Packet Switched Networks
Wired – Local, Metropolitan, and Wide Area Networks

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Standard governance

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Document history

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<thead>
<tr>
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<th>Summary of change</th>
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<tr>
<td>1.0</td>
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</tr>
</tbody>
</table>

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Preface

The Asset Standards Authority (ASA) is an independent unit within Transport for NSW (TfNSW) and is the network design and standards authority for defined NSW transport assets.

The ASA is responsible for developing engineering governance frameworks to support industry delivery in the assurance of design, safety, integrity, construction, and commissioning of transport assets for the whole asset life cycle. In order to achieve this, the ASA effectively discharges obligations as the authority for various technical, process, and planning matters across the asset life cycle.

The ASA collaborates with industry using stakeholder engagement activities to assist in achieving its mission. These activities help align the ASA to broader government expectations of making it clearer, simpler, and more attractive to do business within the NSW transport industry, allowing the supply chain to deliver safe, efficient, and competent transport services.

The ASA develops, maintains, controls, and publishes a suite of standards and other documentation for transport assets of TfNSW. Further, the ASA ensures that these standards are performance based to create opportunities for innovation and improve access to a broader competitive supply chain.

This document has been developed by the Chief Engineer Rail section of the ASA, reviewed by a committee of TfNSW cluster representatives, and approved by the ASA Configuration Control Board.

This standard specifies the requirements for wired packet switching networks used for the purpose of data exchange between connected ethernet and internet protocol (IP) enabled computer systems, across local, metropolitan, and wide area networks.
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1. Introduction

Railway communication systems for applications within the signals and control systems, telecommunications, electrical, and rolling stock disciplines are increasingly based on ethernet and internet protocol (IP) enabled computer systems. Local, metropolitan, and wide area wired networks shall align with national and international standards to create open industry involvement, increased competition, and optimal asset stewardship outcomes.

2. Purpose

This document standardises wired packet switching networks used for the purpose of data exchange between connected ethernet and internet protocol (IP) enabled computer systems, across local, metropolitan, and wide area networks.

2.1. Scope

This document specifies the functional requirements for the following system interfaces:

- data terminal equipment to local area network (DTE to LAN systems)
- local area network to local area network (LAN to LAN systems)
- local area network to wide area network (LAN to WAN systems)
- wide area network to wide area network (WAN to WAN systems)
- LAN and WAN systems to physical environment
- LAN and WAN systems to network management systems

For simplicity and readability, this document considers a metropolitan area network to be a local area network (LAN).

This document specifies wired packet switch networking functional requirements for data communications equipment (DCE) and data terminal equipment (DTE).

The functional requirements specified in this document principally relate to the physical, data link and network layers of the open systems interconnection (OSI) model defined in ISO/IEC 7498-1 and the link and internet layers of the internet protocol suite (commonly referred to as the TCP/IP model).

Figure 1 shows the systems and interfaces that are in scope.
Figure 1 - In-scope systems and interfaces

Figure 1 is informational and is not intended to convey any architectural information.
Solid lines represent systems and system interfaces, dashed lines represent sub-systems and sub-system interfaces.

This document specifies minimum non-functional requirements for local area network (LAN) and wide area network (WAN) systems and data communications equipment (DCE) sub-systems.

More stringent non-functional requirements may be specified as part of a system requirements specification (SRS).

This document does not contain detailed and comprehensive requirements for functional areas of the ASA other than network standards, such as asset planning, technical management or maintenance plans, configuration control, asset stewardship inclusive of network strategy and architecture.
In the special case where a wired packet switch network is required to comply with this standard even though the DTE are not ethernet and internet protocol enabled, where the DTE to LAN network interface is provided by a RS232 or RS422 serial interface, the following applies:

- the DTE system is out of scope
- the DTE to LAN system interface is out of scope
- all other sub-system and system interfaces are in scope

### 2.2. Application

A requirement applies to both LAN and WAN systems unless it is explicitly qualified as applying to either LAN or WAN systems.

This standard applies to all uses of LAN and WAN systems.

This standard applies to installations of LAN and WAN systems. For example, within fixed premises or on rolling stock.

This standard applies to LAN and WAN systems regardless of whether they are used to support safety related functions. A requirement applies unless it is explicitly qualified as applying to either safety or non-safety related functions.

In order to apply this standard for safety related communication, an EN 50159 assessment shall be performed to categorise the transmission system and to ensure the consistency and appropriateness of defences implemented by the safety related system.

### 3. Reference documents

**International standards**

- EN 50159 Railway Applications - Communication, Signalling and Processing Systems - Safety-related Communication in Transmission Systems
- EN 60825-1 Safety of laser products - Equipment classification and requirements
- EN 60825-2 Safety of laser products - Safety of optical fibre communication systems (OFCS)
- EN 60950-1 Information technology equipment - Safety - General requirements
- EN 61508-4 Functional safety of electrical/electronic/programmable electronic safety-related systems - Part 4: Definitions and abbreviations
- ISO/IEC 18028 Information technology - Security techniques - IT network security
- PD IEC TR 62380 Reliability data handbook - Universal model for reliability prediction of electronics components, PCBs and equipment
IEC 60050-191 International Electrotechnical Vocabulary. Chapter 191: Dependability and quality of service

IEEE 802.1AB Station and Media Access Control Connectivity Discovery

IEEE 802.1D Media access control (MAC) Bridges

IEEE 802.1Q Virtual LANs

IEEE 802.1X Port-Based Network Access Control

IEEE 802.3 Ethernet

IETF RFC 1242 Benchmarking Terminology for Network Interconnection Devices

IETF RFC 2474 Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers

IETF RFC 2544 Benchmarking Methodology for Network Interconnect Devices

IETF RFC 3768 Virtual Router Redundancy Protocol (VRRP)

IETF RFC 4271 A Border Gateway Protocol 4 (BGP-4)

IETF STD 5 Internet Protocol, Internet Control Message Protocol

ISO/IEC 27001 Information technology - Security techniques - Information security management systems - Requirements

ISO/IEC 7498-1 Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model

MIL-HDBK-217F Notice 2 Reliability Prediction of Electronic Equipment

Telcordia SR-332 Reliability Prediction Procedure for Electronic Equipment

Transport for NSW standards

T HR TE 21002 ST Communications Earthing and Surge Suppression

T HR TE 81001 ST Telecommunication Equipment – Physical Interfaces and Environmental Conditions

T HR TE 81002 ST Telecommunication Equipment – Network Management

T MU TE 81003 ST Test Processes and Documentation for Programmable Electronic Systems and Software

TS 10502 AEO Authorisation Requirements

TS 10506 AEO Guide to Verification and Validation
4. Terms and definitions

The following terms and definitions apply in this document:

BGP border gateway protocol

CFR constant failure rate

constant failure rate (as defined in IEC 60050-191) that period, if any, in the life of a non-repaired item during which the failure rate is approximately constant

DCE data communication equipment

data communication equipment a physical network node. Example, a switch, router

DTE data terminal equipment

data terminal equipment computer system with one or more internet protocol addresses assigned to its network interfaces for the purpose of resource sharing amongst systems connected to the communication network. For example, workstation, printer, telephone

EN European norms

EOS end of sale

end of sale the date when the original equipment manufacturer (OEM) withdraws a product from sale, both directly and through its authorised points of sale; for example, distributors and resellers

field replaceable units part that can be removed and replaced without having to send the system to a repair facility

first offered for sale the date when the OEM first offers a product for sale in the Australian market

IEC International Electrotechnical Commission

IEEE Institute of Electrical and Electronics Engineers

IETF Internet Engineering Task Force

ICMP internet control message protocol

LAN local area network

local area network computer network consisting of switches which forward ethernet frames

LLDP link layer discovery protocol

MDI media dependent interface

MTTF mean time to failure

mean time to failure (as defined in IEC 60050-191) the expectation of the time to failure
OAM operations, administration, and maintenance

OEM original equipment manufacturer

operational [availability] (as defined in IEC 60050-191) qualifies a value determined under given operational conditions

PNAC port-based network access control

RADIUS remote authentication dial in user service

safety related (as defined in EN 61508-4) designated system that both

– implements the required safety functions necessary to achieve or maintain a safe state for the equipment under control; and

– is intended to achieve, on its own or with other electrical, electronic, or programmable electronic safety-related systems and other risk reduction measures, the necessary safety integrity for the required safety functions

steady state [availability] (as defined in IEC 60050-191) qualifies a value determined for conditions of an item when characteristic parameters of the item remain constant

TACACS+ terminal access controller access-control system plus

VRRP virtual router redundancy protocol

WAN wide area network

wide area network computer network consisting of routers, which forward internet protocol (IP) packets

5. Functional requirements for data communication and terminal equipment

Figure 2 shows the data communication equipment (DCE) and data terminal equipment (DTE) in the overall system. The functional requirements are specified in Section 5.1 through Section 5.15.
5.1. Bridging and management

DCE shall comply with IEEE 802.1D-2004.


DCE shall comply with IEEE 802.1Q-2005.


DCE shall comply with the link layer discovery protocol (LLDP) as defined in IEEE 802 1AB.

DCE shall be configured to use LLDP.

5.2. Ethernet operations, administration, and maintenance (OAM)

DCE shall be configured to use OAM and comply with operations, administration, and maintenance (OAM) as defined in IEEE 802.3.
5.3. **10 Mb/s ethernet interfaces**

Where a DCE provides 10 Mb/s ethernet interface this section has to be complied with.

10BASE-T type 10 Mb/s ethernet interfaces as defined in IEEE 802.3 may be integrated into cards, shelves, or chassis.

DTE may provide 10BASE-T type 10 Mb/s ethernet interfaces as defined in IEEE 802.3.

5.4. **100 Mb/s ethernet interfaces**

Where a DCE provides 100 Mb/s ethernet interfaces, this section has to be complied with.

DCE that provide 100 Mb/s ethernet interfaces using modular transceiver packages shall comply with the media independent interface (MII) as defined in IEEE 802.3.

100BASE-TX type 100 Mb/s ethernet interfaces as defined in IEEE 802.3 may be integrated into cards, shelves, or chassis. Other 100 Mb/s ethernet interface types shall be provided using modular transceiver packages.

DTE may provide 100BASE-TX type 100 Mb/s ethernet interfaces as defined in IEEE 802.3.

5.5. **1 Gb/s ethernet interfaces**

Where a DCE provides 1 Gb/s ethernet interfaces this section has to be complied with.

DCE that provide 1 Gb/s ethernet interfaces using modular transceiver packages shall comply with the gigabit media independent interface (GMII) as defined in IEEE 802.3.

1000BASE-T type 1 Gb/s ethernet interfaces as defined in IEEE 802.3 may be integrated into cards, shelves, or chassis. Other 1 Gb/s ethernet interface types shall be provided using modular transceiver packages.

DTE may provide 1000BASE-T type 1 Gb/s ethernet interfaces as defined in IEEE 802.3.

Modular transceiver packages shall be available that comply with the following 1 Gb/s ethernet interface types as defined in IEEE 802.3:

- 1000BASE-T
- 1000BASE-LX
- 1000BASE-SX
- 1000BASE-LX10
- 1000BASE-BX10

Non-standard 1 Gb/s ethernet interfaces may be used if greater distances are required, provided that equivalent product can be sourced from at least three suppliers.
5.6. 10 Gb/s ethernet interfaces

Where a DCE provides 10 Gb/s ethernet interfaces this section shall be complied with.

DCE that provide 10 Gb/s ethernet interfaces using modular transceiver packages shall comply with the 10 gigabit media independent interface (XGMII) as defined in IEEE 802.3.

All 10 Gb/s ethernet interface types shall be provided using modular transceiver packages.

Modular transceiver packages shall be available that comply with the following 10 Gb/s ethernet interface types as defined in IEEE 802.3:

- 10GBASE-SR
- 10GBASE-LR
- 10GBASE-ER

IEEE 802.3 10GBASE-CR direct attach copper cables may be used within a LAN or WAN system for direct DCE to DCE connections.

Non-standard 10 Gb/s ethernet interfaces may be used if greater distances are required, provided that equivalent product can be sourced from at least three suppliers.

5.7. 40 Gb/s ethernet interfaces

Where a DCE provides 40 Gb/s ethernet interfaces this section shall be complied with.

DCE that provide 40 Gb/s ethernet interfaces using modular transceiver packages shall comply with the 40 gigabit media independent interface (XLGMII) as defined in IEEE 802.3.

All 40 Gb/s ethernet interface types shall be provided using modular transceiver packages.

Modular transceiver packages shall be available that comply with the following 40 Gb/s ethernet interface types as defined in IEEE 802.3:

- 40BASE-SR4
- 40BASE-LR4

IEEE 802.3 40BASE-CR4 direct attach copper cables may be used within a LAN or WAN system for direct DCE to DCE connections.

Non-standard 40 Gb/s ethernet interfaces may be used if greater distances are required, provided that equivalent product can be sourced from at least three suppliers.
5.8. 100 Gb/s ethernet interfaces

Where a DCE provides 100 Gb/s ethernet interfaces this section has to be complied with.

100 Gb/s ethernet interfaces shall not be used.

*Note that 100 Gb/s ethernet interfaces may be reviewed for inclusion in the next revision of this standard.*

5.9. Power over ethernet

LAN DCE that provide power over ethernet (PoE) ports shall comply as a power sourcing equipment (PSE) with the data terminal equipment (DTE) power via media dependant interface (MDI) as defined in IEEE 802.3.

DTE may comply as a powered device (PD) with the data terminal equipment (DTE) power via media dependant interface (MDI) as defined in IEEE 802.3.

Note that IEEE 802.3 incorporates IEEE 802.3af-2003 and IEEE 802.3at-2009.

5.10. Modular transceiver packages

The following is a list of compliant modular transceiver packages for use in DCE and DTE:

- small form factor pluggable (SFP) transceiver compliant to INF-8074i
- enhanced small form factor pluggable (SFP+) transceiver compliant to SFF-8431
- 10 gigabit small form factor pluggable (XFP) transceiver compliant to INF-8077i
- 10 Gb/s 4X pluggable transceiver (QSFP+) transceiver compliant to SFF-8635

Other modular transceiver packages shall not be used.

5.11. Port-based network access control

LAN DCE shall comply with IEEE 802.1X as an authenticator.

5.12. Internet protocol and internet control message protocol

WAN DCE and DTE shall comply with internet protocol (IP) and internet control message protocol (ICMP) as defined in IETF STD 5.

5.13. First hop redundancy protocol

WAN DCE shall comply with virtual router redundancy protocol (VRRP) as defined in IETF RFC 3768.
5.14. **Exterior gateway protocol**

WAN DCE shall comply with border gateway protocol (BGP) as defined in IETF RFC 4271.

5.15. **Quality of service**

DCE shall support weighted round robin (WRR) and strict priority (SP) congestion management mechanisms.

DCE shall support random early detection (RED) congestion avoidance mechanisms.

DCE shall support policed rate-limiting and packet actions (for example: transmit, drop, remark) for conforming and exceeding rates based on traffic transmitted on a particular interface or defined by an access control list (ACL).

6. **Network interfaces between DTE, LAN and WAN systems**

Figure 3 shows the network interfaces between DTE, LAN, and WAN systems and includes the following:

- data terminal equipment to local area network (DTE to LAN systems)
- local area network to local area network (LAN to LAN systems)
- local area network to wide area network (LAN to WAN systems)
- wide area network to wide area network (WAN to WAN systems)

These interfaces are explained in Section 6.1, Section 6.2, Section 6.3, and Section 6.4 respectively.
6.1. **DTE to LAN network interface**

The network interface shall comply with the requirements stated in Section 5.

The network interface shall comply with a minimum speed of 10 Mb/s.

Connections may be made directly over balanced or optical fibre cabling or indirectly over other 'last mile' transmission systems or carriage services.

If balanced cabling is used, the network interface shall comply with the minimum class / category defined in IEC 11801 Class D / ANSI/EIA-568 Category 5e shown in section 8 of T HR TE 81001 ST *Telecommunication Equipment - Physical Interfaces and Environmental Conditions*.

If optical fibre cabling is used the network interface shall comply with the minimum types defined in IEC 11801 types OS1, OM1, or OM2 as defined in section 8 of T HR TE 81001 ST.

Bridge protocol data units (BPDU) shall be dropped.

Where use of the rail infrastructure owner's communication cable is not feasible, carriage services may be used within LAN or WAN systems between two DCE.

![Diagram of system network interfaces](image)

**Figure 3 - System network interfaces**
6.2. **LAN to LAN network interface**

The network interface shall comply with the requirements stated in Section 5.

The network interface shall comply with a minimum speed of 1 Gb/s.

The network interface shall comply with the minimum types defined in IEC 11801 types OS1, OM3, or OM4 as defined in section 8 of T HR TE 81001 ST, or direct attach copper.

The network interface shall be provided by modular transceiver package.

Quality of service markings shall use the IEEE 802.1Q-2005 priority code point (PCP) field.

Bridge protocol data units (BPDU) shall be dropped.

6.3. **LAN to WAN network interface**

The network interface shall comply with the requirements stated in Section 5.

The network interface shall comply with a minimum speed of 1 Gb/s.

The network interface shall comply with the minimum types defined in IEC 11801 types OS1, OM3, or OM4 as defined in section 8 of T HR TE 81001 ST, or direct attach copper.

The network interface shall be provided by modular transceiver package.

Quality of service markings shall use the IEEE 802.1Q-2005 priority code point (PCP) field.

VRRP shall be used as the first hop redundancy protocol.

6.4. **WAN to WAN network interface**

The network interface shall comply with the requirements stated in Section 5.

The network interface shall comply with a minimum speed of 10 Gb/s.

The network interface shall comply with the minimum types defined in IEC 11801 types OS1, OM3, or OM4 as defined in section 8 of T HR TE 81001 ST.

The network interface shall be provided by modular transceiver package.

Quality of service markings shall use the IETF RFC 2474 differentiated services (DS) field.

BGP shall be used as the exterior gateway protocol.

7. **Interfaces to physical environment**

Figure 4 shows the interfaces to the physical environment. The physical environment includes power supply, earth connections, rack and rail mounts, equipment cords, environmental conditions and electromagnetic emissions and immunity.
DCE shall comply with T HR TE 81001 ST.

8. **Interfaces to network management systems**

Figure 5 shows the interface to the network management systems. The network management systems include fault and performance management, configuration management, and security management.
Where a LAN is dedicated to a single application, full compliance to this section may not be required if it can be demonstrated that it is not feasible to implement network management systems based on these protocols. For example, emergency, alert, and critical events in signal applications may be carried by a proprietary protocol to a monitoring centre because the LAN is isolated.

The design of network management systems is not mandated in this standard. Depending on the application, it may be appropriate to design network management systems that are local, remote or both. For example, rolling stock applications may implement an embedded local syslog server within the DCE because a wireless wide area network may not be reliable.

DCE shall comply with T HR TE 81002 ST Telecommunications Equipment – Network Management.

LAN DCE shall be configured as a port-based network access control (PNAC) authenticator compliant to IEEE 802.1X.
9. Non-functional requirements for wired packet switched networks

The non-functional requirements specify the following performance requirements for wired packet switched networks:

- availability
- interoperability
- maintainability
- manageability
- performance
- reliability
- work, health, and safety
- security

9.1. Availability

Unless otherwise qualified in this section, availability refers to the 'operational' and 'steady state' availability inclusive of all factors that contribute to system down time within the operational conditions, such as the physical environment and network management systems defined in Section 7 and Section 8 of this document.

A service is defined as a connection between two boundary interfaces on a system.

Network availability ($A_N$) is the availability of one or more LAN or WAN systems as defined below:

- probability that a typical service is able to make a connection across a network
- percentage of services able to make connections across a network at a given time
- percentage of time a typical service is able to make connections across a network

All these definitions are considered equivalent because they will provide identical network availability values even though they are viewing a network from different perspectives: a service connection, all service connections, and service downtime.

Recovery time ($T_r$) is defined as the maximum time for the system to reconverge in the event of a failure or recovery from a failure for failure modes where the LAN or WAN system has been designed to automatically reconverge (for example by using redundant sub-systems).
Where an application cannot tolerate a loss of traffic forwarding of duration \( T_r \), the application shall implement alternate mechanisms to automatically restore traffic forwarding within the required time.

Table 1 shows the minimum availability requirements for safety related function and non-safety related function.

The availability from a typical connection between two DTE (bounded by the DTE-facing port on the DCE) shall be not less than 99.99% for safety-related functions and 99.9% for non-safety-related functions.

<table>
<thead>
<tr>
<th>System</th>
<th>( A_{\text{S}}(\text{system}) )</th>
<th>( A_{\text{N}}(\text{system}) )</th>
<th>( T_r(\text{system}) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAN</td>
<td>99.998</td>
<td>99.98</td>
<td>20 s</td>
</tr>
<tr>
<td>WAN</td>
<td>99.9995</td>
<td>99.995</td>
<td>300 ms</td>
</tr>
</tbody>
</table>

Availability shall be demonstrated by the reliability block diagram (RBD) method as part of the reliability, availability, and maintainability (RAM) programme.

### 9.2. Interoperability

Where no specific requirement exists, open standards shall be complied with instead of proprietary alternatives.

Interoperability with nominated type approved DCE or existing operators’ DCE shall be verified by testing the systems, which complies to T MU TE 81003 ST *Test Processes and Documentation for Programmable Electronic Systems and Software* as part of the verification plan. This is in addition to other verification methods such as certification that may form part of the verification plan.

Additional interoperability requirements shall be complied with where new DCE interface with existing operators’ systems additional interoperability requirements may exist.

Where used, DCE shall interoperate with any compliant modular transceiver package from any third party. If a third-party modular transceiver package is used the DCE shall not disable or degrade its performance and the DCE supplier shall not alter the support or warranty conditions for the DCE.
9.3. **Maintainability**

Preventative maintenance programs shall be identified for all components with an increasing failure rate (IFR) failure model such as fans, filters, transceivers, and connectors.

Maintenance programs shall be identified to detect imminent or conditional failures such as thresholds for CPU and memory, interface utilisation and errors, temperature, power supply current and voltage.

Maintenance programs shall be identified for all assets to ensure that the hardware, firmware, software, physical and logical configuration is as designed throughout the life of the asset.

Where installed in a redundant configuration, cards and modules shall be able to be inserted or removed without affecting system operation, that is, hot swappable. Hot swapping shall be performed in hardware without issuing any system commands.

Cards and modules shall be held firmly in place by latches or thumbscrews.

Cards and modules shall be able to be inserted or removed without the use of specialised or proprietary tools.

The time to physically interchange faulty cards or modules, which includes repatching cables, shall not exceed 15 minutes.

All message logs with a severity level between 0 and 4 inclusive as defined in IETF RFC 5424 shall be logged to syslog.

All message logs with a severity level between 0 and 2 inclusive as defined in IETF RFC 5424 shall be regarded as failures requiring immediate corrective action.

All message logs with a severity level of 3 or 4 as defined in IETF RFC 5424 shall be regarded as conditional failures requiring priority preventative action.

Table 2 contains the different severity levels of message logs.

<table>
<thead>
<tr>
<th>Severity level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Emergency</td>
</tr>
<tr>
<td>1</td>
<td>Alert</td>
</tr>
<tr>
<td>2</td>
<td>Critical</td>
</tr>
<tr>
<td>3</td>
<td>Error</td>
</tr>
<tr>
<td>4</td>
<td>Warning</td>
</tr>
</tbody>
</table>

Table 2 - Severity levels of message logs
9.4. **Manageability**

Configuration datastore, running configuration datastores and startup configuration datastores are defined in IETF RFC 6241. DCE are not required to support or use IETF RFC 6241.

DCE shall support the following logical configuration management capabilities:

- support separate running and startup configuration datastores
- retrieve all of a configuration datastore
- load all of a configuration to a target configuration datastore
- create or replace a configuration datastore with the contents of another configuration datastore
- delete a configuration datastore
- retrieve running configuration

When queried using SNMPv3, the DCE returns values that correspond with configured values for the following logical configuration attributes:

- hostname (sysName)
- location (sysLocation)
- contact (sysContact)

When queried using SNMPv3, the DCE returns values that correspond with published product documentation for the following physical configuration attributes:

- hardware revision
- firmware revision
- software revision
- serial number of chassis and field replaceable units
- manufacturer name of chassis and field replaceable units
- model name of chassis and field replaceable units
9.5. Performance

Throughput, latency, and frame loss rate are defined in IETF RFC 1242.

DCE shall be tested against the procedure defined in IETF RFC 2544 for throughput, latency, and frame loss rate and obtain the following test results:

- throughput of 100% with line rate equal to 100%
- latency of less than:
  - 130 µs for a 1518 byte frame on a 100 Mb/s ethernet interface
  - 18 µs for a 1518 byte frame on a 1 Gb/s ethernet interface
  - 6.5 µs for a 1518 byte frame on a 10 Gb/s ethernet interface
- frame loss rate of 0% with line rate equal to 100%

Delay and delay variance metrics are inclusive of transmission, switch fabric, queuing and propagation delays.

A connection between two DTE shall have an average delay of 5 ms and delay variance of 5 ms for a 1518 byte frame under a load of 80%. It is assumed a maximum of two 100 Mb/s 100 m links and 20 one Gb/s 1 km links modelled using M/M/1 distribution and 80% load.

All traffic flows shall be assigned a relative priority and information rates as part of a traffic policy and serviced by DCE accordingly.

DCE shall be configured to ensure that safety-related traffic flows are serviced preferentially over non safety-related traffic flows.

9.6. Reliability

Failure models inclusive of the failure distribution and required parameters for all field replaceable units (FRU) that comprise DCE shall be specified. For example, a common failure model is the constant failure rate (CFR) with exponential distribution and mean time to failure (MTTF).

The mean time to failure of all CFR field replaceable units shall exceed 150,000 h.

Failure model parameters shall comply with the yearly average temperature for reliability, availability, maintainability, and safety (RAMS) calculations defined in EN 50125-3.

Acceptable methods for predicting the failure model for electronic equipment are as follows:

- IEC/TR 62380
- Telcordia SR-332 Issue 3
- MIL-HDBK-217F Notice 2
Where multiple MTTF estimates are available, the lowest estimate shall be used.

Failure models shall be justified by stating the data source, methodology, environment, assumptions, and parameters.

9.7. **Work, health, and safety**

DCE shall comply with the safety of information technology requirements as defined in EN 60950-1.

DCE shall comply with the safety of laser products requirements as defined in EN 60825-1 and EN 60825-2.

9.8. **Security**

Defences against security vulnerabilities such as interruption, interception, modification, intrusion, and deception shall be implemented consistent with the guidance contained within ISO/IEC 18028. These defences shall mitigate internal or external and intentional or unintentional security vulnerabilities.

The governance of LAN and WAN system shall comply with ISO/IEC 27001.

9.8.1. **Management-plane security**

Where a LAN is dedicated to a single application, full compliance to this section may not be required if it can be demonstrated that it is not feasible to implement network management systems based on the protocols defined in Section 8 of this document.

As a minimum, the following management-plane security defences shall be implemented on DCE:

- in-band management ports to be on dedicated management VLAN (not VLAN 1)
- prune management VLAN from 802.1Q trunks where not required
- enable password security (hashing) for local passwords
- disable local password recovery using the console, that is, the DCE is factory reset to reinitialise
- disable all unused services, such as discard, daytime, chargen and protocols, such as SNMPv1, SNMPv2
- enable an idle timeout of 5 minutes on console and remote terminal sessions
- enable the generation of a trap or message notification when memory utilisation exceeds 80%
Enabling the generation of a message notification when memory and CPU utilisation thresholds have been exceeded assists in detecting that a security attack is in progress.

- enable the generation of a trap or message notification when CPU utilisation exceeds 80%
- enable authentication in protocols where the support exists; for example, NTPv3, SNMPv3
- enable encryption in protocols where the support exists; for example, SNMPv3
- access control list 'white-list' is implemented to permit access to the DCE management-plane services, such as SNMPv3, syslog, DNS, NTPv3, SNTP, SSHv2, HTTPS, TACACS+, RADIUS from authorised network management servers and clients

All other access to management-plane services is denied.

- access control list 'white-list' is implemented to permit access to the DCE using internet control message protocol (ICMP) types 0, 8, and 11 from authorised network management servers and clients.

All other access to the DCE using ICMP types 0, 8, and 11 is denied.

- access to management services are restricted to configured interfaces
- disable insecure management protocols, such as trivial file transfer protocol (TFTP), telnet
- enable a retry limit for protocols that support authentication
- disable any auxiliary or unused management ports
- enable the banner as shown below on login to notify unauthorised users that they are not permitted to use the system:

```
***** This service is for authorised clients only *****
******************************************************************************
* WARNING: It is a criminal offence to:                             *
*  i. Obtain access to data without authority                        *
*     (Penalty 2 years imprisonment)                                *
*  ii Damage, delete, alter or insert data without authority        *
*     (Penalty 10 years imprisonment)                               *
******************************************************************************
```

- configure the primary method of authentication, authorisation and accounting to TACACS+ or RADIUS
- configure the secondary method of authentication, in the event of the failure of the primary method, to local passwords
• manufacturer default passwords shall not be used
• configure logging of messages with a severity level between 0 and 4 inclusive, as defined in IETF RFC 5424, to syslog servers
• disable logging of messages to console and terminal
• enable logging of configuration change, authentication and authorisation events

9.8.2. **Control-plane security**

As a minimum, the following control-plane security defences shall be implemented on DCE:

- access control list 'white-list' is implemented to permit access to the control-plane. For example, VRRP and BGP.
  
  All other access to the control-plane is denied.

- enable authentication in protocols where the support exists; for example, VRRP and BGP
- enable route filtering using prefix lists where the support exists; for example, BGP

9.8.3. **Data-plane security**

Where a LAN is dedicated to a single application, full compliance to this section may not be required if it can be demonstrated that it is not feasible to implement network management systems based on the protocols defined in Section 8 of this document.

As a minimum, the following data-plane security defences shall be implemented on the system interface to the first LAN DCE contained within the bearer for multiple applications super-system:

- prune VLAN 1 from 802.1Q trunks where not required
- where physical access to DCE, DTE, or patch panels cannot be controlled exclusively to personnel authorised to perform maintenance of LAN and WAN systems, port-based network access control (PNAC) shall be enabled on all DCE access ports. IEEE 802.1X shall be used for PNAC where the DTE supports IEEE 802.1X, otherwise strict MAC address PNAC shall be used. Examples of exceptions may include facilities with electronic access or keyed access with monitored perimeter alarming.

- enable DCE traffic flow statistics
- access control list 'white-list' is implemented to permit access to data-plane, specified by internet layer, such as IP, ICMP or transport layer, such as TCP, UDP rules.

  All other access to data-plane is denied.
9.9. **Scalability**

The LAN DCE switching capacity shall switch traffic at full line rate on all interfaces.

9.10. **Supportability**

The supportability life cycle is shown in Figure 6 and Figure 7.

An advance notice shall be issued by the original equipment manufacturer (OEM) more than six months (180 days) prior to the end of sale (EOS).

DCE shall only be submitted for type approval if either of the following conditions is met:

- the OEM guarantees that the EOS is at least three years from the date of proposed commissioning
- the DCE has been first offered for sale (FOFS) for less than two years from the date of proposed commissioning

Software support services for operating system software shall be commercially available for at least three years following the EOS.

Hardware repair and replacement services shall be commercially available for at least three years following the EOS.

Type approval is withdrawn at EOS.

While software support and hardware repair and replacement services are available after EOS, the use of the product may continue for existing installations, but shall not be used in new works or upgraded installations except for emergency replacements.

When software support or hardware repair and replacement services are unavailable after EOS, the use of the product shall be discontinued.

---

**Figure 6 - Supportability life cycle based on time until end of sale**
9.11. **Sustainability**

DCE shall comply with the restriction of hazardous substances (RoHS) directive requirements as defined in EU 2002/95/EC.

When configured with the maximum supported ports the power consumption shall not exceed 5 W on average per port excluding any power over ethernet loads.

![Supportability life cycle based on time from first offered for sale](image)

<table>
<thead>
<tr>
<th>Product available for sale</th>
<th>Product withdrawn from sale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full software and hardware support services</td>
<td>Software support services for OS Hardware repair and replacement services</td>
</tr>
</tbody>
</table>

- <2 years
- >6 months
- >3 years

<table>
<thead>
<tr>
<th>Submissions for new type approval</th>
<th>Type approved</th>
</tr>
</thead>
<tbody>
<tr>
<td>- FoDS</td>
<td>- Able to use existing and install new</td>
</tr>
<tr>
<td>Project Commissioning</td>
<td></td>
</tr>
<tr>
<td>Notice of EOS</td>
<td>EOS</td>
</tr>
<tr>
<td>Discontinue use</td>
<td></td>
</tr>
</tbody>
</table>