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1. Introduction

Cellular modems have seen vast application in a world where connectivity is increasingly vital for communications. Eskom utilises cellular modems in areas where its own networks either are not available, not suitable for the application, or where hardwire communication options do not exist. As such, there is an array of manufacturers' modems deployed to date, where each application typically utilised their own standard. This has caused fragmentation in the feature-sets of our modem installed base.

In addition, technological progression has seen many previously discrete functions integrated into modern modems, without any significant change in their footprint. These advances have resulted in powerful, yet cost effective modems being available on the market.

Due to the above-mentioned fragmentation and general availability of multipurpose and integrated modems available in industry, this standard was developed to address uniform compliance to Eskom standards and required feature-sets.

2. Supporting clauses

2.1 Scope

2.1.1 Purpose

This document standardises the requirements of a modem (integrated or standalone), to ensure compliance with Eskom's minimum requirements.

Furthermore, these standard details other features that may be selected by end users during procurement stages with guidelines given to assist with the selection criteria.

This document will supersede all existing modem specifications and standards within the Eskom OT Wires space.

2.1.2 Applicability

This document shall apply throughout Eskom OT Wires Divisions and supersede the following specifications\standards either entirely or only the sections pertaining to the modem specifically:

- 240-71630971 – Dx Telecontrol: User Requirements Specification for GSM-Based Communications
 - This document shall supersede only the sections pertaining to the modem sections.
- 240-61266818 – Specification for Cellular Network Modems for Remote Metering
- 240-76625081 – Cellular Modem Standard

2.2 Normative/informative references

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] 3GPP TS 51.010-1, Mobile station conformance specification- part 1
- [2] ETSI EN 301 511, V12.5.1, Global System for Mobile communication (GSM); Harmonised EN for mobile stations in the GSM 900 and GSM 1800 bands covering essential requirements of article 3.2 of the R&TTE directive
- [3] ETSI EN 300 607-1 V9.0.0: Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance standard; Part 1: Conformance standard (GSM 11.10-1 version 9.0.0)

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- [4] ETSI EN 300 910 V8.4.1: Digital cellular telecommunications system (Phase 2+); Radio transmission and reception
 - [5] IEC61850, Standard for communication network and systems in substations
 - [6] IEC60529, Specification for degrees of protection provided enclosures (IP code)
 - [7] IEEE-1613, Communication networking devices in electrical power substations
 - [8] IEEE 1815 (2012), IEEE Standard for Electric Power Systems Communication – Distributed Network Protocol, IEEE.
 - [9] RFC 5246, the Transport Layer Security (TLS) Protocol, Version 1.2.
 - [10] SANS 60950-1, Information technology equipment safety
 - [11] SANS 61000-4-2, 3,4,5 & 8 (Edition 2), Electromagnetic compatibility (EMC) standards
 - [12] SANS 301489-7, EMC standard for radio equipment and services
 - [13] DNP3 IED Certification Procedure Subset Level 2, DNP3 User Group
 - [14] 240-55410927, Cyber Security standard for operational technology
 - [15] 240-64038621: Remote Device Communication Standard For Data Retrieval And Remote Access
 - [16] 240-140068033: Standard for Internet Protocol Security (IPsec) in operational networks
 - [17] 240-61224164: Telecommunications Guideline: Design Guide for Cell Modem Communications
 - [18] 240-59089329: DNP3 Implementation Standard
 - [19] 240-71630971: Dx Telecontrol: User Requirements Specification for GSM-Based Communications

2.2.2 Informative

- [20] 32-9, Definition of Eskom Documents
- [21] 32-644, Eskom Documentation Management Standard
- [22] 240-75670959, Operating Manual of the Steering Committee of Technologies (SCOT)

2.3 Definitions

2.3.1 General

Definition	Description
Authentication	Authentication refers to the process of verifying the identity of a user, process, or device, often as a prerequisite to allowing access to resources in an information system
Bit Error Rate (BER)	A telecoms performance parameter that indicates the ratio of the number of received erroneous bits over the total number of bits transmitted. BER is usually expressed as a coefficient and a power of 10, e.g. 1 error in 1000 bits is expressed as 1×10^{-3} .
Class A modem	CSD and PSD can be operated at the same time
Class B modem	Does not support simultaneous operation of PSD and CSD.
Class C modem	A modem which can be configured to support either CSD or PSD when switching the device on.

Definition	Description
Cyber Security	Cyber security is the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can be used to protect the cyber environment and organization and user's assets.
Encryption	Encryption refers to the cryptographic transformation of data into a form that conceals the data's original meaning to prevent it from being known or used. If the transformation is reversible, the corresponding reversal process is called "decryption", which is a transformation that restores encrypted data to its original state.
GSM/GPRS Modem	A device capable of transferring data via the Global Systems for Mobile Communications (GSM) and General Packet Radio Service (GPRS) network.
Hayes command set (AT commands)	A group of commands, issued from a computer that allows control of the modem whilst in terminal mode.
Integrated Modem	A modem that has its modem functionality and features integrated with the device it is contained within. Does not require a casing as it is housed within the device it is connected to.
Mini-SIM	A SIM card sized 25x15x0.76 mm
Operational data	This is data that is crucial to the monitoring and operation of the power system network and is applicable to Supervisory, Control and Data Acquisition (SCADA) systems. It includes real-time analogue network loading data such as voltages, currents, power flows, and also the status of primary plant equipment such as breakers and isolators. It is the fundamental information required to monitor and control the network.
SIM card	A Subscriber Identity Module (SIM) card is a smart card capable of storing information.
Standalone Modem	A self-contained modem or modem router that shall be used to connect to devices.
Virtual Private Network	A VPN is a communications environment in which access is controlled to permit peer connections only within a defined community of interest, and is constructed though some form of partitioning of a common underlying communications medium, where this underlying communications medium provides services to the network on a nonexclusive basis

2.3.2 Disclosure classification

Controlled disclosure: controlled disclosure to external parties (either enforced by law, or discretionary)..

2.4 Abbreviations

Abbreviation	Description
3G	3 rd Generation
3GPP	3 rd Generation Partnership Project
AES	Advanced Encryption Standard
APN	Access Point Name
ARP	Address Resolution Protocol

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Abbreviation	Description
BER	Bit Error Rate
BLER	Block Error Rate
CE	Conformité Européenne (European health and safety product label)
CoE	Centre of Excellence
CSD	Circuit Switched Data
DHCP	Dynamic Host Configuration Protocol
Dx	Distribution (Eskom Division)
EDGE	Enhanced Data Rates for GSM Evolution
EMC	Electromagnetic compatibility
ESD	Electrostatic discharge
ETSI	European Telecommunications Standard Institute
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile communication
GUI	Graphical User Interface
I/O	Input / Output
ICASA	Independent Communications Authority of South Africa
IEC	International Electro-technical Commission
IED	Intelligent Electronic Device
IMEI	The International Mobile Equipment Identity
IP	Internet Protocol
IPSec	Internet Protocol Security
L2TP	Layer Two Tunnelling Protocol
LAN	Local Area Network
LED	Light Emitting Diode
LTE	Long Term Evolution
MAC	Media Access Control
MIM	Machine Identity Module
MTBF	Mean Time Between Failures
n/a	Not Applicable
NAT	Network Address Translation
NERC	North American Electric Reliability Corporation
OT	Operational Technology
PPP	Point-to-Point Protocol

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Abbreviation	Description
PSD	Packet Switched Data
PTM&C	Protection, Telecommunication, Metering and Control
RF	Radio Frequency
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SCOT	Steering Committee of Technologies
SIM	Subscriber Identity Module
SMS	Short Message Service
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
SSH	Secure Socket Shell
TLS	Transport Layer Security
TCP/IP	Transfer Control Protocol/ Internet Protocol
UDP	User Datagram Protocol
VRRP	Virtual Router Redundancy Protocol
VLAN	Virtual LAN
VPN	Virtual Private Network
WAN	Wide Area Network
WCDMA	Wideband Code Division Multiple Access

3. Requirements

The sections following outline the Mandatory and Selectable requirements of a modem to meet the multitude of uses within the Eskom OT environment. To ensure the modem complies with Eskom's minimum requirements, there are requirements that are mandatory in the document and will be identified with the letter "M" in the technical schedule.

Furthermore, these standard details other features that may be selected by end users during stages. These additional functionalities can be either Mandatory or Preferred depending on the requirements of the end user and the application for which the modem shall be used. Such requirements shall be completed by the end user in the technical schedule.

3.1 Mandatory Physical Requirements

3.1.1 Operating and Storage Conditions

- 3.1.1.1 The modem enclosure shall be manufactured of a durable high impact plastic or metal extrusion.
- 3.1.1.2 Physical dimensions of the Modem: The dimensions shall not exceed 180 (h) x 110 (w) x 80 (d) mm.
- 3.1.1.3 The supplier shall indicate actual outer dimensions of the modem enclosure.
- 3.1.1.4 The modem casing shall have a minimum Ingress Protection (IP) rating of that specified in the technical schedule. [6]

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3.1.1.5 The equipment shall operate without malfunction within the following environmental limits:

3.1.1.5.1 Altitude : 0 to 3000 m above mean sea level

3.1.1.5.2 Ambient temperature : -15 to +75 °C

3.1.1.5.3 Humidity : up to 90% non-condensing

3.1.1.5.4 Barometric pressure : 75 to 106 kPa

3.1.1.5.5 Electric field strength : up to 10 V/m

3.1.2 EMC and EMI immunity and radiation requirements:

3.1.2.1 The modem shall comply with the IEEE 1613 class 2 standard for environmental and testing requirements for communications networking devices in electric power substations [7].

3.1.2.2 The modem shall comply with IEC TS 61000-6-5:2001, the specification of EMC immunity requirements for generation, transmission and distribution of electricity and related telecommunication systems.[11]

3.1.2.3 The modem shall comply with IEC61850-3, Standard for Communication networks and systems in substations. IEC61850-3 General requirements including EMI type tests.[5]

3.1.2.4 The modem enclosure (including all external connectors and wiring) shall be suitably screened to prevent electromagnetic radiation produced by the modem from interfering with the operation of any adjacent electronic equipment, i.e. it shall conform to SANS/IEC 6100-6-3 [11]

3.1.3 Power Consumption

3.1.3.1 The maximum DC power consumption for the different modes of operations across the supply voltage range shall be specified by Eskom (in the technical schedule) and further details to be provided by the supplier for the following operating modes:

3.1.3.1.1 Standby/Idle mode:

3.1.3.1.2 Receive mode:

3.1.3.1.3 Transmit mode:

3.1.3.2 The supplier shall indicate the average as well as peak power consumption in each of the above operating modes.

3.1.3.3 The supplier shall indicate the operation of any power saving techniques or modes and the consumption savings achieved.

3.1.3.4 The supplier shall indicate if and how the power saving mode affects the transmission and reception of data, and the typical delay when changing from power save mode to normal operating mode.

3.1.4 Indications

3.1.4.1 The modem shall have an indication for the power supply (LED or via a Digital Display)

3.1.4.2 The modem shall have an Data Transmit indication (LED or via a Digital Display)

3.1.4.3 The modem shall have an Data Receive indication (LED or via a Digital Display)

3.1.4.4 The modem shall have a Network strength status indication with a minimum of 4 levels (LED or via a Digital Display)

3.1.4.5 The supplier shall specify any other indications that are on the modem.

3.1.5 Modem Markings

3.1.5.1 For standalone modem's the manufacturing name, model type and year of manufacturing shall be clearly visible.

3.1.5.2 The serial number of the modem, which shall relate to the manufacturing name, year of manufacture, model and its unique identification number, shall be displayed on the modem or circuit board in the form of text.

3.1.5.3 All external connectors, test points, switches and status indications shall be clearly and indelibly marked.

3.1.5.4 If the modem has an internal power supply all information regarding Input and Output voltage, Current and Power options shall be clearly and indelibly marked.

3.1.6 Hardware Requirements

3.1.6.1 The modem hardware shall have enough processing capacity to perform all the functionality selected in the technical schedule with extra capacity for reasonable feature upgrades.

3.1.6.2 The modem hardware shall have enough processing and memory capacity to perform all the router functionality selected in the technical schedule with extra capacity for reasonable feature upgrades.

3.2 Selectable Physical Requirements

3.2.1.1 The modem shall be encased in the equipment within which it is embedded to provide physical protection.

3.2.1.2 At minimum, the modem shall meet all operating and storage conditions of the equipment it housed within.

3.2.1.3 Reverse polarity protection: The DC power input of the Cellular modem shall have suitable protection against inadvertent reverse polarity connections. Self-restoring protection is preferred. Protection by means of a fuse is acceptable, provided that the fuse can be accessed without opening the enclosure. The supplier shall indicate the type of protection offered.

3.2.1.4 Modems shall be DIN-rail mountable or have a suitable mounting solution to be mounted inside an equipment cabinet, the modem enclosure shall have suitable mounting holes/lugs which allow it to be securely mounted onto a flat metal surface, or alternatively be provided with a suitable mounting bracket assembly.

3.2.1.5 If the modem has an internal power supply the connectors shall be done through screw terminals, which shall have adequate insulating properties, mechanical strength and a secure mechanism to prevent inadvertent disconnection. Terminals shall also be protected against accidental short-circuiting. The protective earth terminal that forms part of the modem base shall be located adjacent to the power supply screw terminals and shall be electrically bonded to the accessible metal parts of the modem. The clearance and creepage distance between any terminals of a circuit shall not be less than 3.0mm and 3.2mm respectively.

3.2.1.6 The modem shall offer some type of power-down delay through a super-cap or similar, to enable alarm reporting under power failure.

3.2.1.7 The modem shall be capable of sending periodic transmissions (i.e. ping a remote destination address) as a means to confirm that communications is still active. The period of these "comms check" transmissions shall be kept as short as possible to allow for frequent heart beat transmissions without major impact on the data usage. The period of these "comms check" messages shall be user

configurable. It shall be possible to set this parameter in the range 1 to 99 minutes in steps of 1 minute or less.

3.2.1.8 The “comms check” message formats shall be open and non-proprietary.

3.2.1.9 The destination address for the “comms check” messages shall be user configurable.

3.2.2 Power Supply Voltage Options

3.2.2.1 The modem shall operate reliably from a DC input voltage (specify range in technical schedule) of:

3.2.2.1.1 Low Voltage - 5 or 12 Volts DC

3.2.2.1.2 High Voltage – 110 or 220 Volts DC

3.2.2.2 The modem shall operate reliably from an input voltage of 230 Volt AC supply input.

3.2.2.3 The modem shall be able to operate with a voltage deviation of $\pm 15\%$ from the specified supply voltage.

3.2.2.4 The power supply’s connector to the modem shall have adequate insulating properties between the connectors and a secure mechanism to prevent inadvertent disconnection.

3.2.2.5 The power supply connector shall be of the type specified in the technical schedule.

3.2.2.6 The modems power supply shall comply with the following specifications:

3.2.2.6.1 SANS 60950-1 – Information technology equipment standard[10]

3.2.2.6.2 EN 55022 – Information technology equipment: Radio disturbance characteristics

3.2.2.6.3 SANS 61000-4-5 – Electromagnetic compatibility (EMC) part 4-5: Testing and measurements techniques –Surge immunity test [11].

3.3 Mandatory Functionality Requirements

3.3.1.1 The GSM/LTE module shall be integrated within the modem and shall comply with ETSI EN 301 511 – Harmonized standard for MS in the 900 and 1 800 GSM bands.[2]

3.3.1.2 Modem shall be fully compliant with the GSM Phase 2+ standard [3][4]

3.3.1.3 Modem shall be approved by the Independent Communications Authority of South Africa (ICASA) for use in South Africa as well as network approved by all South African network service providers

3.3.1.4 Modem shall support GPRS multi-class 10 as a mandatory requirement.

3.3.1.5 The 3G/WCDMA module shall comply with the 3GPP TS 51.010-1 [1] – Mobile station conformance specification.

3.3.1.6 Modem shall be 3G/ LTE capable and backward compatible with a fall back option to EDGE/GPRS and NBloT.

3.3.1.7 Modem shall be a class A or class B

3.3.1.8 Modem shall as a minimum, be dual band and support all South African approved mobile operators (e.g. MTN, Vodacom, CellC and Telkom).

3.3.1.9 The modem shall automatically reboot to apply network changes.

- 3.3.1.10** The modem shall allow the user to configure the APN settings manually. These settings include but are not limited to the APN name, Username, Password, Access Number and Port Configuration.
- 3.3.1.11** The modem shall support Ethernet as specified in the IEEE 802.3 standard.
- 3.3.1.12** The modem shall support Internet Protocol version 4 (IPv4). The supplier shall also state IPv6 compliance.
- 3.3.1.13** The modem shall support Hypertext Transfer Protocol (HTTP) for device configuration and diagnostics to enable remote engineering and access but it shall be preferred if Hypertext Transfer Protocol Secure (HTTPS) is supported. This option shall be selectable, i.e. the Modem shall have the capability to disable HTTP and HTTPS connections.
- 3.3.1.14** The modem shall be password protected to prevent unauthorised connections and configuration changes.
- 3.3.1.15** Username and Password shall be configurable using both upper and lower case character, numbers and special characters.
- 3.3.1.16** User passwords shall be hashed when transmitted over any network and when stored.

3.4 Selectable Functionality Requirements

- 3.4.1.1** Modem shall support 2G or higher network bandwidths.
- 3.4.1.2** Modem shall be Hayes compatible.
- 3.4.1.3** Modem shall have a transmit-to-receive turnaround time that shall be specified in the Technical schedule else if left blank, the time shall be provided by the supplier.
- 3.4.1.4** Modem shall have a receive-to-transmit turnaround time that shall be specified in the Technical schedule else if left blank, the time shall be provided by the supplier.
- 3.4.1.5** The receiver, when in a stationary position, shall have a Bit Error Rate (BER) performance better than 10^{-4} for an RF receive level of -82 dBm into the RF connector of the modem.
- 3.4.1.6** The supplier shall indicate the maximum usable sensitivity level, i.e. the RF receive level, at which the Block Error Rate (BLER) is 10%.
- 3.4.1.7** The supplier shall provide data on the modem's BER versus Receive Signal Strength Indication (RSSI)
- 3.4.1.8** The supplier shall provide data on the RSSI level versus receive power (in dBm) at the antenna connector.
- 3.4.1.9** The modem shall have an easily accessible slot for a plastic SIM card or make provision for a chip-SIM or a combination thereof i.e. SIM plus chip-SIM. This option shall be identified in the technical schedule.
- 3.4.1.10** The modem shall have slots for two plastic SIM cards or make provision for two chip-SIMs or a combination thereof i.e. SIM plus chip-SIM.
- 3.4.1.11** The modem shall support Dual APN configuration options with automatic failover between the two APNs if there is (the option for failover can be selectable):
- 3.4.1.11.1** The modem shall cutover to the inactive SIM (if fitted) when the GSM network signal is lost or falls below an acceptable level for a user configurable period. This parameter shall be set in minutes in the range 0 (disabled) to 99.

- 3.4.1.11.2** The modem shall cutover to the inactive SIM (if fitted) when no valid protocol message is received from the remote end within a user configurable period. This parameter shall be set in minutes in the range 0 (disabled) to 99.
- 3.4.1.11.3** A mechanism shall be provided to prevent the inactive SIM from being inactive for so long that it is disabled by the Network Operator.
- 3.4.1.12** The modem shall simultaneously support Dual WANs for instantaneous failover or load balancing which shall be a selectable option.
- 3.4.1.13** The modem shall support SSH sessions for diagnostic and configuration to enable remote engineering and access. This option shall be selectable, i.e. the Modem shall have the capability to disable SSH connections.
- 3.4.1.14** All user account shall be locked for a configurable period after three (3) unsuccessful login attempts within a 24-hour period.

3.5 Mandatory Routing and Firewalling

- 3.5.1.1** The modem shall support the Transmission Control Protocol/Internet Protocol suite (TCP/IP) and User Data Protocol (UDP) as a mandatory requirement.
- 3.5.1.2** The modem shall have layer 3 routing capabilities to allow the user to manually setup a static route in addition to dynamically selecting a route.
- 3.5.1.3** The modem shall have a Dynamic Host Configuration Protocol (DHCP) Server that can automatically assign IP address to devices on the LAN. The range of the IP address that will be assigned shall be configurable. The option to enable DHCP shall also be configurable.
- 3.5.1.4** The modem shall have configurable IP masquerading functionality.
- 3.5.1.5** The modem shall support port forwarding between the WAN connection and the Ethernet ports. The ability shall exist to map any internal port to a WAN-based external port, whether the same or not.
- 3.5.1.6** The modem shall support Simple Network Management Protocol (SNMP), to provide the device status and data acquisition as well as support SNMP traps for critical alerts such as but not limited to "power up" or port up/down. Supplier to state which version of SNMP is supported. The supplier shall also provide the SNMP MIBS to Eskom at no additional cost.
- 3.5.1.7** The modem shall support Point to Point Protocol (PPP), to establish the link onto the APN.
- 3.5.1.8** The modem shall support a Terminal network sessions (TELNET) to enable an alternative means of configuration and diagnostics. This option shall be selectable, i.e. the Modem shall have the capability to disable Telnet connections.

3.6 Selectable Routing and Firewalling

- 3.6.1.1** The modem shall be capable of creating and configuring multiple Virtual LANs (VLANs). The VLANs created shall at minimum have the following capabilities:
- 3.6.1.1.1** Be either a Trunk or Edge port
- 3.6.1.1.2** Tagged or Untagged
- 3.6.1.1.3** Be assigned to a Physical Ethernet Port
- 3.6.1.1.4** Allow for more than one IP address to be assigned to it

- 3.6.1.2** The modem shall support Virtual Private Networks (VPN) to provide a secure link between remote engineering and data systems and the end devices as a VPN server. (The Cyber Security standard (NERC CIP-005) requires that critical cyber assets be protected by an electronic perimeter.)
- 3.6.1.3** The modem shall be PPTP enabled and facilitate secure connections to remote devices in a secure manner.
- 3.6.1.4** Supplier to specify if the modem supports both VPN server and client functions (this will allow for modem to modem tunnelling).
- 3.6.1.5** The modem shall include a Simple Network Time Protocol (SNTP version 4) client and server to receive time synchronisation from a SNTP server and to distribute the time to end devices.
- 3.6.1.6** For secure connections like but not limited to VPN's and HTTPS, the modem shall support Transport Layer Security (TLS), cryptographic protocol to secure the link between itself and the remote end.[9]
- 3.6.1.7** The modem shall support the authentication and encryption of the network link using TLS with at least 128bit Advanced Encryption Standard (AES).[9]
- 3.6.1.8** The modem shall be capable of hosting File Transfer Protocol (FTP) sessions, as an FTP server. If this is supported on the modem it shall at minimum:
- 3.6.1.8.1** Support the retrieval of data pertaining to the modem's event logs and system logs.
- 3.6.1.8.2** Be capable of receiving configuration files and firmware upgrades from an FTP client.
- 3.6.1.9** Network activity logging shall be enabled and shall contain sufficient information to support reviewing, to ensure accountability of users and enable traceability.
- 3.6.1.10** The modem shall support other methods for authentication and encryption of the network link such as L2TP and IPsec.
- 3.6.1.10.1** The implementation of IPsec shall comply with the Eskom Standard for Internet Protocol Security (IPsec) in Operational Networks (240-140068033) [16]
- 3.6.1.11** The modem shall have a statefull firewall.
- 3.6.1.12** The modem shall support Virtual Router Redundancy Protocol (VRRP).
- 3.6.1.13** The modem shall support Network Address Translation (NAT) as a security feature, as specified in the IEEE802.11 standard.
- 3.6.1.14** The modem shall support IP whitelisting, i.e. only allows access to the modem for configuration from specific IP addresses and IP ranges.
- 3.6.1.15** The modem shall support MAC whitelisting, i.e. allows one to create a list of devices that have exclusive access to and through the modem.
- 3.6.1.16** The modem shall have a command line interface on the web interface to allow for trouble shooting to the LAN and WAN networks.
- 3.6.1.17** The supplier shall state which other security features are supported and how it is implemented.

3.7 Mandatory Communication Port

3.7.1 Ethernet Ports

- 3.7.1.1** At minimum, the modem shall have a copper Ethernet (IP) communication port.

3.7.1.2 The modem shall have additional Ethernet RJ45 ports as specified in the technical schedule. These ports can be configurable for WAN connections and LAN connections.

3.7.1.3 The Ethernet port shall be 100Base-Tx. Higher speeds may be provided but the Ethernet port shall be able to be configured as auto-sensing and fixed baud rate.

3.7.1.4 The modem shall be able to maintain multiple simultaneous socket connections.

3.8 Selectable Communication Port

3.8.1 Serial Ports

3.8.1.1 The modem shall support EIA-232 EIA-422 and EIA-485 serial communication data ports, preferably through an RJ45 connector.

3.8.1.2 The modem shall have the specified number of EIA 232\422\485 ports as per the technical schedule

3.8.1.3 The communication speed of the serial link shall be selectable from 2400 bps to a maximum of at least 57600 bps.

3.8.1.4 The modem shall support the following framing options for data streams:

3.8.1.4.1 One start bit

3.8.1.4.2 One and two stop bits

3.8.1.4.3 Even, odd and no parity

3.8.1.5 The modem shall support hardware, software or no flow control signalling for EIA-232 ports.

3.8.1.6 The modem shall support terminal server functionality on the serial port/s

3.8.1.7 The modem shall support a raw socket connection to a serial port.

3.8.1.8 The modems serial ports shall have a Transmit and Receive light indication

3.8.2 Additional Ports

3.8.2.1 The supplier shall indicate the connector to be used for programming, configuration and diagnostics.

3.8.2.2 The supplier shall provide full details of any additional connectors the Cellular modem may have.

3.8.3 Antenna

3.8.3.1 Modems shall have a female SMA connector unless a different connector is specified in the technical schedule.

3.8.3.2 The RF connector shall have a non-reactive impedance of 50Ω

3.8.3.3 Specify in the Technical Schedule if antenna needs to be provided and if so the supplier shall provide all details pertaining to it.

3.8.3.4 The antenna provided shall comply to the Eskom Telecommunications Guideline: Design guide for cell Modem communication [17]

3.9 Mandatory and Selectable Configuration and Diagnostics requirements

3.9.1.1 The modem shall have a hardware and software watchdog timer. These timers shall perform their own internal diagnostics that shall operate independently from each other and at least perform or offer the following:

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- 3.9.1.1.1** A cold restart if no communication has taken place in a 36h period.
- 3.9.1.1.2** A cold restart if the modem loses cellular network authentication for more than 10mins.
- 3.9.1.1.3** The cold restart functionality if remotely activated, for example through SMS.
- 3.9.1.2** The modem shall have an Auto Reboot function that can be set to a specified time (0 – 24hrs) as well as after a specified time since the last reboot, to ensure non-essential reboots do not occur after previous reboots. By default, this should be turned “ON”.
- 3.9.1.3** The modem shall have a Ping (ICMP) tool/utility for network diagnostics that shall display the bytes sent and time taken to receive response from target IP address.
- 3.9.1.4** The modem shall have a Trace Route diagnostic tool that will display the route and measuring transit-delays of packets across the network.
- 3.9.1.5** The modem shall have the option to view the routing table in a clear and logical display either through the web interface or SSH/telnet session to the modem.
- 3.9.1.6** The modem shall have the option to view the ARP table in a clear and logical display either through the web interface.
- 3.9.1.7** The modem shall offer a diagnostic port, which could be a shared port with the TIA-232 or Ethernet data port.
- 3.9.1.8** The following device information shall be available via the configuration/diagnostic interface:
 - 3.9.1.8.1** Modem Serial number and module type
 - 3.9.1.8.2** Firmware version
 - 3.9.1.8.3** Device uptime (since last restart/reset)
 - 3.9.1.8.4** GSM module IMEI
 - 3.9.1.8.5** Received Signal Strength Indication of the active SIM.
 - 3.9.1.8.6** Cell tower information of the active SIM.
 - 3.9.1.8.7** GPS co-ordinates (in decimal degrees format compatible with Google Earth), if applicable.
- 3.9.1.9** The configuration/diagnostic interface shall be available in the following ways:
 - 3.9.1.9.1** Locally via a dedicated configuration/diagnostics port (serial or IP) utilizing Telnet, HTTP or HTTPS.
 - 3.9.1.9.2** Remotely via SMS, however the option for SMS configuration will be selectable and by default turned off.
 - 3.9.1.9.3** Remotely via the GSM/network connection (properly secured) utilizing either HTTPS, SSH or the secure application provided.
- 3.9.1.10** The configuration/diagnostics GUI shall be user friendly and menu driven and comprehensive help files shall be provided.
- 3.9.1.11** For browser-based configuration/diagnostics, support for Chromium-based browsers shall be provided as a minimum. The supplier shall indicate all other browsers that are supported.
- 3.9.1.12** It shall be possible to save and upload a modem configuration via all the configuration/diagnostic connection options.

3.9.1.13 It shall be possible to download a modem configuration via all the configuration/diagnostics connection options.

3.9.1.14 It shall be possible to upload a configuration of preconfigured modem to a new modem (i.e. if a modem fails it shall be possible to upload the failed modems config to a new modem and restore communication.)

3.9.1.15 The modems operating system shall have an anti-self-lockout prevention method for incorrect configurations uploads that would disconnect the user from the interface and prevent access back onto the modem after the incorrect config has been uploaded or have some form of validation period/test before the config is applied. The supplier to provide details on how this is implemented.

3.9.1.16 The supplier shall provide details of any additional diagnostics features.

3.10 Firmware and Software

3.10.1.1 The modems firmware shall either be integrated in the equipment's firmware or have a separate firmware as specified by the equipment manufacturer.

3.10.1.2 The firmware shall have preconfigured APN settings which will be supplied by Eskom.

3.10.1.3 The firmware shall be stored in a non-volatile flash memory

3.10.1.4 The modems firmware shall be remotely upgradeable via the cellular network utilizing one of the secure methods used to connect to the modem. The supplier shall provide Eskom with the necessary information and software to do so. Should the firmware upgrade fail, the modem shall revert to a valid firmware version after a configurable period.

3.10.1.5 The supplier shall provide a detailed firmware revision history every time a new release is made.

3.10.1.6 Any modifications and enhancements shall be clearly specified and the impact explained.

3.10.1.7 Any firmware bug fixes shall be made available free of charge within a period of 8 weeks after the problem has been formally communicated to the supplier. Any bugs discovered by either the supplier or any other customers, in a firmware version used by Eskom, shall be brought to Eskom's attention as soon as possible.

3.10.1.8 Future revisions of firmware shall be made available to Eskom at no additional cost for a minimum period of 5 years after the delivery of the last modem of that model.

3.11 Alarming

3.11.1.1 The modem shall generate an alarm/error report for:

3.11.1.1.1 Any modem errors/failures

3.11.1.1.2 Modems that fail to respond to valid data sent to it

3.11.1.1.3 Connection errors

3.11.1.1.4 Database errors

3.11.1.1.5 Modems that have moved outside their geo-fenced area (as per 3.8)

3.11.1.1.6 Or any other problem that relates to the operation of the system

3.11.1.2 The user shall be able to configure the alarm reporting, including the priority of each type of alarm and the frequency of alarm reporting.

- 3.11.1.3** The system shall have a user configurable feature to automatically notify one or more users of alarms by means of SMS and/or email.

3.12 Logging

- 3.12.1.1** The modem shall maintain various logs to record information about important events. The modem shall also perform its own internal diagnostics and log any errors, including all resets. The modem shall have the following log types with the supplier specifying to what degree they are supported and what is logged:

3.12.1.1.1 Security Event Logs - information related to security events

3.12.1.1.2 Syslog

3.12.1.1.3 Diagnostic Logs - record system information for the purposes of troubleshooting.

3.12.1.1.4 Network activity log

3.12.1.1.5 Alarms as listed in section 3.11

3.13 Selectable Application Specific Features

3.13.1.1 The modem shall be equipped with a GPS receiver.

3.13.1.2 The GPS receiver shall be capable of determining the location of the modem to within 10 m.

3.13.1.3 The modem shall have a geo-fencing feature which will disable the data ports should the modem be moved more than 200 m from the location stored at commissioning time. This feature need only check the modem location on power up and then once a day.

3.13.1.4 The modem shall be equipped with an accurate clock, preferably a real-time clock.

3.13.1.5 The GPS receiver shall be used to keep the clock accurate to within 1 millisecond, should GPS time be unavailable for any reason the modem shall keep its clock accurate using the GSM system time.

3.13.2 Advanced Modem version with Embedded RTU

3.13.2.1 There is a requirement for an advanced version of the modem that shall have an embedded RTU which can communicate with the Eskom SCADA master station independently of any RTU connected to the modem as stated in the Dx Telecontrol: User requirement Specification for GSM-Based communications standard [19].

3.13.2.2 The embedded RTU shall have at least four real digital inputs capable of sensing the state of potential free contacts.

3.13.2.3 The supplier shall provide details of the connector type used for any digital inputs capability.

3.13.2.4 The digital input sensing facility shall employ hysteresis to improve noise immunity. The SP shall provide details of all noise immunity measures.

3.13.2.5 The embedded RTU shall have an internal digital indication which is asserted when a tamper condition is detected.

3.13.2.6 The digital indications shall be time-stamped to an accuracy of 1 ms relative to the modem's internal clock.

3.13.2.7 The embedded RTU shall have at least two output relay contacts.

3.13.2.8 The supplier shall provide details of the connector type used for any output capability.

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- 3.13.2.9** The control output contacts shall be able to operate as one single-index, momentary output pair in the Complementary two-output model as described in the DNP3 specification [8].
- 3.13.2.10** The control output contacts shall be able to operate as two single-index, latched outputs in the Complementary Latch model as described in the DNP3 spec [8].
- 3.13.2.11** The control output contacts shall be able to operate as two single-index, momentary outputs in the Activation model as described in the DNP3 spec [8].
- 3.13.2.12** The output contacts shall be wet by a regulated DC power source within the modem. The power source voltage shall be either 12 or 24 V DC.
- 3.13.2.13** The control output contact power supply shall have overload protection that is self-resetting.
- 3.13.2.14** The Embedded RTU shall have a Level 3 protocol implementation that complies with the latest DNP3 specification [8]. The SP shall indicate all protocol features that exceed Level 3.
- 3.13.2.15** The DNP3 implementation shall comply with the latest DNP3 IED Level 2 Test Procedure [13].
- 3.13.2.16** The DNP3 implementation shall also support unsolicited operation.
- 3.13.2.17** The Embedded RTU shall be able to communicate with the Eskom SCADA master's traditional EIA-232 serial ports (DNP3 via the CC) and the master's Ethernet ports (DNP/IP directly).
- 3.13.2.18** The Embedded RTU shall support the ability to only communicate with a user defined DNP master address.
- 3.13.2.19** The embedded RTU shall have at least one analogue input capable of sensing a bipolar voltage with at least 14-bit resolution. The connector type shall be specified by the supplier.
- 3.13.2.20** The analogue shall be reported as a standard 16-bit DNP3 analogue value such that zero volts equals a count of zero and the full-scale voltage is reported as a count of 32767.
- 3.13.2.21** The analogue input sensing facility shall have a full-scale voltage of either 5 V or 10 V.
- 3.13.2.22** The analogue shall generate an event whenever the current value differs from the last reported value by a user configurable count.
- 3.13.2.23** All of the above functionality shall be provided and included in the product pricing, however if this functionality is not part of the suppliers standard product, a period of up to 12 months will be allowed to develop this functionality. The supplier shall provide all relevant details.

3.14 Testing

If testing is required is shall be stated in the Technical Schedule.

3.14.1 Functional Tests

- 3.14.1.1** As part of the product approval process, Eskom intends to perform functional tests on the equipment offered to ensure functionality of the modem and compatibility with existing systems, as well as to verify the products performance in Eskom's operating environment. Therefore, on request the supplier shall supply Eskom with a test Product.

3.14.2 Type Testing

- 3.14.2.1** The following compliance and/or test certificates shall be provided as a minimum requirement:

- 3.14.2.1.1** Certification from ICASA for the use of the equipment in South Africa in the prescribed frequency band.

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3.14.2.1.2 Quality management system conformance to ISO 9001: 2000

3.14.2.1.3 The supplier shall indicate the level of all other type testing performed on the equipment and protocol drivers offered to Eskom. All certificates and type test results shall be submitted with the offer. Eskom will evaluate the test information supplied and may elect to verify some of the test results.

3.15 Product Information and Technical Support

3.15.1.1 Preference will be given to suppliers that offer product support for the longest duration.

3.15.1.2 The supplier shall at least offer telephonic support during office hours (local South African time)

3.15.2 Training

3.15.2.1 Training shall be provided on request (specified in the technical schedule) for Eskom staff to enable them to configure, install, maintain, and operate the product and related systems offered. The formal assessments of attendees shall be preferred.

3.15.3 Documentation

Comprehensive support documentation shall be available for all equipment, hardware and software delivered. The documentation shall be in English. The supplier shall indicate whether the documentation will be free issued, or whether it needs to be separately purchased.

3.15.3.1 Instruction manuals

3.15.3.1.1 All types of modems shall be supplied with the instruction manuals that shall be detailed enough to enable Eskom staff to install, maintain, test, configure and use each item of equipment.

3.15.3.2 Drawings

3.15.3.2.1 The following types of drawings shall be supplied as part of the instruction manuals:

3.15.3.2.1.1 Outline dimensions and mounting details of each item.

3.15.3.2.1.2 Block schematics showing the functional components of the equipment.

3.15.3.2.1.3 Functional diagrams showing operating of equipment

3.15.3.2.1.4 Component layout diagram

3.15.3.2.1.5 Circuit and wiring diagram

3.15.3.2.1.6 Details of the terminals, terminal connectors and all com ports

3.15.4 Warranty

3.15.4.1 The supplier shall submit the warranty period in years of the design or manufacturing or any related product defects.

3.16 Additional Information

3.16.1 Company Information

3.16.1.1.1 Name of Company

3.16.1.1.2 Company Address

3.16.1.1.3 Date of establishment of the company

3.16.1.1.4 The nature of resources in South Africa in terms of workshops, test facilities etc. shall be stated

3.16.2 Product Information

3.16.2.1 A summary of the company's present range of equipment.

3.16.2.2 Expected Mean Time between Failures (MTBF) of all equipment offered, based on historical performance.

4. Authorization

Name and surname	Designation
Alison Maseko	Senior Manager – TX Telecoms
Judith Malinga	Senior Manager – TX PTM&C Engineering
Lenah Mothata	Senior Manager – TX Grids
Johan Pieterse	Chief Engineer – TX Secondary Plant, Work Planning and Centralised Services
Richard McCurrach	Senior Manager – TX IM
Aletta Mashao	Senior Manager – PTM&C DX
Malcolm Van Harte	Senior Manager – DX Smart Grid and Network Operations COE
Ezzard de Lange	Senior Manager – DX Operational Technology and Cyber Security
Christoph Kohlmeyer	Senior Manager – GX Engineering (Acting)
Sithembile Songo	Senior Manager – IT Information Security
Tebogo Makhwelo	Senior Manager - IT Infrastructure Operations
Varsha Pillay	Senior Manager – IT Application Operations
Cornelius Naidoo	Middle Manager – Telecommunication and Physical Security T&S

5. Revisions

Date	Rev	Compiler	Remarks
Oct 2024	2	T.Thakhudi	Review
Jan 2020	1	M Vala	First issue

6. Development team

The following people were involved in the development of this document:

- Raees Dalvie
- Tertius Hyman

7. Acknowledgements

Not applicable.

Annex A – Technical Schedule

This section covers the user specific requirements for modems to be used within the Eskom OT Wires environment. Each requirement has an associated requirement ID, a brief description where necessary as well as whether the requirement is mandatory, preferred or optional through the letters M, P and O respectively. The “Eskom Schedule” section will serve as a guideline for optimal requirements for a modem. When populating “Schedule A” during the tender process use the “Eskom Schedule” as the guideline and as far as possible retain all mandatory selections made. One can remove the “Eskom Schedule” section after completing “Schedule A”.

- a) **Ms** – Mandatory system or services requirements for Standalone modem; 100% compliance required.
- b) **Mi** - Mandatory system or services requirements for Integrated modem; 100% compliance required.
- c) **P** – Preferred support is desired by Eskom but not mandatory
- d) **Blank (shaded grey)** – If the option is left blank it is the responsibility of the subject expert who is compiling the schedule to specify if the option will be M or P or N. Options left blank during procurement stages shall be regarded as Mandatory.
- e) **N or Striped Out [/]** – Not required or Not Applicable

Item	Description	Eskom Schedule	Schedule A	Schedule B
3	Requirements			
3.1	Mandatory Physical Requirements			
3.1.1	Operating and Storage Conditions			
3.1.1.1	The modem enclosure shall be manufactured of a durable high impact plastic or metal extrusion.	Ms		
3.1.1.2	Physical dimensions of the Modem: The dimensions shall not exceed 180 (h) x 110 (w) x 80 (d) mm.	Ms		
3.1.1.3	The supplier shall indicate actual outer dimensions of the modem enclosure.	Ms		
3.1.1.4	The modem casing shall have a minimum Ingress Protection (IP) rating specified in the technical schedule.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.1.1.5	The equipment shall operate without malfunction within the following environmental limits: The equipment shall operate without malfunction within the following environmental limits:			
3.1.1.5.1	Altitude : 0 to 3000 m above mean sea level	Ms Mi		
3.1.1.5.2	Ambient temperature : -15 to +75 °C	Ms Mi		
3.1.1.5.3	Humidity : up to 90% non-condensing	Ms Mi		
3.1.1.5.4	Barometric pressure : 75 to 106 kPa	Ms Mi		
3.1.1.5.5	Electric field strength : up to 10 V/m	Ms Mi		
3.1.2	EMC and EMI immunity and radiation requirements:			
3.1.2.1	The modem shall comply with the IEEE 1613 class 2 standard for environmental and testing requirements for communications networking devices in electric power substations [7].	Ms Mi		
3.1.2.2	The modem shall comply with IEC TS 61000-6-5:2001, the specification of EMC immunity requirements for generation, transmission and distribution of electricity and related telecommunication systems.[11]	Ms Mi		
3.1.2.3	The modem shall comply with IEC61850-3, Standard for Communication networks and systems in substations. IEC61850-3 General requirements including EMI type tests.[5]	Ms Mi		
3.1.2.4	The modem enclosure (including all external connectors and wiring) shall be suitably screened to prevent electromagnetic radiation produced by the modem from interfering with the operation of any adjacent electronic equipment, i.e. it shall conform to SANS/IEC 6100-6-3 [11]	Ms Mi		
3.1.3	Power Consumption			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.1.3.1	The maximum DC power consumption for the different modes of operations across the supply voltage range shall be specified by Eskom (in the technical schedule) and further details to be provided by the supplier for the following operating modes:	Ms Mi		
3.1.3.1.1	Standby/Idle mode:			
3.1.3.1.2	Receive mode:			
3.1.3.1.3	Transmit mode:			
3.1.3.2	The supplier shall indicate the average as well as peak power consumption in each of the above operating	Ms Mi		
3.1.3.3	The supplier shall indicate the operation of any power saving techniques or modes and the consumption savings achieved.	Ms Mi		
3.1.3.4	The supplier shall indicate if and how the power saving mode affects the transmission and reception of data, and the typical delay when changing from power save mode to normal operating mode.	Ms Mi		
3.1.4	Indications			
3.1.4.1	The modem shall have an indication for the power supply (LED or via a Digital Display)	Ms Mi		
3.1.4.2	The modem shall have an Data Transmit indication (LED or via a Digital Display)	Ms		
3.1.4.3	The modem shall have an Data Receive indication (LED or via a Digital Display)	Ms		
3.1.4.4	The modem shall have a Network strength status indication with a minimum of 4 levels (LED or via a Digital Display)	Ms		
3.1.4.5	The supplier shall specify any other indications that are on the modem.	Ms Mi		
3.1.5	Modem Markings			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.1.5.1	For standalone modem's the manufacturing name, model type and year of manufacturing shall be clearly visible.	Ms		
3.1.5.2	The serial number of the modem, which shall relate to the manufacturing name, year of manufacture, model and its unique identification number, shall be displayed on the modem or circuit board in the form of text.	Ms Mi		
3.1.5.3	All external connectors, test points, switches and status indications shall be clearly and indelibly marked.	Ms Mi		
3.1.5.4	If the modem has an internal power supply all information regarding Input and Output voltage, Current and Power options shall be clearly and indelibly marked.	Ms Mi		
3.1.6	Hardware Requirements			
3.1.6.1	The modem hardware shall have enough processing capacity to perform all the functionality selected in the technical schedule with extra capacity for reasonable feature upgrades.	Ms Mi		
3.1.6.2	The modem hardware shall have enough processing and memory capacity to perform all the router functionality selected in the technical schedule with extra capacity for reasonable feature upgrades.	Ms Mi		
3.2	Selectable Physical Requirements			
3.2.1.1	The modem shall be encased in the equipment within which it is embedded to provide physical protection.	Ms		
3.2.1.2	At minimum, the modem shall meet all operating and storage conditions of the equipment it housed within.	Ms		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.2.1.3	Reverse polarity protection: The DC power input of the Cellular modem shall have suitable protection against inadvertent reverse polarity connections. Self-restoring protection is preferred. Protection by means of a fuse is acceptable, provided that the fuse can be accessed without opening the enclosure. The supplier shall indicate the type of protection offered.			
3.2.1.4	Modems shall be DIN-rail mountable or have a suitable mounting solution to be mounted inside an equipment cabinet, the modem enclosure shall have suitable mounting holes/lugs which allow it to be securely mounted onto a flat metal surface, or alternatively be provided with a suitable mounting bracket assembly.			
3.2.1.5	If the modem has an internal power supply the connectors shall be done through screw terminals, which shall have adequate insulating properties, mechanical strength and a secure mechanism to prevent inadvertent disconnection. Terminals shall also be protected against accidental short-circuiting. The protective earth terminal that forms part of the modem base shall be located adjacent to the power supply screw terminals and shall be electrically bonded to the accessible metal parts of the modem. The clearance and creepage distance between any terminals of a circuit shall not be less than 3.0mm and 3.2mm respectively.			
3.2.1.6	The modem shall offer some type of power-down delay through a super-cap or similar, to enable alarm reporting under power failure.			
3.2.1.7	The modem shall be capable of sending periodic transmissions (i.e. ping a remote destination address) as a means to confirm that communications is still active. The period of these "comms check" transmissions shall be kept as short as possible to allow for frequent heart beat transmissions without major impact on the data usage. The period of these "comms check" messages shall be user configurable. It shall be possible to set this parameter in the range 1 to 99 minutes in steps of 1 minute or less.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.2.1.8	The “comms check” message formats shall be open and non-proprietary.			
3.2.1.9	The destination address for the “comms check” messages shall be user configurable.			
3.2.2	Power Supply Voltage Options			
3.2.2.1	The modem shall operate reliably from a DC input voltage (specify range in technical schedule) of:			
3.2.2.1.1	Low Voltage - 5 or 12 Volts DC			
3.2.2.1.2	High Voltage – 110 or 220 Volts DC			
3.2.2.2	The modem shall operate reliably from an input voltage of 230 Volt AC supply input.			
3.2.2.3	The modem shall be able to operate with a voltage deviation of $\pm 15\%$ from the specified supply voltage.	Ms Mi		
3.2.2.4	The power supply's connector to the modem shall have adequate insulating properties between the connectors and a secure mechanism to prevent inadvertent disconnection.	Ms Mi		
3.2.2.5	The power supply connector shall be of the type specified in the technical schedule.			
3.2.2.6	The modems power supply shall comply with the following specifications:			
3.2.2.6.1	SANS 60950-1 – Information technology equipment standard[10]	Ms Mi		
3.2.2.6.2	EN 55022 – Information technology equipment: Radio disturbance characteristics	Ms Mi		
3.2.2.6.3	SANS 61000-4-5 – Electromagnetic compatibility (EMC) part 4-5: Testing and measurements techniques – Surge immunity test [11]	Ms Mi		
3.3	Mandatory Functionality Requirements			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.3.1.1	The GSM/LTE module shall be integrated within the modem and shall comply with ETSI EN 301 511 – Harmonized standard for MS in the 900 and 1 800 GSM bands.[2]	Ms Mi		
3.3.1.2	Modem shall be fully compliant with the GSM Phase 2+ standard [3][4]	Ms Mi		
3.3.1.3	Modem shall be approved by the Independent Communications Authority of South Africa (ICASA) for use in South Africa as well as network approved by all South African network service providers	Ms Mi		
3.3.1.4	Modem shall support GPRS multi-class 10 as a mandatory requirement.	Ms Mi		
3.3.1.5	The 3G/WCDMA module shall comply with the 3GPP TS 51.010-1 [1] – Mobile station conformance specification.	Ms Mi		
3.3.1.6	Modem shall be 3G/ LTE capable and backward compatible with a fall back option to EDGE/GPRS and NBIoT.	Ms Mi		
3.3.1.7	Modem shall be a class A or class B	Ms Mi		
3.3.1.8	Modem shall as a minimum, be dual band and support all South African approved mobile operators (e.g. MTN, Vodacom, CellC and Telkom).	Ms		
3.3.1.9	The modem shall automatically reboot to apply network changes.	Ms Mi		
3.3.1.10	The modem shall allow the user to configure the APN settings manually. These settings include but are not limited to the APN name, Username, Password, Access Number and Port Configuration.	Ms Mi		
3.3.1.11	The modem shall support Ethernet as specified in the IEEE 802.3 standard.	Ms Mi		
3.3.1.12	The modem shall support Internet Protocol version 4 (IPv4). The supplier shall also state IPv6 compliance	Ms Mi		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.3.1.13	The modem shall support Hypertext Transfer Protocol (HTTP) for device configuration and diagnostics to enable remote engineering and access but it shall be preferred if Hypertext Transfer Protocol Secure (HTTPS) is supported. This option shall be selectable, i.e. the Modem shall have the capability to disable HTTP and HTTPS connections.	Ms Mi		
3.3.1.14	The modem shall be password protected to prevent unauthorised connections and configuration changes.	Ms Mi		
3.3.1.15	Username and Password shall be configurable using both upper and lower case character, numbers and special characters.	Ms Mi		
3.3.1.16	User passwords shall be hashed when transmitted over any network and when stored.	Ms Mi		
3.4	Selectable Functionality Requirements			
3.4.1.1	Modem shall support 2G or higher network bandwidths.			
3.4.1.2	Modem shall be Hayes compatible.			
3.4.1.3	Modem shall have a transmit-to-receive turnaround time that shall be specified in the Technical schedule else if left blank, the time shall be provided by the supplier.			
3.4.1.4	Modem shall have a receive-to-transmit turnaround time that shall be specified in the Technical schedule else if left blank, the time shall be provided by the supplier.			
3.4.1.5	The receiver, when in a stationary position, shall have a Bit Error Rate (BER) performance better than 10 ⁻⁴ for an RF receive level of -82 dBm into the RF connector of the modem.			
3.4.1.6	The supplier shall indicate the maximum usable sensitivity level, i.e. the RF receive level, at which the Block Error Rate (BLER) is 10%.			
3.4.1.7	The supplier shall provide data on the modem's BER versus Receive Signal Strength Indication (RSSI)			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.4.1.8	The supplier shall provide data on the RSSI level versus receive power (in dBm) at the antenna connector.			
3.4.1.9	The modem shall have an easily accessible slot for a plastic SIM card or make provision for a chip-SIM or a combination thereof i.e. SIM plus chip-SIM. This option shall be identified in the technical schedule.			
3.4.1.10	The modem shall have slots for two plastic SIM cards or make provision for two chip-SIMs or a combination thereof i.e. SIM plus chip-SIM.			
3.4.1.11	The modem shall support Dual APN configuration options with automatic failover between the two APNs if there is (the option for failover can be selectable):			
3.4.1.11.1	The modem shall cutover to the inactive SIM (if fitted) when the GSM network signal is lost or falls below an acceptable level for a user configurable period. This parameter shall be set in minutes in the range 0 (disabled) to 99.			
3.4.k.2)	The modem shall cutover to the inactive SIM (if fitted) when no valid protocol message is received from the remote end within a user configurable period. This parameter shall be set in minutes in the range 0 (disabled) to 99.			
3.4.k.3)	A mechanism shall be provided to prevent the inactive SIM from being inactive for so long that it is disabled by the Network Operator.			
3.4.1.12	The modem shall simultaneously support Dual WANs for instantaneous failover or load balancing which shall be a selectable option.			
3.4.1.13	The modem shall support SSH sessions for diagnostic and configuration to enable remote engineering and access. This option shall be selectable, i.e. the Modem shall have the capability to disable SSH connections.			
3.4.1.14	All user account shall be locked for a configurable period after three (3) unsuccessful login attempts within a 24-hour period.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.5	Mandatory Routing and Firewalling			
3.5.1.1	The modem shall support the Transmission Control Protocol/Internet Protocol suite (TCP/IP) and User Data Protocol (UDP) as a mandatory requirement.	Ms Mi		
3.5.1.2	The modem shall have layer 3 routing capabilities to allow the user to manually setup a static route in addition to dynamically selecting a route.	Ms		
3.5.1.3	The modem shall have a Dynamic Host Configuration Protocol (DHCP) Server that can automatically assign IP address to devices on the LAN. The range of the IP address that will be assigned shall be configurable. The option to enable DHCP shall also be configurable.	Ms		
3.5.1.4	The modem shall have configurable IP masquerading functionality.			
3.5.1.5	The modem shall support port forwarding between the WAN connection and the Ethernet ports. The ability shall exist to map any internal port to a WAN-based external port, whether the same or not.	Ms Mi		
3.5.1.6	The modem shall support Simple Network Management Protocol (SNMP), to provide the device status and data acquisition as well as support SNMP traps for critical alerts such as but not limited to "power up" or port up/down. Supplier to state which version of SNMP is supported. The supplier shall also provide the SNMP MIBS to Eskom at no additional cost.	Ms		
3.5.1.7	The modem shall support Point to Point Protocol (PPP), to establish the link onto the APN.	Ms Mi		
3.5.1.8	The modem shall support a Terminal network sessions (TELNET) to enable an alternative means of configuration and diagnostics. This option shall be selectable, i.e. the Modem shall have the capability to disable Telnet connections.	Ms Mi		
3.6	Selectable Routing and Firewalling			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.6.1.1	The modem shall be capable of creating and configuring multiple Virtual LANs (VLANs). The VLANs created shall at minimum have the following capabilities:			
3.6.1.1.1	Be either a Trunk or Edge port			
3.6.1.1.2	Tagged or Untagged			
3.6.1.1.3	Be assigned to a Physical Ethernet Port			
3.6.1.1.4	Allow for more than one IP address to be assigned to it			
3.6.1.2	The modem shall support Virtual Private Networks (VPN) to provide a secure link between remote engineering and data systems and the end devices as a VPN server. (The Cyber Security standard (NERC CIP-005) requires that critical cyber assets be protected by an electronic perimeter.)			
3.6.1.3	The modem shall be PPTP enabled and facilitate secure connections to remote devices in a secure manner.			
3.6.1.4	Supplier to specify if the modem supports both VPN server and client functions (this will allow for modem to modem tunnelling).			
3.6.1.5	The modem shall include a Simple Network Time Protocol (SNTP version 4) client and server to receive time synchronisation from a SNTP server and to distribute the time to end devices.			
3.6.1.6	For secure connections like but not limited to VPN's and HTTPS, the modem shall support Transport Layer Security (TLS), cryptographic protocol to secure the link between itself and the remote end.[9]			
3.6.1.7	The modem shall support the authentication and encryption of the network link using TLS with at least 128bit Advanced Encryption Standard (AES).[9]			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.6.1.8	The modem shall be capable of hosting File Transfer Protocol (FTP) sessions, as an FTP server. If this is supported on the modem it shall at minimum:			
3.6.1.8.1	Support the retrieval of data pertaining to the modem's event logs and system logs.			
3.6.1.8.2	Be capable of receiving configuration files and firmware upgrades from an FTP client.			
3.6.1.9	Network activity logging shall be enabled and shall contain sufficient information to support reviewing, to ensure accountability of users and enable			
3.6.1.10	The modem shall support other methods for authentication and encryption of the network link such as L2TP and IPsec.			
3.6.1.10.1	The implementation of IPsec shall comply with the Eskom Standard for Internet Protocol Security (IPsec) in Operational Networks (240-140068033) [16]			
3.6.1.11	The modem shall have a statefull firewall.			
3.6.1.12	The modem shall support Virtual Router Redundancy Protocol (VRRP).			
3.6.1.13	The modem shall support Network Address Translation (NAT) as a security feature, as specified in the IEEE802.11 standard.			
3.6.1.14	The modem shall support IP whitelisting, i.e. only allows access to the modem for configuration from specific IP addresses and IP ranges.			
3.6.1.15	The modem shall support MAC whitelisting, i.e. allows one to create a list of devices that have exclusive access to and through the modem.			
3.6.1.16	The modem shall have a command line interface on the web interface to allow for trouble shooting to the LAN and WAN networks.			
3.6.1.17	The supplier shall state which other security features are supported and how it is implemented.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.7	Mandatory Communication Port			
3.7.1	Ethernet Ports			
3.7.1.1	At minimum, the modem shall have a copper Ethernet (IP) communication port.	Ms		
3.7.1.2	The modem shall have additional Ethernet RJ45 ports as specified in the technical schedule. These ports can be configurable for WAN connections and LAN connections.			
3.7.1.3	The Ethernet port shall be 100Base-Tx. Higher speeds may be provided but the Ethernet port shall be able to be configured as auto-sensing and fixed baud rate.	Ms		
3.7.1.4	The modem shall be able to maintain multiple simultaneous socket connections.	Ms		
3.8	Selectable Communication Port			
3.8.1	Serial Ports			
3.8.1.1	The modem shall support EIA-232 EIA-422 and EIA-485 serial communication data ports, preferably through an RJ45 connector.			
3.8.1.2	The modem shall have the specified number of EIA 232\422\485 ports as per the technical schedule			
3.8.1.3	The communication speed of the serial link shall be selectable from 2400 bps to a maximum of at least 57600 bps.	Ms		
3.8.1.4	The modem shall support the following framing options for data streams:			
3.8.1.4.1	One start bit	Ms		
3.8.1.4.2	One and two stop bits	Ms		
3.8.1.4.3	Even, odd and no parity	Ms		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.8.1.5	The modem shall support hardware, software or no flow control signalling for EIA-232 ports.	Ms		
3.8.1.6	The modem shall support terminal server functionality on the serial port/s	Ms		
3.8.1.7	The modem shall support a raw socket connection to a serial port.	Ms		
3.8.1.8	The modems serial ports shall have a Transmit and Receive light indication	Ms		
3.8.2	Additional Ports			
3.8.2.1	The supplier shall indicate the connector to be used for programming, configuration and diagnostics.			
3.8.2.2	The supplier shall provide full details of any additional connectors the Cellular modem may have.			
3.8.3	Antenna			
3.8.3.1	Modems shall have a female SMA connector unless a different connector is specified in the technical schedule.			
3.8.3.2	The RF connector shall have a non-reactive impedance of 50Ω			
3.8.3.3	Specify in the Technical Schedule if antenna needs to be provided and if so the supplier shall provide all details pertaining to it.			
3.8.3.4	The antenna provided shall comply to the Eskom Telecommunications Guideline: Design guide for cell Modem communication			
3.9	Mandatory and Selectable Configuration and Diagnostics requirements			
3.9.1.1	The modem shall have a hardware and software watchdog timer. These timers shall perform their own internal diagnostics that shall operate independently from each other and at least perform or offer the following:			
3.9.1.1.1	A cold restart if no communication has taken place in a 36h period.	Ms Mi		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.9.1.1.2	A cold restart if the modem loses cellular network authentication for more than 10mins.			
3.9.1.1.3	The cold restart functionality if remotely activated, for example through SMS.	Mi		
3.9.1.2	The modem shall have an Auto Reboot function that can be set to a specified time (0 – 24hrs) as well as after a specified time since the last reboot, to ensure non-essential reboots do not occur after previous reboots. By default, this should be turned “ON”.	Ms		
3.9.1.3	The modem shall have a Ping (ICMP) tool/utility for network diagnostics that shall display the bytes sent and time taken to receive response from target IP address.	Ms		
3.9.1.4	The modem shall have a Trace Route diagnostic tool that will display the route and measuring transit-delays of packets across the network.	Ms		
3.9.1.5	The modem shall have the option to view the routing table in a clear and logical display either through the web interface or SSH\telnet session to the modem.	Ms		
3.9.1.6	The modem shall have the option to view the ARP table in a clear and logical display either through the web interface.	Ms		
3.9.1.7	The modem shall offer a diagnostic port, which could be a shared port with the TIA-232 or Ethernet data port.	Ms		
3.9.1.8	The following device information shall be available via the configuration/diagnostic interface:			
3.9.1.8.1	Modem Serial number and module type	Ms		
3.9.1.8.2	Firmware version	Ms Mi		
3.9.1.8.3	Device uptime (since last restart/reset)	Ms Mi		
3.9.1.8.4	GSM module IMEI	Ms Mi		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.9.1.8.5	Received Signal Strength Indication of the active SIM.	Ms Mi		
3.9.1.8.6	Cell tower information of the active SIM.	Ms Mi		
3.9.1.8.7	GPS co-ordinates (in decimal degrees format compatible with Google Earth), if applicable.	Ms Mi		
3.9.1.9	The configuration/diagnostic interface shall be available in the following ways:			
3.9.1.9.1	Locally via a dedicated configuration/diagnostics port (serial or IP) utilizing Telnet, HTTP or HTTPS.	Ms		
3.9.1.9.2	Remotely via SMS, however the option for SMS configuration will be selectable and by default turned off.	Mi		
3.9.1.9.3	Remotely via the GSM/network connection (properly secured) utilizing either HTTPS, SSH or the secure application provided.	Ms		
3.9.1.10	The configuration/diagnostics GUI shall be user friendly and menu driven and comprehensive help files shall be provided.	Ms		
3.9.1.11	For browser-based configuration/diagnostics, support for Chromium-based browsers shall be provided as a minimum. The supplier shall indicate all other browsers that are supported.	Ms		
3.9.1.12	It shall be possible to save and upload a modem configuration via all the configuration/diagnostic connection options.	Ms		
3.9.1.13	It shall be possible to download a modem configuration via all the configuration/diagnostics connection options.	Ms		
3.9.1.14	It shall be possible to upload a configuration of preconfigured modem to a new modem (i.e. if a modem fails it shall be possible to upload the failed modems config to a new modem and restore communication.)	Ms		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.9.1.15	The modems operating system shall have an anti-self-lockout prevention method for incorrect configurations uploads that would disconnect the user from the interface and prevent access back onto the modem after the incorrect config has been uploaded or have some form of validation period/test before the config is applied. The supplier to provide details on how this is implemented.	Ms		
3.9.1.16	The supplier shall provide details of any additional diagnostics features.	Ms Mi		
3.10	Firmware and Software			
3.10.1.1	The modems firmware shall either be integrated in the equipment's firmware or have a separate firmware as specified by the equipment manufacturer.	Ms Mi		
3.10.1.2	The firmware shall have preconfigured APN settings which will be supplied by Eskom.			
3.10.1.3	The firmware shall be stored in a non-volatile flash memory	Ms Mi		
3.10.1.4	The modems firmware shall be remotely upgradeable via the cellular network utilizing one of the secure methods used to connect to the modem. The supplier shall provide Eskom with the necessary information and software to do so. Should the firmware upgrade fail, the modem shall revert to a valid firmware version after a configurable period.	Ms Mi		
3.10.1.5	The supplier shall provide a detailed firmware revision history every time a new release is made.	Ms Mi		
3.10.1.6	Any modifications and enhancements shall be clearly specified and the impact explained.	Ms Mi		
3.10.1.7	Any firmware bug fixes shall be made available free of charge within a period of 8 weeks after the problem has been formally communicated to the supplier. Any bugs discovered by either the supplier or any other customers, in a firmware version used by Eskom, shall be brought to Eskom's attention as soon as possible.	Ms Mi		

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.10.1.8	Error! Reference source not found.	Ms Mi		
3.11	Alarming			
3.11.1.1	The modem shall generate an alarm/error report for:			
3.11.1.1.1	Any modem errors/failures			
3.11.1.1.2	Modems that fail to respond to valid data sent to it			
3.11.1.1.3	Connection errors			
3.11.1.1.4	Database errors			
3.11.1.1.5	Modems that have moved outside their geo-fenced area (as per 3.8)			
3.11.1.1.6	Or any other problem that relates to the operation of the system			
3.11.1.2	The user shall be able to configure the alarm reporting, including the priority of each type of alarm and the frequency of alarm reporting.			
3.11.1.3	The system shall have a user configurable feature to automatically notify one or more users of alarms by means of SMS and/or email.			
3.12	Logging			
3.12.1.1	The modem shall maintain various logs to record information about important events. The modem shall also perform its own internal diagnostics and log any errors, including all resets. The modem shall have the following log types with the supplier specifying to what degree they are supported and what is logged:			
3.12.1.1.1	Security Event Logs - information related to security events			
3.12.1.1.2	Syslog			
3.12.1.1.3	Diagnostic Logs - record system information for the purposes of troubleshooting.			
3.12.1.1.4	Network activity log			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.12.1.1.5	Alarms as listed in section 3.11			
3.13	Application Specific Features			
3.13.1.1	The modem shall be equipped with a GPS receiver.			
3.13.1.2	The GPS receiver shall be capable of determining the location of the modem to within 10 m.			
3.13.1.3	The modem shall have a geo-fencing feature which will disable the data ports should the modem be moved more than 200 m from the location stored at commissioning time. This feature need only check the modem location on power up and then once a day.			
3.13.1.4	The modem shall be equipped with an accurate clock, preferably a real-time clock.			
3.13.1.5	The GPS receiver shall be used to keep the clock accurate to within 1 millisecond, should GPS time be unavailable for any reason the modem shall keep its clock accurate using the GSM system time.			
3.13.2	Advanced Modem version with Embedded RTU			
3.13.2.1	There is a requirement for an advanced version of the modem that shall have an embedded RTU which can communicate with the Eskom SCADA master station independently of any RTU connected to the modem as stated in the Dx Telecontrol: User requirement Specification for GSM-Based communications standard [19].			
3.13.2.2	The embedded RTU shall have at least four real digital inputs capable of sensing the state of potential free contacts.			
3.13.2.3	The supplier shall provide details of the connector type used for any digital inputs capability.			
3.13.2.4	The digital input sensing facility shall employ hysteresis to improve noise immunity. The SP shall provide details of all noise immunity measures.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.13.2.5	The embedded RTU shall have an internal digital indication which is asserted when a tamper condition is detected.			
3.13.2.6	The digital indications shall be time-stamped to an accuracy of 1 ms relative to the modem's internal clock.			
3.13.2.7	The embedded RTU shall have at least two output relay contacts.			
3.13.2.8	The supplier shall provide details of the connector type used for any output capability.			
3.13.2.9	The control output contacts shall be able to operate as one single-index, momentary output pair in the Complementary two-output model as described in the DNP3 specification [8].			
3.13.2.10	The control output contacts shall be able to operate as two single-index, latched outputs in the Complementary Latch model as described in the DNP3 spec [8].			
3.13.2.11	The control output contacts shall be able to operate as two single-index, momentary outputs in the Activation model as described in the DNP3 spec [8].			
3.13.2.12	The output contacts shall be wet by a regulated DC power source within the modem. The power source voltage shall be either 12 or 24 V DC.			
3.13.2.13	The control output contact power supply shall have overload protection that is self-resetting.			
3.13.2.14	The Embedded RTU shall have a Level 3 protocol implementation that complies with the latest DNP3 specification [8]. The SP shall indicate all protocol features that exceed Level 3.			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
3.13.2.15	The DNP3 implementation shall comply with the latest DNP3 IED Level 2 Test Procedure [13].			
3.13.2.16	The DNP3 implementation shall also support unsolicited operation.			
3.13.2.17	The Embedded RTU shall be able to communicate with the Eskom SCADA master's traditional EIA-232 serial ports (DNP3 via the CC) and the master's Ethernet ports (DNP/IP directly).			
3.13.2.18	The Embedded RTU shall support the ability to only communicate with a user defined DNP master address.			
3.13.2.19	The embedded RTU shall have at least one analogue input capable of sensing a bipolar voltage with at least 14-bit resolution.			
3.13.2.20	The analogue shall be reported as a standard 16-bit DNP3 analogue value such that zero volts equals a count of zero and the full-scale voltage is reported as a count of 32767.			
3.13.2.21	The analogue input sensing facility shall have a full-scale voltage of either 5 V or 10 V.			
3.13.2.22	The analogue shall generate an event whenever the current value differs from the last reported value by a user configurable count.			
3.13.2.23	All of the above functionalities shall be provided and included in the product pricing, however if this functionality is not part of the SP's standard product, a period of up to 12 months will be allowed to develop this functionality. The SP shall provide all relevant details.			
3.14	Testing			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
	If testing is required shall be stated in the Technical Schedule.			
3.14.1	Functional Tests			
	As part of the product approval process, Eskom intends to perform functional tests on the equipment offered to ensure functionality of the modem and compatibility with existing systems, as well as to verify the products performance in Eskom's operating environment. Therefore, on request the supplier shall supply Eskom with a test Product.			
3.14.2	Type Testing			
3.14.2.1	The following compliance and/or test certificates shall be provided as a minimum requirement:			
3.14.2.1.1	Certification from ICASA for the use of the equipment in South Africa in the prescribed frequency band.			
3.14.2.1.2	Quality management system conformance to ISO 9001: 2000			
3.14.2.1.2	The supplier shall indicate the level of all other type testing performed on the equipment and protocol drivers offered to Eskom. All certificates and type test results shall be submitted with the offer. Eskom will evaluate the test information supplied and may elect to verify some of the test results.			
3.15	Product Information and Technical Support			
3.15.1.1	Preference will be given to suppliers that offer product support for the longest duration			
3.15.1.2	The supplier shall at least offer telephonic support during office hours (local South African time)			
3.15.2	Training			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
	Training shall be provided on request (specified in the technical schedule) for Eskom staff to enable them to configure, install, maintain and operate the product and related systems offered. The formal assessments of attendees shall be preferred.			
3.15.3	Documentation			
	Comprehensive support documentation shall be available for all equipment, hardware and software delivered. The documentation shall be in English. The supplier shall indicate whether the documentation will be free issued, or whether it needs to be separately purchased.			
3.15.3.1	Instruction manuals			
	All types of modems shall be supplied with the instruction manuals that shall be detailed enough to enable Eskom staff to install, maintain, test, configure and use each item of equipment.			
3.15.3.2	Drawings			
3.15.3.2.1	The following types of drawings shall be supplied as part of the instruction manuals:			
3.15.3.2.1.1	Outline dimensions and mounting details of each item.			
3.15.3.2.1.2	Block schematics showing the functional components of the equipment.			
3.15.3.2.1.3	Functional diagrams showing operating of equipment			
3.15.3.2.1.4	Component layout diagram			
3.15.3.2.1.5	Circuit and wiring diagram			
3.15.3.2.1.6	Details of the terminals, terminal connectors and all com ports			
3.15.4	Warranty			

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Item	Description	Eskom Schedule	Schedule A	Schedule B
	The supplier shall submit the warranty period in years of the design or manufacturing or any related product defects.			
3.16	Additional Information			
3.16.1	Company Information			
3.16.1.1.1	Name of Company	Ms Mi		
3.16.1.1.2	Company Address	Ms Mi		
3.16.1.1.3	Date of establishment of the company	Ms Mi		
3.16.1.1.4	The nature of resources in South Africa in terms of workshops, test facilities etc. shall be stated	Ms Mi		
3.16.2	Product Information			
3.16.2.1	A summary of the company's present range of equipment.	Ms Mi		
3.16.2.2	Expected Mean Time between Failures (MTBF) of all equipment offered, based on historical	Ms Mi		

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