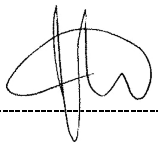
A Division of Transnet SOC Limited

RAIL NETWORK

TECHNICAL SPECIFICATION

DIGITAL/IP MICROWAVE RADIO EQUIPMENT

Author:	Senior Engineer: Transmission Network Engineering	S. Mashishi	
Reviewed:	Senior Engineer: Project Management	K. Ngobeni	
Reviewed:	Principal Engineer: Operations and Maintenance	S. Mahlangu	Sibusiso Mahlangu Digitally signed by Sibusiso Mahlangu DN: cn=Sibusiso Mahlangu, o=Transnet, ou=Rail Network, email=Sibusiso.mahlangu@transnet.net, c=US Date: 2020.04.07 14:13:56 +02'00'
Authorized:	Principal Engineer: Telecom Network Engineering	M. Mashologu	
Approved:	Chief Engineer: Rail Network Telecoms	T. Maloma	Tshepo Maloma 00156998 2020.04.07 13:25:35 +02'00'

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II ABBREVIATIONS, ACRONYMS AND DEFINITIONS

ABBREVIATIONS AND ACRONYMS	DESCRIPTION
ODU	Outdoor Unit
AM	Adaptive Modulation
ATPC	Automatic Transmit Power Control
BER	Bit Error Rateio
BFD	Bidirectional Forwarding Detection
CC	Continuous Check
CV	Connectivity Verification
DC	Direct Current
DCN	Data Communication Network
E1	European Digital Transmission Format
E-Band	Extremely high frequency bands
ERP	Ethernet Ring Protection
ETH	Ethernet
FCAPS	Fault Configuration Accounting Performance and Security
FD	Frequency Diversity
FEC	Forward Error Correction
FFD	Fast Failure Detection
Gb/s	Gigabit per Second
GE	Gigabit Ethernet
GHz	Gigahertz
HSB	Hot-Standby
ICASA	Independent Communications Authority of SA
IDU	Indoor Unit
IEEE	Institute of Electrical and Electronic Engineers
IF	Intermediate Frequency
IP	Internet Protocol
IPv4	Internet Protocol Version Four
IPv6	Internet Protocol Version Ssix
ISO	International Organisation for Standardisation
ITU-R	International Telecommunications Union – Radio Ccommunication Sector
ITU-T	International Telecommunication Union - Telecom. Standard. Sector
LB	Loop Back
LCT	Local Craft Terminal
LPT	Link Pass Through/Trace
LSP	Label Switch Path
Mb/s	Megabit per second
MCAG	Multi Carrier Aggregation
MEF	Metro Ethernet Forum
MHSB	Monitored Hot standby

MPLS	Multi-Protocol Label Switching
MPLS-TP	Multi-Protocol Label Switching – Transport Profile
NMS	Network Management System
NOC	Network Operations Centre
OAM	Operation Administration and Maintenance
ODU	Outdoor Unit
OEM	Original Equipment Manufacturer
OS	Operating System
OSS	Operational Support System
PD	Polarised Diversity
PDH	Plesiochronous Digital Hierarchy
PoE	Power over Ethernet
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RSTP	Rapid Spanning Tree Protocol
SD	Space Diversity
SDH	Synchronous Digital Hierarchy
SLA	Service Level Agreement
STM	Synchronous Transport Mode
TDM	Time Division Multiplexing
TFR	Transnet Freight Rail
VLAN	Virtual Local Area Network
VSWR	Voltage Standing Wave Ratio
XPIC	Cross-polar Iinterference Ccanceller

1. INTRODUCTION

1.1. This specification covers the requirements of Transnet Freight Rail (TFR) for the supply of split mount or full outdoor digital microwave radio equipment operating all capacities, short and long haul in the 7 to 38 Gigahertz (GHz) traditional frequency bands and 60GHz to 90GHz Extremely high frequency bands (E-Band).

1.2. The microwave radio equipment must support channel bandwidth of 7 to 112 Megahertz (MHz).

1.3. The microwave radio equipment must support the modulation scheme ranging from 4 Quadrature Amplitude Modulation (QAM) to 4096QAM and Quadrature Phase Shift Keying (QPSK).

1.4. The microwave radio equipment must be able to offer a unified platform for hybrid Time Division Multiplexing (TDM), that is, native Plesiochronous Digital Hierarchy (PDH) and native Synchronous Digital Hierarchy (SDH), native Ethernet (ETH) and native Internet Protocol (IP) service routing.

1.5. For this native hybrid TDM, ETH and IP microwave system, the backplane switching fabric must be separate and support a minimum of 50 Gb/s switching capacity.

1.6. The radio equipment should have the capability to support mixed mode, i.e. IP, ETH and TDM n x E1 traffic. ETH traffic interface options should include 10/100/1000 base-T, with Intelligent Layer 2 Ethernet Quality of Service (QoS) features.

1.7. The equipment must support Power over Ethernet (PoE) with off-the-shelf weatherproof Cat 5e cable & accessories.

1.8. The microwave radio equipment must be able to operate from a 48V DC supply, with positive tied to the earth.

1.9. The envisaged microwave radio equipment must have a clear roadmap to support Multi Carrier Aggregation (MCAG) functionality for simultaneous high throughput and long haul transmission implementation without any significant platform changes.

1.10. The bidder needs to indicate how their equipment will support zero touch functionality.

1.11. The bidder needs to indicate their capability on delivering point to multipoint solution, i.e. type of equipment, frequency bands, channel bandwidth and modulation schemes.

2. STANDARDS

2.1. Except where otherwise stated in this specification, all equipment must conform to the latest recommendations of the following ITU-R, ITU-T, IEEE and ISO recommendations.

- F.385
- F.386
- F.497
- F.636
- F.637
- F.748
- F.749
- G.703
- G.704
- G.811
- G.821
- G.826
- G.8032
- IEEE 802.1Q
- IEEE 802.1ad
- IEEE 802.1w
- IEEE 802.3
- ISO 9001

2.2. Bidders must certify that they are familiar with these recommendations and must state all instances where their equipment offered is unable to comply. Failure to comply will lead to disqualification of the bid.

2.3. The bidder must state his equipment's performance with respect to the following:

2.3.1. EN 60950-1

3. TENDER REQUIREMENTS

3.1. Where additional information is supplied, the bidder must state where in the tender document this information can be found.

3.2. Bidders must submit a clause-by-clause statement of compliance for all specifications. Failure to comply or offer the necessary reasons for compliance and/or non-compliance will exclude the Bidder from further consideration.

3.3. This tender calls for the planning, surveying, supply, delivery, installation and commissioning of the equipment; plus support and transfer of skills from the start of network deployment.

3.4. The bidders must include all recommended installation material.

3.5. All software and management tools must be included in the price list; this includes all the updates and software patches for the duration of the support contract.

3.6. The microwave equipment supplied with this tender must be type-approved by the Independent Communication Authority of South Africa (ICASA) and ICASA approval certificates must be provided.

3.7. All equipment must have minimum Metro Ethernet Forum (MEF) 2.0 certification. MEF certificates must be supplied for each equipment included in the bid.

3.8. Provide the net filter discrimination curves of the radio receivers.

3.9. Provide the branching losses of various radio configurations.

3.10. Adjacent channel and co-channel interference curves of the radios must be provided.

3.11. The bidder needs to indicate the various types of polarization schemes available with their equipment.

3.12. For equipment ease of use, the bidder must source all the equipment from a single Original Equipment Manufacturer (OEM).

4. MICROWAVE EQUIPMENT TECHNICAL REQUIREMENTS

4.1. IN-DOOR UNIT (IDU)

4.1.1. The equipment must be able to deliver the following interface types:

4.1.2. PDH from 2 E1 to a maximum of 16 E1.

4.1.3. SDH from STM 1 to STM 4 (on the increments of STM 1).

4.1.4. The IDU must support ETH capacities from 10Mb/s to 1Gb/s with either electrical or optical interfaces and 10Gb/s optical interfaces on E-Band.

4.2. All E1 tributaries offered must be 120 ohm balanced, using HDB3 code as per ITU-T Recommendation G.703.

4.3. 155 Mbit/s Traffic Interfaces must be available in Electrical 75 ohm to G.703 and Optical to G.957 S.1.1.

4.4. All split type indoor units must be frequency independent.

4.5. IDU must support IPv4 and IPv6 networking protocols.

4.6. IDU must support VLAN, the bidder to indicate how their solution will support this function.

4.7. IDU must support Rapid Spanning Tree Protocol (RSTP), the bidder to indicate how their system will support RSTP.

4.8. IDU must support Ethernet Ring Protection (ERP), the bidder to indicate how their system will support ERP.

4.9. IDU must support Forward Error Correction (FEC).

4.10. IDU must support Adaptive Modulation (AM).

4.11. The IDU must be IP/MPLS or MPLS-TP capable.

4.12. The bidder must indicate the minimum Bidirectional Forwarding Detect (BFD) capability for their equipment.

4.13. The IDU must be able to evolve from TDM to ETH, ETH to packet IP/MPLS or MPLS-TP without significant platform changes, the bidder needs to indicate how will this be achieved with their solution.

4.14. The IDU must support IP Payload Compression based on RFC 3173 standard.

4.14.1. It should be able support at least twelve (12) RF direction on one IDU mainly for aggregation sites.

4.15. The bidder must provide synchronization information with respect to the type of clock sources to be supported by the microwave system, protection schemes, architecture in terms of additional equipment, quality and repeater clocking signal required.

4.16. **OUT-DOOR UNIT (ODU)**

4.16.1. The radio must be able to indicate the minimum of the following alarm outputs:

4.16.1.1. Power supply unit failure

4.16.1.2. Failure on each Transmitter

4.16.1.3. Failure of each Receiver

4.16.1.4. Digital data input loss to the Transmitter

4.16.1.5. Transmitter level

4.16.1.6. Receiver level

4.16.1.7. BER 10^{-6} or worst adjustable threshold

4.16.2. The proposed equipment must support configurations as follows:

4.16.2.1. Non-Protected 1+0

4.16.2.2. Monitored Hot Standby (MHSB) 1+1

4.16.2.3. Space Diversity (SD)

4.16.2.4. Frequency Diversity (FD)

4.16.2.5. Polarised Diversity (PD)

4.16.3. It must be possible to expand all radios to an N+1 configuration, the bidder to indicate the maximum N value available for long haul, aggregation sites and last mile sites.

4.16.4. The modules must be hot swappable when repairing a faulty channel on MHSB, SD or FD setup.

4.16.5. The ODU must be powered via the Intermediate Frequency (IF) cable.

4.16.6. The equipment needs to offer loopback fault finding option.

4.16.7. All receiver baseband switching must be of the hitless type when used in a 1 + 1 radio system configuration.

4.16.8. Transmitter switching due to hardware failure must be less than 200 ms in duration.

4.16.9. The microwave equipment must support XPIC (Cross Polarization Interference Cancellation) without significant platform changes and impact on costs (i.e. changing single to dual polarization with the same antenna reflector).

4.16.10. The antenna should be of modular type and allow changing from traditional frequency bands to E-Band without changing the reflector.

4.16.11. The ODU Transmitter/Receiver must be tuneable to allow the usage of the entire frequency band.

4.16.12. The antenna should be of modular type and allow changing from traditional frequency bands to E-Band without changing the reflector.

4.16.13. The transmitter must support Automatic Transmitter Power Control (ATPC) over the full transmit manual attenuation range; with the operator able to select a not-to-exceed transmit power.

4.16.14. The Voltage Standing Wave Ratio (VSWR) for the feeder and antenna should not exceed 1.2/ return loss of 20.8 dB across the antenna bandwidth.

4.16.15. The microwave feeder cable system must be able to operate on a feeder maximum cable length of 150m.

4.16.16. The feeder cable impedance must be 50 Ohm.

4.16.17. The feeder cable must be at least 10mm thick.

4.16.18. The bidder must provide radiation pattern data that can be integrated into the planning tool.

4.16.19. The bidder must provide a full technical specification for waveguides, feeder cables and antennas of which wind loading, guaranteed minimum gains and radiation envelopes information must be included.

5. ENVIRONMENTAL REQUIREMENTS

5.1. All indoor units supplied must be designed to operate without degradation under the following conditions:

5.1.1. **Temperatures:** from -5 to +50°C (degrees Celsius)

5.1.2. **Relative Humidity** from 0% to 95%

5.1.3. **Air Pollutio**n: dust and heavily laden saline and industrial pollutant

5.1.4. Vibration tolerance in the rail environment

5.2. All outdoor units supplied must be designed to operate without degradation under the following conditions:

5.2.1. **Temperature:** from -30 to +50°C

5.2.2. **Relative Humidity:** all weather conditions

5.2.3. **Altitude:** 0 to 2500m (metres) above sea level

5.2.4. At least comply to **IP 57** enclosure rating (Bidder to state their ODU IP rating)

5.3. Bidder to denote their lighting protection feature that is offered with their equipment

6. NETWORK MANAGEMENT SYSTEM (NMS)

6.1. The bidder must supply full details of their NMS platform including but not limited to the NMS model, industry standards, published architecture, open OSS platforms, capabilities, database and communication structures to integrate with other platforms when required.

6.2. The NMS platform must comply with ISO's FCAPS, SLA, usage, topology, policy, integrated accounting and end-to-end management of the network.

6.3. Network data must be kept in a central server. The connection to the server must be via a client interface.

6.4. The most recent planning tool needs to be provided with the solution, the planning tool maybe be a standalone or integrated on the NMS.

6.5. At least 15 simultaneous client connections to the server must be possible.

6.6. The network control software must be such that it allows the user to control, configure and monitor the system in an intuitive and user-friendly way.

6.7. A centralized server type management platform is required.

6.8. A main server and standby server configuration must be supplied and must operate in a load-sharing mode.

6.9. All relevant licences must be included.

6.10. Alarm severity indication communication for QoS, equipment, environmental and processing.

6.11. Proactive, reactive, easy and detailed diagnostic and troubleshooting tools to ensure maximum availability.

6.12. Provide fault management at all layers, that is, network, device and services.

6.13. The software must run with a multitasking operating system. The software must preferably be in a Windows type set-up. The operating systems must be Windows Server, Unix or Linux.

6.14. The software must be such that it will prompt the user if an alarm condition occurs, irrespective of the level in which the user is busy in.

6.15. The alarm must be in a different colour to the rest of the display.

6.16. The alarm must give an audible indication.

6.17. The network layout must be graphically displayed and it must be possible for the user to zoom into the detail of each network element up to card/module level where the fault occurred.

6.18. It must be possible to specify the required clock synchronisation source and a list of priorities in the event of clock source failing.

6.19. It must also be possible to monitor network performance via software and must be in accordance with ITU-T Recommendation G.709, G.697.

6.20. Monitoring BER before FEC by analysing the number of corrected bits by FEC as per G.798 ITU-T standard

6.21. Network performance data/reports must be available in Microsoft spread sheet format

6.22. It must be possible to create inbound and outbound loop-back tests to all network elements on a per channel and client level.

6.23. It must be possible to provide real time printouts of alarm conditions at one or more locations.

6.24. Access to individual nodes for fault diagnostics must be possible using Local Craft Terminal (LCT) and access to the LCT must be given by the NMS.

6.25. Monitoring BER before FEC by analysing the number of corrected bits by FEC as per ITU-T Rec. G.798.

6.26. Network performance data/reports must be available in Microsoft spreadsheet format.

6.27. It must be possible to create inbound and outbound loop-back tests to all network elements on a per channel and client level.

6.28. It must be possible to provide real time printouts of alarm conditions at one or more locations.

6.29. Access to individual nodes for fault diagnostics must be possible using LCT and access to the LCT must be given by the NMS.

6.30. Web access to the system must be provided, on any web browser (recent enough) and on any machine, whatever the operating system is. This access to be password protected.

6.30.1. It must be possible to view status of the alarms on any node.

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

6.30.3. Resource administration.

6.30.4. Write network documentation.

6.30.5. Creation and Deletion of circuits and nodes.

6.31. At least 5 simultaneous accesses to the server via the Web must be possible.

6.32. The bidder must indicate all necessary hardware, bandwidth and operating system (OS) required for Data Communication Network (DCN) functionality.

7. FAULT MANAGEMENT

7.1. The NMS must provide supervision functions to check that the network elements are operating according to the requirements set forth in the particular specifications.

7.2. The NMS must provide alarm surveillance functions to monitor and interrogate the network elements about alarms.

7.3. The alarm records must include the following information:

7.3.1. Network element identity.

7.3.2. Network/service that the network element belongs to.

7.3.3. Date and time of alarm event.

7.3.4. Alarm severity (alarm class).

7.3.5. Problem type.

7.3.6. Problem data.

7.3.7. Acknowledgement data (date, time and operator identity).

7.3.8. Date and time of clearing.

7.3.9. A comments field where the operator can add any additional information or comments.

7.4. The alarms must be divided into classes according to severity. It must be possible to define at least three classes.

7.5. The NMS must provide functions to route the textual alarms to any I/O device connected to the NMS.

7.6. The NMS must provide options to use the alarm record data to route the alarms to a specific I/O device.

7.7. The NMS must provide functions to acknowledge received alarms from the network elements. When an alarm has been acknowledged, the state of the alarm symbol must change and the alarm must be removed from the active alarm list.

7.8. The NMS must indicate to the operator any incoming change in alarm status where the alarm type is one of the highest severity classes.

7.9. The NMS must provide functions to retrieve all types of alarm records active or historical from the alarm log. The NMS system must be equipped with tools for generation of different types of reports and statistics from the alarm log. Search criteria for retrieval must include:

7.9.1. Location (site).

7.9.2. Equipment (Element) identity.

7.9.3. Time and date.

7.9.4. Alarm class.

7.9.5. Character string.

7.10. The NMS must support facilities to present spontaneous alarm reports by means of text, graphics and acoustics. It must be possible to highlight alarms of high severity class and suppress less severe alarms.

7.11. The NMS must provide access to analysis functions in the controlled network elements to identify and locate the failures in the network elements, down to functional unit level

7.12. The NMS must provide operator access to test functions in the controlled network elements, for failure diagnostics and failure location.

7.13. The NMS must support the following IEEE 802.1ag and 802.3ah ETH Operation, Administration and Maintenance (OAM):

7.13.1. Link Discovery and Link Monitoring

7.13.2. Remote Fault Detect

7.13.3. Remote Loopback

7.13.4. Link Pass Through (LPT)

7.13.5. Continuous Check (CC)

7.13.6. Loop Back (LB)

7.13.7. Link Pass Trace (LPT)

7.14. The NMS must support the following ITU-T Y.1711 IP/MPLS OAM functionalities:

7.14.1. Connectivity Verification (CV)

7.14.2. Fast Failure Detect (FFD)

7.14.3. LSP Ping

7.14.4. LSP Traceroute

8. PERFORMANCE MANAGEMENT

8.1. The NMS must provide performance-monitoring functions to collect traffic data, QoS data and performance data from the network elements. The NMS must handle both raw data and processed reports.

8.2. The request of data collection must be both on demand, and automatically on a schedule or threshold basis. The NMS must provide functions to modify the current schedule and/or threshold.

8.3. It must also be possible to monitor the performance of any number of links via software and must be in accordance with ITU-T and must be available in Microsoft Office formats.

8.4. The NMS must provide statistical functions to analyse the collected data and present network status and network performance reports on a per equipment basis and as network-wide reports.

8.5. All types of reports must be presented in a uniform and standard manner.

8.6. Specific reports must be automatically generated monthly.

8.7. The NMS must provide functions to correlate information between different types of network elements and service.

8.8. The network status and network performance reports must highlight any abnormal and threatening condition.

8.9. The NMS must provide functions to enable highlighting of network elements, designated with high operation and maintenance priority, in the network status and network performance reports.

8.10. In the reports, degraded performance must be analysed and localised to a specific network element - or to a specific part of the network.

8.11. The NMS must have built-in intelligence to aid the operators with information and actions to be taken during traffic and network management.

8.12. The NMS must provide functions to archive reports and data in a history database.

8.13. The NMS must provide functions to retrieve and present long-term reports based on the archived data. The logic of the NMS must allow long-term reports to span over one year.

8.14. In the reports, transmission systems with high operation and maintenance priority must be highlighted.

8.15. In the reports, degraded performance must be analysed and localised to specific equipment or to a specific part of the network. The NMS must have built-in intelligence to aid the operators with information and actions to be taken during traffic and network management.

8.16. Presentation of collected data and performance reports must be made both as text and graphics, including network maps.

9. FAULT LOCALISATION FUNCTIONS

9.1. The NMS must provide operator access to test functions in the controlled transmission facilities for failure diagnostics and failure location.

9.2. In order to isolate the source of a fault condition, events that occur at various points on a transmission route must be recorded and analysed.

9.3. The NMS must be able to identify failures caused by events producing multiple alarms such as cable breaks or microwave channel interruptions. The NMS must be able to suppress the redundant alarms in order to ease the fault location.

9.4. The NMS must be able to display the whole transmission route and standby protection bearers, and indicate the faulty equipment entity - when the failure is localised.

9.5. The NMS must provide functions to be included in fault tickets including the following information:

9.5.1. Priority.

9.5.2. Type of failure.

9.5.3. Site and route at which a failure has occurred.

9.5.4. Probable cause of the failure.

9.5.5. Recommended plug-in units to take to site.

9.5.6. The date and time at which the fault first appeared.

9.5.7. The date and time at which the fault was repaired.

9.5.8. Current fault status.

9.5.9. Actual cause of failure (entered by the operator.

9.6. It must be possible to categorise faults according to the information in the fault tickets.

9.7. The NMS must enable the operators to enter status information about a particular fault, recording progress in fault restoration.

9.8. The reception of a change of fault status, “failure” or “corrected failure” must be indicated at the terminal by means of a flashing display and an audible alarm.

10. SUPPORT SERVICES AND TRAINING

10.1. The bidder must quote for the support and training services which will be valid for the duration of the contract to achieve the following aspects:

10.2. The bidder must up-skill and train the TFR NOC staff to do the second line support on the equipment.

10.3. The bidder must train the operations and maintenance teams to be capable of doing the first line support on the network.

10.4. The bidder must provide High Level and third line support for the network services. Since this network will be carrying critical traffic, there must be a technical specialist to support the operations on a 24/7 basis.

10.5. The bidder must train the TFR specialists to perform Planning, provisioning and Optimization services on the network.

10.6. The bidder must supply a recommended list of specialised test instruments.

END OF SPECIFICATION