MINISTRY OF EDUCATION
TE TĀHUHU O TE MĀTAURANGA

Technology in Schools

Information and Communications Technology (ICT) Switching Infrastructure:

Policy and Standards for Schools

Version 1.70

June 2015

Document Information

Acknowledgements

The Ministry of Education, New Zealand, acknowledges with thanks the assistance and contribution of a number of organisations, institutions, statutory bodies, and individuals in the preparation of these Standards. In particular, the assistance of the following parties is acknowledged:

Torque IP, Connector Systems, Allied Telesis, Cisco Systems, Network for Learning Ltd.

Table of Contents

Foreword

The educational environment provides one of the most challenging frameworks for the operation of comprehensive structured information and communications technology (ICT) infrastructure solutions. It has exceptionally high requirements for reliability, fault-tolerance and service availability that exceed many other similar sized operating environments.

Educational providers are frequently at the leading edge of the technology and application lifecycle, with teaching systems often involving new and innovative applications, extensive use of graphical content, monitoring, and reviewing functions. They are also much more likely to involve the use of complementary technologies, including wireless and cabled monitoring systems, audio-visual applications, presentation applications, multi-media content, metering and control requirements and collaborative developments, than their commercial or government counterparts.

The modern school infrastructure must address not only the standard applications of telephony and data connectivity, but must also support the unique requirements of heavy burst-oriented network traffic requirements over relatively shorter periods associated with educational systems, extensive use of multi-media technologies, and both wired and wireless networking.

The goal of this document, *Ministry of Education: Technology in Schools Information and Communications Technology (ICT) Switching Policy and Standards for Schools v1.70* is to provide a reference document for cost effective design and construction of telecommunications distribution infrastructure for all facilities in New Zealand schools. It has been prepared to outline the minimum standards required to ensure consistency and compatibility of all new and existing Ministry of Education schools switching systems and network infrastructure systems.

This document provides the technical standards and guidelines which are to be followed for the design and technical performance of any ICT telecommunications infrastructure in facilities owned by Ministry of Education schools. It is updated regularly as Standards, school requirements and Ministry policy change. Prior to using this document the user should confirm that they have the latest version. The latest version of this document may be obtained from http://www.education.govt.nz/ict-standards/.

Purpose

This document has been prepared by the Ministry of Education for use by New Zealand Schools and other organisations which participate in the design, supply and implementation of information technology infrastructure within New Zealand schools. The documentation addresses the planning for switched data network systems in new schools but applies equally to existing schools planning significant upgrades and extensions to existing infrastructures.

It provides guidance and minimum technical standards in the following areas:

- Technical requirements for switching systems
- Product selection and system dimensioning
- Design, installation and testing environments
- Switching administration and documentation

This document will assist in the provision of a robust high performance campus wide school network switching infrastructure to enable full use of ultra-fast broadband and to maximise teaching and learning opportunities.

Document Sponsor

This document has been developed by and is controlled by the Ministry of Education. All queries, errors, omissions or suggestions are to be directed to:

The Director

Technology in Schools

Education Infrastructure Service

45-47 Pipitea St

PO Box 1666

Wellington 6140

Outcome Statement

By using this document, designers and installers will successfully meet the Ministry of Education's minimum standards for the design, installation and support of data and voice network switching systems in operation within New Zealand schools.

1. USING THIS DOCUMENT

1.1 Interpretation of this Document

1.1.1 Interpretation

For the purposes of this document, the word 'shall' refers to requirements that are mandatory, while the word 'should' refers to practices that are advised or recommended.

1.1.2 Scope of this Document

This document addresses the following areas:
a) Switching system and product selection for use in New Zealand schools.
b) Switching equipment installation in New Zealand schools.

1.1.3 Criteria for Use

All school ICT installation and upgrade work shall be in accordance with this document.

The Ministry requires that all schools, designers and installers of networks for schools shall use this document, in order to allow the school to fully participate in the e-learning environment and protect the investment in switching systems.

In addition to this document, the designer and installer should refer to other sources for detailed design and installation guidance, such as relevant mandatory legislation, publications outlined in this document, and manufacturer installation guidelines.

1.2 Application of this document

1.2.1 Regulations, Codes and Standards

All switching system works are to be carried out in accordance with the regulations, codes, and Standards listed within this document.

Where New Zealand and international Standards are referenced in this document the application of the Standard shall be, unless specifically stated elsewhere to the contrary, to the latest edition and amendments available on the date 30 calendar days prior to the issue of any request, quote, tender or proposal.

Where specifications or Standards, or any other references in this document refer in turn to other specifications, Standards or documents whether whole or in part, the strictest of those consequential references shall apply to this specification as if they were completely contained in the original reference.

1.2.2 Regulatory Requirements and Codes of Practice – Switching

Other than for compliance with the Electricity Safety Regulations 2010 and relevant New Zealand Codes of Practice, there are **no** regulatory requirements for telecommunications switching components or design practice in New Zealand. This includes electromagnetic compatibility.

The Telecommunications Act 1987 gives Telecom New Zealand, now Spark New Zealand, along with any other Service Provider the right to refuse connection, or to disconnect from their networks, any equipment which does not comply with Permit to Connect specifications or equivalent.

For equipment connected to a service provider's network, compliance with Spark New Zealand's PTC Access Standards specification is a contractual requirement.

1.2.3 Installation Specific Standards and Requirements

The designer and installer shall conform to all the requirements of this Standard.

1.2.4 Variation from this Document

Compliance to the requirements of this document may, under some circumstances, not be practical, or cost-effective, or an alternative solution may exist that better suits the conditions on site.

The designer and installer are advised, in the event that compliance to this document cannot be met, to obtain written approval for a variation before undertaking the non-compliant works from:

The Director

Technology in Schools

Education Infrastructure Service

45-47 Pipitea St

PO Box 1666

Wellington 6140

1.2.5 Conflicts

If a conflict exists between the Standards or with the Scope of Works then the installer shall notify the Project Manager or their representative of any conflicts and seek clarification prior to continuation.

In general, the order of precedence shall be:

a) Statutory Codes and Regulations

b) The Ministry of Education publication *Technology in Schools, ICT Switching Infrastructure: Policy and Standards for Schools* (this document)

c) Standards and specifications within the tender or contract

d) Referenced New Zealand and international Standards

In situations where tender specific Standards, specifications, or both, exceed Ministry requirements, these shall take precedence.

1.3 Definitions and Abbreviations

1.3.1 Definitions

Term	Definition
Category 5 (Cat 5)	A definition of cabling components which provide AS/NZS 3080 Class D performance
Category 5e	Any reference to Category 5e shall be interpreted as Category 5 providing Class E performance
Category 6 (Cat 6)	A definition of cabling components which provide AS/NZS 3080 Class E performance
Channel	The end-to-end transmission path connecting two pieces of application specific equipment
Enclosure	A housing for accommodation of equipment and cabling that includes mounting rails and protective panels
Ministry (the)	The Ministry of Education
Preferred Switch Supplier	The Ministry's LAN switch supplier for SNUP which has been awarded a contract through an open tender process
Preferred Switching Equipment	Switching equipment provided through the SNUP Project from the Preferred Switch Supplier
Recommended Switch Brands	LAN switching equipment which has been deemed to meet the minimum Standards required by the Ministry and listed in the Recommended List of Switch brands and Suppliers
Registered Jack 45	In the United States of America, RJ45 is the Universal Service Ordering Code (USOC) for circuit configuration 45 (either T568A or T568B) for an 8-position modular connector. In this document RJ45 shall mean a modular 8-pin connector wired according to T568A configuration in accordance with AS/NZS 3080 Z.A.2
Structured Cabling System	A set of cabling and connectivity products that are constructed according to standardised rules to facilitate integration of voice, data, video, and other signals
Uplink	A high-speed connection for aggregating traffic from an edge switch to a backbone switch or a server

1.3.2 Abbreviations

10GbE	10 Gigabit (per second) Ethernet	**MDI**	Medium Dependent Interface
10GBASE-SR	10 Gigabit 'Short Reach' Multi Mode Fibre	**MDI-X**	Medium Dependent Interface Crossover
10GBASE-CR	10 Gigabit Copper	**MIBs**	Management Information Bases
100BASE-T	100 Megabit (per second) Fast Ethernet	**MMF**	Multi Mode optical Fibre
1000BASE-T	1 Gigabit (per second) Copper Ethernet	**MPLS**	Multi Protocol Label Switching
1000BASE-SX	1 Gigabit (per second) Multi Mode Fibre	**MTBF**	Mean Time Between Failures
AC	Alternating Current	**NDP**	Network Design Plan
BGPv4	Border Gateway Protocol version 4	**NTP**	Network Time Protocol
CLI	Command Line Interface	**OEM**	Original Equipment Manufacturer
DHCP	Dynamic Host Configuration Protocol	**OM3**	Optical Multimode fibre category 3
DC	Direct Current	**OSPF**	Open Shortest Path First
DVMRP	Distance Vector Multiple Routing Protocol	**PIM**	Protocol Independent Multicast
EMC	Electromagnetic Compatibility	**PING**	Packet Internet Groper
EMI	Electromagnetic Interference	**PoE**	Power over Ethernet
EPR	Earth Potential Rise	**QoS**	Quality of Service
GARP	Generic Attribute Registration Protocol	**RFC**	Request for Comment
GbE	Gigabit (per second) Ethernet	**RFI**	Radio Frequency Interference
GBIC	Gigabit Interface Converter	**RFP**	Request For Proposal

Gbps	Gigabits per second	**RIP**	Routing Information Protocol
GVRP	Group VLAN Registration Protocol	**RJ45**	Registered Jack 45 (USOC reference)
HSRP	Hot Standby Router Protocol	**RMON**	Remote Monitoring Agent
HTTP	Hyper-Text Transfer Protocol	**(R)STP**	(Rapid) Spanning Tree Protocol
ICMP	Internet Control Messaging Protocol	**RU**	Rack Units (1RU = 44.5mm)
ICT	Information and Communications Technology	**SCS**	Structured Cabling System
IEEE	Institute of Electrical and Electronic Engineers	**SFF**	Small Form Factor (connector)
IEEE 802.1D	Spanning Tree Protocol standard	**SFP**	Small Form Factor Pluggable (alternative to SFF)
IEEE 802.1Q	VLAN tagging standard	**SLA**	Service Level Agreement
IEEE 802.1w	Rapid Spanning Tree Protocol Standard	**SME**	Small to Medium Enterprise
IEEE 802.1x	Access control standard	**SMF**	Single Mode Optical Fibre
IEEE 802.3a	Port aggregation standard	**SNMP**	Simple Network Management Protocol
IEEE 802.3ab	1000Base-T (Gigabit UTP copper standard)	**SNMP**	Simple Network Time Protocol
IEEE 802.3ad	Trunk aggregation standard	**SNUP**	School Network Upgrade Project
IEEE 802.3ae	10GbE fibre and copper standard	**SOHO**	Small Office(s) and Home Office(s)
IEEE 802.3af	Power over Ethernet (15.4W DC)	**STP**	Shielded Twisted Pair
IEEE 802.3at	Power over Ethernet (25.4W DC)	**SX**	A small form factor optical fibre connector
IEEE 802.3p	VLAN Priority tagging standard	**TFTP**	Trivial File Transfer Protocol

IEEE 802.3u	Fast Ethernet standard	**UFB**	Ultra Fast Broadband
IEEE 802.3z	1000Base-SX/LX (Gigabit fibre standard)	**UPL**	Uplink to higher level network infrastructure
IGMP	Internet Group Management Protocol	**UPS**	Uninterruptible Power Supply
IP	Internet Protocol	**USOC**	Universal Service Ordering Code
ISP	Internet Service Provider	**UTP**	Unshielded Twisted Pair (cable)
LAG	Link Aggregation	**VLAN**	Virtual Local Area Network
LACP	Link Aggregation Control Protocol	**VoIP**	Voice over Internet Protocol
LAN	Local Area Network	**VRRP**	Virtual Router Redundancy Protocol
LC	A small form factor optical fibre connector	**WLAN**	Wireless Local Area Network
LED	Light Emitting Diode	**WAP**	Wireless Access Point
LUP	Link Up from core to edge network infrastructure		
MAC	Media Access Controller		
Mbps	Megabits per second		

2 REFERENCE DOCUMENTS

Switching systems and equipment shall be installed in accordance with the manufacturer's specifications and Regulations, Codes and Standards listed below. Where New Zealand and international Standards are referenced in this document, the application of the Standard shall be, unless specifically stated to the contrary, the latest edition and amendments available on the date 30 calendar days prior to the issue of any request for a quote, tender or proposal.

Where specifications or standards or any other references referred to in this document refer in turn to other specifications, standards or documents whether whole or in part, those consequential references shall apply to this specification as if they were completely contained in their entirety in the original reference.

2.1 New Zealand and International Standards

The work covered by this document shall comply with the following New Zealand and international Standards, Specifications and Technical Bulletins.

Standard/Specification or Technical Bulletin Number	Description
NZS 2772.1:1999	Maximum exposure levels - 3kHz to 300GHz (Radiofrequency Fields)
AS/NZS CISPR 22:2009	Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
AS/NZS 1269	Occupational noise management
AS/NZS 2107:2000	Acoustics – Recommended design sound levels and reverberation times for building interiors
AS/NZS IEC 60825.2:2011	Laser safety – Safety of optical fibre communications
AS/NZS 3000:2007	Electrical installations (known as the Australian / New Zealand Wiring Rules)
AS/NZS 3080:2013	Telecommunications Installations – Integrated Telecommunications Cabling Systems for Commercial Premises
AS/NZS 3084:2003	Telecommunications Pathways and Spaces for Commercial Buildings
AS/NZS 3085.1:2004	Telecommunications Installations Administration of Communication Cabling System - Part 1: Basic Requirements
AS/NZS IEC 61935:2012	Balanced cable testing
AS/NZS 4117:1999	Surge protection devices for telecommunication applications
AS/NZS 61000.6.3:2012	Generic standards - Emission standard for residential, commercial and light-industrial environments This Standard is identical with and has been reproduced from CISPR/IEC 61000-6-3:1996
IEC-60297 Part 1 and Part 2	Dimensions of mechanical structures of the 482.6 mm (19 in) series
IEEE 802.3	Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications

2.2 Application of the Standards

All school LAN switching upgrade work undertaken through the Schools Network Upgrade Project (SNUP) will be in accordance with this Standard.

It is recommended that the switching systems be designed and installed in accordance with this document by inclusion in tender and contract documents.

In the event of conflict between Ministry standards or specifications and other regulations, codes or standards the order of precedence shall be:

a) Statutory Codes and Regulations
b) Standards or Specifications within the tender or contract
c) The Ministry of Education publication *ICT Switching Infrastructure: Policy and Standards for Schools* (this document)
d) Referenced New Zealand and international Standards

3 GENERAL CONDITIONS

3.1 Switching System Works

The scope of work for the provision of switching systems and equipment in schools typically includes design, supply, installation, testing, commissioning, and documentation.

3.2 Switching Equipment

The switching system supplier/reseller shall maintain a list of equipment that complies with these Standards.

All equipment shall be new and selected to ensure satisfactory operation under the environmental conditions present at the site.

3.3 Minor Materials, Fittings and Consumables

All materials, fittings or any work which is necessary for the installation and satisfactory function of the equipment or which is generally provided in accordance with accepted trade practices shall be provided or carried out as part of the works. Even though such material or work may not be explicitly mentioned in this specification or shown on the design drawings.

3.4 Electrical Installation Works

All electrical power system work shall be undertaken by qualified electricians in accordance with the relevant New Zealand Standards (AS/NZS 3000:2007).

3.5 Site Conditions

Suppliers shall undertake the necessary investigations to fully inform themselves of the site conditions which could impact the cost of the job. This shall include, but not be limited to, available cabinet space, environment conditions, and power provisioning.

4. SWITCHING SYSTEMS: DESIGN STANDARDS

4.1 General

Because of the diversity of school sizes, building layouts, and networking requirements, a range of common switching system architectures are described. Schools are encouraged to discuss their requirements with the supplier of the Recommended Switch Brand or a system integrator prior to purchasing hardware.

Schools should consider the following when selecting network switching system hardware:

- Required number and speed of access ports
- Requirement for up-link bandwidth and interface type
- Present or future requirement of IP telephony
- Present or future requirement for VLANS
- Requirement for network management and reporting
- The use of proprietary and generic network management tools
- Adherence to international Standards for connectivity
- Need for uninterruptable power supplies where applicable and redundancy in the network to avoid “single points of failure” dictated by the maximum acceptable downtime for a network component
- Ability to backup complex device configuration files and to restore to replacement devices in the event of a failure
- Total number of proposed devices (workstations, servers, printers etc.) on the network, network segmentation and network use which may impact on other users
- Complex security requirements such as segmenting administration and curriculum networks (protecting administration resources whilst allowing Internet access and messaging to all students and staff)
- Requirements for bandwidth management; traffic prioritization, traffic shaping and traffic filtering
- Requirement for future growth (e.g. stackable switches)
- Performance capacities of switching devices (e.g. non blocking internal bandwidth, packet buffering capacity and forwarding rates)
- Many switch manufacturers offer both Small Office Home Office(SOHO) and Small Medium Enterprise(SME) switch product ranges - Schools should not employ switches with performance capacities designed for the SOHO market
- The ability of the switch management system to provide health checking, error and performance monitoring, and reporting
- Ability of supplier to support product and respond to faults

Some of the above considerations can be particularly complex and will involve specialist product and network skills. A systems integrator should be used to ensure that value for money is obtained when purchasing complex networking solutions.

4.2 Minimum Standards

The Ministry's minimum standard for new switching installations is based on providing at least one Gigabit Ethernet (GbE) over the links between switches and other common network resources, as well as 1 Gigabit per second (1 Gbps) to the desktop. It is likely that 10 Gigabit Ethernet (10GbE) inter-switch links will be required in the future.

The Ministry has tabulated a list of physical and technological base requirements which offer a selection of switching solutions which simplify the integration of applications and ensure cost effective reliability and performance across the entire network.

These standards are available in the appendix of this document.

Integrated software provides built-in functionality for end-to-end integration, including bandwidth aggregation.

The Gigabit Ethernet and 10 Gigabit Ethernet switching architectures described below provide a combination of high data transfer rates, low latency, manageability and extensibility ideally suited to school campus environments. The recommended selection of switches also has the ability to support networks that integrate data, voice, and video applications under a single converged architecture. Support for IP telephony applications, such as video conferencing, unified messaging, desktop integration and e-learning, requires fast LAN switches with Quality of Service (QoS) capabilities and highly-available components.

4.3 Generic Network Architectures

The network hierarchy for large installations includes three functional divisions or layers: edge or access, distribution and core. In smaller installations one or more of these layers may be "collapsed" into a single layer.

Unless able to be included very cost effectively, built in redundancy may be considered a luxury for most schools. However, careful design can minimise any "single points of failure" in the network and the impact of failure of a component on the rest of the network (e.g. the use of Spanning Tree Protocol and uninterruptible or redundant power supplies to the core switch and servers).

4.3.1 Access Layer

The access layer provides the first level of access to the network and provides terminal device attachment. Layer 2 switching, security, and QoS reside at this layer. These switches should be manageable to provide for the detection and resolution of problems such as broadcast storms, auto-negotiation failures and transmission errors which may arise.

Because architectures up to Layer 2 allow end station connectivity, it is possible to construct a Layer 2–only network, providing simple, inexpensive, high-performance connectivity for small installations. However, Layer 2 functions do not generally extend beyond the school boundary and Layer 3 (routing) capabilities are required to connect to the Internet and other logical sub networks within the school campus.

4.3.2 Core and Distribution Layers

All school networks need a centralised core switch to enable optimum connections to common network resources. They should support management for the detection and resolution of problems which may arise such as broadcast storms and auto-negotiation failures. The core is the backbone of the network – a central conduit designed to transfer data at high speeds, this layer is designed to be highly reliable, and stable. The core switching cabinet should also provide load balancing, fast convergence, and scalability.

Layer 3 functionality allows the movement traffic between VLAN network segments without network performance 'bottlenecks' or dependence on the campus' Internet Service Provider (ISP).

The distribution layer, which fits between the access and core layers, aggregates wiring cabinets in port dense areas and provides security policy enforcement. These switches offer benefits such as fast convergence, greater throughputs and greater scalability.

4.3.3 Internet Connectivity

Layer 3 (routing) functionality is required for network connection to the Internet. Routing is included in Layer 3 switches but for the purpose of Internet connectivity is best performed by the network edge Internet Service Provider's managed router.

4.3.4 Wireless LAN Interfaces

Wireless LAN (WLAN) equipment conforming to the IEEE 802.11 standards is been being deployed as an access technology at the network edge. Wireless bridges and routers are also available for access between buildings and campuses where wired Ethernet is not a cost effective option. WLANs may be used to provide a cost effective alternative to extending the coverage of existing network infrastructures where reduced performance is acceptable.

WLAN equipment is not considered in detail in this document because of the requirement for specialist design. However, WLANs may be used to provide a cost effective alternative to extending the coverage of existing network infrastructures.

For further information please refer to the following documents available on http://www.education.govt.nz/ict-standards.

- School Wireless LAN Guidelines – Understanding Wireless
- School Wireless LAN Guidelines – Building and Maintaining a Wireless Network
- Wireless Product Specifications

4.4 Typical Network Architectures

4.4.1 Small Schools (20 – 200 Students)

In small schools the core and distribution layers are typically combined into a single layer. This limits requirement to a small number of access switches. A very small school, typically contained within one building, may have a single 24 or 48 port switch which provides all required networking and management functionality.

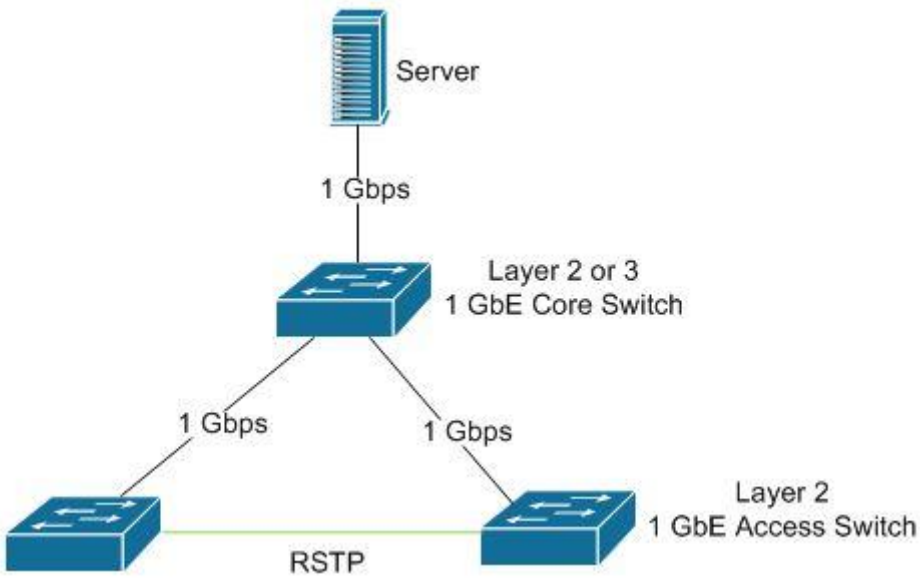

FIGURE 1: SMALL SIZE SCHOOL NETWORK

4.4.2 Medium Schools (200-500 students)

For medium schools network performance and priority becomes an issue as users compete for limited network resources such as:

- Core switching capacity
- File server processor and data transfer performance
- Bandwidth on links between switches
- Bandwidth on links to file servers
- Internet connection
- Latency for voice, video and other real time applications

To ensure the network fabric is not a bottleneck, three design opportunities are available:

1. Optimisation of network performance may be effected by putting terminals in the same network VLAN or subnet as the servers they use. For medium to large sized schools it is recommended that VLANs are used to segment the network logically into well-defined

broadcast groups and for application and security management. VLAN groups should contain no more than 250 networked devices. Separate VLANs should be assigned for:

a. Network and switch management
b. School administration
c. Specialist applications such as video conferencing and IP Cameras
d. Students
e. Guest users

Networking for a medium school is designed for high availability, performance, and manageability. The core switch would also use Layer 3 switching to facilitate efficient communications between network segments and other common resources.

2. Increased network bandwidth by increasing Ethernet speeds or aggregating ports and links between devices.

3. Optimisation of network performance by prioritising critical traffic with Quality of Service (QoS) mechanisms.

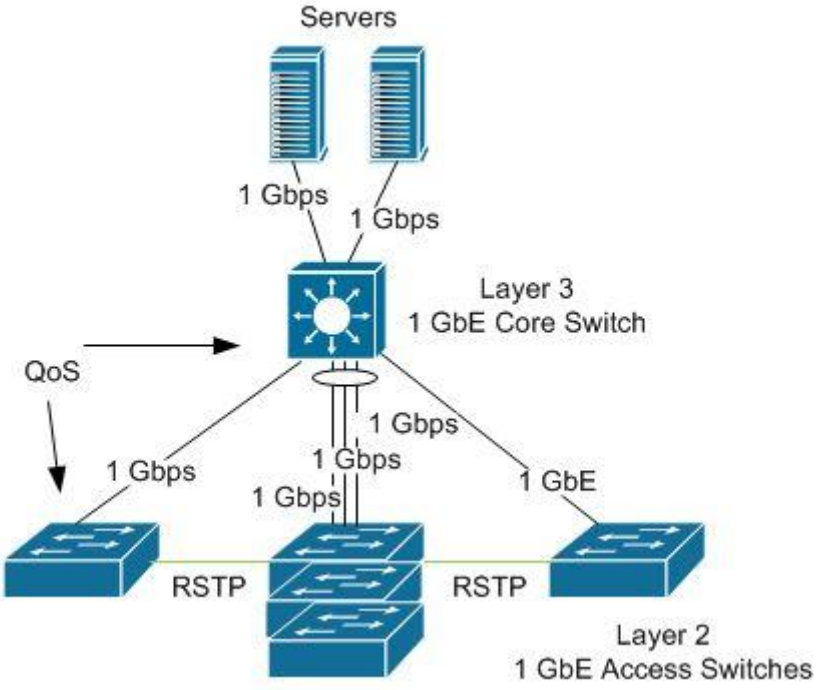

FIGURE 2: MEDIUM SIZED SCHOOL NETWORK

4.4.3 Large Schools (500+ students)

A typical large school network connects multiple buildings across a high-performance switched backbone and may have requirements for high availability and manageability. This is an important consideration in handling high-bandwidth or time dependant applications and services such as IP telephony, video conferencing and IP multicast applications.

While voice and video traffic may be relatively low-bandwidth applications, the primary consideration for networks carrying these applications is latency and jitter. Unlike normal data traffic, voice and video are real-time applications are unable to tolerate delay or retransmission of

packets. High data throughputs and prioritisation of real-time traffic by QoS mechanisms ensures timely delivery of voice and video packets ahead of other less time sensitive traffic.

Where IP telephony and networked connected IP cameras are of interest, consideration should be given to edge switches that support Power over Ethernet (PoE) to provide power to these edge devices.

In very large schools or port dense switching cabinets, a separate distribution layer may allow for flexibility and future growth. These aggregated data paths help to ensure high availability as well as reducing network congestion. Logical network resiliency may be achieved by using redundant paths, Rapid Spanning Tree Protocol (RSTP) or Ethernet link aggregation (LAG).

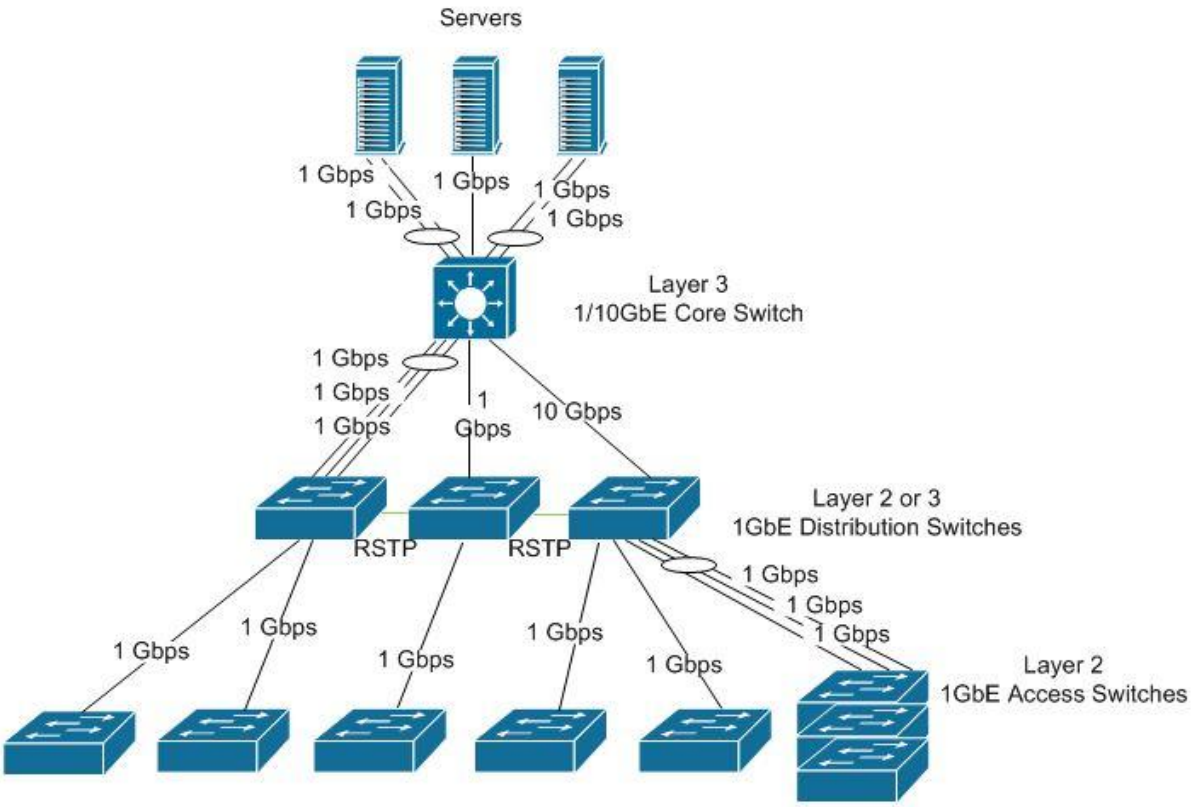

FIGURE 3: (VERY) LARGE SIZED SCHOOL NETWORK

4.5 Switch Selection

Network architects will generally choose switching products according to the formula provided in the next section.

The Ministry has tabulated a number of switch 'Types' and outlined physical and technological requirements which will enable an easy fit into networking scenarios that will be encountered within school campuses.

The Ministry may also from time to time hold tenders for a Preferred Switch Supplier to provide equipment specifically for use in school ICT environments.

Should schools wish to install switching equipment other than the preferred option, the devices selected and network architecture implemented shall be at a minimum in accordance with this Standard.

4.6 Allocation of Switching Equipment

4.6.1 General

The Ministry, through a centralised bulk purchasing agreement, will provide schools with access to switching equipment from a Preferred Switching Equipment supplier which will meet and exceed the technology, design and implementation Standards as set out in this document.

4.6.2 Core Switches

All core switches shall have a minimum of 1GbE ports.

All common network resources, such as servers, network attached storage (NAS) devices and wireless controllers, should be connected to a core or dedicated centralised server switch at a minimum of 1Gbps speeds. Multiple aggregated 1Gbps links are often used where load sharing and failover to a network resource is required.

4.6.3 Distribution Switches

The distribution layer of switches is generally only required for the largest schools. Where a large number of edge switches are required the distribution layer provides an additional high speed up-link capacity and traffic consolidation point. They provide a higher level of network traffic management and the ability to re-route traffic in case of link failure or congestion. Generally there could be one distribution switch connecting a number of edge switches in a particular school block. Networks are often created without the distribution layer where the edge switches are connected directly to the core switch.

4.6.4 Edge Switches

The minimum design (for each switching cabinet) shall include in most cases one 24 port 1GbE edge switch with a minimum of two fibre-capable SFP ports.

Switch allocation shall be as follows:

- For a cabinet requirement of less than 24 ports, there shall be one 24 port switch installed
- For a cabinet requirement of less than 48 ports, there shall be one 48 port switch installed
- For a requirement of between 48 and 72 ports, there shall be one 24 port switch plus one 48 port switch
- In excess of 72 ports there shall be two 48 port switches or more

Uplink ports between edge switches and core switches shall be at least one 1Gbps connection.

Where a wireless system has been deployed, or where one is intended to be deployed, 1GbE edge ports shall be present.

Wireless Access Points of a Small Office Home Office (SOHO) grade (single radio, single spatial stream) are not recommended.

4.6.5 Switch Interconnection Links

The current backbone cabling standard prescribes, at a minimum, the use of six core OM3 Fibre enabling up to three 1GbE/10GbE data connections per cable. In some cases where no foreseeable expansion is required, externally rated copper cabling may be used connect outlying buildings such as halls and gymnasiums.

For more information, please refer to the Ministry's *ICT Cabling Infrastructure: Policy and Standards for schools* which can be found at www.education.govt.nz/ict-standards.

Uplink allocations are as follows:

- One 1 Gbps uplink is required for each 24 port 1GbE switch
- Two 1 Gbps uplinks for a 48 port 1GbE switch
- Three 1Gbps uplinks for two stacked 48 port 1GbE switches
- 10GbE uplinks should be assessed on a need and cost effectiveness basis.

Where there is more than one uplink from a cabinet, it is recommended they form a dynamic Link Aggregation (LAG) as opposed to an STP (Spanning Tree Protocol) ring so as to increase bandwidth availability. Physical circuit resilience is provided by the failover component of the Link Aggregation Control Protocol (LACP).

Where a link aggregation enters a stack of switches, the LAG should be spread across the stack members to increase resilience.

4.6.6 Retention of Existing Switches

The decision to retain or replace existing switching equipment should be based on the following criteria:

a) Switches greater than five years old – **replace**

b) Switches with no management function or those based on websmart configuration only – **replace**

c) Switches which do not support SNMPv3 and/or MIBs – **replace**

d) Switches that are at End of Life (EoL), outside of warranty or are no longer supported by the manufacturer – **replace**

e) Switches which are 1 GbE and compliant with the base feature sets outlaid in appendices 1.1 and 1.6-1.8 of this document and not stackable may be redeployed in appropriate locations at the network edge – **redeploy/repurpose**

4.7 Switch Management

Switches may be managed, websmart or completely unmanaged. Websmart and unmanaged switches have no, or at most, a very limited configuration interface. They are plug and play and typically used in home, SOHO, or small businesses networks. Whilst coming at a lower cost and simple to use, they are not recommended for school applications.

A managed switch may be monitored and modified using common management methods:

- Command line interface (CLI)
- Serial Console (RS-232)
- Secure Shell (SSH)
- Simple Network Management Protocol (SNMP)
- Secure web interface via web browser (HTTPS)

Special attention should be paid to SNMP configurations. In most cases they should utilise an access control list and be matched to a trusted internal network IP address.

For medium to large schools, centralised management ability will result in significant savings in administrative time and effort.

Minimum management features for the various switch types are provided in the appendices of this document.

5 SWITCHING SYSTEMS: TECHNICAL REQUIREMENTS

5.1 General

A variety of switch ‘Types’ have been tabulated in the appendices of this document to enable scenario driven decision making with regards to switch selection and deployment in schools. The range covers edge or access workgroup switches and core switches for all schools and distribution switches required for larger more complex installations.

Each switch will have features specific to a particular ‘Type’ which will determine the selection for specific situations.

Please see the appendix for additional information on switch requirements.

5.2 Edge Switches

Basic edge switches are typically used as workgroup switches at small to medium sized schools. The basic Layer 2 models are typically fixed configuration, non-blocking switches with 8 to 24 ports for creating cost effective LANs with high performance and functionality. The 1Gbps auto-sensing and auto-negotiating ports support QoS for prioritising different traffic streams.

Basic edge switches provide at least one modular uplink interface that supports 1Gbps data transmission over Category 5e or higher copper cable and duplex single-mode and multi-mode optical fibre cable.

They are typically deployed on the edge of pathways in low port density areas where no foreseeable expansion is required.

Advanced edge switches are typically used as workgroup switches within medium to larger sized school campuses. The advanced Layer 2 and 3 capable models are typically fixed configuration, non-blocking switches with 24 and 48 ports access ports designed for the creation of cost effective LANs with high performance, functionality and extensibility. The 1Gbps auto-sensing and auto-negotiating ports support QoS for prioritising different traffic streams. A greater range of switch management options may be available.

These devices shall have least four modular uplink interfaces which support 1 Gigabit Ethernet and 10 Gigabit Ethernet connections over Category 5e or higher copper cable and duplex single-mode and multi-mode optical fibre cables. Models are stackable to provide high density switching in the wiring closet.

5.3 Core and Distribution Switches

Basic core switches are typically used as the core switch at small to medium sized schools and as distribution switches at large schools. The basic core switch models are typically fixed configuration, non-blocking switches with 24 to 48 1Gbps auto-sensing and auto-negotiating ports.

To avoid data flow bottlenecks from occurring between switches at the edge of the network and the core and distribution switches, aggregated LAG 1GbE or 10GbE uplinks should be used to provide enough capacity to the school network's common resources and also to ensure high network availability for users connected at the edge.

Each switch shall support at least two modular 10GbE interfaces and a range of copper and optical fibre cable types.

Advanced core switches would typically be used at a medium school with a role exceeding 200 students.

Layer 3 switches are essentially wire-speed routers. These devices are ideally suited to delivering high-performance routing between LAN segments. Layer 3 switches also provide advanced security services, such as access control lists and advanced QoS features to support real-time applications such as IP telephony. These features may not be required in small schools and hence a Layer 2 only switch may also be used as a core switch.

6 SWITCHING SYSTEM INSTALLATION PRACTICES

6.1 General

The switching system supplier/reseller shall supply all labour, materials and equipment required for installing, testing and commissioning the network.

The supplier shall include a copy of all relevant specifications, compliance reports, documentation and diagrams including the switch IP address assignments for installation in an "as-built" document manual.

6.2 Safety

Any electrical work shall be carried out by a registered electrician to AS/NZS 3000:2007 standards and the Ministry of Education's ICT Cabling Infrastructure Policy and Standards for Schools found at www.education.govt.nz/ict-standards.

An IEEE 802.3 compliant transformer coupled with auto-sensing MDI and MDI-X ports may be an important consideration if UTP copper cabling is to be used to connect switches in separate buildings which have their own separate earth connections. This is to avoid electrical discharges created by electrical current imbalances across the two discrete electrical systems.

6.3 Qualifications of Installer

Switching infrastructures shall be installed only by organisations accredited by the manufacturer of the switches and by personnel properly trained and certified by the manufacturer to install their products.

6.4 Manufacturer's Recommendations

All equipment shall be installed and performance tested in full accordance with manufacturer's and distributor's recommendations and instructions.

6.5 Documentation

The vendor shall produce both pre and post installation, a full network diagram with IP addresses and VLAN information detailed. Also required, within one week of the site visit, is a commissioning report and excel spreadsheet containing equipment serial numbers and a completed network switch site sign-off form.

The commissioning report form should include, at a minimum, the following information:

- Key ports – ports of interest; servers, switch link-ups and internet routers
- Interface check – all ports set to auto negotiate, full duplex, 1Gbps or 10Gbps where applicable
- Rapid Spanning Tree Protocol status check – Root Bridge switch documented, RSTP turned on and Portfast / BPDU Guard enabled
- Network loop test – create loop in network and verify loops are been blocked by RSTP
- Verify device configuration – final check configurations for errors
- LAN end to end speed test – network core to edge throughput and latency tests
- Internet speed test
- IP address scan – a list of devices operating on the network at the time of scan

A backup of all device configurations should be produced and retained by the vendor with a copy remaining at the school for general use. Any of the original switches retained after a network upgrade must be configured or reconfigured so as to be consistent with the upgraded network.

7 WARRANTY AND SUPPORT

7.1 General

The switching system supplier shall warrant that all products will operate to the standards and specifications claimed by the manufacturer and that the product is free from any defects in materials or workmanship.

The supplier shall make technical and user documentation on the product available to the school.

7.2 Manufacturer's Warranty

7.2.1 Hardware Warranty

The supplier shall provide a limited lifetime replacement warranty on the switch and associated hardware. Warranty provisions shall include on-site repair or replacement and the supplier should hold sufficient replacement stock in New Zealand to deliver a replacement unit to any school suffering a failure no later than "next business day".

It is the expectation that assistance is guaranteed within two working days during the business week and in instances where workarounds are provided, a resolution will be carried out within five working days to the occurrence of the issue depending on severity.

7.2.2 Software Warranty

The supplier shall provide limited lifetime software support on the switch and free access to firmware upgrades within the firmware feature set purchased.

7.2.3 Service Level Agreements

Quotations for service support may include an option for a Service Level Agreement. In event of hardware failure the SLA should stipulate within what time frame a replacement unit will be dispatched to the school. Premiums may be charged for service outside normal business hours.

Quotations may be formulated to include financial penalties for failure to meet the agreed SLA or Contractual Agreement.

8 QUALIFICATIONS

8.1 Installer Qualifications and Selection

The specialist contractor engaged to design, supply, install, and commission the selected switching system shall be approved as a reseller and certified as an installer by the manufacturer or distributor of the equipment in New Zealand prior to commencing work on the installation. The specialist contractor shall also be capable of maintaining the selected switching system.

When calling for tenders or requesting quotations schools should invite responses from resellers/installers who can provide documentation detailing their level of manufacturer/distributor certification together with the following information:

- Company overview and profile
- Copy of warranty certification statements from the manufacturer
- Customer reference letters with contact details (three required)
- Company staff details and number of certified engineers
- Full-time staff & responsibilities
- Part-time contractors & responsibilities
- Training
- Industry specific training (e.g. Cisco, Juniper, Allied Telesis, D-Link, HP)
- Manufacturer/distributor certification held by the reseller/installer
- Manufacturer certification held by the New Zealand supplier/distributor
- Type, make and model of testing equipment used, for example:
    - UTP and Fibre cable certification equipment
    - Traffic performance analysers
    - Packet capture and protocol analysis tools
    - IP addressing audit tools

8.2 Supplier Qualifications

The New Zealand specialist supplier/distributor approved by the equipment manufacturer as a qualified supplier/distributor shall provide second level support services to the reseller/installer of the switching system.

The supplier/distributor shall maintain an engineering staff specifically to support their resellers. The engineering staff shall be certified to install and maintain the selected switching systems. The installer shall provide documentation detailing the level of manufacturer certification held by their supplier/distributor when submitting quotations and tender responses.

9 OTHER CONSIDERATIONS

9.1 Other Associated Systems

The following systems and peripheral components should be considered in conjunction with the design and implementation of the switching system:

- UPS system capacity requirements, accommodation, battery maintenance and life span
- Fire sprinklers in server and communications rooms
- Smoke detection in server and communications rooms
- IP telephony systems/servers
- Video conferencing systems
- Multicast streaming systems
- Access to the Internet and associated firewall
- Wireless Controller and Wireless Access Points
- Network Area Storage devices
- IP surveillance cameras and recording devices
- Printers and printer servers
- File servers
- Equipment room alarms and climate control
- Security and alarm systems
- Building management systems

9.2 Health and Safety Considerations

9.2.1 Laser Safety

All switch equipment capable of fibre optic connections should be equipped with fibre terminal dust covers (or equivalent) to avoid accidental exposure to laser light. These covers should remain in place until such time as a cable connection is in place.

9.2.2 Protection from Radiofrequency Electromagnetic Fields

The Ministry of Education acknowledges that the health and safety of children in our schools is of primary importance. As such it regularly monitors New Zealand Standards, international Standards and credible research on wireless technologies and radiofrequency electromagnetic fields as they become available.

Current advice from the New Zealand Ministry of Health states that:

> *The health research carried out to date shows that working and studying in areas with WiFi equipment poses no health and safety risks to adults or children. Although no special precautions are needed, if individuals are concerned and wish to reduce their exposures, they can take simple steps to do so:*

- *Place the wireless access point up on a high shelf or away from where people might sit and work.*
- *When working with a WiFi enabled laptop, place it on a table rather than directly on the lap.*

For further advice about safe use of Wi-Fi in the workplace, please visit: http://www.health.govt.nz/your-health/healthy-living/environmental-health/household-items-and-electronics/wifi-networks.

APPENDIX 1: SNUP SWITCH REQUIREMENTS

1.1 Switch Requirement Summary

The table below provides a summary of the switch Type requirements.

Item	Typical Usage	Description
Type 1	Core Switch Large Schools	Form Factor: 19” Rack Mountable 2RU Layer: 3 10GbE SFP+ Ports: 4 1GbE Ports: 48 * SFP or combo ports Blocking: fully non-blocking Stacking: true, not virtual Other: redundant power supply
Type 2	Core Switch Large Schools Distribution Switch Large Schools	Form Factor: 19” Rack Mountable 1RU Layer: 3 10GbE SFP+ Ports: 2 1GbE Ports: 24 * SFP or combo ports Blocking: fully non-blocking Stacking: true not virtual Other: redundant power supply
Type 3	Core Switch Large and Medium Schools Distribution Switch Large Schools	Form Factor: 19” Rack Mountable 1RU Layer: 3 10GbE SFP+ Ports: 2 1GbE Ports: 24 * SFP or combo ports Blocking: fully non-blocking Stacking: true not virtual Other: redundant power supply
Type 4	Core Switch Medium and Small Schools Distribution Switch Large and Medium Schools	Form Factor: 19” Rack Mountable 1RU Layer: 3 10GbE SFP+ Ports: 2 1GbE Ports: 24 * 10/100/1000 RJ45 + 2 * SFP Blocking: fully non-blocking Stacking: true not virtual

Type 5	Core Switch Small Schools Distribution Switch Access Switch General	Form Factor: 19” Rack Mountable 1RU Layer: 2 or 3 10GbE SFP+ Ports: 2 1GbE Ports: 24 *10/100/1000 RJ45 + 2 * SFP Blocking: fully non-blocking Stacking: true not virtual
Type 6	Core Switch Medium and Small Schools Distribution Switch Access Switch High User Density	Form Factor: 19” Rack Mountable 1RU Layer: 2 or 3 10GbE SFP+ Ports: 2 1GbE Ports: 48 * 10/100/1000 RJ45 + 2 * SFP Blocking: fully non-blocking Stacking: true not virtual
Type 7	PoE Access Switch High Device Density	Form Factor: 19” Rack Mountable 1RU Layer: 2 10GbE SFP+ Ports: N/A 1GbE Ports: 20 * 10/100/1000 PoE (min 16@15w) RJ45 + 2 * SFP Blocking: fully non-blocking Stacking: N/A
Type 8	PoE Access Switch Low Device Density	Form Factor: 19” Rack Mountable 1RU Layer: 2 10GbE SFP+ Ports: N/A 1GbE Ports: 8 * 10/100/1000 PoE (min 8@15w) RJ45 + 1 * SFP Blocking: fully non-blocking Stacking: N/A
Type 9	Access Switch Where no foreseeable expansion required	Form Factor: 19” Rack Mountable 1RU Layer: 2 10GbE SFP+ Ports: N/A Ports: 20 * 10/100/1000 RJ45 + 2 * SFP Blocking: fully non-blocking Stacking: N/A
Type 10	Access Switch Low User Density Where no foreseeable expansion required	Form Factor: 19” Rack Mountable 1RU Layer: 2 10gb SFP Ports: N/A Ports: 8 * 10/100/1000 RJ45 + 1 * SFP Blocking: fully non-blocking Stacking: N/A

Legend:

Mandatory	M
Highly Desirable	HD
Desirable	D

Note 1: Items listed that require a software license upgrade or additional fee and are not included in the base unit are to be clearly stated in the excel compliance sheet under and the price to incorporate these license costs.

Note 2: Copper and fibre connections are supplied via the appropriate GBIC module.

1.2 Switch Type 1 Requirements

Core Switch Features **Type 1 Advanced Core Switch**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	2RU	M
Power supply	Internal 230V	M
Power supply Hot Swappable	Yes	HD
Power supply redundancy	Yes	M
Switching Modules/Cards Hot swappable	Yes	HD
Stackable (with dedicated stacking interface)	Yes	M
	Stacking cable included	M
	Stacking module included	M
10GbE SFP+ Ports **(Note 1&2)**	4+	HD
1GbE SFP (MMF/SMF or 1000T) **(Note 2)**	48 or more scalable	M
10/100/1000T RJ45 Ports **(Note 2)**	Note 2	Note 2
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M
Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Across the stack	M
PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M

SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management (SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	3	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Vendor to state	Vendor to state
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	8	M
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M
	Switch Port	M
	MAC Address	M
	IP Address	M
	TCP/UDP Port	M
Broadcast storm control	Yes	M
PoE support	N/A	N/A
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M

	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
	802.3ad LAG	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	M
	OSPF	M
	PIM (DM & SM)	M
	Static Routing	M
Router resilience	VRRP/HSRP	M
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	M
	SNMP IPv6	M
	802.1x	M
	AAA/Radius	M
	CIDR RFC4632	M
	IPv6 Basic RFC2460	M
	Dual Stack IPv6 IPv4 support	M
	IPv6 over v4 tunnelling	M
	Path MTU discovery	M
	Neighbour discovery	M
	SLAAC	M
	OSPF IPv6 RFC4552	HD
IPv6 Certification	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD

MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.3 Switch Type 2 Requirements

Core Switch Features **Type 2 Advanced Core Switch**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Power supply Hot Swappable	Yes	HD
Power supply redundancy	Yes	M
Switching Modules/Cards Hot swappable	Yes	HD
Stackable (with dedicated stacking interface)	Yes	M
	Stacking cable included	M
	Stacking module included	M
10GbE SFP+ Ports **(Note 1&2)**	2+	HD
1GbE SFP (MMF/SMF or 1000T) **(Note 2)**	24 or more scalable	M
10/100/1000T RJ45 Ports **(Note 2)**	Note 2	Note 2
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M
Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Across the stack	M

PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management (SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	3	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum 32K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	8	M
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M
	Switch Port	M
	MAC Address	M
	IP Address	M
	TCP/UDP Port	M
Broadcast storm control	Yes	M
PoE support	N/A	N/A

IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	M
	OSPF	M
	PIM (DM & SM)	M
	Static Routing	M
Router resilience	VRRP/HSRP	M
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	M
	SNMP IPv6	M
	802.1x	M
	AAA/Radius	M
	CIDR RFC4632	M
	IPv6 Basic RFC2460	M
	Dual Stack IPv6 IPv4 support	M
	IPv6 over v4 tunnelling	M
	Path MTU discovery	M
	Neighbour discovery	M
	SLAAC	M
	OSPF IPv6 RFC4552	HD
IPv6 Certification	IPv6 Ready Phase 1 Certification	HD

	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.4 Switch Type 3 Requirements

Core Switch Features **Type 3 Advanced Core Switch**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Stackable (with dedicated stacking interface)	Yes	M
	Stacking cable included	M
	Stacking module included	M
Power supply Hot Swappable	Yes	HD
Power supply redundancy	Yes	M
Switching Modules/Cards Hot swappable	Yes	HD
10GbE SFP+ Ports **(Note 1&2)**	2+	M
1GbE SFP (MMF/SMF or 1000T) **(Note 2)**	24 or more scalable	M
10/100/1000T RJ45 Ports **(Note 2)**	Note 2	Note 2
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M
Manual override of auto negotiation	Yes	M

IEEE 802.3ad Port aggregation / LACP	Across the stack	M
PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management (SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	3	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum of 32K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP Query	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	8	M
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M
	Switch port	M
	MAC Address	M
	IP Address	M
	TCP/UDP port	M
Broadcast storm control	Yes	M

PoE support	N/A	N/A
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	M
	OSPF	M
	PIM (DM & SM)	M
	Static Routing	M
Router resilience	VRRP/HSRP	M
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	M
	SNMP IPv6	M
	802.1x	M
	AAA/Radius	M
	CIDR RFC4632	M
	IPv6 Basic RFC2460	M
	Dual Stack IPv6 IPv4 support	M
	IPv6 over v4 tunnelling	M
	Path MTU discovery	M
	Neighbour discovery	M
	SLAAC	M
	OSPF IPv6 RFC4552	HD

IPv6 Certification	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.5 Switch Type 4 Requirements

Core Switch Features **Type 4 Basic Core Switch**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Stackable (with dedicated stacking interface)	Yes	M
	Stacking cable included	M
	Stacking module included	M
Power supply Hot Swappable	Yes	HD
Power supply redundancy	Yes	M
Switching Modules/Cards Hot swappable	Yes	HD
10GbE SFP+ Ports **(Notes 1&2)**	2	HD
1GbE SFP (MMF/SMF or 1000T) **(Note 2)**	2+	M
10/100/1000T RJ45 Ports	24 or more scalable	M
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M

Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Across the stack	M
PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management(SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	3	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum of 16K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	4	M
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M
	Switch Port	M
	MAC Address	M
	IP Address	M

	TCP/UDP Port	M
Broadcast storm control	Yes	M
PoE support	N/A	N/A
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	M
	OSPF	M
	PIM (DM & SM)	M
	Static Routing	M
Router resilience	VRRP/HSRP	M
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	M
	SNMP IPv6	M
	802.1x	M
	AAA/Radius	M
	CIDR RFC4632	M
	IPv6 Basic RFC2460	M
	Dual Stack IPv6 IPv4 support	M
	IPv6 over v4 tunnelling	M
	Path MTU discovery	M
	Neighbour discovery	M

	SLAAC	M
	OSPF IPv6 RFC4552	HD
IPv6 Certification	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.6 Switch Type 5 and 6 Requirements

Edge Switch Features **Type 5 & Type 6 Advanced Edge Switches**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Stackable (with dedicated stacking interface)	Yes	M
	Stacking cable included	M
	Stacking module included	M
10GbE SFP+ Ports **(Notes 1&2)**	2	M
1GbE SFP (MMF/SMF or 1000T)**(Note 2)**	2+	M
10/100/1000T RJ45 Ports(**Type 5**)	24	M
10/100/1000T RJ45 Ports(**Type 6**)	48	M
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M

Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Across the stack	M
PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management(SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	2 or 3	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum of 16K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	4	M
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M
	Switch Port	M
	MAC Address	M
	IP Address	M

	TCP/UDP Port	M
Broadcast storm control	Yes	M
PoE	N/A	N/A
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	D
	OSPF	D
	PIM (DM & SM)	D
	Static Routing	D
Router resilience	VRRP/HSRP	D
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	HD
	SNMP IPv6	HD
	802.1x	HD
	AAA/Radius	HD
	CIDR RFC4632	D
	IPv6 Basic RFC2460	D
	Dual Stack IPv6 IPv4 support	D
	IPv6 over v4 tunnelling	D
	Path MTU discovery	D
	Neighbour discovery	D

	SLAAC	D
	OSPF IPv6 RFC4552	D
IPv6 Certification	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.7 Switch Type 7 & 8 Requirements

Edge Switch Features **Type 7 & Type 8 PoE Switches**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Stackable (with dedicated stacking interface)	N/A	N/A
	Stacking cable included	N/A
	Stacking module included	N/A
10GbE SFP+ Ports	N/A	N/A
10/100/1000T RJ45 Ports(**Type 7**)	24	M
1GbE SFP (MMF/SMF or 1000T) (**Type 7**)	2+	M
10/100/1000T RJ45 Ports(**Type 8**)	8	M
1GbE SFP (MMF/SMF or 1000T) (**Type 8**)	1+	M

IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M
Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Yes	M
PoE support 802.3af (**Type 7**)	Minimum 16 ports at 16W	M
PoE support 802.3af (**Type 8**)	Minimum 8 ports at 16W	M
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management(SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	2	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum of 16K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	Vendor to state	Vendor to state
Traffic Classification (COS) defined on:	TOS	M
	Diffserv (DSCP)	M

	Switch port	M
	MAC Address	M
	IP Address	M
	TCP/UDP port	M
Broadcast storm control	Yes	M
PoE support	IEEE 802.3af and 802.3at	M
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	N/A
	OSPF	N/A
	PIM (DM & SM)	N/A
	Static Routing	N/A
Router resilience	VRRP/HSRP	N/A
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	HD
	SNMP IPv6	HD
	802.1x	HD
	AAA/Radius	HD
	CIDR RFC4632	D
	IPv6 Basic RFC2460	D
	Dual Stack IPv6 IPv4 support	D

	IPv6 over v4 tunnelling	D
	Path MTU discovery	D
	Neighbour discovery	D
	SLAAC	D
	OSPF IPv6 RFC4552	D
	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state

1.8 Switch Type 9 & 10 Requirements

Edge Switch Features **Type 9 & Type 10 Basic Edge Switch**	**Requirement**	**Compliance**
Part Number	Vendor to state	Vendor to state
Rack mounting	19 inch rack mountable	M
Number of RU	1RU	M
Power supply	Internal 230V	M
Stackable (with dedicated stacking interface)	N/A	N/A
	Stacking cable included	N/A
	Stacking module included	N/A
10GbE Ports	N/A	N/A
1GbE SFP (MMF/SMF or 1000T) (**Type 9**)	2+	M
10/100/1000T RJ45 Ports(**Type 9**)	24+	M

1GbE SFP (MMF/SMF or 1000T) (**Type 10**)	1+	M
10/100/1000T RJ45 Ports(**Type 10**)	8+	M
IEEE N-way auto negotiation, Speed, duplex, & MDI-X	All ports	M
Manual override of auto negotiation	Yes	M
IEEE 802.3ad Port aggregation / LACP	Yes	M
PoE	N/A	N/A
Web browser manageable (HTTPS)	Yes	M
SNMP V3 manageable	Yes	M
RMON management	1,2,3 & 9	M
Telnet management V2	Yes	M
CLI management(SSH)	Yes	M
Configuration backup and restore support	Yes	M
LLDP	Yes	M
Firmware upgradeable	Yes	M
Port Mirroring	Yes	M
Layer	2	M
VLAN Security options	IEEE 802.1x	HD
IP Address setting	Static & Dynamic	M
IP filtering for management security	Yes	M
Maximum supported number of VLANs	Vendor to state	Vendor to state
Non Blocking & Wire Speed operation	Yes	M
Size of MAC address tables	Minimum of 8K	M
Jumbo frame support	Vendor to state MTU supported	M
IGMP V1,V2 & V3	Yes	M
Number of Concurrent Multicast streams supported	Vendor to state	Vendor to state
IGMP querier	Yes	HD
ICMP Ping send and receive	Yes	M
Number of QoS Queues	4	M
Traffic Classification	TOS	M

(COS) defined on:	Diffserv (DSCP)	M
	Switch port	M
	MAC Address	M
	IP Address	M
	TCP/UDP port	M
Broadcast storm control	Yes	M
IEEE standards	802.1p	M
	802.1Q VLAN Tagging	M
	802.1AD (QinQ)	HD
	802.3x Ethernet Flow Control	M
	802.3ae 10 Gigabit Ethernet	M
	802.3z 1 Gigabit Ethernet	M
	802.3ab 1000Base-T Auto Negotiation	M
	802.1D	M
	802.1w RSTP	M
	802.1s MSTP	M
802.1x	Dynamic VLAN	M
	Radius Accounting	M
	Guest VLAN	M
Routing	RIP V1, V2	N/A
	OSPF	N/A
	PIM (DM & SM)	N/A
	Static Routing	N/A
Router resilience	VRRP/HSRP	N/A
IPv6	ICMPv6 with MLDv2 support for IPv6 Mcast	M
	IPv6 QoS	M
	IPv6 ACL	M
	SNMP IPv6 for Dead or Alive monitoring	HD
	SNMP IPv6	HD
	802.1x	HD
	AAA/Radius	HD
	CIDR RFC4632	D
	IPv6 Basic RFC2460	D
	Dual Stack IPv6 IPv4 support	D

	IPv6 over v4 tunnelling	D
	Path MTU discovery	D
	Neighbour discovery	D
	SLAAC	D
	OSPF IPv6 RFC4552	D
IPv6 Certification	IPv6 Ready Phase 1 Certification	HD
	IPv6 Ready Phase 2 Certification	HD
MTBF	Manufacturer must stipulate	M
Operating Temperature	0-40 degrees Celsius	Vendor to state
Noise	<50dB	HD
Latency 10Mbps	Vendor to state	Vendor to state
Latency 100Mbps	Vendor to state	Vendor to state
Latency 1000Mbps	Vendor to state	Vendor to state
RoHS Compliant	Yes	M
Maximum current draw	Manufacturer must stipulate	Vendor to state
Maximum heat dissipation	Manufacturer must stipulate	Vendor to state