

# NATIONAL ENTERPRISE ARCHITECTURE FRAMEWORK KINGDOM OF BAHRAIN

## Technology Standards and Guidelines

### Network Domain



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## 1. INTRODUCTION

This document covers tools, technologies and standards used in the Network domain. The process of arriving at these standards has been outlined in the NEAF - Technology Standards Methodology & Process document in Section 3 - Methodology and Approach. Some of the tools, technologies and standards have been identified as potential requirements and hence been incorporated in this document. These may be considered as recommendations for current and future use.

This document shall be considered for revision in conjunction with the NEAF - Technology Standards Methodology & Process document at appropriate intervals of time as decided by the ICT Governance Committee. Any addition or upgrade to these tools and standards may be incorporated by following the process described in the NEAF - Technology Standards Methodology & Process document in Section 6 - Review and Maintenance of Technology Standards and Guidelines.

## 2. SUMMARY OF TECHNOLOGY STANDARDS/SPECIFICATIONS AND TOOLS

This section contains a summary of standards and tools applicable to the Network domain. These have been grouped into sub-sections (categories), with each category addressing one aspect of the related standards and tools. Further details and links to these standards and tools have been provided in the following sections of this document.

The rationale for selection of these standards and tools are :

- Based on the usage across ministries as captured in the internal survey.
- Technology best practices.
- References from international standards bodies.

2.1. NETWORKING PROTOCOLS	
Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ LAN/WAN Internetworking protocol is required to enable transmission of data from one computer to another on a LAN or WAN based on the computer's unique address on the network.</li> <li>▪ While network transport protocol such as TCP handles packet flow between systems, LAN/WAN Internetworking protocol handles the routing of packets (data) from one computer to another.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ IPv4 – (<a href="#">Details</a>)</li> <li>▪ TCP/IP – (<a href="#">Details</a>)</li> <li>▪ IPv6 – (<a href="#">Details</a>)</li> <li>▪ UDP – (<a href="#">Details</a>)</li> </ul>
Remarks	
Exceptions	

2.2. SUPPORTING NETWORK SERVICES	
Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ Network services are the foundation of a networked computing environment. Generally network services are installed on one or more servers to provide shared resources to client computers.</li> <li>▪ Network services are configured on corporate LAN's to ensure security and user friendly operation. They help the LAN run smoothly and efficiently. Corporate LANs use network services such as DNS (Domain Name System) to give names to IP and MAC addresses (people remember names like "nm.lan" better than they remember numbers like "210.121.67.18"), and DHCP to ensure that everyone on the network has a valid IP address.</li> </ul>

Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ DHCP – (<a href="#">Details</a>)</li> <li>▪ NTP – (<a href="#">Details</a>)</li> <li>▪ DNS – (<a href="#">Details</a>)</li> </ul>
Remarks	
Exceptions	

### 2.3. TRANSPORT TECHNOLOGIES

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ Data Exchange is concerned with the sending of data over a communications network and the definition of data communicated from one application to another. Electronic data and documents can be transmitted using any methodology agreed to by the sender and recipient. It is important to differentiate between the documents formats and the methods for transmitting them.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ SMTP (Email) (<a href="#">Details</a>)</li> <li>▪ FTP (<a href="#">Details</a>)</li> <li>▪ HTTP/HTTPS (<a href="#">Details</a>)</li> <li>▪ SFTP (<a href="#">Details</a>)</li> <li>▪ Web Services – (<a href="#">Details</a>)</li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ None</li> </ul>
Exceptions	<ul style="list-style-type: none"> <li>▪ None</li> </ul>

### 2.4. LOCAL AREA NETWORK

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ A local area network (LAN) is a computer network covering a small physical area, like a home, office, or small group of buildings, such as a school, or an airport. The defining characteristics of LANs, in contrast to wide-area networks (WANs), include their usually higher data-transfer rates, smaller geographic place, and lack of a need for leased telecommunication lines.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ LAN Cabling - (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ Category 6 and Category 6a Unshielded Twisted Pair</li> <li>○ Category 7 Ethernet Cabling Standard</li> </ul> </li> <li>▪ LAN Protocol - (<a href="#">Details</a>)</li> </ul>

	<ul style="list-style-type: none"> <li>○ IEEE 802.3u Fast Ethernet (100 Mbit/s) or a higher bandwidth Ethernet service (e.g., up to 802.3an 10 Gbit/s Ethernet over unshielded twisted pair (UTP))</li> <li>▪ Virtual LAN - (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ IEEE 802.1Q – VLAN Tagging</li> </ul> </li> <li>▪ Network Access Control - (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ IEEE 802.1X</li> </ul> </li> </ul>
Remarks	
Exceptions	

## 2.5. WIRELESS NETWORKS

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ A wireless local area network (WLAN) links devices via a wireless distribution method (typically spread-spectrum or OFDM) and usually provides a connection through an access point to the wider Internet. This gives users the mobility to move around within a local coverage area and still be connected to the network.</li> <li>▪ Wireless LANs have become popular in the home due to ease of installation and the increasing popularity of laptop computers. Public businesses such as coffee shops and malls have begun to offer wireless access to their customers, sometimes for free. Large wireless network projects are being put up in many major cities: New York City, for instance, has begun a pilot program to cover all five boroughs of the city with wireless Internet access.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ Wireless LAN – (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ IEEE 802.11 b/g/n</li> </ul> </li> <li>▪ Wireless MAN – (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ IEEE 802.16 – WiMAX</li> </ul> </li> <li>▪ Wireless Network Security – (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ IEEE 802.11i – WPA2 and WPA2-PSK</li> </ul> </li> </ul>
Remarks	
Exceptions	

## 2.6. WIDE AREA NETWORKS

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ A wide area network (WAN) is a computer network that covers a broad area (i.e., any network whose communications links cross metropolitan, regional, or national boundaries).</li> <li>▪ This is in contrast with personal area networks (PANs), local area</li> </ul>
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	networks (LANs), campus area networks (CANs), or metropolitan area networks (MANs) which are usually limited to a room, building, campus or specific metropolitan area (e.g., a city) respectively.
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ MPLS – (<a href="#">Details</a>)</li> <li>▪ SONET/SDH (Fiber Optic) – (<a href="#">Details</a>)</li> <li>▪ Leased Lines – (<a href="#">Details</a>)</li> <li>▪ xDSL – (<a href="#">Details</a>)</li> </ul>
Remarks	
Exceptions	

## 2.7. VIRTUAL PRIVATE NETWORKS (VPN)

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ A virtual private network (VPN) is a computer network in which some of the links between nodes are carried by open connections or virtual circuits in some larger networks (such as the Internet), as opposed to running across a single private network.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ IPSec – (<a href="#">Details</a>)</li> <li>▪ SSL – (<a href="#">Details</a>)</li> </ul>
Remarks	
Exceptions	

## 2.8. LOAD BALANCING

Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ In computer networking, load balancing is a technique to distribute workload evenly across two or more resources, in order to get optimal resource utilization, maximize throughput, minimize response time, and avoid overload. Using multiple components with load balancing, instead of a single component, may increase reliability through redundancy. Load balancers can be software based (often come as an integrated component of web servers and application servers) or hardware based (routing TCP/IP packets). However the field has seen growth from network load balancers, to traffic managers, to the present day application delivery controllers. Research groups are focusing on shifting the attention from basic load-balancing features to application delivery features to aid in the deployment and delivery of applications.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ F5 – (<a href="#">Details</a>)</li> <li>▪ Citrix – (<a href="#">Details</a>)</li> </ul>



	<ul style="list-style-type: none"> <li>▪ Cisco – (<a href="#">Details</a>)</li> <li>▪ Radware – (<a href="#">Details</a>)</li> </ul>
Remarks	
Exceptions	

2.9. NETWORK HARDWARE COMPONENTS	
Introduction to Sub-Category	<ul style="list-style-type: none"> <li>▪ All networks are made up of basic hardware building blocks to interconnect network nodes, such as Bridges, Hubs, Switches, Wireless Access Points, and Routers.</li> </ul>
Applicable Standard(s)	<ul style="list-style-type: none"> <li>▪ Cisco – (<a href="#">Details</a>)</li> <li>▪ HP Networking – (<a href="#">Details</a>)</li> <li>▪ Juniper – (<a href="#">Details</a>)</li> <li>▪ Wireless Network Devices – (<a href="#">Details</a>) <ul style="list-style-type: none"> <li>○ Cisco – (<a href="#">Details</a>)</li> <li>○ Airlive</li> <li>○ D-Link</li> <li>○ Redline Communications</li> </ul> </li> </ul>
Remarks	
Exceptions	

### 3. DETAILS OF STANDARDS / SPECIFICATIONS AND ASSOCIATED GUIDELINES

This section provides a brief description of the relevant standards listed in section 2 along with links for references to these standards.

3.1. IPV4	
Description	<ul style="list-style-type: none"><li>The Internet Protocol (IP), defined by IETF RFC791, is the routing layer datagram service of the TCP/IP suite. All other protocols within the TCP/IP suite, except ARP and RARP, use IP to route frames from host to host. The IP frame header contains routing information and control information associated with datagram delivery.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>LAN/WAN interworking</li></ul>
Reference(s)	<ul style="list-style-type: none"><li><a href="http://www.protocols.com/pbook/tcpip2.htm#IP">http://www.protocols.com/pbook/tcpip2.htm#IP</a></li></ul>
Remarks:	<ul style="list-style-type: none"><li>IPv4 uses 32-bit (four-byte) addresses, which limits the address space to 4,294,967,296 (2<sup>32</sup>) possible unique addresses. However, some are reserved for special purposes such as private networks (~18 million addresses) or multicast addresses (~270 million addresses). This reduces the number of addresses that can potentially be allocated for routing on the public Internet.</li><li>As addresses are being incrementally delegated to end users, an IPv4 address shortage has been developing. However, network addressing architecture redesign via classful network design, Classless Inter-Domain Routing, and network address translation (NAT) has contributed to delay significantly the inevitable exhaustion.</li></ul>

3.2. TCP	
Description	<ul style="list-style-type: none"><li>The Transmission Control Protocol (TCP) is intended for use as a highly reliable host-to-host protocol between hosts in packet-switched computer communication networks, and in interconnected systems of such networks.</li><li>TCP is a connection-oriented, end-to-end reliable protocol designed to fit into a layered hierarchy of protocols which support multi-network applications. The TCP provides for reliable inter-process communication between pairs of processes in host computers attached to distinct but interconnected computer communication networks.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>Network Transport</li></ul>

Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://www.rfc-editor.org/rfc/rfc793.txt">http://www.rfc-editor.org/rfc/rfc793.txt</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ Transmission Control Protocol/Internet Protocol (TCP/IP) to interconnect various defence department computer networks. The Internet uses TCP/IP to connect government and educational institutions across the world.</li> </ul>

3.3. UDP	
Description	<ul style="list-style-type: none"> <li>▪ UDP is an alternative to TCP. It uses the IP to actually get a data unit (called a datagram) from one computer to another. Unlike TCP, UDP is a connectionless protocol, therefore it does not divide a message into packets (datagrams) and reassemble it at the other end nor guarantee that messages will arrive at the destination in the correct sequence. These characteristics of UDP show that it cannot be relied on for data delivery.</li> <li>▪ UDP is preferred when network applications that want to save processing time (speed) because they have very small data units to exchange i.e. very little message reassembling to be done.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Network Transport</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://tools.ietf.org/html/rfc2460">http://tools.ietf.org/html/rfc2460</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ UDP is a matured standard that was filed in 1980.</li> <li>▪ Widely adopted by relevant products.</li> </ul>

3.4. 802.11 B/G/N	
Description	<ul style="list-style-type: none"> <li>▪ The 802.11 family includes over-the-air modulation techniques that use the same basic protocol. The most popular are those defined by the 802.11b and 802.11g protocols, which are amendments to the original standard. 802.11-1997 was the first wireless networking standard, but 802.11b was the first widely accepted one, followed by 802.11g and 802.11n. Security was originally purposefully weak due to export requirements of some governments, and was later enhanced via the 802.11i amendment after governmental and legislative changes. 802.11n is a new multi-streaming modulation technique. Other standards in the family (c-f, h, j) are service amendments and extensions or corrections to the previous specifications.</li> </ul>

Applicable to	<ul style="list-style-type: none"> <li>Wireless LAN</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li><a href="http://standards.ieee.org/getieee802/download/802.11-2007.pdf">http://standards.ieee.org/getieee802/download/802.11-2007.pdf</a></li> <li><a href="http://standards.ieee.org/getieee802/802.11.html">http://standards.ieee.org/getieee802/802.11.html</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>IEEE 802.11 g/n are most widely used for Wireless LAN.</li> <li>IEEE 802.11 g/n is the most widely available and implemented wireless LANs today.</li> <li>The specification was accepted by the IEEE in 1997.</li> <li>802.11 g/n compliant products are readily available now.</li> </ul>

### 3.5. MPLS

Description	<ul style="list-style-type: none"> <li>MPLS Transport Profile (MPLS-TP) is the name of a technology being standardized by the IETF with support from and partly based on requirements from the ITU-T.</li> <li>Multiprotocol Label Switching (MPLS) is a mechanism in high-performance telecommunications networks which directs and carries data from one network node to the next. MPLS makes it easy to create "virtual links" between distant nodes. It can encapsulate packets of various network protocols. MPLS is a highly scalable, protocol agnostic, data-carrying mechanism.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>WAN</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li><a href="http://wiki.tools.ietf.org/misc/mpls-tp/">http://wiki.tools.ietf.org/misc/mpls-tp/</a></li> <li><a href="http://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.html">http://www.cisco.com/en/US/products/ps6557/products_ios_technology_home.html</a></li> <li>MPLS at IETF <a href="http://www.ietf.org/html.charters/mpls-charter.html">http://www.ietf.org/html.charters/mpls-charter.html</a></li> <li>Broadband and IP/MPLS Forum <a href="http://www.broadband-forum.org/">http://www.broadband-forum.org/</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>(MPLS) enables Enterprises and Service Providers to build next-generation intelligent networks that deliver a wide variety of advanced, value-added services over a single infrastructure.</li> </ul>

### 3.6. DHCP

Description	<ul style="list-style-type: none"> <li>Dynamic Host Configuration Protocol (DHCP) is a network protocol for automatically assigning TCP/IP information to client machines. Each DHCP client connects to the centrally-located DHCP server which returns that client's network configuration including IP address, gateway, and DNS servers.</li> </ul>
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Applicable to	<ul style="list-style-type: none"> <li>Network Services</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li><a href="http://tools.ietf.org/html/rfc2131">http://tools.ietf.org/html/rfc2131</a></li> <li><a href="https://rhn.redhat.com/errata/RHSA-2009-0046.html">https://rhn.redhat.com/errata/RHSA-2009-0046.html</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>DHCP is useful for fast delivery of client network configuration. When configuring the client system, the administrator can choose DHCP and not have to enter an IP address, netmask, gateway, or DNS servers.</li> <li>The client retrieves this information from the DHCP server. DHCP is also useful if an administrator wants to change the IP addresses of a large number of systems.</li> </ul>

### 3.7. NTP

Description	<ul style="list-style-type: none"> <li>The Network Time Protocol (NTP) is used to synchronize a computer's time with a referenced time source.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Network Services</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li><a href="http://support.ntp.org/bin/view/Main/WebHome">http://support.ntp.org/bin/view/Main/WebHome</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>NTP uses Marzullo's algorithm, and includes support for features such as leap seconds. NTPv4 can usually maintain time to within 10 milliseconds (1/100 s) over the public Internet, and can achieve accuracies of 200 microseconds (1/5000 s) or better in local area networks under ideal conditions.</li> <li>NTP provides Coordinated Universal Time (UTC). No information about time zones or daylight saving time is transmitted; this information is outside its scope and must be obtained separately. In isolated LANs, NTP could in principle be used to distribute a different time scale (e.g. local zone time), but this is uncommon.</li> </ul>

### 3.8. LAN PROTOCOL

Description	<ul style="list-style-type: none"> <li>IEEE 802.3 is a collection of IEEE standards defining the physical layer, and the media access control (MAC) sublayer of the data link layer, of wired Ethernet. This is generally a LAN technology with some WAN applications. Physical connections are made between</li> </ul>
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	nodes and/or infrastructure devices (hubs, switches, routers) by various types of copper or fiber cable.
Applicable to	<ul style="list-style-type: none"> <li>▪ Local Area Networking</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ IEEE 802.3 ETHERNET WORKING GROUP <a href="http://www.ieee802.org/3/">http://www.ieee802.org/3/</a></li> <li>▪ IEEE 802.3 at Wikipedia <a href="http://en.wikipedia.org/wiki/IEEE_802.3">http://en.wikipedia.org/wiki/IEEE_802.3</a></li> </ul>
Remarks	

### 3.9. LAN CABLING

Description	<ul style="list-style-type: none"> <li>• Category 6 cable, commonly referred to as Cat-6, is a cable standard for Gigabit Ethernet and other network protocols that is backward compatible with the Category 5/5e and Category 3 cable standards.</li> <li>• Category 6a cable, commonly referred to as Cat-6a provides enhanced performance standards for twisted pair cable systems. Cat6a can currently support 10 Gbit/s applications</li> <li>• Category 5e cable (Cat 5e) is an enhanced version of Cat 5 that adds specifications for far end crosstalk. It was formally defined in 2001 as the TIA/EIA-568-B standard, which no longer recognizes the original Cat 5 specification.</li> <li>• Category 7 cable (Cat 7) is cables standard for Ethernet and other interconnect technologies that can be made to be backwards compatible with traditional Cat 5 and Cat 6 Ethernet cable.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Local Area Networking</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ Category 5 cable - TIA/EIA-568-B <a href="http://en.wikipedia.org/wiki/TIA/EIA-568-B">http://en.wikipedia.org/wiki/TIA/EIA-568-B</a></li> <li>▪ Category 6 cable - TIA/EIA-568-B <a href="http://en.wikipedia.org/wiki/TIA/EIA-568-B">http://en.wikipedia.org/wiki/TIA/EIA-568-B</a></li> <li>▪ Category 6a cable - ANSI/TIA/EIA-568-B.2-10 <a href="http://en.wikipedia.org/wiki/Category_6_cable">http://en.wikipedia.org/wiki/Category_6_cable</a></li> <li>▪ Category 7 cable - ISO/IEC 11801 - <a href="http://en.wikipedia.org/wiki/ISO/IEC_11801">http://en.wikipedia.org/wiki/ISO/IEC_11801</a></li> </ul>
Remarks	

### 3.10. VIRTUAL LAN

Description	<ul style="list-style-type: none"> <li>• IEEE 802.1Q, or VLAN Tagging, is a networking standard written by the IEEE 802.1 workgroup allowing multiple bridged networks to transparently share the same physical network link without leakage of information between networks. IEEE 802.1Q — along with its shortened form dot1q — is commonly used to refer to the encapsulation protocol used to implement this mechanism over Ethernet networks.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Local Area Networking</li> </ul>
Reference(s)	

	<ul style="list-style-type: none"> <li>IEEE 802.1Q <a href="http://standards.ieee.org/getieee802/download/802.1Q-2005.pdf">http://standards.ieee.org/getieee802/download/802.1Q-2005.pdf</a></li> </ul>
Remarks	

### 3.11. NETWORK (LAN) ACCESS CONTROL

Description	<ul style="list-style-type: none"> <li>IEEE 802.1X is an IEEE Standard for port-based Network Access Control ("port" meaning a single point of attachment to the LAN infrastructure). It is part of the IEEE 802.1 group of networking protocols. It provides an authentication mechanism to devices wishing to attach to a LAN, either establishing a point-to-point connection or preventing it if authentication fails.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Local Area Networking</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>IEEE 802.1X <a href="http://www.ieee802.org/1/pages/802.1x-2004.html">http://www.ieee802.org/1/pages/802.1x-2004.html</a></li> </ul>
Remarks	

### 3.12. TCP/IP

Description	<ul style="list-style-type: none"> <li>The Internet Protocol Suite (commonly known as TCP/IP) is the set of communications protocols used for the Internet and other similar networks. It is named from two of the most important protocols in it: the Transmission Control Protocol (TCP) and the Internet Protocol (IP), which were the first two networking protocols defined in this standard. The TCP/IP protocol suite consists of protocols across four layers - from lowest to highest, these are the Link Layer, the Internet Layer, the Transport Layer, and the Application Layer.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Network Protocols</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>TCP/IP tutorial from Internet Engineering Task Force (IETF) <a href="http://tools.ietf.org/html/rfc1180">http://tools.ietf.org/html/rfc1180</a></li> </ul>
Remarks	

### 3.13. IPv6

Description	<ul style="list-style-type: none"> <li>Internet Protocol version 6 (IPv6) is the next-generation Internet Protocol version designated as the successor to IPv4. It is an Internet Layer protocol for packet-switched internetworks. The main driving force for the redesign of Internet Protocol was the foreseeable IPv4 address exhaustion. IPv6 was defined in December 1998 by the Internet Engineering Task Force (IETF) with the publication of an Internet standard specification, RFC 2460.</li> </ul>
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Applicable to	<ul style="list-style-type: none"> <li>Network Protocols</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>IPv6 at Internet Engineering Task Force (IETF) <a href="http://tools.ietf.org/html/rfc2460">http://tools.ietf.org/html/rfc2460</a></li> </ul>
Remarks	

### 3.14. DNS

Description	<ul style="list-style-type: none"> <li>The Domain Name System (DNS) is a distributed internet directory service. DNS is used mostly to translate between domain names and IP addresses, and to control email delivery. Most internet services rely on DNS to work. If DNS fails or is too slow, web sites cannot be located and email delivery stalls. The DNS system consists of three components: DNS data (called resource records), servers (called name servers), and Internet protocols for fetching data from the servers.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Domain Name Services</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li><a href="http://www.dns.net/dnsrd/docs/whatis.html">http://www.dns.net/dnsrd/docs/whatis.html</a></li> <li><a href="http://www.dns.net/dnsrd/rfc/">http://www.dns.net/dnsrd/rfc/</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>By itself, DNS doesn't appear to do much, and on top of that, DNS can seem a bit intimidating because it has number of different features and record types. One key to understanding the importance of DNS is realizing how other processes and applications depend on the services DNS provides.</li> <li>By understanding how DNS provides the underlying services used by various applications, you can get a clearer picture of why DNS exists and how it works. Many common applications use DNS services, including World Wide Web (WWW) E-mail other applications, such as instant messaging.</li> </ul>

### 3.15. SONET/SDH (FIBRE OPTICS)

Description	<ul style="list-style-type: none"> <li>Synchronous optical networking (SONET) and Synchronous Digital Hierarchy (SDH) are standardized multiplexing protocols that transfer multiple digital bit streams over optical fiber using lasers or light-emitting diodes (LEDs). Lower rates can also be transferred via an electrical interface. They are characterized by standard line rates, optical interfaces, and signal formats.</li> </ul>
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Applicable to	<ul style="list-style-type: none"> <li>Wide Area Network (WAN) Technologies</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>ANSI T1.105: SONET - Basic Description including Multiplex Structure, Rates and Formats</li> <li>ITU-T recommendation G.707, G.783 and G.803 for SDH</li> </ul>
Remarks	

### 3.16. LEASED LINES

Description	<ul style="list-style-type: none"> <li>A leased line is a symmetric telecommunications line connecting two locations. It is sometimes known as a 'Private Circuit' or 'Data Line' in the UK. Unlike traditional PSTN lines it does not have a telephone number, each side of the line being permanently connected to the other. Leased lines can be used for telephone, data or Internet services.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Wide Area Network (WAN) Technologies</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>Leased Lines <a href="http://en.wikipedia.org/wiki/Leased_line">http://en.wikipedia.org/wiki/Leased_line</a></li> </ul>
Remarks	

### 3.17. xDSL

Description	<ul style="list-style-type: none"> <li>DSL or xDSL is a family of technologies that provides digital data transmission over the wires of a local telephone network. DSL can be used at the same time and on the same telephone line with regular telephone, as it uses high frequency bands, while regular telephone uses low frequency.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Wide Area Network (WAN) Technologies</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>xDSL <a href="http://en.wikipedia.org/wiki/Digital_subscriber_line">http://en.wikipedia.org/wiki/Digital_subscriber_line</a></li> </ul>
Remarks	

### 3.18. WIRELESS MAN (WiMAX)

Description	<ul style="list-style-type: none"> <li>IEEE 802.16 is a series of Wireless Broadband standards authored by the IEEE. Although the 802.16 family of standards is officially called WirelessMAN in IEEE, it has been commercialized under the name "WiMAX" (from "Worldwide Interoperability for Microwave Access") by the industry alliance called the WiMAX Forum. The mission of the Forum is to promote and certify compatibility and interoperability of broadband wireless</li> </ul>
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	products based on the IEEE 802.16 standards.
Applicable to	<ul style="list-style-type: none"> <li>▪ Wireless LAN</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ WiMAX Forum <a href="http://www.wimaxforum.org/">http://www.wimaxforum.org/</a>,</li> <li>▪ <a href="http://www.wimaxforum.org/resources/documents/marketing/analyst_reports">http://www.wimaxforum.org/resources/documents/marketing/analyst_reports</a></li> </ul>
Remarks	

### 3.19. WIRELESS NETWORK SECURITY

Description	<ul style="list-style-type: none"> <li>▪ 802.11i is an amendment to the original IEEE 802.11 standard specifying security mechanisms for wireless networks. It replaced the short Authentication and privacy clause of the original standard with a detailed Security clause, in the process deprecating the broken WEP. WPA2 implements the mandatory elements of 802.11i. In particular, it introduces a new AES-based algorithm, CCMP, which is considered fully secure. Pre-shared key mode (PSK, also known as Personal mode) is designed for home and small office networks that don't require the complexity of an 802.1X authentication server. The 802.11i architecture contains the following components: 802.1X for authentication, RSN for keeping track of associations, and AES-based CCMP to provide confidentiality, integrity, and origin authentication.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Wireless LAN</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ IEEE 802.11 Working Group <a href="http://www.ieee802.org/11/">http://www.ieee802.org/11/</a></li> <li>▪ 802.11i at Wikipedia <a href="http://en.wikipedia.org/wiki/WPA2-PSK">http://en.wikipedia.org/wiki/WPA2-PSK</a></li> </ul>
Remarks	

### 3.20. SMTP (EMAIL)

Description	<ul style="list-style-type: none"> <li>▪ Simple Mail Transport Protocol (SMTP) is the protocol used to deliver or relay e-mail messages.</li> <li>▪ Multipurpose Internet Mail Extensions (MIME) is a specification for enhancing the capabilities of standard Internet electronic mail.</li> <li>▪ It offers a simple standardized way to represent and encode a wide variety of media types for transmission via Internet mail.</li> </ul>
Applicable to:	<ul style="list-style-type: none"> <li>▪ Data Exchange Transport Technology</li> </ul>

Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://www.ietf.org/rfc/rfc0821.txt">http://www.ietf.org/rfc/rfc0821.txt</a></li> <li>▪ <a href="http://www.networksorcery.com/enp/protocol/smtp.htm">http://www.networksorcery.com/enp/protocol/smtp.htm</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ SMTP/MIME are globally recognized, matured and widely adopted standards.</li> <li>▪ Widely supported by common email packages such as Netscape Messenger, Microsoft Outlook and Outlook Express, and Lotus Notes.</li> </ul>

3.21. FTP	
Description	<ul style="list-style-type: none"> <li>▪ The File Transfer Protocol (FTP) is a standard internet protocol to enable the exchange of files between computers on the Internet. It enables users to move large files of any sort (i.e., video clips, large documents, audio or multi-media clips) between computers.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Data Exchange Transport Technology</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://www.ietf.org/rfc/rfc959.txt">http://www.ietf.org/rfc/rfc959.txt</a></li> <li>▪ <a href="http://cr.yip.to/ftp.html">http://cr.yip.to/ftp.html</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ FTP is a global, matured and widely adopted standard. FTP is a proposed IETF standard defined in RFC 959 "File Transfer Protocol (FTP)".</li> <li>▪ Widely adopted and supported by relevant products.</li> </ul>

3.22. HTTP/S	
Description	<ul style="list-style-type: none"> <li>▪ HTTP is an application-level protocol for distributed, collaborative, hypermedia information systems. It is the set of rules for exchanging files (text, graphic images, sound, video, and other multimedia files) on the World Wide Web.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Data Exchange Transport Technology</li> </ul>
Reference(s)	

	<ul style="list-style-type: none"> <li>▪ <a href="http://www.ietf.org/rfc/rfc2616.txt">http://www.ietf.org/rfc/rfc2616.txt</a></li> <li>▪ <a href="http://www.w3.org/Protocols/">http://www.w3.org/Protocols/</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ HTTP is a global, matured and widely adopted standard.</li> <li>▪ HTTP has been in use by the World Wide Web global information initiative since 1990.</li> <li>▪ Version 1.1 is currently the most widely used and latest version of this standard.</li> <li>▪ Widely adopted and supported by all web servers and browsers.</li> </ul>

<b>3.23. SFTP</b>	
Description	<ul style="list-style-type: none"> <li>▪ In computing, the SSH File Transfer Protocol (sometimes called Secure File Transfer Protocol or SFTP) is a network protocol that provides file access, file transfer, and file management functionality over any reliable data stream.</li> <li>▪ It was designed by the Internet Engineering Task Force (IETF) as an extension of the Secure Shell protocol (SSH) version 2.0 to provide secure file transfer capability, but is also intended to be usable with other protocols as well. It could be used in a number of different applications, such as secure file transfer over Transport Layer Security (TLS) and transfer of management information in VPN applications.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Data Exchange Transport Technology</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://winscp.net/eng/index.php">http://winscp.net/eng/index.php</a></li> <li>▪ <a href="http://www.mksoftware.com/docs/man1/sftp.1.asp">http://www.mksoftware.com/docs/man1/sftp.1.asp</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ SFTP protocol allows for a range of operations on remote files – it is more like a remote file system protocol.</li> <li>▪ SFTP attempts to be more platform-independent than SCP; for instance, with SCP, the expansion of wildcards specified by the client is up to the server, whereas SFTP's design avoids this problem. While SCP is most frequently implemented on UNIX platforms, SFTP servers are commonly available on most platforms.</li> </ul>

### 3.24. WEB SERVICES

Description	<ul style="list-style-type: none"><li>Web Service is a software system designed to support interoperable machine-to-machine interaction over a network. Web services are frequently just Internet Application Programming Interfaces (API) that can be accessed over a network, such as the Internet, and executed on a remote system hosting the requested services.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>Data Exchange Transport Technologies</li></ul>
Reference(s)	<ul style="list-style-type: none"><li>Web Services on World Wide Web Consortium <a href="http://www.w3.org/2002/ws">http://www.w3.org/2002/ws</a></li></ul>
Remarks	<ul style="list-style-type: none"><li>This is the most transparent way to exchange data. The current developments in web services have ensured secure and reliable exchange of even the most sensitive data.</li></ul>

### 3.25. IPSEC

Description	<ul style="list-style-type: none"><li>Internet Protocol Security (IPsec) is a protocol suite for securing Internet Protocol (IP) communications by authenticating and encrypting each IP packet of a data stream. IPsec also includes protocols for establishing mutual authentication between agents at the beginning of the session and negotiation of cryptographic keys to be used during the session.</li><li>IPsec can be used to protect data flows between a pair of hosts (e.g. computer users or servers), between a pair of security gateways (e.g. routers or firewalls), or between a security gateway and a host.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>VPN</li></ul>
Reference(s)	<ul style="list-style-type: none"><li><a href="http://tools.ietf.org/html/rfc4306">http://tools.ietf.org/html/rfc4306</a> (Obsolete)</li><li><a href="http://tools.ietf.org/html/rfc5998">http://tools.ietf.org/html/rfc5998</a></li><li></li></ul>
Remarks	<ul style="list-style-type: none"><li>IPsec is a successor of the ISO standard Network Layer Security Protocol (NLSP). NLSP was based on the SP3 protocol that was published by NIST, but designed by the Secure Data Network System project of the National Security Agency (NSA).</li><li>IPsec is officially specified by the Internet Engineering Task Force (IETF) in a series of Requests for Comment addressing various components and extensions, including the</li></ul>

	official capitalization style of the term.
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3.26. SSL	
Description	<ul style="list-style-type: none"> <li>▪ Secure Socket Layer (SSL), are cryptographic protocols that provide security for communications over networks such as the Internet. SSL encrypt the segments of network connections at the Transport Layer end-to-end.</li> <li>▪ Several versions of the protocols are in widespread use in applications like web browsing, electronic mail, Internet faxing, instant messaging and voice-over-IP (VoIP).</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ VPN</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ <a href="http://tools.ietf.org/html/rfc5246">http://tools.ietf.org/html/rfc5246</a></li> <li>▪ <a href="http://tools.ietf.org/html/rfc5746">http://tools.ietf.org/html/rfc5746</a></li> <li>▪ <a href="http://tools.ietf.org/html/rfc5878">http://tools.ietf.org/html/rfc5878</a></li> <li>▪ <a href="http://tools.ietf.org/html/rfc6176">http://tools.ietf.org/html/rfc6176</a></li> </ul>
Remarks	<ul style="list-style-type: none"> <li>▪ It is mainly used to ensure authenticity and integrity to communications</li> </ul>

## 4. DETAILS OF TOOLS SUPPORTING RECOMMENDED STANDARDS

This section provides a brief description of the relevant tools listed in section 2 along with links for references to these tools.

4.1. F5 LOAD BALANCER	
Description	<ul style="list-style-type: none"><li>F5 Offers the feature-rich AP ADC, combined with excellent performance and programmability. It has strong focus on applications, including long-term relationships with major application vendors, including Microsoft, Oracle and SAP.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>Load Balancing</li></ul>
Reference(s)	<ul style="list-style-type: none"><li>F5 Network <a href="http://www.f5.com/solutions/availability/">http://www.f5.com/solutions/availability/</a></li><li><a href="http://devcentral.f5.com/weblogs/macvittie/archive/2009/04/20/itrsquos-like-load-balancing.-on-steroids.aspx">http://devcentral.f5.com/weblogs/macvittie/archive/2009/04/20/itrsquos-like-load-balancing.-on-steroids.aspx</a></li></ul>
Remarks	

4.2. CITRIX LOAD BALANCER	
Description	<ul style="list-style-type: none"><li>Citrix has AP ADC with excellent performance, combined with leading client code. It has a broad product line, including highly scalable multisystem clusters.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>Load Balancing</li></ul>
Reference(s)	<ul style="list-style-type: none"><li>Citrix Systems <a href="http://www.citrix.com/lang/English/home.asp">http://www.citrix.com/lang/English/home.asp</a>, <a href="http://www.citrix.com/English/ps2/products/product.asp?contentID=21679">http://www.citrix.com/English/ps2/products/product.asp?contentID=21679</a></li></ul>
Remarks	

4.3. CISCO LOAD BALANCER	
Description	<ul style="list-style-type: none"><li>Cisco has a large installed base of Content Services Switch/Content Switching Module (CSS/CSM) and a broad product portfolio related to the ADC market.</li></ul>
Applicable to	<ul style="list-style-type: none"><li>Load Balancing</li></ul>
Reference(s)	<ul style="list-style-type: none"><li>Cisco Systems <a href="http://www.cisco.com/">http://www.cisco.com/</a>, <a href="http://www.cisco.com/en/US/products/ps6906/index.html">http://www.cisco.com/en/US/products/ps6906/index.html</a>, <a href="http://www.cisco.com/en/US/products/hw/contnetw/ps792/index.html">http://www.cisco.com/en/US/products/hw/contnetw/ps792/index.html</a></li></ul>

Remarks	
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#### 4.4. RADWARE LOAD BALANCER

Description	<ul style="list-style-type: none"> <li>Radware has a clear vision of the market and the evolution of its product offering. Its products provide a strong feature set covering availability, performance and security.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Load Balancing</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>Radware <a href="http://www.radware.com/">http://www.radware.com/</a>, <a href="http://www.radware.com/Products/ApplicationDelivery/default.aspx">http://www.radware.com/Products/ApplicationDelivery/default.aspx</a></li> </ul>
Remarks	

#### 4.5. CISCO

Description	<ul style="list-style-type: none"> <li>Cisco Systems is a multinational corporation and a leading manufacturer of network infrastructure devices including Switches, Routers, Security appliances and Cisco Wireless LAN products</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Network Hardware Components</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>Cisco System <a href="http://www.cisco.com/en/US/products/index.html">http://www.cisco.com/en/US/products/index.html</a></li> </ul>
Remarks	

#### 4.6. HP NETWORKING

Description	<ul style="list-style-type: none"> <li>3Com is a manufacturer best known for its computer network infrastructure products. 3Com is a global provider of enterprise and small-business networking solutions.</li> <li>HP ProCurve Networking is the networking division of HP. They produce a line of network switches, wireless access points, WAN routers, and Access Control Servers/Software sold under the "HP ProCurve Networking" brand name. ProCurve is the world's second-largest vendor of networking switches based on port count and revenue</li> <li>HP acquired 3Com and renamed it's networking division from HP ProCurve to HP Networking in April 2010</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>Network Hardware Components</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>HP Networking - <a href="http://h17007.www1.hp.com/us/en/index.aspx">http://h17007.www1.hp.com/us/en/index.aspx</a></li> </ul>



	<ul style="list-style-type: none"> <li>▪ <a href="http://en.wikipedia.org/wiki/HP_Networking_Products">http://en.wikipedia.org/wiki/HP_Networking_Products</a></li> </ul>
Remarks	

4.7. JUNIPER	
Description	<ul style="list-style-type: none"> <li>▪ Juniper is an information technology and computer networking products multinational company. The Juniper products are widely used in the large networks around the world and it is a leader in high-performance networking.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Network Hardware Components</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ Juniper Networks <a href="http://www.juniper.net/us/en/products-services/">http://www.juniper.net/us/en/products-services/</a></li> </ul>
Remarks	

4.8. WIRELESS NETWORK DEVICES	
Description	<ul style="list-style-type: none"> <li>▪ Airlive is a well known manufacturer of wireless internet router, outdoor CPE and other wireless related products.</li> <li>▪ D-Link is a designer, developer, and manufacturer of networking solutions for both the consumer and business markets and market leader in Wi-Fi product shipments worldwide.</li> <li>▪ Redline Communications is the leading provider of broadband wireless access and backhaul products. Redline's products enable carriers and service providers to establish fixed and mobile broadband wireless networks.</li> </ul>
Applicable to	<ul style="list-style-type: none"> <li>▪ Network Hardware Components</li> </ul>
Reference(s)	<ul style="list-style-type: none"> <li>▪ Airlive <a href="http://www.airlive.com/product/product_2.jsp?pcid=PC1217313596115">http://www.airlive.com/product/product_2.jsp?pcid=PC1217313596115</a></li> <li>▪ D-Link <a href="http://www.dlink.com">http://www.dlink.com</a></li> <li>▪ Redline Communications <a href="http://www.redlinecommunications.com">http://www.redlinecommunications.com</a></li> </ul>
Remarks	

## 5. APPENDICES

### 5.1. APPENDIX A: ABBREVIATIONS AND ACRONYMS

Abbreviation / Acronym	Network
ipv4, ipv6	Internet Protocol Version 4,6
TCP/UDP	Transmission Control Protocol
UDP	User Datagram Protocol
WLAN	Wireless Local Area Network
RADIUS	Remote Authentication Dial In User Service
TACACS	Terminal Access Controller Access-Control System
MPLS	Multiprotocol Label Switching
DHCP	Dynamic Host Configuration Protocol
NTP	Network Time Protocol
TCP/IP	Transmission Control Protocol / Internet Protocol
IEEE	Institute of Electrical and Electronics Engineers
WiMAX	Worldwide Interoperability for Microwave Access
WPA2	Wi-Fi Protected Access 2
WPA2-PSK	Wi-Fi Protected Access 2 - Pre-Shared Key
SONET/SDH	Synchronous Optical Networking / Synchronous Digital Hierarchy
xDSL	Digital Subscriber Line
DNS	Domain Name System

## 5.2. APPENDIX B: RELATED DOCUMENTS / LINKS

### Acknowledgement of major references for international technology standards and Specifications:

- Internet Engineering Task Force (IETF)  
<http://www.ietf.org>
- International Standards Organization (ISO)  
<http://www.iso.org>
- World Wide Web Consortium (W3C)  
<http://www.w3c.org>

### Acknowledgement of other references for international technology standards and specifications:

- American National Standards Institute (ANSI)  
<http://www.ansi.org>
- ECMA International  
<http://www.ecma-international.org>
- Institute of Electrical and Electronics Engineers (IEEE)  
<http://www.ieee.org>
- National Institute of Standards and Technology (NIST)  
<http://www.nist.gov>
- Object Management Group (OMG)  
<http://www.omg.org>
- Open Mobile Alliance (OMA) and WAP Forum  
<http://www.openmobilealliance.org>  
<http://www.wapforum.org>
- Organization for the Advancement of Structured Information Standards (OASIS)  
<http://www.oasis-open.org>
- Unicode, Inc.  
<http://www.unicode.org>