TECHNICAL SPECIFICATION T-2101 A

MULTISERVICE MULTIPLEXER

CONTENTS

1. Scope

This technical specification covers the IPTO's requirements regarding the technical characteristics of Multiservice Multiplexer equipment that will be installed in the IPTO existing telecommunication network.
The requested Multiservice Multiplexer equipment will be installed in the IPTO High Voltage Substations and Energy Control Centers to expand the existing telecommunication network.

2. IPTO existing telecommunication infrastructure

Telecommunication network infrastructure of IPTO consists of Power Line Carrier equipment over High Voltage Transmission Lines and SDH/PDH transmission backbone which consists mostly of PDH/MUX (E1s links) and SDH/MUX (STM-1/STM-4). The SDH MUXs are built on fiber optics, laid on IPTO's High Voltage Transmission lines and the PDH MUXs are built on E1 leased lines from telecom operators.
The fibers that are used are Single Mode conforming to ITU-T G.652 and G.655 standards.

3. General characteristics of Multiservice devices

The requested Multiservice Multiplexers must be capable to support circuit switched and packet switched networks (SDH & Carrier Ethernet or MPLS-TP).
The system should offer high-quality service aggregation and high-bandwidth transport for voice and data traffic in a single platform which supports ITU-T G.703, G.704, G.707, G.783, G.957, G.7041 (GFP), G.7042 (LCAS), G.841, G.842, G.709 and Y.1731(ETH OAM), supporting interconnections between 2Mbit/s up to 10Gbit/s (STM-64) etc. The system that is proposed shall provide very high density solutions reducing space and power consumption whilst offering extreme flexibility and robustness.
IPTO requires High Availability and resiliency of its telecom systems. For example, the need for ultra-fast and reliable transmission in Teleprotection is translated to extremely low, symmetrical delay below 10 ms and minimal delay variation ("jitter"). Some SCADA applications, on the other hand, tolerate latency levels as high as 1 second, while power quality Class A data needs 20ms at most.
Another aspect that requires attention when introducing packet - and IP-based communications is cyber security.
The offered equipment concerning the Ethernet technology must allow the use of sophisticated mechanisms to provide mission-critical substation applications such as SCADA messaging with the level of deterministic quality of service and priority they require. By managing bandwidth consumption and transmission priorities with CoS (Class of Service) granularity, multi-level hierarchical traffic management enables predictable latency and jitter performance across the service path. The classification of incoming traffic into flows according to type and required QoS. Ethernet supports a wide

variety of sorting criteria, such as VLAN-ID, Priority Code Point (PCP/P-bit) and MAC/IP address marking, to allow traffic identification in fine granularity.

In this manner, SCADA protocols that operate over TCP/IP, such as IEC 60870-5-101/104, can be classified according to L3/L4 characteristics, whereas Ethernet traffic can be handled per VLAN – ID L2 identifiers/characteristics.

4. Network topology

The coexistence of latest technology equipment (Ethernet interfaces, higher serial speed transmission and new SCADA protocols) with legacy infrastructure and substation devices results in two types of communications traffic that must be transmitted over the IPTO's telecommunication network:

- Ethernet and IP based data and signals from/to Substations.
- TDM - based traffic from existing equipment, e.g., analog voice, serial SCADA and Teleprotection signals.

The offered MultiService MUX equipment must be able to operate in a multivendor network environment, with E&M, RS232, nx64kbps, E1, STM-1/STM-4/STM-16 protocols.

Equipment from other manufacturers that are currently installed and operate in the IPTO network are AM3440 & O9500 LOOP Telecom, ABB FOX 512 and 1662 SMC ALCATEL. The interconnection must be allowed with the existing & similar third party equipment.

All multiplexers shall be configured as Terminal Add/ Drop and Cross-Connect multiplexer to work in line, ring, star, and meshed networks, fulfilling the requirement of multiplexers according to ITU-T G.783 and MEF CE2.0 or MPLS-TP. The network proposed shall be configured as proposed in the figure 4.1.
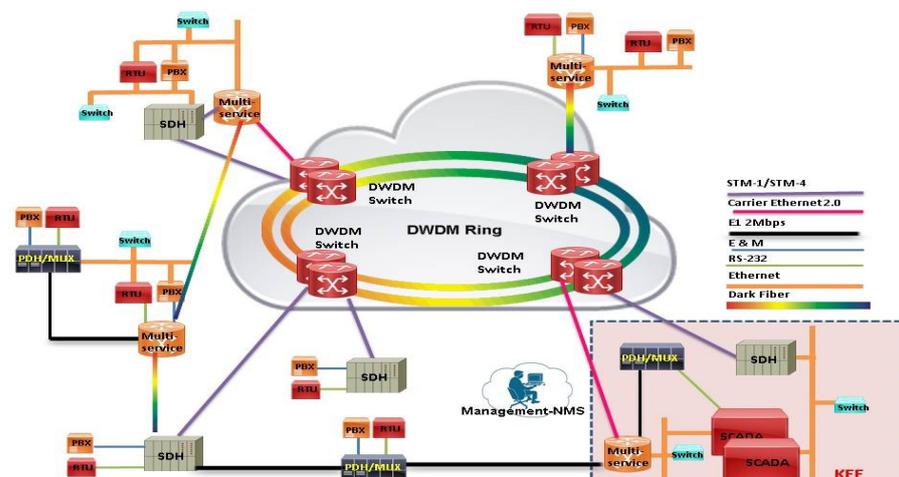

Figure 4.1. Sample of the proposed network configuration

5. Technical requirements for the MultiService MUX

5.1   Hardware Redundancy

5.1.1 No single point of failure design, with redundant hot-swappable power supply units.
5.1.2 Redundant in control level / CPUs etc.
5.1.3 High Availability 99.999%.

5.2   Link Redundancy

5.2.1 1+1 protection topology with automatic switchover between links (for SDH aggregation FO link or Carrier Ethernet or MPLS-TP link).
5.2.2 1+1 protection topology with automatic switchover between E1 links.
5.2.3 Link aggregation control group per IEEE 802.3 – 2005 (Link aggregation control protocol) for Ethernet-based services.

5.3   Path protection

5.3.1 Ethernet Linear protection switching (G.8031) Ethernet Virtual Connection (EVC).
5.3.2 SDH Ring protection mechanism - Multiplex Section Protection (MSP) & Subnetwork connection protection (SNCP).
5.3.3 Ethernet Ring Protection Switching (G.8032 ERPS) - Ethernet Ring Protection Switching – to provide 99,999% availability.

5.4   Timing over Packet (ToP)

5.4.1 Robust clock accuracy (free run situations).
5.4.2 IEEE 1588-2008 Precision Time Protocol (PTP) for time synchronization.
5.4.3 Connectivity to any PRC, ITU-T G.811 & G.812 external clock source device (GPS clock precision, Rubidium, crystal etc.).
5.4.4 SDH / PDH clock.
   5.4.4.1 Internal (local source 10E-10).
   5.4.4.2 External clock source for the system synchronization. Available in any interface e.g. through G.703, STM frame - FO board etc.

5.5   Non-Blocking

Non-blocking cross connect for a high volume of DS0 channels (64Kbps) & voice channels.

5.6   Delays – Latencies

5.6.1   SCADA < 1sec latency.
5.6.2   Teleprotection <10ms symmetrical delay.

5.7   Teleprotection

5.7.1   Built-in board/module for distance Teleprotection for power utility applications fully compliant with IEC 60834-1.
5.7.2   Four (4) x command inputs for trip signals per board (Optoisolated with operation voltage 24, 48, 110, 220 VDC).
5.7.3   Four (4) x outputs for solid state trip signals (MERCURY-WETTED reed contacts (NO) with surge protection 250 VDC 0,5A or solid state relay).
5.7.4   Trip duration adjustable to 200 ms.
5.7.5   At least two (2) programmable auxiliary relays for alarm outputs.
5.7.6   Must support optical connection and hard terminal block for direct wiring.
5.7.7   Must support 1+1 path protection with less than 5 ms switchover time.
5.7.8   All inputs and outputs must be galvanically isolated.
5.7.9   Event recorder and trip counters.

5.7.10   In the case of Packet/Fiber Optical interconnection must support SFP cages:
   5.7.10.1   Multi-mode FO 850nm at LC or SC interface.
   5.7.10.2   Single-mode FO 1310nm at LC or SC interface.

5.8   Alarms

Each equipment/module/board/card will be equipped with alarm and status LED indicators.
Each multi-service MUX must provide at least 4 input / output alarm ports.

5.9   Power Supply

Power supply: -36 to -56 VDC.
Hot swappable Duplicated Power Supply.

5.10   Mechanics-Dimensions-Housing capabilities

Standard 19" design ETSI.

5.11   EMC conditions

EN 55022 : 2010 class A.
Safety : IEC60950-1, EN60950-1.
EN 61000-6-3, EN 61000-6-2.
Electromagnetic disturbance characteristics:

The equipment must comply for industrial environment and especially for High Voltage Substations sites.

5.12   Environmental conditions

- Temperature: from -5º C to + 45º C
- Humidity from: 5% to 95%.

6. Interfaces

The following interfaces should be supported:

6.1   Optical Fiber Interface:

Fiber Type:
  6.1.1   Single Mode Optical Fiber as per ITU-T G.652/G.655
  6.1.2   Optical port for dual uni-directional fiber
  6.1.3   Wavelength : 1310 ±50 nm, 1550 ±40 nm
  6.1.4   Attenuation at 1310 nm : ≤ 0,35 dB/km
  6.1.5   Attenuation at 1550 nm: ≤ 0,28 dB/km
  6.1.6   Connector Type : SC or LC optical connector
  6.1.7   Maximum optical length : 150 km

6.2   E1 2Mbps interfaces (ports):

  6.2.1   Line Rate : 2.048Mbps±50ppm
  6.2.2   Line Code : HDB3 or AMI
  6.2.3   Input/Output Signal : ITU-T G.703
  6.2.4   Framing : ITU-T G.704
  6.2.5   Clock supply :   internal , external G.703 , recovered
  6.2.6   Line Impendence 120Ω twisted pair, 75 Ω coaxial
  6.2.7   Connector : RJ48C or BNC
  6.2.8   Synchronization : CRC4 G.706
  6.2.9   Jitter /wander : ITU-T G.823

6.3   Analogue telephone subscriber 2w/4w with E&M:

  6.3.1   A-law (ITU G.711)
  6.3.2   Line port 4 wire balanced
  6.3.3   Connector: RJ45
  6.3.4   Support signaling types I to V
  6.3.5   Impedance (input/output): 600 Ohm
  6.3.6   Frequency range: from 300 Hz to 3400 Hz
  6.3.7   Operating relative levels adjustable:
          input: -17 dBr to +6 dBr
          output: +6 dBr to –17 dBr
  6.3.8   Signaling characteristics:
      6.3.8.1 Line impedance of signal lines connected: 0 to 200 Ohm
      6.3.8.2 Load circuit switching voltage : -60 V

6.4   Serial interface V.24 / V.28, V.35:

6.4.1 Number of channels per 64 Kbit/s: 8 min 4 (MUX mode of Time Slot)
6.4.2 Connector : DB25S or DB9 or RJ45
6.4.3 Maximum signal distortion: ≤ 25%
6.4.4 Data bit rate : 100bit/s to 38,4Kbit/s transparent (Asynchronous)
6.4.5 Data bit rate : up to 64 Kbit/s transparent (Synchronous)

6.5   Ethernet interface (MEF CE2.0 or MPLS-TP)

6.5.1 GbE interfaces, 1GbE and 10GbE.
6.5.2 IEEE 1613 compliant option (class 2 for EMI stress).
6.5.3 Carrier   Ethernet/MPLS-TP   capabilities: traffic   management, Operation & Maintenance (OAM) and Performance Monitoring (PM).
6.5.4 G.8032 Ethernet Ring Protection Switching or equivalent standard of ring protection.
6.5.5 GbE ports SFP/XFP interface.
6.5.6 PTP IEEE 1588-2008 sync / Sync-E clock capabilities.
6.5.7 QoS Per port traffic classification, Policing per port.
6.5.8 E-Line, E-LAN, E-Tree CE2.0 configuration support or equivalent for MPLS-TP.

6.6   Ethernet / Router interfaces

6.6.1 L1/L2 Ethernet switch
    6.6.1.1   10/100 Base T RJ45 connector
    6.6.1.2   SFP-cages for 100 Base-FX or 1000 Base-SX/LX
6.6.2 L2 Ethernet with optional PoE (IEEE 802.3af, IEEE 802.3at)
    6.6.2.1   L2 switching According to IEEE 802.1D and 802.1Q
    6.6.2.2   Traffic prioritization according to IEEE 802.1p
    6.6.2.3   Traffic protection STP, RSTP (IEEE 802.1w)
6.6.3 L3 Ethernet
    6.6.3.1   L3-routing features:
    6.6.3.2   OSPF v2 acc. RFC 2328, RIP v2 acc. RFC 2453 Static routing, VRRP, Inter-VLAN routing.
    6.6.3.3   Traffic protection:
    6.6.3.4   MLPPP, STP, RSTP (IEEE 802.1w), VRRP, OSPF v2, RIP v1, v2.

6.7 System Configuration

Each offered equipment must include the following hardware configuration:

Multi-Service Switch Configuration per site				
Quantity	Description	Interface	Comments	Comments of Bidder
SDH/PDH Section				
1	Equipment Chassis		Expansion capability >=50% of the below hardware configuration	
2	Power Supply 48V-DC units		Duplicated Power Supply Unit	
2	Control Units / CPU boards		Duplicated Control Unit (Main/Backup)	
2	STM-1/STM-4 Boards of 2 ports each	FO SC/LC	Optical port for dual uni-directional fiber for SM fiber (G.652 & G655)	
4	E1 ports	G.703	Unframed / CAS w/wo CRC	
1	Teleprotection card - of 4 commands	Analog		
8	E&M ports	2w/4w		
16	RS-232 ports	ITU-T V.24, V.28	MUX mode on 64Kbps channel / No MUX mode on single 64Kbps channel	
8	Ethernet ports with L2/L3 capabilities		LAN/WAN (routing capabilities)	
Carrier Ethernet (CE) or MPLS-TP Section				
2	GbE interfaces, 1GbE and 10GbE	Ethernet	802.3 (1985-2012) - IEEE Standard for Ethernet	
1	Set of HW and/or SW licenses for (CE) or MPLS-TP OAM & PM, PTP-IEEE1588, G8032 Ring protection, QoS		HW and/or SW licenses, misc. etc.	

The equipment must be cooled by free air convection (fanless).
The offered equipment must be able to expand its capacity (boards, services, licenses) for at least 50%.

6.8   Spare parts

For every type of module of the system e.g.:
   - chassis
   - power supply module,
   - control boards (CPU),
   - STM-1/STM-4 boards,
   - 2Mbps (E1) interface module,
   - teleprotection module,
   - E&M interface module,
   - RS232 interface module,
   - Ethernet interface module,
   - Carrier Ethernet/MPLS-TP interface module etc,
two (2) spare modules/boards must be offered.

The final amount of the spare modules/boards that will be purchased will be defined by the IPTO.

Moreover the contractor must guarantee the availability of spare parts for at least ten (10) years.

6.9   Management interfaces

The multi-service switch should be able to be managed remotely and locally via Ethernet (SSH, Telnet, SNMP, etc.), or through serial ports (e.g. RS232, V.24/V.28) and via modem through the offered Management System Software by the supplier.

7. Network Management System NMS- Operation and Maintenance O&M

All the required Hardware and Software for the connection and the operation of the Network Management System must be counted as part of the offered equipment.

The Network Management System must include the following functions:

7.1   Operations

7.1.1   Administration
   - To ensure effective implementation and control of operation activities.
   - Initial setup and modification of configuration data.

7.1.2   Conduct of Operations
   - To ensure efficient, safe, and reliable process operations.

7.1.3 <u>Equipment Status Control:</u>
- Alarms, Monitoring, logging of the equipment status and history files.

7.1.4 <u>Operator Knowledge and Performance</u>
- To ensure that operator knowledge and performance will support safe and reliable plant operation.

7.1.5 <u>System & Configuration Backup and Migration.</u>
- Procedures of maintaining system & configuration backup/restore files.
- Procedures of maintaining external backup of configuration data & whole system.
- Procedures of uploading and downloading firmware to the system and/or the boards.

7.1.6 <u>NMS server</u>
- Graphical display/interface of the network and the elements such as equipment, boards etc.
- Standards IP, SNMP v1, v2, v3, MIB etc.

7.2 Maintenance

7.2.1 <u>Preventive Maintenance</u>
- To contribute to optimum performance and reliability of plant systems and equipment.

7.2.2 <u>Maintenance Procedures and Documentation</u>
- To provide directions, for the performance of work and to ensure that maintenance is performed safely and efficiently.

8. Eligibility Criteria

The bidder must possess the requisite experience, strength and capabilities in providing the services necessary to meet the requirements as described in this document. The bidder must also possess the technical know-how and the financial wherewithal that would be required for successful execution of the project and support services for the entire period of the contract.

The bids must be complete in all respect and should cover the entire scope of work as stipulated in the tender document.

The bidder must provide a customer list with brand names, address, fax, e-mail of utility companies that have installed and successfully operate similar equipment the last 3 years.

9. Technical Evaluation

For the purpose of evaluation the suppliers should arrange a presentation of the offered equipment in a predefined time and place.
A pair of the offered equipment must be available to technical evaluation committee during the technical evaluation period.

10. Warranty

The Supplier warrants that the Goods supplied under the Contract are new, unused, of the most recent models and incorporate all **recent improvements** in design and materials. This warranty shall remain valid for a period of two years after the successful completion of FAT.
The Purchaser shall promptly notify the supplier in writing of any claims arising under this warranty. Upon receipt of such notice, the Supplier shall, with all reasonable speed, replace the defective Goods or parts thereof, without cost to the Purchaser.
If the Supplier, having been notified, fails to remedy the defect(s) within a reasonable period, the Purchaser may proceed to take such remedial action as may be necessary, at the Supplier's risk and expense and without prejudice to any other rights which the Purchaser may have against the Supplier under the contract.

11. Provisional Acceptance Test (PAT) & Final Acceptance Test (FAT)

11.1 Parameters for the Multi-Service MUX testing beyond the supplier proposal, must include the following tests/parameters:

11.1.1   Power up / Shutdown process.
11.1.2   Power up and operation with full load under -36 to -56 VDC power unit operation.
11.1.3   Hot swap of the CPU. (2 x CPU controller)
11.1.4   Hot swap of the Power Unit.
11.1.5   Synchronization of the free run clock (internal crystal clock)
11.1.6   Synchronization on different inputs e.g. Telecom providers and recovery procedure.
11.1.7   Synchronization on holdover mode and recovery procedure.
11.1.8   Synchronization on different outputs path E1 or Gigabit Ethernet at PTP.
11.1.9   E1 boards 1:1 protection failover.
11.1.10   RS232 bit rate test from 100bps to 38,4Kbps asynchronous / 64Kbps synchronous.
11.1.11   SDH Ring Protection tests. (Alternative choices etc.)
11.1.12   Carrier Ethernet or MPLS-TP Protection Path tests. (Alternative choices etc.)

11.2 Provisional Acceptance Test (PAT) shall be conducted after ten (10) days of successful operation of the first pair of the tested equipment.

11.3 Final Acceptance Test (FAT) shall be conducted over one month after the PAT on the same pair of equipment as described at 11.2.

12.   Training

The objective of the training program shall be to enable the personnel to acquire the expertise concerning system installation, operation, maintenance, troubleshooting, repair and detailed concept of the offered equipment. The training program shall enable personnel to acquire:

A. Independence in maintenance of the system.
B. System installation capability that allows personnel to undertake future expansion of the network independently.
C. The training program shall adhere to the following instructions:

- Complete proposal of the training courses and their duration under manufacturer training program at IPTO premises covering Operation, Maintenance, Diagnosis, Testing, Measurements, Repairs and Management Information Reporting procedures shall be submitted.
- All the instructors shall possess high technical ability to impart training. They shall have a high command on Greek or English language.
- The efficiency of the training program conducted by the bidder will be under close scrutiny and it will have to be repeated by the bidder without extra cost to IPTO if the training given is found to be ineffective, deficient or un-satisfactory.

12.1 The bidder must add the training charges separately from the contract charges of the Multi-Service MUX Equipment.

12.2 At least five (5) days training shall be conducted to a group of 15 engineers at mutually decided times during the installation period.

13.   Technical offer format

Every offer must be accompanied by the following:

13.1 Complete set of Technical documentation.

13.2 Compliance list stating the compliance or no compliance with all the relative requirements of the specification.

13.3 Full break down list of all offered materials (Full list of materials-BoM).

13.4 The supplier must provide a customer list with brand names, address, fax, e-mail of utility companies where have installed and successfully operate similar equipment the last 3 years.