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GENERIC REQUIREMENTS FOR PRECISION TIME PROTOCOL (PTP) SLAVE CLOCK

GENERIC REQUIREMENTS
GR No. TEC/GR/TX/PTP-003/01/MAR-12

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History Sheet

Sl. No.	GR No.	Particulars	Remarks
1.	GR No. TEC/GR/TX/PTP-003/01/MAR-12	Generic Requirements for Precision Time Protocol (PTP) Slave Clock	New Release – A Stand alone sync. equipment, used as clock source in Packet Switched network

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List of Reference Documents

ITU-T Rec. G.8261	Timing and synchronization aspects in packet networks
ITU-T Rec.G.8265.1	Precision time protocol telecom profile for frequency synchronization
ITU-T Rec. G.812	Timing requirements of slave clocks suitable for use as node clocks in synchronization networks
IEEE-1588-2008	Time distribution via Precision Time Protocol – 2008.
CISPR 22 {2006}	Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment
IEC Publication 61000-4-2	Testing and measurement techniques of Electrostatic discharge immunity test
IEC Publication 61000-4-3	Radiated RF electromagnetic field immunity test
IEC Publication 61000-4-4	Testing and measurement techniques of electrical fast transients/burst immunity test
IEC Publication 61000-4-6	Immunity to conducted disturbances
IS 8437 {1993}	Guide on the effects of current passing through the human body
IS 13252 {1993}	Safety of information technology equipment including electrical business equipment
QM-118	Quality and Reliability in product design
QM-205	Guidelines for Standards of Workmanship for Printed Boards
QM-206	Guidelines for Standards of Workmanship for Printed Board Assemblies
QM-210	Guidelines for Standards of Workmanship for Surface Mounted Devices
QM-301	Transmission Equipment General Documentation}.
QM-333	Specification for environmental testing of electronic equipment for transmission and switching use
TEC/EMI/TEL-001/01/FEB-09	Electromagnetic Compatibility Standard for Telecommunication Equipment

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PART-I: TECHNICAL REQUIREMENTS

1.0 Introduction

This document gives the Generic Requirements for a Precision Time Protocol (PTP) Slave/Client Clock, a standalone synchronization equipment, used as clock source in Packet Switched network. In cases where network elements in a telecom network are not equipped with integrated PTP slave clock, a user would need to install a stand-alone PTP Slave Clock besides network element in order to supply highly stable Frequency and Phase synchronization signals. It covers typical application of synchronization of 2G, 3G, LTE, CDMA 2000, Wi-MAX base station, RNC or Node-B etc.

With the introduction of packet switched networks, new protocol based synchronization techniques were introduced essentially because of asynchronous nature of packet switching. The second version of the PTP standard, known as IEEE 1588-2008 provides the PTP profile for telecommunications use. The client shall support Telecom-2008 profile.

2.0 Functional Requirement

2.1 The PTP shall be deployed in cases where synchronous network elements (such as base stations and Nodes B) are connected to the rest of the network via a packet switched network. While traditional synchronization technologies distribute just a common frequency, PTP shall be capable of distributing common frequency as well as common phase-alignment. In a packet switched network environment, information is transferred in the form of packet or frames; each packet of a packet flow traverses the network independently of the other packets of that flow. In the case of synchronization transfer, the master clock and a slave clock shall exchange information in both directions.

2.2 The two end systems shall be PTP Grandmaster clock and PTP Slave clock in the basic architecture in Packet synchronization network. The protocol stacks are available inside the end systems and the network elements.

2.3 The IEEE 1588-2008 standard provides for flexible use of PTP in different applications. However, the slave clock shall support specific PTP Telecom profile (Telecom-2008 profile) 1.

2.4 The set of options, together with the ranges and default values of configurable attributes adopted for a specific application form what is called a 'PTP Profile'. The purpose of defining PTP Profiles is to assure interworking between clocks and required performance level for a specific application and a specific network context.

2.5 PTP master clocks and PTP slave clocks shall comply with PTP profile to achieve interoperability. This means that PTP master clocks compliant with the PTP profile (as per IEEE 1588-2008) shall have the ability to serve multiple PTP slave clocks from different vendors, and slaves require the ability to derive synchronization from one or more masters from different vendors.

2.6 In the field of telecommunications, PTP profiles are defined and published mainly by the ITU-T and the IETF. The first of a series of upcoming profiles is contained in ITU-T Recommendation G.8265.1: "Precision time protocol telecom profile for frequency synchronization". This profile is targeted towards frequency synchronization. This is required for operating GSM base stations, UMTS Node Bs, WiMax-FDD base stations, etc.

Note: PTP Profile for Phase Synchronization is not yet released by ITU-T. It shall be supported by the supplier as soon as ITU-T finalizes the standards**.**

2.7 The PTP Slave clock shall provide synchronization requirements in the form of frequency and phase. It is stipulated that the slave clock (stand alone) shall be interoperable with the Grand Master clock as long as the grand master clock is as per IEEE 1588-2008 and the relevant ITU-T PTP profile.

2.8 The equipment shall facilitate configuration and local maintenance through local as well as remote management.

2.9 The PTP Slave clock shall support a fully managed Synchronization architecture providing full FCAPS for all the levels of manageability viz. Configuration, Performance, Fault/Alarm and Security managements, through a centralized location.

2.10 The management of the PTP slave device shall be managed through SNMPv2c or HTTP or TL1 or CLI.

2.11 The EMS of the system shall reside in the work station/network server. Local & remote software download facility shall be provided in the equipment.

2.12 Master selection – The slave device shall provide for BMC (Best Master Selection) selection algorithm as per the relevant ITU-T PTP profile.

3.0 Architecture of PTP Slave Clock

A stand-alone PTP IEEE-1588 2008 Slave Clock shall supply highly stable Frequency and Phase synchronization signals to the network elements. The PTP slave clock shall consist of a PTP protocol engine which will connect to one or several distant PTP Grandmaster clocks over an IP or Ethernet network. Therefore, there shall not be any need of GNSS antenna installation along with PTP Slave clock.

It shall find its typical application of synchronization of 2G, 3G, LTE, CDMA 2000, Wi-MAX base station, RNC or Node-B etc.

4.0 PTP Slave Clock : Technical Requirements

4.1 The PTP slave shall receive the input clock information from PTP GM in the form of PTP packets. The information is then used to generate precise time, frequency and phase signals.

4.2 The equipment shall provide the following synchronization outputs for the system to be used as a local sync. references:

- **Frequency -**

- 1 x 2 MHz, G.703 - Connector: BNC 75 Ohms or 120 Ohms RJ48 ,
- 1 x E1, G.703 – Connector: BNC 75 Ohms or 120 Ohms RJ48.

- **Phase**

- 1 x 1PPS, 50 Ohms, BNC - amplitude – between 1.2 & 5.5 Vpp, rise/fall time – 10 ns, pulse width – between 100 ns & 500 ms.

4.3 The PTP slave clock shall provide highly stable internal oscillator to maintain accurate synchronization in holdover condition. Under the condition of failure of all references, the device shall go to hold over mode of operation. The frequency stability in holdover condition shall be as per the table below:

Clock hold-over stability	$\pm$ 1x10 $^{-10}$ /day or better
Output frequency accuracy	4.6 x 10^{-6} over the entire temperature range
Pull-in/Hold-in range	$\pm$ 4.6 x 10^{-6} or better
Warm-up time for internal oscillator	< or = 1 hour

4.4 PTP Messaging:

The PTP messaging shall be configurable from 16 – 64 messages/second.

- Sync messages : X sync messages per second,
- Announce messages : 1 announce messages per 2 seconds (or other user defined value),
- Delay Requests from slaves : X delay_request messages per second,
- Delay Response from master : X delay_delay_response messages per second.

❖ *X shall be the message rate selectable by the user up from 16 to 64 messages per second.*

Note Vendors may optionally provide message rate 8 and 128 messages/second as well.

4.5 The Slave clock shall work on dual feed DC power supply ranging from -40V to -60V DC.

4.6 A PTP slave shall be able to recover frequency to provide synchronous interfaces with +/- 15ppb accuracy or better under the test conditions specified by ITU-T G.8261, Appendix VI, test cases 12 to 17".

4.7 The time accuracy of PTP Slave clock shall be better than 1.5 micro second using Gigabit Switches.

4.8 The PTP profile shall be as per ITU-T Telecom-2008 profile and shall be user configurable.

4.9 **Packet Based Priority**

a. Ethernet

Ethernet : The PTP Slave Clock shall support CoS (Class of Service) as per IEEE 802.1p. The PTP Slave clock shall support VLAN as per IEEE 802.1q. It shall be possible to configure the PTP slave clock to use any one out of the 4094 allowed values of the VID (VLAN Identifier) field. It shall be possible to accept untagged or priority tagged frames".

b. IP

The PTP slave device shall be able to encapsulate PTP packets into IP datagram in order to allow PTP work over IP networks, even if the physical layer at the master and client is Ethernet. The priority, in such a case, shall be marked in DSCP (Diffserv).

5.0 Management System

An embedded management interface shall be provided for carrying out the Element Management functions of the PTP slave. It shall be managed locally and remotely through a separate management interface either a USB or an RJ-45 Ethernet port. It shall be possible to manage the slave independently using TL1 or SNMP or HTTP or CLI. The remote management functions (FCAPS) shall be provided through an Ethernet port running IP and connected to a data communication network. The EMS shall provide SNMPv2c (or later) northbound interfaces towards a higher-level management system.

5.1 Configuration Management

The following configurations shall be possible in the equipment:

- Switching to a selected master clock,
- Inhibit automatic reference switching,

It shall be possible to perform local as well as remote configuration of the equipment as mentioned above. To meet these requirements efficiently, proper port address, port status and destination tags etc. shall be provided.

5.2 Performance Management

It shall be possible to store all performance monitoring parameters in memory and detect threshold crossing, which can be set by the user. The equipment shall provide the following performance parameters:

- Display of current source on which equipment is working,
- Performance history of past 30 days stored in EMS,
- Display of working normal/redundant input port/output port.

5.3 Fault Management

The equipment shall have inherent self-diagnostic capability to store and evaluate system alarms. The equipment shall collect the performance data and shall generate the status and alarm indications. The diagnostic mechanism, of the system shall be capable of detecting the fault events, resulting in interruption or degradation of performance. Consequently, it will generate data indicating the position of faulty board in the system and activate the

protection actions. All the fault events reported by the system shall have a local clock time stamp.

5.4 **Security Management**

The management system shall provide adequate security to the data and for the access to the management system as per the following details:

1. The EMS shall have the capability of supporting the management of Network through local and remote Operators. The authorizations and the privileges of the operators (Remote and Local) shall depend upon the Login and Password.

a. Low level protection for read only access to faults and performance information.

b. Medium level protection for access to configuration status and features.

c. High level protection for control of access to change in the configuration and control parameters.

2. Network management security features shall include operator authentication, command, menu-restriction and operator privileges. No password without encryption shall be allowed. The EMS shall support multi-level passwords as below-

a. EMS shall allow the System Administrator to define the level of access to the network capabilities or feature for each assigned password. It shall be desirable that the EMS shall block the access to the operator in case of unauthorized commands being tried for five consecutive times. Also it is desirable that the EMS shall also not allow the entry into the EMS in case wrong password is provided more than five consecutive times during the login. Idle time out feature shall also be supported.

b. The system administrator shall be able to monitor and log all operator activities in the EMS and Local Craft Terminal.

c. The dynamic password facility shall be provided in which the operator may change his password at any time.

3. All log-in and log-out attempts shall be logged in the security log file of the EMS system.

4. The network and the management system shall be protected against intentional or accidental abuse, unauthorized access and loss of communication.

5. It should be mandatory for the system to have a record of all log-ins for a period of at least six months after which a back up should be possible under system administrator command.

5.5 **Network Management**

For a PTP Slave to select the most suitable source reference from a list of candidates, each slave requires knowledge of the synchronization quality level of each potential reference candidate or the Grand Master. The slave shall use the Announce messages to determine which one is the better Grand Master clock.

5.6 **Software download**

Facility to locally upgrade software shall be provided. During software upgrade, the performance of the equipment shall not be affected. It shall be desirable to provide facility to load the software remotely from the management system.

It is mandatory to download the software upgrades remotely.

6.0 Minimum Equipment for Type approval:

PTP Slave

PTP slave device cannot function in isolation – it shall require PTP GM for the exchange of the information. Therefore, the equipment required for type Approval are as follows:

a. PTP slave device : 1
b. PTP grandmaster : 2
c. EMS : 1 no.

7.0 Field trial

The equipment shall be subjected to field trial for a minimum period of 4 weeks with working traffic to assess the performance of the equipment in actual field conditions. Ensure to load the equipment with as much traffic as possible. During the field trial testing, it shall be ensured that the equipment meets the GR requirements. Also, obtain a certificate from the maintenance personnel about the satisfactory performance of the equipment.

PART II - GENERAL REQUIREMENTS

1.0 Reference Documents

1.1 Whatever that has not been specifically stated in this document, shall deem to be as per relevant latest ITU-T recommendations.

1.2 All references to TEC GRs imply for the latest issues.

2.0 Engineering requirements

2.1 The equipment shall be fully solid-state and shall adopt state-of-the-art technology.

2.2 The equipment shall be compact and composite in construction and light-weight. The manufacturers shall furnish the actual dimensions and weight of the equipment.

2.3 All connectors shall be reliable and of standard type to ensure failure-free operation over long periods and under specified environmental conditions.

2.4 All cables shall be of Gigabit Ethernet ready standards.

2.5 The mechanical design and construction of each card/unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport.

2.6 Each sub-assembly shall be clearly marked with schematic reference to show its function, so that it is identifiable from the layout diagram in the handbook.

2.7 All controls, switches, indicators etc., shall be clearly marked to show their circuit diagrams and functions.

3.0 Operational Requirements

3.1 The equipment shall be designed for continuous operation.

3.2 The equipment shall be able to perform satisfactorily without any degradation at an altitude upto 3000 meters above mean sea level.

3.3 Wherever the visual indications are provided, green colour for healthy and red colour unhealthy conditions shall be provided. Some other colour may be used for non-urgent

alarms.

3.4 If special tools required for wiring, it shall be provided along with the equipment

3.5 In the event of a bug found in the software, the manufacturer shall provide patches and firmware replacement if involved, free of cost. Compatibility of the existing hardware shall be maintained with future software/firmware.

3.6 In the event of a full system failure, a trace area shall be maintained in non-volatile memory for analysis and problem resolution.

3.7 Necessary alarms (indicators) for indication of faults at various levels of hardware shall be provided on the individual modules

3.8 The hardware and software components shall not pose any problems in the normal functioning and also wherever interfacing other network for voice, data and transmission systems.

3.9 Visual indication to show power ON/OFF status shall be provided.

4.0 Quality Requirements:

4.1 The manufacturer shall furnish the MTBF values. The calculations shall be based on the guidelines as contained either in the BSNL-QA document No.: QM-115 (January'1997) - "Reliability Methods and Predictions" or any other international standard.

4.2 a) The equipment shall be manufactured in accordance with international quality management system ISO-9001:2008 for which the manufacturer shall be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer, shall be required to be submitted.

b) The instrument shall be manufactured as per the latest BSNL QA Guidelines indicated in Quality Manuals QM-118 {Quality and Reliability in product design}, QM-205 {Guidelines for Standards of Workmanship for Printed Boards}, QM-206 {Guidelines for Standards of Workmanship for Printed Board Assemblies}, QM-210 {Guidelines for Standards of Workmanship for Surface Mounted Devices} and QM-301 {Transmission Equipment General Documentation}.

4.3 The instrument shall conform to the requirements for environment as specified in the DoT-QA document No.: QM-333 (Latest issue: March 2010) - "Specification for environmental testing of electronic equipment for transmission and switching use". The applicable tests shall be taken for environmental category B2 including vibration test.

5.0 Maintenance requirements:

5.1 Maintenance philosophy shall to replace faulty units/subsystems after quick on-line analysis through SW. The actual repair will be undertaken at centralized repair centers. The corrective measures at site shall involve replacement of faulty units/sub-systems.

5.2 The equipment shall have easy access for servicing and maintenance.

5.3 Suitable alarms shall be provided for identification of faults in the system and faulty units.

5.4 As and when bugs are found/determined in the software the manufacturer shall provide patches/firmware replacement, if involved, free of cost as per the tendering requirements. Modified documentation, wherever applicable, shall also be supplied free of cost.

5.5 Ratings and types of fuses used are to be indicated by the supplier wherever applicable.

5.6 The manufacturer/supplier shall furnish the list of recommended spares for three years maintenance.

5.7 Supplier should guarantee the spares so long as the equipment is in service, at least for 10 years from the date of supply. The purchaser would like to stock spares as and when the supplier decides to close down the production of the offered equipment. In such an event, supplier shall give one year's notice to the purchaser so as to stock the spares.

6.0 Power Supply:

The equipment shall be powered by the -48V DC power supply from the station power plant and shall meet the following requirements -

Nominal power supply is –48V DC with a variation over the range –40V to –60V. The equipment shall operate over this range without any degradation in performance.

The equipment shall be adequately protected in case of voltage variation beyond the range specified in sub clause (a) and also against reverse input polarity.

The power consumption should be minimal. The actual power consumption to be furnished by the manufacturer.

The derived DC voltages in the equipment shall have adequate protection against over-voltage, short-circuit and overload.

7.0 Accessories:

7.1 The supplier shall provide one complete set of:

All necessary interfaces, connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment wherever applicable. Types of connectors, adopters and the accessories shall be clearly indicated in the operating manuals whenever applicable as per the GR;

Software and the arrangement to load the software at site.

7.2 Special tools, extender boards, extender cables and accessories as essential for installation, operation, maintenance as well as for repair of the equipment shall be clearly indicated and supplied along with the equipment.

8.0 Documentation:

Technical literature in English language detailing installation, operation and maintenance of the equipment only shall be accepted.

Installation spares, Operation and Maintenance manual

It should cover the following:

a) Safety measures to be observed in handling the equipment;
b) Precautions for installation, operation and maintenance;
c) Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance and sub-assembly replacement.

9.0 Protection Requirements:

9.1 The equipment shall have a terminal for grounding the rack.

9.2 Protection against short circuit/ open circuit in the accessible points shall be provided.

9.3 All switches/controls on front panel shall have suitable safeguards against accidental operation.

9.4 The equipment shall be adequately covered to safe-guarded against entry of even dust, insects etc.

10.0 Safety Requirements:

10.1 The operating personnel should be protected against shock hazards as per IS 8437 {1993} "Guide on the effects of current passing through the human body" [equivalent to IEC publication 60950-1 2nd edition 2010].

10.2 The equipment shall follow proper construction practice to minimize unintended radiation due to leakage from any gap or monitoring points. All unused ports and monitoring points shall be terminated. The power flux density shall not exceed 1 mW/cm2 at a distance of 2.5 cms.

Note: A test certificate from independent and accredited laboratory shall be acceptable on this account.

11.0 General Electromagnetic Compatibility (EMC) Requirements:

The equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from an accredited test agency.

a) Conducted and radiated emission *(applicable to telecom equipment)*:

Name of EMC Standard: "CISPR 22 (2005) with amendment 1 (2005) & amendment 2 (2006) - Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment".

Limits:-

i) To comply with Class A of CISPR 22 (2005) with amendment 1 (2005) & amendment 2 (2006).

ii) The values of limits shall be as per TEC Standard No. TEC/EMI/TEL-001/01/FEB-09**.**

b) Immunity to Electrostatic discharge:

Name of EMC Standard: IEC 61000-4-2 {2001) "Testing and measurement techniques of Electrostatic discharge immunity test".

Limits: -

i) Contact discharge level 2 {± 4 kV} or higher voltage;

ii) Air discharge level 3 {± 8 kV} or higher voltage;

c) Immunity to radiated RF:

Name of EMC Standard: IEC 61000-4-3 (2006) "Testing and measurement techniques- Radiated RF Electromagnetic Field Immunity test"

Limits:-

For Telecom Equipment and Telecom Terminal Equipment with Voice interface (s)

i) Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and

ii) Under test level 3 (10 V/m) for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

For Telecom Terminal Equipment without Voice interface (s)

Under Test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

d) Immunity to fast transients (burst):

Name of EMC Standard: IEC 61000-4- 4 {2004) "Testing and measurement techniques of electrical fast transients/burst immunity test"

Limits:-

Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0. 5 kV for signal / control / data / telecom lines;

e) Immunity to surges:

Name of EMC Standard: IEC 61000-4-5 (2005) “Testing & Measurement techniques for Surge immunity test"

Limits:-

i) For mains power input ports : (a)1.0 kV peak open circuit voltage for line to ground coupling (b) 0.5 kV peak open circuit voltage for line to line coupling,
ii) For telecom ports : (a) 0.5 kV peak open circuit voltage for line to ground (b) 0.5 KV peak open circuit voltage for line to line coupling.

f) Immunity to conducted disturbance induced by Radio frequency fields:

Name of EMC Standard: IEC 61000-4-6 (2003) with amendment 1 (2004) & amd. 2 (2006) "Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields "

Limits:-

Under the test level 2 {3 V r.m.s.}in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.

Note-1 The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted.

Alternatively, EMC test report from a non-accredited test lab, which is audited by an accredited lab / accrediting authority for the availability of all the essential facilities (test equipment, test chamber, calibrations in order, test instructions, skilled personnel etc.), required for performing the tests according to the EMC test methods audited, may be acceptable.

However, such accredited lab / accrediting authority should take responsibility of the test results of the "non accredited lab" along with indication of period of such delegation and the submitted test report should be of such valid period of delegation. The audit report, mentioning above facts, should be provided along with EMC test report.

Note-2 For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/EMI/TEL-001/01/FEB-09 and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g) and TEC Standard No. TEC/EMI/TEL-001/01/FEB-09. The details of IEC/CISPR and their corresponding Euro Norms are as follows:

IEC/CISPR	**Euro Norm**
CISPR 11	EN 55011
CISPR 22	EN 55022
IEC 61000-4-2	EN 61000-4-2

IEC 61000-4-3	EN 61000-4-3
IEC 61000-4-4	EN 61000-4-4
IEC 61000-4-5	EN 61000-4-5
IEC 61000-4-6	EN 61000-4-6
IEC 61000-4-11	EN 61000-4-11

ABBREVIATIONS

BSNL	Bharat Sanchar Nigam Limited
BNC	Bayonet Neill–Concelman
CACT	Component Approval Centre for Telecommunications
CISPR	Special International Committee on Radio Interference
DC	Direct Current
DOT	Department of Telecommunications
EMC	Electro Magnetic Compatibility
EMS	Element Management System
ETSI	European Telecommunications Standards Institute
FCAPS	Fault, Configuration, Administration, Performance & Security Management
GLONASS	Global Navigation Satellite System
GM	Grand Master
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HTTP	Hypertext Transfer Protocol
IEC	International Electro-technical Commission
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
ISO	International Standard Organization
ITU	International Telecommunication Union
LCT	Local Craft Terminal
MPLS-TP	Multi-protocol Label Switching – Transport Profile
MTBF	Mean Time Before Failure
MTTR	Mean Time To Repair
NGN	Next Generation Network
PON	Passive Optical Network
PPS	Pulse per second
PTP	Precision Timing Protocol
QA	Quality Assurance
QM	Quality Manual
RF	Radio Frequency
SNMP	Small Network Management Protocol
SSM	Synchronization Status Message
STM	Synchronous Transport Module

SW	Soft Ware
TDM	Time Division Multiplexing
TEC	Telecommunication Engineering Centre
TL1	Transaction Language 1
UMTS	Universal Mobile Telecommunications System
WiMax-FDD	Worldwide Interoperability for Microwave Access -Frequency Division Duplex

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