

# Main Roads Technical Standard

## **MRTS245**

# **Principal's Telecommunications Network**

**October 10**

 **Queensland** Government

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# Table of Contents

	Page
1 INTRODUCTION .....	1
2 DEFINITION OF TERMS.....	1
3 REFERENCE DOCUMENTS .....	2
4 QUALITY SYSTEM REQUIREMENTS.....	2
5 PRINCIPAL'S TELECOMMUNICATIONS NETWORK MODEL .....	2
5.1 Field Network .....	2
5.2 Field Equipment Sub-Network .....	2
5.3 TMC LAN.....	2
6 STREAMS ARCHITECTURE OVERVIEW.....	2
7 FUNCTIONAL REQUIREMENTS.....	3
7.1 General.....	3
7.2 Network Architecture.....	3
7.3 Dynamic Routing (Self-Healing Ring) .....	3
7.4 Network Management.....	3
7.5 Network Communications .....	3
7.6 Level of Service.....	3
7.7 Special Requirements .....	4
7.7.1 CCTV .....	4
7.7.2 Vehicle Tolling Data.....	4
7.8 System and Device Interfaces .....	4
8 TELECOMMUNICATIONS NETWORK ARCHITECTURE REQUIREMENTS .....	4
8.1 Backbones .....	4
8.2 Field Devices.....	5
8.2.1 Direct Ethernet Connections.....	5
8.2.2 Serial Connections.....	5
8.2.3 IP Addressing.....	5
9 TECHNICAL REQUIREMENTS .....	5
9.1 General.....	5
9.2 Physical Mounting and Connection.....	5
9.3 Dynamic Routing (Self-Healing Ring) .....	5
9.4 Latency.....	5
9.5 PTN Management .....	5
9.6 Indicators.....	6
9.7 PTN Equipment Interfaces.....	6
9.7.1 Field Network Point of Access.....	6
9.7.2 Field Equipment Sub-Network Point of Access.....	6
9.7.3 Remote Field Equipment .....	6
9.7.4 Standards.....	6
9.7.5 Connectors and Cabling .....	7
9.8 Ethernet Switches .....	7
10 SECURITY REQUIREMENTS.....	7
11 ELECTRICAL REQUIREMENTS.....	7
12 OPERATIONAL REQUIREMENTS .....	8
13 INSTALLATION REQUIREMENTS .....	8
13.1 Telecommunication Cables.....	8
13.2 Network Node Cabinets .....	8
13.2.1 General.....	8
13.2.2 Locations .....	8
13.2.3 Construction .....	8
13.3 PTN Equipment Configuration .....	8

14	TESTING AND COMMISSIONING .....	8
15	DOCUMENTATION .....	8
16	TRAINING .....	8
17	MAINTENANCE .....	9
18	HANDOVER .....	9
19	COMMUNICATIONS ARCHITECTURE DIAGRAM .....	10

# Principal's Telecommunications Network

## 1 INTRODUCTION

This standard defines the design, supply, installation, testing and commissioning, performance, documentation, training, maintenance and handover requirements for the Principal's telecommunication network (PTN) including all elements of the PTN to be provided by the Contractor in accordance with the requirements of the Contract. PTN in the context of this standard denotes a non-telecommunications carrier provided network.

This standard is primarily intended for optical fibre based field networks employing Layer 2 and Layer 3 switches to connect to the Principal's TMC.

The PTN shall transmit all data and video between field devices and network node cabinets at the road-side.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRTS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Technical Standard forms part of the Main Roads Specifications and Technical Standards Manual.

## 2 DEFINITION OF TERMS

The terms defined in Clause 2 of MRTS 01 *Introduction to Technical Standards* and MRTS201 apply to this standard. Additional terminology relevant under this standard are defined in Table 2 below.

**Table 2 – Definitions**

Term	Definition
CCTV	Closed circuit television
Device	As defined in the Contract
Field Equipment	Portable STREAMS workstations, vehicle detectors, vehicle identification equipment, VMS, CCTVs, help phones etc.
Field Equipment Sub-Network	The interconnection of Field Processors and/or CCTV cameras in a localised area, back to a Network Node
Field Network	The interconnection of a number of Network Nodes in a given geographic area (such as along a motorway), back to the Principal's TMC
Isolated	Separate through using dedicated telecommunication channels, for example, physically distinct fibre cores
IT	Information technology
LAN	Local area network
LED	Light emitting diode
Network Node	POA for the Field Equipment Sub-Network to the Field Network
POA	Point of Access
PPP	Point-to-Point Protocol
PTN	Principal's private telecommunication network for private use and non-telecommunications carrier provided network.
QoS	Quality of Service

Term	Definition
SNMP	Simple network management protocol
System	As defined in the Contract
TCP/IP	Transport communications protocol / internet protocol
TMC	A traffic management centre from which traffic operations are managed
VMS	Variable message sign/s
VLAN	Virtual local area network/s

### 3 REFERENCE DOCUMENTS

The requirements of the referenced documents listed in Table 3 of MRTS201 and Table 3 below apply to work under this standard. Where there are inconsistencies between this standard and referenced MRTS (including those referenced in MRTS201), the requirements specified in this standard shall take precedence.

**Table 3 – Referenced Documents**

Document ID	Document Name / Description
MRTS201	General Equipment Requirements
IS-18	Queensland Government Information Security Standard

### 4 QUALITY SYSTEM REQUIREMENTS

The quality system requirements defined in MRTS201 apply to work under this standard. Additional quality system requirements for equipment provided under this standard are listed in Table 4 below.

**Table 4 – Hold Point**

Clause	Hold Point
13.2.2	1. Determination of final location

### 5 PRINCIPAL'S TELECOMMUNICATIONS NETWORK MODEL

The PTN forms a Field Network with multiple Field Equipment Sub-Networks.

A typical network configuration is shown in the drawing in Annexure A to this standard.

#### 5.1 Field Network

The Field Network shall consist of a full duplex, bi-directional, backbone ring with a number of Network Nodes to allow the transfer of data over the backbone between the Field Equipment Sub-Network(s) and a TMC LAN.

#### 5.2 Field Equipment Sub-Network

Each Field Equipment Sub-Network shall consist of a full duplex, bi-directional ring and connect to a number of Telecommunications Field Cabinets to allow the transfer of data between Field Equipment in a localised area (either via a Field Processor or directly) and a TMC LAN via the Field Network.

#### 5.3 TMC LAN

The STREAMS application server and work stations are located on an Ethernet LAN in a TMC. Connectivity between the Field Network and this Ethernet LAN is provided via an Ethernet Layer 3 switch and a firewall at a TMC (by others).

### 6 STREAMS ARCHITECTURE OVERVIEW

STREAMS is the platform used for management and control of road traffic on motorways and arterial roads.

The STREAMS system typically consists of a suite of distributed software applications operating on a STREAMS Application Server located in a TMC and on STREAMS Field Processors (FPs) located in the field. STREAMS Workstations provide a user interface to the applications.

Unless otherwise specified, all field devices shall connect to STREAMS through a FP. STREAMS ensures that data telecommunications between the STREAMS server and the FPs are secure.

## **7 FUNCTIONAL REQUIREMENTS**

The functional requirements defined in MRTS201 apply to equipment provided under this standard. In addition, the following functional requirements also apply to equipment provided under this standard.

### **7.1 General**

The PTN shall have adequate levels of security to protect the network from unauthorised users.

The required telecommunications services may be implemented on a physical circuit basis using separate fibre cores or integrated in a virtual circuit technology over the optical fibre.

### **7.2 Network Architecture**

The PTN shall be of a modular design with demonstrated capability to be expanded in the future. The Field Network and Field Equipment Sub-Networks shall be consistent with the PTN model described in this standard.

The PTN shall utilise full duplex, bi-directional, asymmetric fibre ring(s) as the primary communications channel, so as to overcome single points of failure in the fibre links and/or PTN equipment.

Where the primary fibre ring is collapsed (i.e.: more than one segment of the ring shares the same physical conduit alignment as another segment), a secondary (fully redundant) communications channel shall also be provided that provides full backup of the primary network. Where the primary fibre ring is expanded (i.e.: provides physical separation in excess of 2m between ring segments) a secondary communications channel need not be provided.

Where provided, the secondary communications channel shall provide full duplex, bi-directional communications and utilise a separate physical route to that of the primary communications channel. Where the secondary channel utilises a radio frequency (RF) medium, the secondary channel shall connect with every Ethernet switch on the primary channel.

### **7.3 Dynamic Routing (Self-Healing Ring)**

Data shall be routed via the primary communications channel as the first preference.

The PTN equipment shall monitor the communications channel(s) and automatically route data traffic around failures in the communications channel(s) within 30 seconds of detecting the failure. The PTN equipment shall automatically re-route data via the primary communications channel segment, within 30 seconds of restoration of the affected segment.

### **7.4 Network Management**

The PTN equipment and network traffic shall be able to be remotely managed via the PTN.

### **7.5 Network Communications**

All ITS Devices and/or Systems that connect directly to the PTN, and the PTN equipment itself, shall use IT-industry standard internet protocols for all communications.

### **7.6 Level of Service**

The PTN shall provide an adequate level of service (e.g. bandwidth, latency etc.) to support all equipment connected to it, and provide sufficient capacity for future growth in connected devices. The PTN shall be provided with sufficient capacity to transmit the data requirements specified in the Contract plus an additional 50% traffic. The total expected traffic (including spare capacity) shall not exceed 30% of the rated network capacity. Network traffic calculations shall be included in the design documentation.

Notwithstanding the above requirement, the PTN design and equipment shall be selected to ensure economic use of capacity (for example, QoS techniques rather than greater bandwidth).

The primary Field Network backbone shall utilise Gigabit Ethernet (1000 Mbps) as a minimum. The primary Field Equipment Sub-Network shall utilise Fast Ethernet (100 Mbps) as a minimum.

Where a secondary communications channel utilises a medium other than fibre optics, this channel may provide a reduced bandwidth capacity as defined in the Contract. This may be the case, for example, in a point to point microwave radio system.

The total return trip latency from the Field Equipment Sub-Network POA to the Layer 3 switch at a TMC shall be 20 ms or less when the network is fully loaded (i.e. all required communications equipment is connected and transmitting data).

## **7.7 Special Requirements**

### **7.7.1 CCTV**

CCTV video images and control data (compressed or otherwise) transmitted on an Ethernet LAN connection shall use internet protocol (IP) and be transmitted over the same communications channel. The CCTV camera control system data and the video images shall be transmitted over the PTN but may be isolated from other telecommunications traffic/applications where shown in the design documentation.

Where CCTV video and control data shares the same communications channel as other ITS Device and/or System data, QoS techniques shall be utilised to give priority to ITS Device and/or System data.

CCTV video and control data shall connect directly to the Field Equipment Sub-Network Layer 3 switch.

### **7.7.2 Vehicle Tolling Data**

The PTN shall be suitable to allow data concerned with the Principal's vehicle tolling operations to be transmitted using the PTN in future.

Where CCTV data shares the same communications channel as vehicle tolling data, Quality of Service (QoS) techniques shall be utilised to give priority to the vehicle tolling data.

## **7.8 System and Device Interfaces**

Where specified in the relevant MRTS document, ITS Devices and/or Systems shall be connected to Field Processors. Telecommunications protocols for ITS Devices and/or Systems shall be provided in accordance with MRTS201.

Industry-standard hardware interfaces for digital inputs and outputs, Ethernet and serial protocols such as EIA/ RS-232 and EIA/RS-422 shall be used.

ITS Devices and/or Systems shall connect to the Field Equipment Sub-Network using either:

- a) an Ethernet LAN connection with a data rate of 10/100 Mbps UTP connection; or
- b) via a Field Processor using serial communication or digital inputs and outputs

## **8 TELECOMMUNICATIONS NETWORK ARCHITECTURE REQUIREMENTS**

The telecommunications channels shall provide full-duplex, simultaneous bi-directional operation. Virtual local area networks (VLAN) tagging support shall be available to logically combine part of the system providing the same function. The PTN shall be of a modular design to facilitate future network expansion (by others) and reduce future associated costs. The PTN shall be suitable for operating using PTN equipment from multiple vendors.

### **8.1 Backbones**

IEEE 802.1d Spanning-Tree Protocol may be used to support the redundant backbone connections.

The backbone links of the Field Network shall transmit data at a rate of at least 1000 Mbps at ISO Layers 1 and 2 – based on IEEE 802.3 standard (Gigabit Ethernet) and at ISO Layers 3 and 4 – based on TCP/IP protocol.

The backbone links of the Field Equipment Sub-Network shall transmit data at a rate of at least 100 Mbps at ISO Layers 1 and 2 – based on IEEE 802.3 standard (Fast Ethernet) and at ISO Layers 3 and 4 – based on TCP/IP protocol.

## **8.2 Field Devices**

Data protocols shall be compatible with STREAMS and in accordance with MRTS201.

### **8.2.1 Direct Ethernet Connections**

Direct links between ITS Devices (such as CCTV) and Ethernet switches shall support a standard Ethernet LAN (IEEE 802.3) connection at 10 / 100 Mbps at ISO Layers 1 and 2. Protocols for ISO Layers 3 and 4 shall be as required for each ITS Device and/or System.

Serial-to-Ethernet converters may be provided as necessary for EIA/ RS-232 and EIA/ RS-422 connections.

### **8.2.2 Serial Connections**

Serial links between ITS Devices and/or Systems and Field Processors shall support EIA RS232 and RS422 interfaces. Field Processor Device Drivers shall be developed for each ITS Device and/or System in accordance with MRTS201.

More than one ITS Device and/or System may be connected to a single Field Processor.

Where an ITS Device and/or System is located remote to the primary communications channel, an alternate communications channel may be provided to a Field Processor, or a TMC. Electrically isolated communications links such as fibre or wireless are preferred, however a copper cable solution may be provided. Where this is not feasible, leased telecommunications services may be used. The Contractor shall provide all such links in accordance with MRTS201.

### **8.2.3 IP Addressing**

The IP address planning and IP address allocation shall be as directed by the Principal in accordance with the Principal's statewide IP addressing plan.

## **9 TECHNICAL REQUIREMENTS**

### **9.1 General**

The operational requirements defined in MRTS201 apply to work under this standard.

The minimum additional operational requirements for equipment provided under this standard are described below.

### **9.2 Physical Mounting and Connection**

The PTN equipment shall be of a modular design allowing connection to the other LAN(s) via patch leads in accordance with Clause 9.7.5 and modular, plug-in interface cards. The telecommunications equipment shall be chassis based and designed to mount in an industry standard 19-inch rack.

### **9.3 Dynamic Routing (Self-Healing Ring)**

Equipment shall use dynamic routing protocols such as Routing Information Protocol (RIP) or Open Shortest Path First (OSPF) to achieve the desired functionality. All PTN equipment shall be configured as ISO Layer 3 devices and be compatible with dynamic route distribution. Dynamic routing updates shall use industry-standard routing authentication.

### **9.4 Latency**

The latency in data communications across the PTN shall not exceed the following times:

- 70 microseconds between 10Base-T ports;
- 11 microseconds between 100Base-T ports.

### **9.5 PTN Management**

Equipment forming part of the PTN shall support remote management via:

- a) simple network management protocol (SNMP); and
- b) web-based secure interface to enable configuration and management.

RF channels shall provide higher level encryption such as AES, and provide facilities to tie-down communications to a specific MAC address.

It shall be possible to address a minimum of 1024 MAC addresses in each Field Equipment Sub-Network.

All data transmitted via the PTN shall be capable of being centrally managed via network management software. This software shall have functions for performance monitoring, diagnostics and the management of the network configuration, security, QoS and resources down to the device interface level.

Where multiple communications channels are included in the PTN design, all network management protocols shall be interoperable.

The PTN management software shall be able to operate from any STREAMS workstation running Microsoft Windows XP Professional, or other industry standard operating system at the time of use.

## **9.6 Indicators**

The PTN equipment shall provide:

- a) status LEDs: Link Integrity, Disabled, Activity, and Full-Duplex indicators for each port; and
- b) system status LEDs: System, Redundant power supplies Module Enabled, Bandwidth utilisation indicator is a desirable option.

## **9.7 PTN Equipment Interfaces**

### **9.7.1 Field Network Point of Access**

Unless otherwise specified, the Field Equipment Sub-Network shall be connected to the Field Network backbone via an industry-standard Ethernet connection at an ISO Layer 3 switch, in a Network Node cabinet. At least 2 spare (unused) ports shall be provided at each Network Node.

Patch leads complying with Clause 9.7.5 shall be provided to connect all equipment.

### **9.7.2 Field Equipment Sub-Network Point of Access**

Unless otherwise specified, the Field Equipment shall be connected to the Field Equipment Sub-Network by connectors and cabling in accordance with Clause 9.7.5.

An ISO Layer 3 Ethernet switch shall be provided to allow connection of Field Processors and other direct connected ITS Devices and/or Systems.

At least one Field Processor shall be provided at each Field Equipment Sub-Network POA to allow connection of network devices to the Field Equipment Sub-Network.

Patch leads complying with Clause 9.7.5 shall be provided to connect all equipment.

### **9.7.3 Remote Field Equipment**

For remote field equipment Sites that are not co-located with a Field Equipment Sub-Network POA, communications links shall be provided to connect the devices back to a Field Equipment Sub-Network POA, to allow connection to the Field Network backbone in accordance with Clause 8.2.2.

Communication between the ITS Device and Field Equipment Sub-Network POA shall be as per the interface defined in the relevant MRTS.

Copper cabling may be provided to connect to remote field equipment to a Field Equipment Sub-Network POA.

### **9.7.4 Standards**

The PTN equipment shall comply with the following:

- a) IEEE 802.3x full duplex on 10Base-T and 100Base-T ports;
- b) IEEE 802.3x flow control on 100Base-T ports;
- c) IEEE 802.1d Spanning-Tree Protocol;
- d) IEEE 802.3u 100Base-TX and 100Base-FX Specifications;
- e) IEEE 802.3 10Base-T specification; and
- f) IEEE 802.3 AUI specification.

### 9.7.5 Connectors and Cabling

Cabling shall comply with the requirements of MRTS234.

In addition, the PTN equipment shall comply with the following:

- a) for 10Mbps ports: RJ-45 connectors; two pair Category 3, 4 or 5 UTP cabling; DB15 connector on AUI port;
- b) for 100BaseTX ports: RJ-45 connectors; two-pair Category 5 UTP cabling;
- c) for 100Base-FX port and Gigabit Ethernet: SC connector, fibre-optic cabling; and
- d) for management console port: RJ-45 connector.

### 9.8 Ethernet Switches

Unless otherwise specified, the PTN equipment shall comply with the following:

- a) high speed, ISO Layer 3 switching and routing – Ethernet / TCP / IP based (standards);
- b) ability to support multiple media types e.g. fibre (Multi Mode MMF and Single Mode Fibre SMF) via hot-swappable hi-density modules;
- c) port speeds ranging from 10 Mbps to 1 Gbps and the option of dedicated 10Gbps uplink ports;
- d) number of data ports sufficient to meet the Contract requirements;
- e) full-duplex operation on all ports;
- f) auto-negotiation on ports for automatically selecting half-and full-duplex operation;
- g) software upgradeable;
- h) web-based network management;
- i) user-selectable address learning mode;
- j) configurable network port that supports a minimum number of 16K of MAC addresses for backbone connectivity;
- k) redundancy – dual CPUs, dual Power Supplies for Chassis Model and Redundant Power Supply for Standalone Models;
- l) redundant switching fabric, no single point of failure for chassis model;
- m) VLAN tagging support;
- n) Layer 2 and Layer 3 Quality of Service (QoS) support to enable prioritisation of data streams; and
- o) configuration of priorities via Management Platform.

## 10 SECURITY REQUIREMENTS

To ensure a high level of security, the PTN shall comply with the Principal's security requirements for authentication, data integrity and visibility.

A security audit shall be performed at the Contractor's expense on the PTN in accordance with IS-18 and the Memorandum of Understanding between DMR and Queensland Transport (QT) for the Secure Interconnect between the DMR/QT corporate network and the PTN.

Further details on the security requirements may be obtained from:

Director ITS & Electrical Technology  
Road System Operations Branch  
Road Safety and System Management Division  
Department of Transport and Main Roads

## 11 ELECTRICAL REQUIREMENTS

The electrical requirements defined in MRTS201 apply to work provided under this standard.

## 12 OPERATIONAL REQUIREMENTS

The operational requirements defined in MRTS201 apply to equipment provided under this standard.

## 13 INSTALLATION REQUIREMENTS

### 13.1 *Telecommunication Cables*

The PTN design shall ensure that a minimum of one fibre is used in each fibre cable.

All telecommunication cables shall be installed in accordance with MRTS234.

All optic fibres installed in a median shall be spliced in a Network Node cabinet, Telecommunications Field Cabinet, or a pit located in the verge. Sufficient spare length shall be allowed for the cable to be removed from the pit or cabinet for the splicing process. In addition, 10 m spare length shall be provided at each end of the cables.

### 13.2 *Network Node Cabinets*

#### 13.2.1 General

Network node cabinets shall be used to house termination of the fibre optic cables and provide a telecommunications concentration point for connection between the Field Network and Field Equipment Sub-Network. The Network Nodes shall also allow for a full-duplex, bi-directional ring connection between the PTN and a TMC.

#### 13.2.2 Locations

The network node cabinets shall be located such that connections to mains power and connections to leased telecommunication services can be easily made. The final location shall be agreed with the Administrator and shown in the design documentation. **Hold Point 1**

#### 13.2.3 Construction

Network node cabinets shall comply with Telecommunications Field Cabinets described in MRTS201, except as follows:

- outer dimensions shall not exceed 1600 mm (H), 2100 mm (W) and 700 mm (D);
- the concrete mounting plinth shall be a single pour that contains a rag bolt assembly customised to suit the cabinet; and
- the plinth shall extend at least 1200 mm past the outer dimensions of the cabinet as part of the same pour as that housing the rag bolt assembly.

### 13.3 *PTN Equipment Configuration*

The PTN shall be configured so that devices connected at a POA will receive an IP address and have a routing path (in both directions) to the Layer 3 switch located at the Principal's TMC.

Supply and configuration of both the Layer 3 switch (router) and firewall located at the Principal's TMC will be done by others.

## 14 TESTING AND COMMISSIONING

The testing and commissioning requirements defined in MRTS201 apply to work under this standard.

## 15 DOCUMENTATION

The documentation requirements defined in MRTS201 apply to work under this standard. In addition, full network diagrams including IP addresses, and all configuration settings and details shall form part of the design documentation. Where possible, electronic versions of configuration settings shall also be submitted.

## 16 TRAINING

The training requirements defined in MRTS201 apply to work under this standard.

## **17 MAINTENANCE**

The maintenance requirements defined in MRTS201 apply to work under this standard. The supplier shall have proven ability in designing and supporting the proposed equipment. Support personnel and resources shall be locally based.

## **18 HANDOVER**

The handover requirements defined in MRTS201 apply to work under this standard.

19 Communications Architecture Diagram

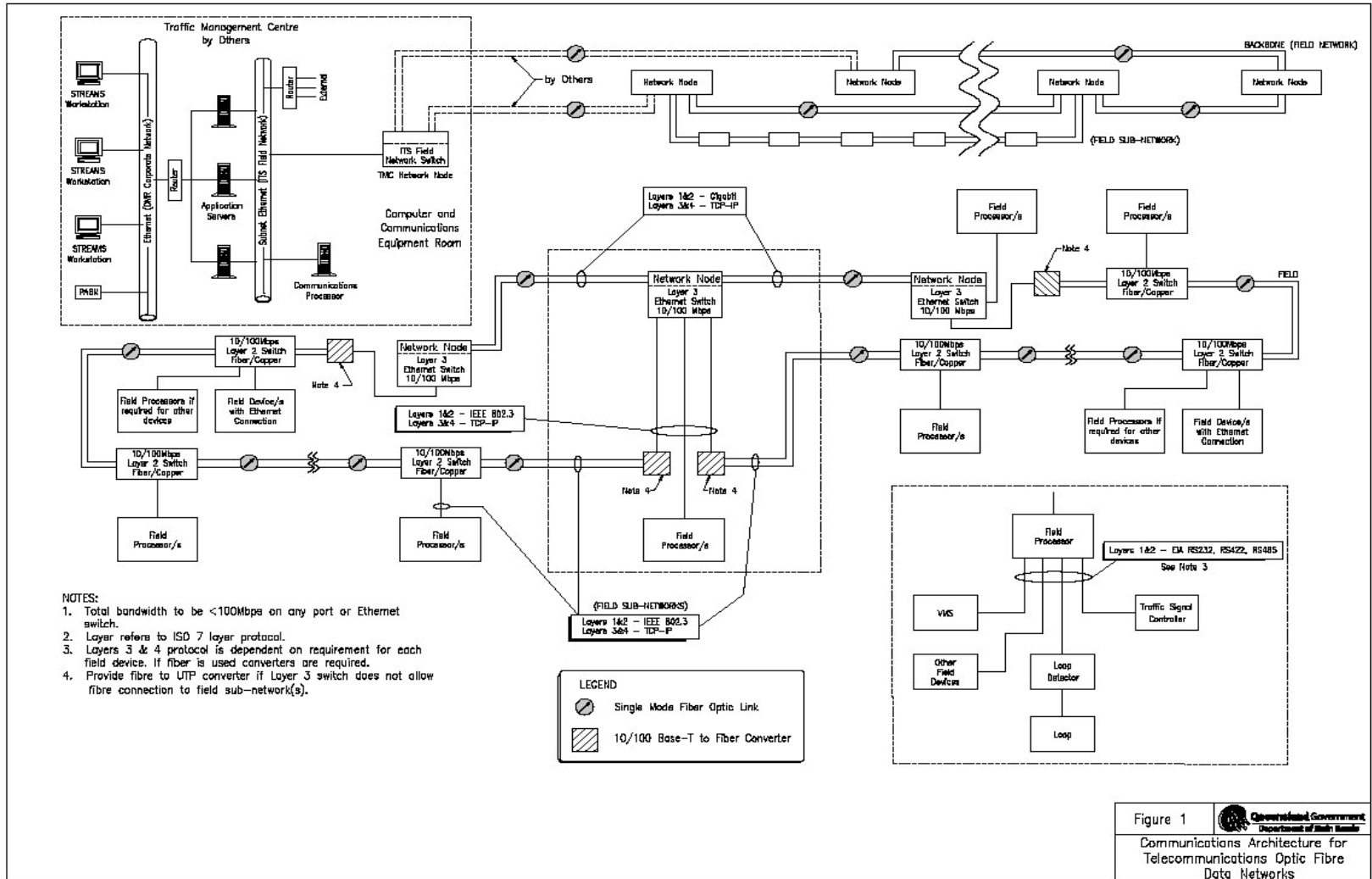


Figure 1 Queensland Government Department of Transport and Main Roads  
Communications Architecture for Telecommunications Optic Fibre Data Networks