TRANSPORT TELECOMS
TRANSMISSION

TECHNICAL SPECIFICATION

OPTICAL NETWORK MANAGEMENT SYSTEM

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DISTRIBUTION

Once updated, a copy of the latest revision will be published in the document management system in use. E-mail to this effect will be sent to the relevant personnel or heads of department.

DOCUMENT CHANGE HISTORY

ISSUE NO.	DATE ISSUED	ISSUED BY	HISTORY DESCRIPTION
1.00	January 2008	Transmission	New document
2.00	February 2008	QA	Changes in OTDR requirements
2.10	March 2008	Transmission	Additional documentation functionality (section 7)
3.00	November 2009	Transmission	Changes to design and technology
4.00	March 2010	Transmission	Removed server and client station hardware to conform to TFR IT policy. Changes to NEC / SCS format

CHANGES SINCE LAST REVISION

CLAUSE	DESCRIPTION
6.7	OTDR Module changes

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ABBREVIATIONS, ACRONYMS AND DEFINITIONS

ABBREVIATIONS AND ACRONYMS	DESCRIPTION
APC	Angle polished connector
DWDM	Dense Wavelength Division Multiplexing
EDFA	Erbium-doped fibre amplifier
EDZ	Event dead zone
ESRI	Environmental Systems Research Institute
ETSI	European Telecommunications Standards Institute
FTTx	Fibre To The home/office etc
GIS	Geographic Information System
GPRS	General Packet Radio
GPS	General Positioning System
GSM	Global Systems for Mobile communications
GUI	Graphical User Interface
HTML	Hypertext Mark-up Language
IEC	International Electronic Committee
LAN	Local Area Network
MTTR	Mean Time To Restore
ODF	Optical Distribution Frame
ONMS	Optical Network Management System
OSP	Outside plant
OSS	Open source software
OTAU	Optical Test Access Unit
OTDR	Optical Time Domain Reflectometer
PSTN	Public Switched Telecommunication Network
RFTS	Remote fibre test system
ROTAU	Remote Optical Test Access Unit
RTU	Remote Terminal Unit
SLA	Service Level Agreements
SMS	Short Message Service
SNMP	Simple network management protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
UPS	Uninterruptible power supply
WAN	Wide Area Network
WDM	Wavelength Division Multiplex

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DEFINITIONS	DESCRIPTION
Contractor	The successful Tenderer
DAT tape	Digital Audio Tape
FTP server	File Transfer Protocol
HTML file	**H**yper **T**ext **M**ark-up **L**anguage, a text file containing small mark-up tags
RJ45	The **RJ-45** is similar in shape and appearance to the RJ-11, but it contains up to eight conductors as opposed to four for the RJ-11
X.733	Alarm Reporting Function, which provides the user with the ability to transmit and clear alarms.
XML file	E**X**tensible **M**ark-up **L**anguage, designed to describe data and to focus on what data is
XMS file	e**X**tended **M**emory **S**pecification

RELEVANT DOCUMENTATION

APPLICABLE

DOCUMENT NO.	DESCRIPTION	LOCATION
SPC-00033	Specification for the Optic Fibre Testing Equipment	Domino-doc

RELEVANT

DOCUMENT NO.	DESCRIPTION	LOCATION
SPC-00002	Specification for Technical Handbooks and Documentation	Domino-doc
SPC-00003	Specification for the Training of Transtel Personnel on New Equipment	Domino-doc

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1. INTRODUCTION

1.1 The scope of this document is to define technical specifications regarding a optical fibre monitoring system used for telecommunications transmission. These specifications establish the hardware and software components requirements and describe the required functionality. The monitoring system shall be able to support the associated documentation of the network on a geographical basis, to provide extended alarm management and reports to improve the management of the network.

1.2 The system will be owned and operated by Infrastructure (Telecommunications), a division of Transnet Freight Rail. It may be shared with other operators of optical fibre cable infrastructure alongside the railway lines of South Africa. The alarms, measurements and relevant information in this system must be transferable to the other operator(s) who are using a similar system.

2. COMPLIANCE: INSTRUCTIONS TO TENDERERS

2.1 Tenderers must supply a clause by clause compliance statement / document indicating full or partial compliance with supporting information. Failure to do so will result in disqualification.

2.2 Transnet Freight Rail has designed a network of RTUs to satisfy its requirements, and this is indicated in the attached drawings and Bill of Quantities. For the financial evaluation of the tenders, all offers must be based on this BoQ, without any additions or exclusions. Options may be quoted for separately.

2.3 The Tenderer's offer must include delivery of all materials within 3 months of the finalisation of the order, installation of all units and systems within a further 3 months, and completion of all database loading, commissioning, testing and training within the next 3 months. Final payment will only be made upon full completion of all requirements.

2.4 All installation material shall be included in the packaging of the relevant equipment. Such installation material shall not be packaged separately.

2.5 Unit prices for all materials and labour charges must be provided. The successful Tenderer may redesign the solution. This would alter the quantities in the BoQ, and so the value of the contract will be adjusted according to the unit rates.

2.6 Tenderers must provide a list of recommended spares with quantities and prices. This will not form part of the BoQ.

2.7 Tenderers must have all configurations of equipment available during the adjudication phase. In the event that Freight Rail requires the equipment for evaluation, the Tenderer shall deliver the equipment within seven days of notification. Failure to submit the equipment within the prescribed time will exclude the Tenderer from consideration.

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2.8 In accordance with TFR IT policy, all server and workstation hardware will be provided by TFR. Tenderers must specify the hardware required for the applications and databases, scoping it for a network double the existing size. Prices given in the BoQ must include all software and licences required for the specified functionality to be provided. Tenderers may offer to supply the hardware as a separate option that will not form part of the BoQ.

2.9 Since the ONMS is based on the principle of OTDR testing, OTDR performance is crucial and critical in fault location / detection. The Tenderer must supply detailed information substantiating its OTDR performance and indicate what variations of OTDR modules are available. All OTDR modules will be evaluated for field performance; failure to detect events could disqualify a Tenderer's bid / offer.

2.10 It is mandatory that the Tenderer provides the history of the software releases of their monitoring system for the last 3 years.

2.11 It is mandatory that the Tenderer provides the official road map of their system for the next 5 years.

2.12 The Tenderer shall indicate the installed base of other optical test solutions in South Africa.

2.13 The Tenderer shall give some customer references based on their activities in South Africa.

2.14 Local support/assistance. The Tenderer shall list the names with full supporting documentation of at least three (3) personnel located in South Africa that can provide immediate assistance with OTDR or ONMS system related queries.

2.15 The Tenderer shall list features which he believes distinguishes his ONMS system from other similar solutions available in the industry. The Tenderer must advise what additional value his offer contains that will benefit Transnet.

3. SYSTEM OBJECTIVES

Objectives with such a system are:

3.1 Reduce MTTR

The ONMS shall monitor the optical network twenty-four (24) hours a day, seven days a week. Fast, precise notification of optical problems shall be provided automatically by the system without user intervention. The ONMS shall detect and locate faults along the cable and send plain alarm reports to the right person at the right place.

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3.2 Improve Network Availability

The ONMS shall provide tools for pro-active maintenance. These tools shall allow the user to view and analyze any degradation of fibres and in particular predict any gradual component degradation (splice, connector, etc.). The ONMS shall generate service reports showing the quality of the fibre plant and the ongoing performance over time.

3.3 Improve Maintenance Team Efficiency

The ONMS shall integrate a comprehensive cable documentation database including all available data. This cable documentation must integrate into GIS. The database must be easily updated ensuring that any new network repairs, cable modifications or fibre activations are documented immediately.

3.4 Establish and maintain infrastructure records

3.4.1 A database with GIS GUI will capture all as-built information of OFC infrastructure and the allocation of all optical fibres.

3.4.2 All deviations and additional joints will be recorded in this database to assist in fault localisation.

4. SYSTEM MAIN FEATURES

4.1 To be able to achieve these objectives, this system shall offer the following main features

- Alarm management
- System interoperability
- Reports generation
- Physical fault detection and location
- Physical network documentation
- Pro-active maintenance

4.2 The ONMS must be Based on a Modular Test Unit

It will be based around a client - server system architecture. It should provide measurement on either active or passive (dark) fibres. Fault and degradation will be detected by comparing the current measurement with earlier reference measurements. It will provide either permanent monitoring or on demand measurement. In this document, this optical measurement unit will be called RTU (Remote Test Unit).

4.3 Dark Fibre Monitoring Uses a Fibre without Traffic

Generally, only one fibre per cable will be used. This fibre represents the whole cable. The test wavelength for the dark fibre will be 1550 nm and 1625 nm. This must be selectable on commissioning and during manual testing.

4.4 Active Fibre Monitoring

Where no dark fibres are available, then a fibre bearing traffic must be selected. The test wavelength shall be 1625 nm

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This will be combined with the traffic wavelength. At intermediate points where there are active components such as optical transmission equipment, an optical splitter shall be inserted to allow the test signal to bypass the equipment and then recombine with the traffic signal on the far side. These components are referred to as wavelength filters.

4.5 The Network Documentation of the System will Physically Describe the Optical Cable Network

This description begins at the lowest level of the network (access point, frame, cable description, cable routes, physical characterization, installation company, customers etc.) up to an overall overview of the network. This software will have GIS capabilities. The system must be able to manage not only network data but also associated customer data.

4.6 The Predictive Maintenance Module will Provide Information about Network Aging

The main purpose of this module is to detect faults before network failures and will give the possibility to get accurate information on all technical parameters concerning physical layer.

5. THE OPTICAL CABLE NETWORK

5.1 Network Overview

Refer to the separate document: "System design".

5.2 Remote Test Unit Positioning

5.2.1 Final RTU location and positioning will be discussed with the Contractor

6. ONMS TECHNICAL DESCRIPTION

6.1 System Components

The system shall include the following components:

- Server
- Client Stations
- Web Client Stations
- Remote Test Unit (RTU)s

6.2 The Server

6.2.1 In accordance with TFR IT policy, the server hardware shall be provided by TFR.

6.2.2 The applications running on the server shall offer multi-user capabilities. The operating system shall be Windows or Linux based.

6.2.3 The Contractor shall provide all the software and licenses for proper and immediate use of all applications and databases.

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6.2.4 The server applications must have a backup facility to copy all settings and data to an external hard disk drive which must also be included as part of the software price.

6.2.5 It will be equipped with tele-maintenance solution allowing remote control from the Contractor's premises in order to:

- Help users
- Solve problems.
- Download patches or upgrade software following a change management process.

6.2.6 This access to be password protected.

6.3 **The Client Station**

6.3.1 The client stations shall be provided by TFR.

6.3.2 The Contractor shall provide all the client applications and software licenses for proper and immediate use.

6.3.3 It will be required to update the databases with information on new joints, SLA conditions, active fibres and cables.

6.3.4 Client stations will be required for the NOC, back office specialists and the NOCs of other operators (who will have restricted functionality and access).

6.4 **The Web Client Station**

6.4.1 Web access to the system shall be provided, with no extra software to be installed, on any web browser (recent enough) and on any machine, whatever the operating system is. This access to be password protected.

6.4.2 The following functions shall be available :

6.4.2.1 View status of the monitored fibres.

6.4.2.2 View OTDR traces with basic OTDR measurement features (distance, loss).

6.4.2.3 Access alarm information.

6.4.2.4 Ask for a test or measurement on demand and view the resulting trace.

6.4.3 For security reasons, the following functions shall not be available by any means (even using user/password protection).

6.4.3.1 Resource administration.

6.4.3.2 Modification of the monitoring cycles and all traces & information associated.

6.4.3.3 Physical network documentation.

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6.4.4 Access to data via the web shall be limited if needed, down to the fibre: a Web User shall be able to view the status of some fibres and not others, which are monitored by the same RTU. Customer and SLA information will be restricted.

6.4.5 This access shall offer a specific "internet style" GUI, using frames and hyperlinks.

6.4.6 At least 5 simultaneous accesses to the server via the Web shall be possible.

6.5 Local Control of RTU

6.5.1 The RTU must be capable of local control from a laptop, via its RJ45 connector.

6.5.2 Without any specific software on this laptop except a web browser, a user can locally configure and control the RTU. If additional software and licences are required, then this must be stated and priced.

6.5.3 This access will be protected by user ID and password.

6.5.4 In case of a communication problem with the server, this access will allow the user to locally retrieve all alarm information.

6.6 Remote Test Unit

The Remote Test Unit shall include the measurement control unit (optical switch), the optical test modules (OTDR) and the communication ports (for server connectivity and local access).

6.6.1 Mechanical Dimensions

RTU shall be mounted in a 48 cm or ETSI rack. Its height must be less than or equal to 4U and its depth (including connectors) must be less than 30 cm.

6.6.2 Connectors

6.6.2.1 To protect the connectors of the optical switch and OTDR, it shall be possible to cover the front panel with a cover.

6.6.2.2 Red patch cords, 2m in length, must be included in the offer, to connect to Transnet ODFs and to wavelength filters.

6.6.2.3 Note that Transnet ODFs use E2000 connectors XMP1 multiplexers use DIN connectors and SDH multiplexers use LC connectors. The detailed BoQ gives an indication of the quantities required.

6.6.2.4 For maintenance purposes all components must be easily accessible.

6.6.3 Front Panel

6.6.3.1 LEDs must be available on the front panel to display:

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- When the power is On
- That the laser is On
- The status of the last self-test
- The status of the data communication

6.6.3.2 The On/Off switch shall be located on the back panel.

6.6.4 **Power Supply**

6.6.4.1 The RTU shall operate on -48 volt DC.

6.6.4.2 A fuse is required and shall be accessible from the back panel.

6.6.4.3 For improved availability, the RTU power shall be supplied from a protected source – vendors must propose the most suitable solution.

6.6.5 **Data Communications**

6.6.5.1 The Remote Test Unit shall be able to communicate with the management system by at least two integrated channels, one as primary and the other one as backup.

6.6.5.2 Ethernet (10bT) shall be available as choice as primary channel.

6.6.5.3 V.24, GSM or GPRS shall be offered as secondary channel.

6.6.5.4 In case Primary Channel failure, the Remote Test Unit (or Server) shall detect automatically the failure and switch on the Secondary Channel. It will return automatically on the Primary Channel when it is restored.

6.6.5.5 In case a fault is detected and in case of a communication problem with the main and backup communication channel, the Remote Test Unit shall detect automatically the failure and trigger a dry-contact alarm output.

6.6.5.6 The RTU shall be able to communicate with the server by using a data rate as slow as 9600 bit/s.

6.6.5.7 No permanent communication between the server and the RTU shall be necessary.

6.6.6 **Alarms**

6.6.6.1 The RTU should be equipped with an output alarm module as standard.

6.6.6.2 The outputs (dry contacts) shall be used to indicate a system or a hardware failure.

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6.7 OTDR Modules

6.7.1 Minimum OTDR specifications (based on SPC-0033 and current network deployment requirements) must be complied with.

6.7.2 In addition, the OTDR units must be capable of continuous operation, 24 hours a day, every day. They must be able to conduct a scan and analyse the trace against the reference every 5 minutes for at least 7 years.

6.7.3 Where there is any discrepancy between different documents and specifications, the higher accuracy specification / requirement will take precedence.

6.7.4 In order to simplify design and exploit the latest technology in OTDRs, a single OTDR type is required for all ranges. It must operate at 1550 and 1625 nm (selectable). At 1550 nm, it must have a dynamic range of 45 dB or better, with an effective measuring range of 40 dB or better. Any event occurring within this range must be detected.

NOTE : Measurement Range for this Transport Telecoms evaluation is defined as the optical attenuation for a length of fibre at which the OTDR would be able to detect ±0,5 dB event and or change.

General characteristics:

- Connector on the OTDR shall be angled (APC) type interface for low reflection.
- Distance accuracy shall be equal or better than (1+ 0,0025% x distance).
- Sampling resolution of ± 5 cm.
- Sampling points required >120 000 for accurate event and incident detection.
- Event dead Zone < 10 m.
- Attenuation dead Zone < 15 m.
- Offline software for general / additional OTDR trace analysis must be included.
- Re-analyzing the trace offline: The software must be able to detect and display any possible event, even previously deleted events.

6.8 Optical Test Access Unit (Optical Switch)

6.8.1 This unit must be an integral part of the RTU.

6.8.2 Optical Test Access Unit must be modular and easy to access.

6.8.3 All the ports will be equipped with 8° APC-type connectors.

6.8.4 RTU must offer up to 16 ports internally with no external box.

6.8.5 External OTAU will be possible for configurations above 16 ports.

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6.9 **Environmental Condition**

6.9.1 Operating temperature: -5°C to 50°C.

6.9.2 Humidity: 10 to 80% non-condensing.

6.10 **Optical Passive Components**

6.10.1 The test wavelength is 1625 nm and the traffic band of wavelengths is 1310 - 1550 nm.

6.10.2 Passive components shall provide the following characteristics (or better):

6.10.2.1 WDM combiner: traffic signal loss <1 dB; test signal loss <1 dB.

6.10.2.2 WDM splitter: traffic signal loss <1 dB; test signal loss <1 dB.

6.10.2.3 The WDM equipment must be accommodated in ETSI standard cabinets and not occupy more than 2U in height.

6.10.2.4 All relevant parameters and characteristics of the passive component(s) offered must be provided.

6.10.2.5 WDM equipment is to be supplied with all the necessary patch cords (red) to make the associated connections to ODF, multiplexers and RTU.

7. MANAGEMENT SYSTEM FUNCTIONS

7.1 **Physical Network Documentation**

7.1.1 The system shall offer a flexible physical network documentation capacity, which must be integrated with the monitoring part.

7.1.2 GIS/Cable Documentation shall be included as well as Outside Plant and inside plant, equipment workspace and floor workspace and such as customer information.

7.1.3 For maintenance reasons, both the software monitoring system and the GIS/cable documentation must be supported by the Contractor.

7.2 **Schematic View of Fibre**

7.2.1 Each fibre under test shall be displayed as a dedicated schematic, showing all physical and optical distances, optical events (splices and connectors) for this particular fibre and will also be displayed in the Transport topology view

7.2.2 An event table shall be displayed if needed, showing attenuation and reflectance of each event.

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7.2.3 Modifications of physical distances as well as comments may be done on this schematic.

7.2.4 Monitored points as well as landmarks may be indicated directly on the schematic.

7.2.5 Reference traces shall be linked to this schematic. Associated traces shall be able to automatically update the optical distances on schematic.

7.2.6 This schematic shall be created or updated by means of a drawing toolbox and by imports from external files and from the physical network documentation.

7.2.7 This toolbox must be a simple user-friendly application such as MS Visio or MS Picture. Features of this toolbox must be provided.

7.3 Cable Documentation

7.3.1 This system management shall provide a complete physical network documentation tool to manage the Outside Plant.

7.3.2 It must represent the OSP graphically - draw, describe, modify and store in a consistent database, all information about point-to-point and point-to-multi-point networks for:

- Cable routes and fibre routes
- Optical Distribution Frames (ODF)
- Manholes
- Splices
- Buildings
- Ducts and sub ducts
- Connectors
- Slack boxes

7.3.3 It must contain the fibre allocations of each cable section, including customer information and associated SLA, etc.

7.3.4 This tool must allow the user to associate or disassociate network elements together: a frame shall be associated to a building, a fibre to a cable, a splice to an enclosure, etc. This will allow a direct access to all linked elements: i.e. find all splices inside an enclosure.

7.3.5 It must allow the user to display maps as well as pictures or AutoCAD drawings.

7.3.6 It must allow the user to add and display on the maps, some icons highlighting some events along the cable route.

7.3.7 It must allow the user to zoom in and out from a very detailed element description to the full representation of the network.

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7.3.8 This tool will allow the user to define customised records, to calculate and show the best route following customer requirements e.g.: minimizing the link budget, minimizing the number of ODFs, cable used, etc.

7.3.9 It must allow the user to define some advance queries on the cable documentation database as 'Cables already deployed', Cables under construction etc. The results of the queries can be highlighted on the maps.

7.3.10 It must provide a very accurate localization, taking in account slack information, spurs, express joints and the helix factor.

7.3.11 The tool shall have the functionality to represent graphically, draw, describe, modify and store all perceived Network Elements (multiplexer equipment, cards, ports, WDM filters, etc.) in the system.

7.4 **Integrated GIS**

7.4.1 Associated to the cable documentation, a GIS system allows the use of maps in the format compatible with MapInfo or ESRI products.

7.4.2 It shall be possible to set pre-defined zooms, corresponding to the different presentation needs (visualization of a regional alarm, design of a new link, etc.).

7.4.3 It shall be possible to draw the OSP network documentation directly on the map to populate the database.

7.4.4 It shall be possible to display the exact geographical location of all cable routes on the Map.

7.4.5 It shall be able to enter a distance from the origin of a cable route to display the corresponding location.

7.4.6 It shall be able in case of alarm to automatically display the fault location on the map. The GPS coordinates of this fault location will be automatically provided and displayed.

7.4.7 Faults should be viewable in .kml format for easy viewing in Google Earth (not licenced). Fault should be viewable in formats supported by Mapinfo for easy viewing of maps associated to the database

7.5 **Surveillance of Physical Layer**

7.5.1 The surveillance will be done by processing a test composed of:

7.5.1.1 The reference trace for fault detection.

7.5.1.2 The points of the trace to be monitored.

7.5.1.3 Thresholds used for fault detection.

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7.5.1.4 The reference trace for fault location.

7.5.1.5 Identification of the fibre number and tube number of the test fibre.

7.5.2 It shall be possible to set alarm thresholds per event automatically (system defaults), manually (user selectable) and dynamically (system adapts to seasonal changes, etc).

7.5.3 As the technician will have to access to the fault location when they will be at RTU location, it is very important that the RTU software detect and locate the fault accurately.

7.5.4 The set of tests will be interrupted only in case of:

7.5.4.1 Test on demand triggered manually.

7.5.4.2 Measurement on demand.

7.5.4.3 Predictive maintenance test.

7.5.5 The alarm notification will come with:

7.5.5.1 The name of the RTU and fibre where the fault occurs.

7.5.5.2 Date and time of the alarm.

7.5.5.3 The alarm severity (critical, minor, etc.) and state (new, cleared, etc.).

7.5.5.4 The optical distance from the nearest landmark.

7.5.6 The optical distance from the nearest marker:

7.5.6.1 When the fault is no longer detected (the measured level is not over the threshold anymore), a new notification shows up indicating: "Back to normal state".

7.5.6.2 All the alarms shall be stored in the database. They shall be time stamped. Each record shall contain all the information coming with the alarm notification including corresponding detection and localization traces. It shall be possible to easily read all this information.

7.5.6.3 It shall be possible to have an overview of all the fibres under test from any client station. The status of the fibre: under test, under alarm, monitoring ceased, etc. shall be associated with different colours.

7.6 OTDR Measurement Functions

7.6.1 A reference trace shall only be taken when a new fibre is added to the system, or after a fibre has been repaired or physical amended. Otherwise the reference trace shall **not** be changed. Every time a test is done it should be compared with the reference trace.

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7.6.2 To assure accurate and sensitive alarm generation, but eliminating false alarms, actual measurement results shall be compared to optical event thresholds specified by the user.

7.6.3 The following automatic measurement functions shall be available:

7.6.3.1 Slope (Fibre section attenuation) dB/km.

7.6.3.2 Event Reflectance.

7.6.3.3 Distance measurement to event and per fibre section.

7.6.3.4 Optical Return Loss, mask control measurement.

7.6.3.5 Automatic ghost detection.

7.6.4 The following semi automatic and manual measurement functions shall be available:

7.6.4.1 Slope (Fibre section attenuation) dB/km.

7.6.4.2 Reflectance.

7.6.4.3 Distance measurement with dual cursors.

7.6.4.4 Optical Return Loss.

7.6.5 It shall be possible to display / view the measurement results in a tabular form.

7.6.6 Trace files shall be stored in native format with the possibility / capability to be exported to Bellcore recommendations GR196 V2.

7.6.7 It is essential that the trace files created by the RTU are fully compatible with another software application running on a PC, for instance Optical Fibre Cable Acceptance application software.

7.6.8 The Contractor shall allow Freight Rail to install as many copies as required to evaluate the performance and use of the offline software.

7.6.9 The Optical Fibre Cable Acceptance application software shall allow :

7.6.9.1 Re-analysing of raw trace data.

7.6.9.2 Overlaying / comparing existing Freight Rail OTDR traces in native format with traces obtained from an RTU and or field OTDR currently being used.

7.6.9.3 All automatic and manual measurements as required in subclause 7.6.3.

7.6.9.4 Zoom into any part of the new and stored trace.

7.6.9.5 Perform both manual and automatic cursor measurements.

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7.7 OTDR Test and Measurement on Demand

7.7.1 The system shall allow the user to test a fibre without OTDR knowledge. The system shall compare automatically the trace of the selected fibre and check if the difference does not exceed the pre-defined thresholds.

7.7.2 A brief message in plain English shall give the fibre status.

7.7.3 The system shall offer graphical functions such as zooms and shifts on an OTDR trace.

7.7.4 Traces under native *.trc and Bellcore *.sor format shall be readable.

7.7.5 All these tests and measurements shall be accessible from a Web interface.

7.8 OTDR Pro-active Maintenance

7.8.1 The system shall make automatic and regular acquisitions of the characteristics of the fibres (attenuation, reflectance, etc.).

7.8.2 The software must have the capability to automatically recommend new parameters subject to results obtained after a learning period which is based on a statistical distribution over a period of time and / or a series of results (user selectable). The user must be prompted to accept such new parameters.

7.8.3 The measurement results shall be automatically stored in the database.

7.8.4 With the measurement of slight variations, this routine shall allow:

7.8.4.1 Identification and repair of a fault before service is affected.

7.8.4.2 Quality control of optical cables.

7.8.4.3 Calculation of one or several quality indicators, representative of the network state.

7.8.5 It shall be possible to display, print and export (with format readable by Excel) report of performance trend of splices, connectors, etc.

7.9 Alarm Management

7.9.1 It shall be based on the ITU recommendation X.733.

7.9.2 Two different forms of storage shall exist for alarms: active alarms and alarm history. A new alarm automatically belongs to the active alarms. It can be transferred to the alarm history after it is cleared and acknowledged.

7.9.3 All alarms are gathered independently of their origin: fibre, system, network, etc.

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7.9.4 In order to have a quick overview of the on-going alarms handled by the system, the GUI shall display all RTU on a background map with an associated colour code for each RTU showing the current status of a RTU.

7.10 Alarm Viewer

7.10.1 The alarm viewer shall display the list of active alarms in a similar format as below:

7.10.1.1 "Reference": It will contain a unique alarm identifier. A sign indicating if it is acknowledged shall precede it.

7.10.1.2 "Date": It will indicate the date and time when the alarm is created.

7.10.1.3 "Severity": It will indicate the alarm severity among: Cleared, Warning, Minor, Major, Critical.

7.10.1.4 "Occurrences": It will indicate the number of events corresponding to the alarm.

7.10.1.5 "Resource name": It will indicate the name of the object that detected the alarm or the object, which is in alarm.

7.10.1.6 "Monitored resource": It will indicate the name of the object that is actually monitored.

7.10.1.7 "Resource category": It will indicate the category of the resource which can trigger an alarm: Client station, server or OTU.

7.10.1.8 "Resource type": It will indicate the alarm type, typically, if it is from the physical layer (OTDR).

7.10.2 It shall be possible to filter the list by region, severity, resource category and resource type.

7.10.3 It shall be possible to display a dashboard indicating the number of active alarms by severity and if they are filtered or not.

7.10.4 From the alarm viewer it shall be possible to have a complete alarm description. This alarm description will give for an OTDR the fault distance from origin and from the nearest landmarks. From the alarm description, it shall be possible to see the OTDR trace (reference and alarm trace). The alarm should be displayed on the GIS system

7.10.5 From the alarm description it shall be possible to generate a complete report imprinted, test or HTML format including all the information of the alarm description.

7.10.6 If shall be possible to add comments to the alarm. Comments will be stored in the database with the user name of their author.

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7.11 **Alarm History**

7.11.1 The system should keep an accurate record of the alarm history.

7.11.2 Alarms dispatching by e-mail, SMS, fax, pager.

7.11.3 This function shall allow notification of a user when an alarm is created by sending an e-mail, a fax or a SMS message.

7.11.4 The information which are sent with the SMS or email message must be at least:

7.11.4.1 Date and Time of the optical alarm.

7.11.4.2 Link identification (link affected by the problem).

7.11.4.3 Severity of the problem.

7.11.4.4 Nearest site and distance to the fault.

7.11.5 At least, the content of SMS message can be customized by the administrator of the system.

7.11.6 The severity shall be superior or equal to the level indicated in the user configuration. Only one notification is sent by alarm.

7.11.7 The system should support a Duty Roster applicable to any alarm to ensure correct persons are notified.

7.11.8 The information included within the alarm notification shall correspond to the information given by the alarm viewer.

7.12 **XML File**

7.12.1 A XML file can be automatically generated on optical alarm and can be sent to an external server.

7.12.2 The content of this XML file will be provided.

7.13 **Alarm Management from the Web Client**

7.13.1 The Web Client shall provide a graphical user interface of the current status of customer routes.

7.13.2 The alarms list shall be limited to the user's domain.

7.13.3 The web user shall have the possibility to:

7.13.3.1 To see active alarms.

7.13.3.2 To filter active alarms.

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7.13.3.3 To have a complete description of the alarm by generating an alarm report.

8. PERFORMANCE REPORTS

8.1 The system shall allow the creation of performance reports, taking into account all alarm information about each monitored resource.

8.2 These reports shall indicate average downtime per fault.

8.3 These reports shall be customisable, including the possibility of inserting a company logo.

9. SYSTEM ADMINISTRATION

9.1 It shall be possible to define regions, and to associate supervised cables to them.

9.2 Client-stations shall be able to be associated to one or more regions.

9.3 Association will not depend on the physical location of the client station, but on the desired organization of information.

9.4 A fault detected in a region shall be notified to client stations that are configured as clients for that region.

9.5 Client-stations will also be associated to regions, in order to alarm only the concerned clients in case of a fault.

9.6 The system access privileges shall be controlled by the system Administrator. It shall be possible to define groups. A group will be a set of users with same privileges. Each user will be defined by his name and his password.

9.7 A profile will consist of a list of privileges.

9.8 Profiles will be given per function and per network area (region). This means that a user will be able to modify the tests on a region and only to see the alarms on another region.

9.9 Some profiles will be predefined: user, expert, (regional) administrator.

9.10 A system administrator (national administrator user having all privileges) will exist but will neither be visible nor modifiable.

9.11 The system administrator shall have access to all past operations on the system, indicating, name of log-in, date, time, and action.

9.12 New profiles can be created. These profiles shall be customisable, setting for each possible action, the right to read, to modify or add information.

9.13 Please list all customisable parameters for a new profile creation.

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9.14 Every log-in and log-off will be stored in the database, as well as all modifications. This information will contain user identification, date, time, action done and shall be accessible by the system administrator only.

10. SYSTEM INTEROPERABILITY

10.1 OSS Interface

10.1.1 The system shall be able to interface with an OSS system by using SNMP. The OSS shall poll all necessary information from the system whenever necessary (RTUs, Clients, etc).

10.1.2 The system shall send the OSS all optical and system alarms.

10.1.3 The OSS shall be able to launch a test on demand on a specific fibre.

10.1.4 Since this system will also manage OFC belonging to other operators, but maintained by Transport Telecoms, there must be an interface so that alarms and measurement information can be conveyed to the other operator(s) who are using a similar system.

11. SECURITY ASPECTS

11.1 Communication Security

11.1.1 The system shall run periodically, at least every twenty-four (24) hours, a **self-test**. This self-test shall allow identifying and distinguishing the problems concerning the RTU itself and the communication means.

11.1.2 The system shall also enable a **Heartbeat** between the server and each RTU. Heartbeat frequency shall be customisable.

11.2 Data Security

11.2.1 As standard, the System shall offer the following features :

11.2.1.1 A DAT tape (preferably and external, removable hard disc drive) and a software facility for fully automatic daily backup and easy recovery of the system must be present.

11.2.1.2 At least two hard drives, one mirroring permanently the main one, for automatic take over in case of failure of the main hard drive.

11.2.1.3 A UPS specific software to ensure that all data will be correctly stored in the database before a clean shut off of the system. (This is for the server and Client Servers only).

11.3 Operator Security

11.3.1 The system may be accessed by other allowed operators, however :

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11.3.1.1 Other operators my not control, reconfigure or alter any of the data.

11.4 **Remote Hot Backup Server**

The system must include the facility to revert to a Hot Standby Server should there be any fault on the Main Server.

12. WARRANTY AND TECHNICAL SUPPORT

12.1 The warranty period shall be at least twelve (12) months from the commissioning of the whole system with full local and international commitment / back-up.

12.2 The warranty shall include:

12.2.1 Local and international telephone support (Help desk).

12.2.2 Local and international hardware repair.

12.2.3 Remote control of management systems from suppliers premises for:

12.2.3.1 Remote assistance.

12.2.3.2 Upload/download files.

12.2.3.3 Update/upgrade software versions.

13. TELEPHONE SUPPORT

13.1 The Contractor shall register the service calls and handle them promptly. He shall help and instruct promptly, over the telephone, the system users and operating personnel.

13.2 The Help Desk shall be available from Monday to Friday, twenty-four (24) hours a day.

14. HARDWARE REPAIR

14.1 Faulty equipment shall be repaired within four (4) weeks from the receipt on the Contractor's premises (local), for items where this arrangement cannot be met, an acceptable replacement process shall be offered – describe in full.

14.2 The Contractor will provide the recommended verification / calibration period of their OTDR module embedded in their RTU and the associated process minimizing the impact on the system.

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15. SOFTWARE UPGRADE

15.1 Software upgrades from the server and client shall all be able to be done remotely via tele-maintenance.

15.2 Software upgrades on Remote Test Units shall all be done from the server which will contact every RTU automatically one after the other and upgrade it. RTU shall not stop monitoring or activity for longer than a few minutes. This automatic upgrade may be launched remotely by tele-maintenance.

16. TRAINING

16.1 The Contractor shall carry out training for the following:

16.1.1 Basic course for ten (10) operators. This course should train -

16.1.1.1 to view and to understand the system messages,

16.1.1.2 to understand the system components,

16.1.1.3 to understand and use the system's capabilities and functions.

16.1.2 Advanced course for five (5) administrators. This course should train -

16.1.2.1 to view and to understand the system messages,

16.1.2.2 to understand the system components,

16.1.2.3 to understand and use the system's advanced capabilities and functions,

16.1.2.4 to maintain the system.

16.1.3 Training for five (5) Web Viewer Client Server users.

16.1.4 First line maintenance for twenty (20) field technicians to conduct first line trouble shooting and maintenance on RTUS and WDM equipment

16.1.5 Duration, course content and presenter must be approved by Freight Rail and shall be defined by the final installed configuration.

16.1.6 Training shall be presented at various regions where the equipment is to be installed and operated.

16.1.7 The supplier and its local representative shall supply proof of courses (state type of equipment) presented to Freight Rail employees.

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16.1.8 Information on local expertise available for back-up / support and follow-up training, any possible future training requirements on fibre technology as well as system maintenance

Also refer to SPC-00003 - SPECIFICATION FOR THE TRAINING OF TRANSNET PERSONNEL ON NEW EQUIPMENT

17. DOCUMENTATION

17.1 The Contractor shall provide complete technical documentation necessary to operate the equipment.

17.2 Documentation shall be in English.

18. TEST AND ACCEPTANCE PROCEDURE

The Contractor shall propose a complete example of his test and acceptance procedure for a standard 'remote fibre test system' project.

END OF DOCUMENT

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