical leaders in individual state and local agencies (universities, colleges, local governments, 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 2006-2008 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
    - Local Area Networking (LANs)
    - Wide Area Networking (WANs)
    - Wireless Considerations
    - 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

Methodology

The first 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 have considered the continuing relevance of the earlier efforts and have provided revisions to the scope when needed along with recommendations for 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 the 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 continues to do so during its reviews. The objectives are to:

- 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 wide area networking, 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.

As-IS and To-Be Architecture for Networking and Telecommunications Infrastructure and Services

As-Is Architecture

The data available for describing current and past networking and telecommunications in the Commonwealth are primarily from 2005 and 2008. The 2005 information was compiled for a due diligence effort in preparation for negotiating partnerships with several companies interested in helping the Commonwealth modernize its infrastructure. The data displayed here provide a picture of networking and telecommunications in the Commonwealth at the start of the partnership with a private company for the provision of many of the networking and telecommunications services covered by this domain report. Current data are from VITA and partnership sources.

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 networking and telecommunications services.

It should be recognized that the local government business model is somewhat complex, thus requiring network solutions to be creative and flexible. State programs are often administered at the local level. They may be housed in local government facilities and permitted to use local government IT resources. Several different business models are present in local governments which require careful thought and consideration when designing state/local government technology solutions.

- **There are local government departments and local school divisions that need access to state government data to perform their jobs effectively.** These include local police who need access to VCIN, Treasurer's Office personnel who need access to DMV, and school divisions that need connectivity to DOE for student reporting.
- **There are state offices/agencies which are out of scope to VITA services but located in local government buildings or campuses**. These state offices access state applications and often ask for help and support from the local government IT department. The court system is an example of this business model.
- **There are state mandated and state funded programs that are operated by local government and some state employees and may be housed in local government facilities.** The state will often have central IT systems to support these programs and both state and local program staff will need access to state systems and the state network. The local agency will also have local (non-state supported) applications to support their operations. The local Departments of Health and Social Services are examples of these types of agencies.
- **There are state mandated programs operated with a mix of state and local funds and operated by local employees.** These include local and regional programs outside of the central agency IT office's scope. An example of this is the Virginia Department of Health's implementation of health planning using local government GIS systems and data. Payroll, check printing and other services are performed at the local IT department. Email is provided by local IT staffs.
- **There are multiple state and local agencies working together on a common program**. An example is the Hampton Healthy Families Partnership program which focuses state and local resources on improving the health of children from conception to entry into the public schools. State and local health programs, local libraries, physicians, hospitals, schools and others work together to support families.

Present facilities and services include the following:

- Cabling plants (these are often provided by the agencies, local governments, and the building owners)
- LANs within each state agency, within most local offices of state agencies, and within local governments including LAN-based services (e.g., print services) and connectivity (e.g., email)
- Wireless access within offices and across campuses
- Teleworker-provided wired and wireless LAN and Internet connectivity to state VPN to LAN services, Web-based email, application connections and more
- Wide area connectivity including regional area networking (RANs), WANs, WAN building to building connections, campus WANs, MANs, and LAN to LAN connections
- LAN and WAN connectivity between local government and state central data centers and local program offices.
- Telephone services provided to local agency offices by local governments
- LAN and WAN-based services including data transfer, connecting distributed applications, connecting business partners, and providing multimedia services including Internet connectivity, voice over IP (VoIP), audio and video conferencing, and more.

Available statistics from the 2005 due diligence effort may be used to describe the scope of government networking and telecommunications. The 2008 estimates column provides the 2005 data as the best estimate when there is no available information on changes. New inventory information from VITA's partner regarding service changes and infrastructure transformations that have taken place through the end of 2008 will be available soon. Changed data and confirmed but unchanged data are presented in bold in the 2008 column. This information is provided separately for state agencies that participate in the partnership and higher education agencies unless otherwise noted. Commonwealth networking supports the following persons, agencies, and infrastructure:

As Is Networking and Telecommunications Data

Units Counted	Unit Detail	2005 Estimates	2008 Estimates*	Expected Change
State Agencies	Total non-higher education Executive Branch agencies. Note that institutions such as prisons are counted as part of their central control agency.	60 (agencies such as all prisons are counted as 1 with DOC; DMHMRSAS facilities are counted as 1with DMHMRSS)	**67****	Changed by GA/Governor proposed reorganizations or voluntary agency participation decisions only
State Agency Locations	Total locations	1,627 presence 1,562 locations	1,627 presence 1,562 locations	Some reductions
State Agency Applications	Total applications	1,645	1,645	Agency business determined
State Agencies	Number of agencies using some VoIP services	13	**37**	Increase up to 100% of participating agencies
State Agencies	Number of agencies using separate agency-based VoIP	13	13	Decrease to 0% of VoIP agencies
State Agency Employees	VITA Executive branch customers (non-higher education agencies)	59,000[1] based on FTE salary and wage	**59,000** based on FTE salary and wage	Agency business determined
State Agency Employees	Cell users	13,000	**10,602 (not HE)** **1,956 (HE)**	Agency business determined, but increases expected
State Agency Employees	Central VoIP users	1,600	1,600	100% of participating office phone users
State Agency Employees	Premises VoIP users	4,500	4,500	Expect 100% to move to central services at equipment end-of-life
Network Devices and Infrastructure	Wired PCs	50,000	50,000	Eventually, reduce to 5%
Network Devices and Infrastructure	Wireless/Docked PCs/Laptops	300	300	Eventually increase to 95%
Network Devices and Infrastructure	Connected servers	3,000	3,000	Decrease to 33%
Network Devices and Infrastructure	Wired analog and digital phone lines (mainly Centrex)	90,000	90,000	Decrease to 10%
Network Devices and Infrastructure	Wireless multiservice phones	0	**1,040**	Increase to 90% of wireless phone users
Network Devices and Infrastructure	Switch devices	6,000	6,000	Decrease due to network centralization
Network Devices	Wired hubs	1,500	1,500	Decrease due to

[3] Estimates using DHRM FTE data include classified FTE of agencies served plus 4/3 of wage FTEs for a total of 58,521 for 2003 and 58,803 for 2008. Not all staff have computers or services.

Units Counted	Unit Detail	2005 Estimates	2008 Estimates*	Expected Change
and Infrastructure				future wireless
Network Devices and Infrastructure	Routers/MPLS devices	2,500	2,500	Combined decrease due to network centralization
Network Devices and Infrastructure	Token ring network devices (e.g., MAUs, switches)	430	430	Decrease to 0% due to policy
Network Devices and Infrastructure	VoIP network devices (e.g., media servers and call managers)	65	65	Increase
Network Devices and Infrastructure	Wireless network access points (802.11 a,b,g)	Unknown	Unknown	Increase followed by decrease due to technology change
Network Devices and Infrastructure	Wireless access points (802.11n)	0	**0**	Future increase due to technology change/standards approval
Network Devices and Infrastructure	Other wireless network devices (e.g., scanners, PAN devices,	Unknown	Unknown	Increase due to technology improvements
Network Devices and Infrastructure	Printers, shared	12,000	12,000	Large decrease (>50%) due to policy
Network Devices and Infrastructure	Printers, personal	17,000	17,000	Decrease to 5% due to policy
Network Devices and Infrastructure	Infrared Point to Point	Unknown	Unknown	Decrease due to technology changes
Other Devices	Unconnected field laptops	Unknown	Unknown	Decrease to 0
Network Services	WAN physical circuits (ATM, Frame Relay, FRASI, T1, etc.)	4,700	4,700	Decrease if cost effective due to technology changes including wireless options
Network Services	Internet connections	85	85	Reduce to 2 for unified network
Network Services	Separate Microsoft directories	Unknown	Unknown	Minimize the number of directories such as Active Directories due to centralization
Network Services	MPLS wrapped connections	Pilot agencies including numerous central Richmond sites	**405 of agency sites**	Increase if cost effective and improves business services

* Additional 2008 data are expected later during the 2008-2009 Fiscal Year. Complete LAN migration is scheduled for January 2009.

** See bold numbers in the 2008 column for change or confirmation of numbers using new data

Commonwealth Networking and Telecommunications in 2005 and 2008

In 2005, although the Commonwealth's LANs were primarily switched Ethernet LANs, there were also users, devices, and network segments that were not switched or not Ethernet. Two large agencies operated significant token ring environments. These two agencies had been slowly moving towards Ethernet solutions. One was then about 30 percent Ethernet. The other agency ran parallel Ethernet and token ring networks and intended to continue doing so until it was able to replace network printers and modify mission-critical applications, which relied on token ring connectivity for redundancy and mainframe access solutions. Both agencies had network operations throughout the Commonwealth.

Also, in 2005, the majority of cabling in agency sites, whether used for token ring or Ethernet services, was Category 5 twisted pair. Although some agencies had Category 5e or Category 6 capable cabling, these were the exception. Plant upgrades in agencies are the responsibility of the agency and are typically the result of a facility move or a new application such as VoIP. Category 6 cabling and fiber would have been in use for many agency backbones.

A small agency in 2005 might have had a simple LAN for sharing printers, Internet, and email. Often the services were provided by another, larger agency. A complex agency would have had LANs, MANs and WANs, wired and wireless connectivity, multiple public and private services throughout the state, agency-owned IP address blocks or RFC (Request for Comment) 1918 addressing with NAT translation, traffic segregation to address quality of service (QoS) for video and voice, and complex, multifunction switches and routers.

Remote connectivity in 2005 was provided via public telephone dial-up, agency owned wired and wireless connections, and leased infrastructure with or without services. Services purchased or provided by the agency included Internet, Intranet, Extranet, VPN access to LANs/WANs, email, wireless email, VoIP, thin client access to hosted applications, and remote server access.

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

Since 2005, those agencies that have been involved in network transformation activities have seen changes to their infrastructure. In 2008, the following changes have been documented:

- Network services offered to some agencies now include MPLS WAN connectivity to the data center and certain other resources.
- Twenty percent of agency networks have been connected to the MPLS services
- Plans are being developed to assign new IP addresses to all server resources in the data center and at agencies.
- Agency network transformations are ongoing and include equipment upgrades when needed.

Higher Education in 2005 and 2008

For higher education, little Virginia data is available centrally to describe the networking and telecommunications physical architectures and services that were in place in 2005 or that are in place currently. National data from EDUCAUSE and similar sources provide the best picture of higher education trends in networking. The 2005-2006 EDUCAUSE survey results are available, but 2006-2007 have not yet been published. Like all colleges and universities in the nation, Virginia's higher education institutions have massive, campus-wide and inter-campus infrastructures providing connectivity, distance learning, voice, streaming video, data, and high-end research capabilities whenever programs demand. Virginia's public institutions support more than 300,000 students, 60,000 faculty and staff, and often, multiple

campuses for each of the 39 institutions. Most colleges have gained central control over all LANs and are making progress towards or have achieved centralization of student, faculty and staff directory services enabling central authentication and authorization. Now they are moving to expand wireless network access across interior and exterior campus spaces and are deploying numerous campus-wide services including VoIP, IPTV, electronic libraries, and more. The following describe current higher education networking and telecommunications services.

- Ethernet and a variety of non-Ethernet WAN services are used (e.g., layer 3 MPLS)
- Substantial bandwidth is provided to on-campus faculty, staff and student users
- Bandwidth is shaped to meet traffic type needs
- Efforts provide continuing growth in wireless connectivity throughout campuses
- There is continued growth in the use of VPNs for faculty remote access
- Increasing Internet access is provided via central authentication and authorization to numerous library and similar resources for students and faculty
- Pervasive videoconferencing is possible using desktop solutions for those needing videoconferencing due to good bandwidth availability. Slow growth of high-end (high cost) videoconferencing solutions continues.
- VoIP/IPTV/Video-over-IP continue to grow replacing other voice and video services
- Increasing centralization of directories permits central control of networks and resources on them

National higher education groups such as EDUCAUSE are proposing greater cooperation across the nation's colleges and communities espousing efforts such as "Big Broadband ," which recommends the joint sponsorship of broadband resources nationwide by governments and the private sector enabling 100Mbps to 1Gbps for every home and business.

Networking and Telecommunications for VITA-served State Agencies in 2008

VITA reports the following results of network build-out and transformation efforts in the Commonwealth as of early 2008.

- Establishment of the MPLS core network in Richmond
- Networked data centers opened in 2007 and connected to MPLS services
- Servers physically migrated to the Commonwealth Enterprise Solution Center (CESC) data center
- Network migration including connection to MPLS services was completed for 405 agency sites of 1,942 targeted networks (20%). The target for January 2009 is 90%. This migration included:
    - Network equipment due diligence and upgrades enable MPLS/network management
    - Messaging rollover to a central system
    - Applications with hard-coded IP addresses verified
- IP re-addressing of servers
    - Planning initiated
    - Implementation targeted for 2008

[4] A Blueprint for Big Broadband; An EDUCAUSE White Paper; John Windhausen Jr. President, Telepoly Consulting; January 2008; http://www.educause.edu/ir/library/pdf/EPO0801.pdf
[5] Network Work Plan Overview: Sherilyn Whiting, Booz Allen Hamilton, May 19, 2006 https://vitaweb.virginia.gov/C17/COIN/Document%20Library/Forms/WebFldr.asp

- Altiris Asset Control is to be the system of record (integrated with service delivery via Peregrine)
    - Network-connected assets being tracked include
        - Desktops
        - Laptops
        - Servers
        - Printers
        - BlackBerry devices/PDAs
        - Networking devices
    - Non-network connected devices are also tracked

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. Mobility will be fully accommodated.

These goals are now supported in both the Commonwealth's Strategic Plan for Information Technology, by the Chief Information Officer's (CIO's) objectives and by VITA's partnership plans. Strategic initiatives emphasize productivity improvements from mobilizing the workforce and access to government through networking and telecommunications technologies. Partnership efforts emphasize milestones for the transformation of networking and telecommunications infrastructure and services not only for state agencies but also for local government and education. Also, partnership efforts envision integrated voice and data networks and centralized management

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 supporting network;
- wired and wireless networks seamlessly integrated;
- roaming capabilities (mobile services) seamlessly provided on multifunction devices;
- 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 service reliability, quality, and throughput performance;
- remote provision of quality troubleshooting and service problem resolution; and
- extranet or single pipeline connectivity to local government network resources.

A roadmap of past and anticipated future progress in Commonwealth networking is provided in Table 1 below. Additional information on networking trends is provided in Appendix A. VITA/Partnership plans for network migration/centralization are provided in Appendix B. Detailed information on network protocol "generations" is provided in Appendix C. Appendix D provides Internet links to network topic resources

[6] Strategic Plan Goals: http://www.vita.virginia.gov/uploadedFiles/Library/COVStrategicPlanInformationTechnology07.pdf
Partner Goals http://www.vita.virginia.gov/itpartnership/default.aspx?id=231#Network
CIO Objectives http://www.vita.virginia.gov/uploadedFiles/ITIB/Meetings/2008/F-2007CIOObjectivesIndependentInputandDependencies.pdf

Table 1: Anticipated LAN-WAN Solutions over Time

1980-2000	2001-2005	2006-2010	2011-2015
10 Mb Ethernet/ Cat 5 **Bridges, Routers, and Gateways** **Token ring/Cat 5** **Appletalk/Cat 5** **Hubs/MAUs** **Frame Relay, T1** **analog voice**	**100 Mb Ethernet/ Cat 5e, fiber** **Hubs, Switches and Routers** **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** **10GB Ethernet** **Switches and multi-function Routers; multiband access points;** **Carrier MPLS (Frame Relay and ATM, VPN)** **Digital to analog voice; all-in-one wireless multitasking devices with voice, internet, email, camera, video, music, podcast and storage. (smartphones; VoFi)** **Site-based and Carrier VoIP within agencies; wired and wireless VoIP; cellular expansion with all services** **Pervasive self-healing, dense deployed wireless; mixed 802.11a/b/g/n designs (with n approval expected in 2008 and rapid deployment to follow); integration of wired and wireless management; some wireless only networks; no more site surveys.** **3GPP LTE and WiMAX (but WiMAX will decline)** **Wireless bridges (point to point) replacing line of sight, short distance outdoor connections** **Ratification of standards- based management (e.g., LWAPP); edge intelligence** **Wide area storage area networks or SANs** **Increased satellite use in rural solutions**	**xGB Ethernet/ Cat 6a; fiber** **Buildings built and leased with comprehensive wired and wireless infrastructure** **Movement to wireless everything** **Pervasive mobile networking; synching replaced by secure access everywhere to everything.** **Telco providers move to global standards** **Wireless recharging of wireless devices is pervasive** **Digital voice; wireless phone roaming across cellular/VoIP/Other; multitasking devices only.** **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** **Mature, 4th generation mobility solutions; multi carrier mobility** **IPv6 will begin to emerge in state government agencies as a planned future migration**
		Agency 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.	**Agency Caution: must know bandwidth needs to the application level or risk overbuying highly scaled bandwidth services; must know business security needs or risk overbuying. Must know security risks of wireless for your business.**

[7] A variety of sources including Gartner Hype Cycles are used to prepare this table of anticipated government strategies. Examples include Gartner's Hype Cycle for Networking and Communications, 2007 and numerous articles from websites whose links are displayed in this publication following the Glossary.

Domain-Wide Principles, Recommended Practices and Requirements

Domain-specific principles, recommended practices and requirements are presented for the networking and telecommunications 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: The networking and telecommunications ETA should be based on a set of industry standards.

NET-P-02: Standardization on layered protocols provides user transparency.

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

NET-P-04: The Commonwealth must actively work to enable the convergence of voice with data traffic over LANs and WANs. This convergence will require a quality of service level for voice that approaches what is provided by the existing Public Switched Telephone Network

NET-P-05: The Commonwealth should seek to meet service quality guarantees within its networking and telecommunications *Enterprise Technical Architectures*.

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

NET-P-07: 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: 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: State and local agency business leaders should review anticipated business changes with networking and telecommunications staff or service providers to ensure that *networking* 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 for complex projects

Domain-Wide Recommended Practices

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

NET-R-01 *Agencies planning facilities changes must provide timely notification to appropriate networking and telecommunications authorities to ensure the availability of business critical telecommunications and networking services.* Networking and telecommunications infrastructure requirement changes are 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. When state-owned or state-leased buildings are involved, agencies must notify the Department of General Services, Division of Engineering and Buildings. *When local government-owned buildings are involved, agencies must notify the local government entity responsible for networking and telecommunications.*

Rationale:
Notifications to involved government authorities helps 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 *to ensure that delays will be avoided*

NET-R-02: Agencies, except for institutions of higher education, which Require network interconnections between two or more buildings, shall work with *VITA* 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. *The local government shall be a participant in discussions whenever local government owned or leased buildings are involved.*

NET-R-03: Agencies are required to report *state to local* 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.

Networking and Telecommunications Domain Technical Topics

There are two topics within the networking and telecommunications domain: facilities telecommunications infrastructure and telecommunications services. 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. Within both networking and telecommunications, wireless issues are addressed. 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).

In the past, a local area network or LAN has generally been a private network 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. As networks become more integrated, public support of LANs will increase.

A wide area network or WAN is a geographically dispersed telecommunications network. The network may be physical or virtual. It may use public and private infrastructure. The public telephone systems and wireless systems may be incorporated.

Telecommunications are services and applications that run on local and wide area networks. Telecommunications services connect people, servers, work groups, meeting participants, applications tiers, businesses, security services, 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. When teleworkers are involved, home networking and telecommunications may become part of the worker's business infrastructure. Other possibilities for the teleworker and mobile worker include public hoteling facilities, public hotspots and mobile services.

The physical cabling component of telecommunications infrastructure in the Commonwealth is typically under the control of individual agencies. The Department of General Services (DGS) is responsible for managing and leasing many of the agency-occupied buildings and works with agencies to ensure their networking needs are met. 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. Specialized nationwide infrastructure for research initiatives is also common. Infrastructure for non-higher education agencies may also span multiple buildings and include connectivity to multiple locations within and across 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 into the future.

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 networking) and standards-based documentation. Also, state and local agencies should ensure that leases hold them harmless with respect to costs for removal and disposal of old cable and wiring when they require improvements to their networks during a lease. In cases where a state agency, local agency, partner company or other external business is a guest or subleaser in a state or local government building, the charge for the guest's or subleaser's building change requirements should include any required cabling removal and disposal costs.

Central availability of documentation of cable plants in a common format across agencies is needed. This will enable estimation of the costs and savings for new network services and capabilities. Such estimates 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, the central storage of and access to such documentation will become increasingly important.

Electrical and cooling plants in agency buildings must be adequate to support premises networking equipment and wireless implementations in addition to meeting 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 for the state or local agency to consider in determining the adequacy of space leased or occupied. As applications such as VoIP are implemented in the Commonwealth, air-conditioned, well-ventilated and highly accessible wiring closets become a necessity. New network services will continue to increase the demands for network capabilities. State and local agencies should take care to pass all such facility change costs, including wiring closet and air conditioning change costs on to subleaser.

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 and equipment closets
- Present network cable does not support Voice over IP (VoIP)
- Present network cable does not support switched Ethernet
- Future plans include multimedia applications such as 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 heating, ventilating and air conditioning (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 those used 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.[2] 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 of building improvements by the General Assembly.

[8] Categories (Cat) of cabling:

Cat 1: Currently unrecognized by TIA/EIA. Previously used for POTS telephone communications, ISDN and doorbell wiring.

Cat 2: Currently unrecognized by TIA/EIA. Previously was frequently used on 4 Mbps token ring networks.

Cat 3: Currently defined in TIA/EIA-568-B, used for data networks using frequencies up to 16 MHz. Historically popular for 10 Mbps Ethernet networks.

Cat 4: Currently unrecognized by TIA/EIA. Provided performance of up to 20 MHz, and was frequently used on 16 Mbps token ring networks.

Cat 5: Currently unrecognized by TIA/EIA. Provided performance of up to 100 MHz, and was frequently used on 100 Mbps Ethernet networks. May be unsuitable for 1000BASE-T gigabit Ethernet.

Cat 5e: Currently defined in TIA/EIA-568-B. Provides performance of up to 100 MHz, and is frequently used for both 100 Mbps and gigabit Ethernet networks.

Cat 6: Currently defined in TIA/EIA-568-B. It provides performance of up to 250 MHz, more than double category 5 and 5e. This is the minimum recommended for horizontal cabling.

Cat 6a: Future specification for 10 Gbps applications. Ratification expected in 2008.

Cat 7: An informal name applied to ISO/IEC 11801 Class F cabling. This standard specifies four individually-shielded pairs (STP) inside an overall shield. Class F is being designed for transmission at frequencies up to 600 MHz.

Data Center Cabling and Pathways

In 2006, the Telecommunications Industry Association (TIA) released TIA-942, a Telecommunications Infrastructure Standard for Data Centers. This was really the first standard that specifically addressed data centers and their in infrastructure. It is mainly a telecommunications standard, but a considerable portion of the standard deals with facilities and facility requirements for space, power, layout, etc. For this domain, the focus is only on that part of the standard that addresses cabling and pathways and for the purposes of classification and communication, the part of the standard that deals with data center tiers. Tiers address redundancy and quality of services. The structured cabling standards build on existing standards. The Commonwealth can use these standards in interpreting contracts with datacenter providers. When a tier 1 (lower), tier 2 (middle), or tier 3 (higher) data center is specified in a contract, this standard is presumed to be referenced.

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 five recommended practices for the Facilities Telecommunications Infrastructure Topic:

NET-RP-03: When modifying cable plants, agencies should encourage the use of integrated documentation software and hardware by their staff and contractors. *Tool sets* may facilitate infrastructure documentation and lower the cost of cable labeling.

NET-RP-04: Agencies should assess the adequacy of electrical infrastructure for networking when considering modifications to their network cabling plants.

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

NET-RP-06: (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 *or their contractors* 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.

NET-RP-20: *Data center application hosting options provided should support a range of networking and telecommunications services to meet cost-effectively, the varying connectivity needs of agencies. Agency needs for connectivity, throughput, secure transmission and other application networking and telecommunications infrastructure services vary substantially from application to application*

Requirements

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

NET-R-04: 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.** These 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 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 4-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 4 fibers (2 pair) 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 2 dark fibers (1 pair) for every 4 active fibers (2 pair) 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.*** *These 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 telecommunication 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: NET-R-04, DGS shall provide a central repository for agency cable plant documentation (see ANSI/TIA/EIA-606-A documentation). The DGS repository must be accessible to the Virginia Information Technologies Agency for planning purposes.

NET-R-06: The Department of General Services (DGS), Division 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:
Common data and formats are needed 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. At that time, WANs and LANs were clearly differentiated; today, it is no longer possible to draw clean lines between them. 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 for various activities

Table 2: Responsibilities for Networking and Telecommunications

Activity	VITA as Central Services	Higher Ed. Agencies	Executive Branch, not Higher Ed.	Other State Agencies	Local Govern-ments
Provide building cabling, plant documentation, and electrical connec-tions (i.e., infrastructure that is part of a facility) through lease agree-ments, space occupa-tion agreements or other methods		X	X	X	X
Provide business re-quirements for telecom-munications services		X	X	X	X
Provide and manage routers, hubs, firewalls, bridges, interfaces, directors, switches, software stacks, and related network equipment	X	X		X	X
Provide and manage LAN services	X	X		X	X
Provide contracts for building cabling/ wiring	X	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				X
Provide telecommunica-tions help desk	X	X		X	X
Purchase from VITA telecommunications contracts or VITA approved contracts	X	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. LANs also use 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 among separate LANs and over greater than LAN 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 selected and 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, remote access, 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 may use several of these network subsystems.

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.

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.

Anticipated Wireless Changes
From 2008 to 2015, the world will experience significant changes in wireless technologies. From consumer perspectives and from business viewpoints, the nature and impact of the coming changes can be hypothesized as follows:

- Devices used to access the wireless networks
  - Users will have multifunctional handheld devices more capable than the present day iPhone
  - The handheld device will meet the mobility and in-office communications needs of a very large proportions of Commonwealth employees and will even replace multiple devices for some (e.g., laptops, cells, desk phones, and BlackBerry devices)
  - The device, whether a phone-type handheld or a lightweight notebook in form factor, will seamlessly interconnect with LAN and phone systems at the office. This connectivity will include Internet connectivity, video conferencing, and streaming multimedia.
  - The device battery may even be recharged wirelessly as employees roam the office building
- The personal office space
  - At the agency's building, it will be possible to have no wires in personal offices for phones or computing equipment
  - Between the teleworker's home office and the agency's office, it may be
- The office building networks
  - The LAN will continue to have wired and wireless components.
  - The building-based systems and storage will be wired to the 10 gigabits, switched Ethernet.
- On the move
  - All devices will be mobile
  - You will step outside, get into your commuter van, head out on the highway and you will be able to remain connected. You transfer to the high-speed train and you will still be connected through to your destination. Internet, multimedia, data, phone, and everything works as it should. You will have total mobility.
- Fourth Generation (4G) versus third generation (3G)

[9] MIT Scientists Pave the Way For Wireless Battery Charging; Wall Street Journal; William M. Bulkeley; http://online.wsj.com/article/SB118123955549228045.html?mod=googlenews_wsj

Typically, distant future wireless is referred to as 4G or 4th generation. Existing services are generally 2G or 3G (2nd/3rd generation). Changes that are being implemented or that will be implemented in the near future are considered to be between 3rd and 4th generation; these transitional technologies and services are referenced by a variety of names such as "post 3G" or "pre 4G."

- 4G will provide seamless integration across networks ("The real technical step-up of 4G with respect to 3G can be summarized with the word integration — seamless integration of already existing and new networks, services, and terminals, in order to satisfy ever-increasing user demands."[3])
- Order of magnitude technical changes ("4G should not be seen exclusively as a linear extension of 3G"[4])

The aforementioned 4G changes will be made possible by the availability of new user devices, new telecommunications standards (protocols), and wireless advances in commercial products that move wireless broadband into territory previously served only by wired infrastructure. From a customer perspective and from a business perspective, the next generation of changes will be groundbreaking.

There are several families of protocols that are competing to become the widely adopted future direction. These families are typically referenced in the news by the latest technology developed, which will be the adopting company's future direction. For example, lately, there has been much talk about Verizon adopting LTE, Sprint wavering on its original decision to support WiMAX development, and Qualcomm's recent UMB advances. For the Commonwealth, decisions regarding the use of interim technologies require weighing various pros and cons due to the fact that none of the technologies has met all of the requirements for "4G" and each is, therefore, lacking in some important quality needed to meet future communication needs.

There are so many protocols in use across companies that sell wireless services, that it is difficult to address them in detail. For agencies, understanding the service enabled is more important than understanding the protocols. However, it can be helpful to understand what is new and what is old. A table that lists the protocols by acronym and by generation is provided in Appendix A for general reference.

Current wireless devices are based on the 802.11 a, b, and g standard. Customers understand that their wireless is "a, b, or g." One very important new protocol, the Institute of Electrical and Electronic Engineering's IEEE 802.11n specification, is anticipated to clear the approval process by 2009. Equipment manufacturers have been placing 802.11n devices on the market in anticipation of what will be approved for more than a year. However, the use of these devices in Commonwealth agencies is prohibited by Virginia wireless standards unless a waiver is obtained for the purpose of testing adequacy for future business needs. This protocol will enable significant advances in throughput, data rates, and distances. The following are anticipated:

- Speed—at 74 Mbps, 802.11n has more than three times the throughput of predecessor 802.11 a/b/g Wi-Fi
- Data Rate—at 254 Mbps, 802.11n will have a maximum rate that is nearly 5 times current Wi-Fi
- Transmission Distance—at maximums of about 70 meters indoors and 250 meters outdoors, transmission distances will double
- Performance—using Multiple Input Multiple Output (MIMO) technology, 802.11n improves overall performance by having multiple transmitters and receivers at the physical layer

[10] IEEE Network ; Defining 4G Technology from the User's Perspective; Simone Frattasi, Hanane Fathi, Frank H.P Fitzek, and Ramjee Prasad, Aalborg University Marcos D. Katz, Samsung Electronics; January/February 2006 0890-8044/06/$20.00 © 2006 IEEE; p. 38.
[11] Ibid. (p. 35).

The world is moving rapidly to increase the use of wireless applications throughout businesses, buildings, campuses, enterprise wide area networks and public networks. Technologies will eventually come together to enable the bandwidth increases to help wireless solutions to meet more of the business needs that previously could only be met with wired infrastructure.

Where wireless networking and telecommunications are headed and how fast depends on the interplay of multiple complex factors including end-user device development, network device development, protocol completion, standards body progress, marketplace competition, telecommunication company decisions, adoption rates, partnerships, and product transitioning. Other factors include customer appeal, business needs, and economic trends. Currently, the economic downturn is having a major effect. Companies need more time to recoup their investments in earlier technologies before going in altogether new directions with fourth generation or 4G technologies.

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

Requirements

NET-R-07: 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 *(e.g., up to 802.3an 10GBASE-T 10 Gbit/s (1,250 MB/s) Ethernet over unshielded twisted pair (UTP)).*

NET-R-08: Agencies must ensure that each agency LAN node and LAN segment may be accessed using IP addressing.

Note:
This mandatory requirement was *to have been* met in December of 2003.

NET-R-09: 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: *Agencies that provide servers and networking equipment are* 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: *Agencies that provide web hosting or network services* should provide for all served *entities* a secondary DNS server which resides on a separate network from agency primary DNS servers (required for domain registration). This will enable an *entity's* public-facing services to remain visible to users if the network is down.

NET-RP-09: 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: Agencies acquiring new network hardware (i.e. firewalls, routers, switches, etc.) must ensure that the devices are Simple Network Management Protocol (SNMP) compliant.

NET-R-11: All agencies that manage networks must employ Simple Network Management Protocol (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: 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 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 without also using route distinguishers (i.e., VPN-IPv4 RD). 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 use only 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 comments. In many instances, RFCs are treated as industry standard recommendations. Many standards groups issue RFCs.

VITA must provide agencies with assurance that recorded IP address information will not be shared with anyone who may be required to divulge the information to the public.

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: 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-12: 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: 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: 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: 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 *(LWAPP is called CAPWAP by the IETF, Control and Provisioning of Wireless Access Points),* 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: 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: 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: 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 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.

NET-RP-21 *Category 6 cabling is recommended for new and replacement cabling in anticipation of distance benefits for IEEE's yet-to-be completed power over Ethernet plus proposal (IEEE 802.3at, PoE Plus).*

Requirement

NET-R-14: 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 *Reviewed October 1, 2008*
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)
10 Gigabit Ethernet LAN (little need but becoming highly cost effective—see FTTE-H[5] or Fiber to the Telecommunication Enclosure)
VoIP Centrex (cost reductions)
Note: Category 5e LAN is the minimum required for enabling VoIP.
Emerging:
Transitional/Contained:
Ethernet 10Mbps (IEEE 802.3)
ATM 25 Mbps (LAN emulation or LANE, an element of Multiprotocol over ATM (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

[12] FTTE-H cabling architecture discussion that addresses cost reductions is available at http://www.bicsi.org/events/conferences/dublin/2007/pdf/presentations/Eric%20Valade.pdf

Reviewed October 1, 2008
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) (security and other issues)
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 *Reviewed October 1, 2008*
Strategic:
Data and VoIP 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 VoIP Centrex
Emerging:
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 *Reviewed October 1, 2008*
Strategic:
Dial up (e.g., remote access service (RAS))
VPN (e.g., IP VPN)
BlackBerry Services
Microsoft Exchange Direct Push Mail via SPS
Other BlackBerry Competitors (Good, Nokia, Sybase)
Wi-Fi
Emerging:
Intel integrated wireless chipsets (Wi-Fi, WiMAX and HSDPA in one chipset)
Transitional/Contained:
Obsolescent/Rejected:
Waiver History:

Table NET-S-05: Wireless Telecommunications (Voice, Image, Data, Conference, and Other Multimedia) **Technology Component Standard** *Reviewed October 1, 2008*
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) Cingular or 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:
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:
CDPD
Waiver History:

Definitions and Terminology

[Include any needed definitions – all will be added to glossary before posting to ORCA.]

3GPP LTE	3GPP LTE – Long Term Evolution is the name given to a project within the Third Generation Partnership Project to improve the UMTS mobile phone standard to cope with future technology evolutions. Goals include improving spectral efficiency, lowering costs, improving services, making use of new spectrum and refarmed spectrum opportunities, and improving integration with other open standards. The LTE project is not a standard, but it will result in the new evolved Release 8 of the 3GPP specifications, including mostly or wholly extensions and modifications of the UMTS system. The architecture that will result from this work is called EPS (Evolved Packet System) and comprises E-UTRAN (Evolved UTRAN) on the access side and EPC (Evolved Packet Core) on the core side.
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 transceiver transmits and receives in a previously unused frequency band of 2.45 GHz that is available globally (with some variation of bandwidth in different countries). In addition to data, up to three voice channels are available. Each device has a unique 48-bit address from the IEEE 802 standard. Connections can be point-to-point or multipoint. The maximum range is 10 meters. Data can be exchanged at a rate of 1 megabit per second (up to 2 Mbps in the second generation of the technology). A frequency hop scheme allows devices to communicate even in areas with a great deal of electromagnetic interference. Built-in encryption and verification 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.
CAPWAP	The Control And Provisioning of Wireless Access Points (CAPWAP) protocol is under development within the IETF to enable an Access Controller (AC) to manage a collection of Wireless Termination Points (WTPs). CAPWAP aims at simplifying the deployment and control of large scale, possibly heterogeneous, wireless networks.
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.
LambdaRail	National LambdaRail is a high-speed national computer network infrastructure in the United States that runs over fiber-optic lines, and is the first transcontinental Ethernet network. The name is shared by the organization of research institutions that developed the network, and, to date, plans to continue developing it. LambdaRail is similar to the Abilene Network, but LambdaRail permits deeper experimentation than Abilene does. It is primarily oriented to aid terascale computing efforts and to be used as a network testbed for experimentation with next-generation large-scale networks. National LambdaRail is a university-based and -owned initiative, in contrast with Abilene and Internet2, which are university-corporate sponsorships. This gives universities more control to use the network for these research projects.

	National LambdaRail also supports a production layer on its infrastructure. Links in the network use dense wavelength-division multiplexing (DWDM), which allows up to 32 or 40 individual optical wavelengths to be used (depending on hardware configuration at each end). At present, individual wavelengths are used to carry a 10-gigabit Ethernet signal. Erv Blythe is the Chair of the LambdaRail Board of Directors. In 2004, LambdaRail completed its first main "phase".
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 (see CAPWAP) 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).
MIMO	Multiple input multiple output is the use of multiple antennas at both the transmitter and receiver to improve communication performance
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 Network Management Protocol (SNMP)	A set of network communication specifications that cover all the 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 Bell Labs term originally used in 1962 for the first digitally multiplexed transmission system for voice signals. Present day use indicates a digital carrier facility used to transmit a digital signal 1 or DS1 formatted digital signal at 1.544 megabits per second. This is equivalent to 24 analog lines. T1 transmission uses a bipolar Return To Zero alternate mark inversion line coding scheme.
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.
UMB	UMB (Ultra Mobile Broadband) is the brand name for the project within 3GPP2 to improve the CDMA2000 mobile phone standard for next generation applications and requirements. The system is based upon Internet (TCP/IP) networking technologies running over a next generation radio system, with peak rates of up to 280 Mbit/s. Its designers intend for the system to be more efficient and capable of providing more services than the technologies it replaces. Commercialization is unlikely as Qualcomm, its main developer, 3GPP2 and major CDMA carriers are concentrating on LTE instead. To provide compatibility with the systems it replaces, UMB supports handoffs with other technologies including existing CDMA2000 1X and 1xEV-DO systems. However 3GPP2 added this functionality to LTE, allowing LTE to become the single upgrade path for all wireless networks. According to the technology market research firm ABI Research, Ultra-Mobile Broadband might be "dead on arrival." No carrier has announced plans to adopt UMB, and most CDMA carriers in Australia, USA, China, Japan and Korea have already announced plans to adopt HSPA or LTE.
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).
USOC	Universal Service Ordering Code

Vo-Fi	Voice over Wi-Fi (or wireless VoIP). This is used successfully in hospitals or areas when no hand offs are needed.
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.)
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.
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

Terminology Sources and Links

Information provided in this Glossary was liberally borrowed from a number of Internet sources including the following highly recommended sources:

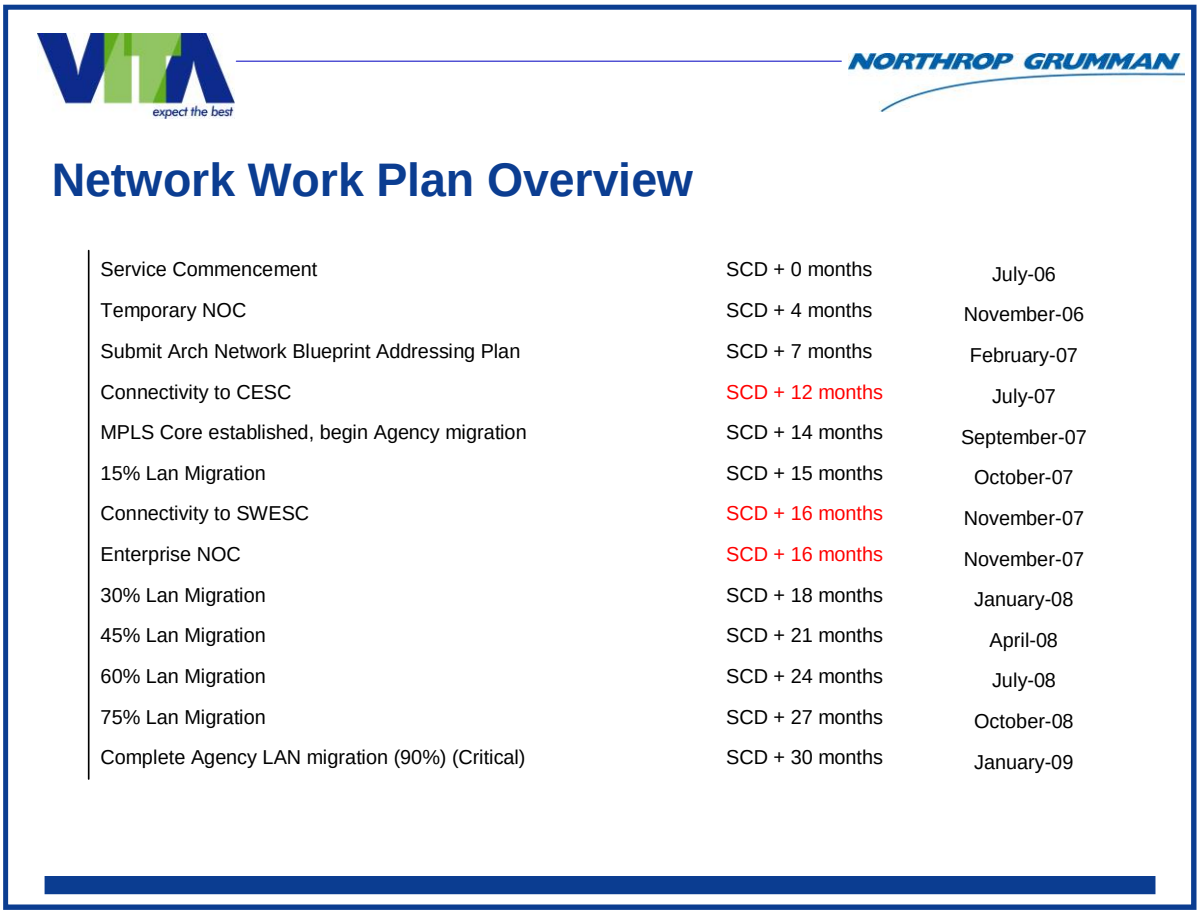
- O'Reilly's (search box at the bottom of the page) http://www.oreilly.com/reference/dictionary/tsearch.cgi
- What Is? http://whatis.techtarget.com/
- Cisco's Glossary of LAN terms http://www.cisco.com/univercd/cc/td/doc/product/lan/trsrb/glossary.htm
- MobilInfo.Com Glossary http://www.mobileinfo.com/Glossary/
- 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
- www.wikipedia.org

Appendix A. 2007-8 Network Domain Team Analysis of Technology Trends

The 2007-8 network domain team identified nine critical technology trends that will shape networking in the future. These critical trends are as follows:

- Wireless communications will escalate eventually replacing many wired networks.
- Mobile networking will increase, and the workforce will expect anytime, anywhere connectivity.
- The line between public and private communications will blur.
- 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.
- Over time, the LAN will continue to decrease in importance and the WAN will take over more and more LAN functions.
- 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

Appendix B. Vita Network Migration Plan Overview



Network Work Plan Overview
Sherilyn Whiting
Booz Allen Hamilton
May 19, 2006
https://vitaweb.virginia.gov/C17/COIN/Document%20Library/Forms/WebFldr.aspx

Appendix C: Protocols by Generation

(Modified from Wikipedia http://en.wikipedia.org/wiki/Comparison_of_wireless_data_standards)

Family	**Past 0, 1, 2G:** Typically Voice and often Analog	**Present 2G** Typically Commercial and Digital	**Present 3G** Typically Digital Voice or Data	**Present/Future (Post 3G; Pre 4G)** Mobile and Digital with IP Packet-based transmission of everything
GSM/UMTS (3GPP) Family		GSM GPRS EDGE (EGPRS 2.75G) EDGE Evolution CSD HSCSD	UMTS (3GSM) HSPA HSDPA (3.5) HSUPA (3.5) HSPA+ UMTS-TDD TD-CDMA TD-SCDMA FOMA	UMTS Rev. 8 (Pre-4G) **LTE** HSOPA (Super 3G)
cdmaOne / CDMA2000 (3GPP2) Family		cdmaOne (2G)	CDMA2000 (3G) EV-DO (1x) IS-856	**UMB** (Pre-4G)
AMPS Family	AMPS (1G) TACS / ETACS	D-AMPS (2G)	n/a	n/a
Other Families	PTT (0G) MTS (0G) IMTS (0G) AMTS (0G) OLT (0G) MTD (0G) Autotel / PALM(0G) ARP (0G) NMT (1G) Hicap (1G) CDPD (1G) Mobitex (1G) DataTAC (1G)	2G iDEN PDC CSD PHS WiDEN	GAN (UMA)	iBurst (Pre-4G) HIPERMAN (Pre-4G) **WiMAX** (Pre-4G) WiBro (Pre-4G)

Appendix D: References, Links and Recommended Reading

General Networking and Telecommunications References:

Forrester:
http://www.forrester.com/

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

Government Computer News:

http://www.gcn.com/

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

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

Information Week:
http://www.informationweek.com/whitepaper/index.jhtml?catID=600001

Standards

Bicsi:

http://www.ietf.org/rfc.html

IEEE:

http://standards.ieee.org/

IETF:

http://www.ietf.org/

http://www.ietf.org/rfc.html

National Institute of Standards and Technology (NIST):
http://www.nist.gov/