Application Note

Mobile Backhaul Test

Synchronous Ethernet Evaluation

MT1000A Network Master Pro

MU100010A 10G Multirate Module

MT1100A Network Master Flex

MU110010A 10G Multirate Module

MU110011A 100G Multirate Module

The rapid spread of smartphones and many new Cloud services in the last decade has led to explosive growth in mobile data traffic. Simultaneously, the new LTE and LTE-Advanced mobile technologies with faster data throughput are driving dramatic increases in mobile data traffic as well, naturally creating an urgent need to expand mobile backhaul networks to provide sufficient capacity.

Introduction

The first mobile communications backhaul was based on TDM technology (SDH/SONET and PDH) but quickly migrated to Ethernet-based packet-switched networks due to simplicity and relatively low costs. However, the asynchronous nature of Ethernet is a challenge because mobile networks require frequency synchronization across the entire network. Although TDM technology has a built-in physical layer supporting frequency synchronization, Ethernet has replaced TDM in mobile backhaul by using Synchronous Ethernet technology, which applies synchronization to Ethernet-based networks.

There are two Synchronous Ethernet technologies:

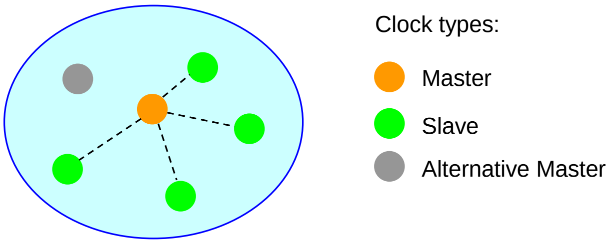
- Physical synchronization signal forwarding defined in ITU-T Rec. G.8261, G.8262 and G.8264 (now often called SyncE)
- Protocol based synchronization defined in IEEE1588 v2 Precision Time Protocol (PTP), detailed further in ITU-T G.8265.1 IEEE 1588 v2 Profile for Telecommunications

Applications

IEEE 1588 v2 Precision Time Protocol (PTP) and ITU-T G.8265.1

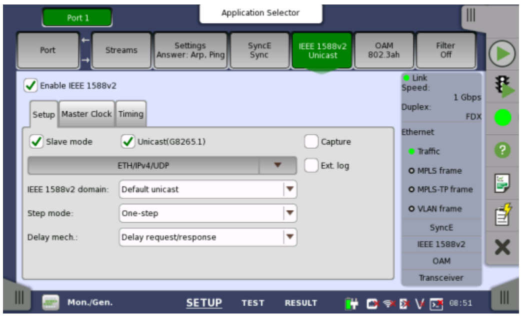
The IEEE 1588 v2 Precision Time Protocol (PTP) synchronizes clocks across a computer network by providing ToD (Time of Day), phase, and frequency synchronization. The frequency synchronization is sufficient for telecommunications and is detailed in ITU-T G.8265.1 IEEE 1588 v2 Profile for Telecommunications.

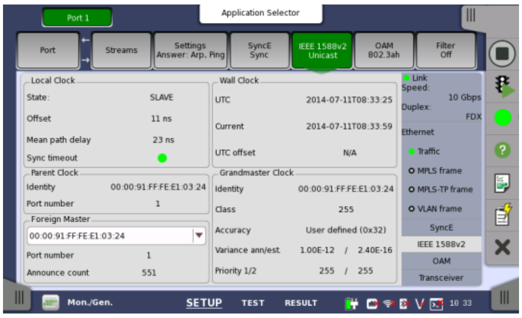
ITU-T G.8265.1 defines a domain as a logical grouping of clocks communicating with each other using the PTP protocol. There is only one, active PTP master clock per domain but alternative master clocks may be available.

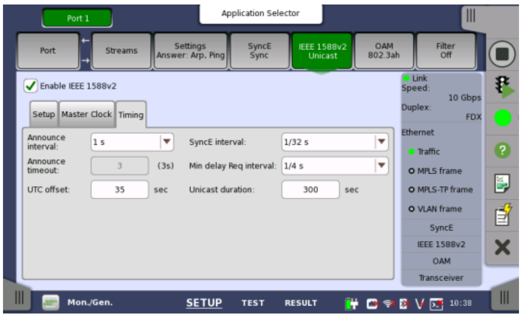


G.8265.1 Clock Domain Example

By connecting the MT1000A or MT1100A as a slave clock in a G.8265.1 clock domain, the user can verify the correct connection to the domain master clock. VLAN and MPLS settings can be configured if required together with IEEE 1588 v2 related parameters.



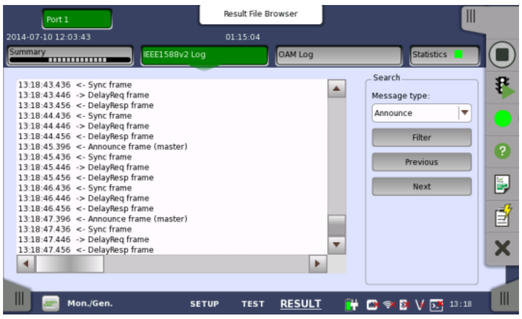




The above display shows the current values for the MT1000A or MT1100A acting as a PTP slave clock. Information announced by the master clock can be monitored and verified.

MT1000A or MT1100A setup as slave clock

If there are problems connecting to the network master clock, the transfer of PTP messages between the master and MT1000A or MT1100A (acting as slave clock) can be monitored from the IEEE 1588v2 instrument log giving a summary of the message exchanges. Messages can be logged for export to WireShark® for more detailed analysis.



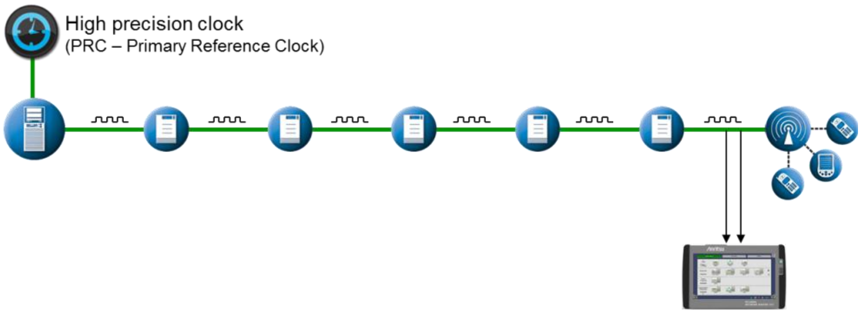
Since IEEE 1588 v2 is based on using packets sent on the Ethernet link for synchronization, it depends heavily on the Ethernet link stability, and disturbances such as PDV (Packet Delay Variation) affect the G.8265.1 frequency synchronization. PDV can be checked by connecting the MT1000A or MT1100A as a slave clock in the G.8265.1 clock domain.

The display opposite shows PDV measured by the MT1000A or MT1100A acting as a PTP slave clock. The Offset Variance parameter is defined in IEEE 1588 v2 section 7.6.3 as an estimate of the stability of the PTP slave clock; this parameter is also calculated by the MT1000A or MT1100A.

The Mean Path Delay for the line between the master clock and MT1000A or MT1100A (slave clock) can be monitored.

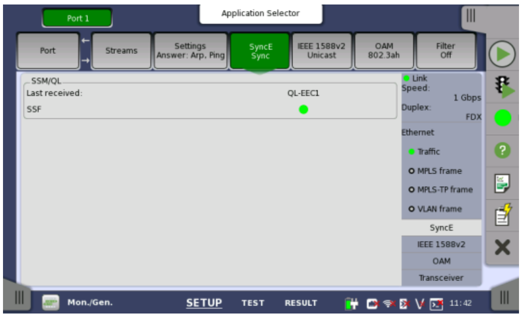
SyncE (G.826x) Ethernet Synchronization

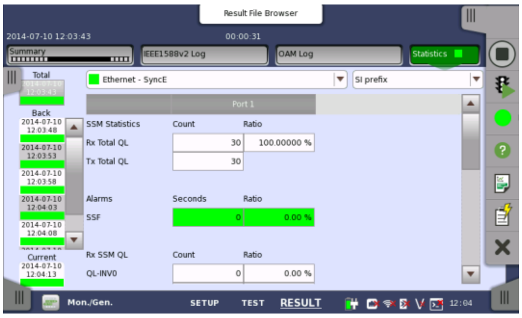
Physical synchronization signal forwarding defined in ITU-T Rec. G.8261, G.8262 and G.8264 (SyncE) is based on SDH/SONET/PDH synchronization systems. Timing information is sent over the physical line; the transmitted signals are synchronized directly or indirectly to a high-precision clock source in the network. SyncE requires support by all elements in the Synchronous Ethernet network.



SyncE Timing Distribution

Information on the clock source quality is carried in the transmitted signal as the SSM (Synchronization Status Message). The value of this signal can be verified by connecting the MT1000A or MT1100A in parallel with the Ethernet link carrying SyncE as shown in the diagram above.





Using the above display, the quality of the clock used for transmitting the signal received by the MT1000A or MT1100A – as reported by the transmitter – can be inspected to verify that the signal has the expected quality level.

During measurement, the user can monitor that SSM are sent constantly on the SyncE line. The MT1000A or MT1100A SSF alarm field displays when the SSM stream is disrupted. If disruption occurs, synchronization may be lost, causing problems on the mobile network. The user can also inspect how many SSM are received during measurement.

Product Features

- Synchronous Ethernet testing up to 10 Gbps
- IEEE 1588 v2 (PTP):
  - Functions as PTP master clock using internal instrument clock or GPS signal (when present) as clock source
  - Functions as PTP slave
  - Supports Multicast (native PTP) and Unicast (G.8265.1) modes
  - Supports PTP-UDP-IP and PTP-MAC encapsulations
  - Supports PTP message logging
- SyncE (ITU-T G.826x):
  - Detects and displays received SSM/QL information
  - Supports ESMC message logging
  - Generates alarm if SSM/QL not received for 5 s
  - Sends ESMC/SSM messages with user-defined QL
  - Supports SyncE Tx clock synchronization
- Normal Monitor/Generate Ethernet test functions available with SyncE functions

Summary

The MT1000A Network Master Pro and MT1100A Network Master Flex Synchronous Ethernet test functions support comprehensive testing and analysis of SyncE (ITU-T G.826x) and IEEE 1588 v2 (PTP) Synchronous Ethernet technologies. The MT1000A and MT1100A can identify problems at all Synchronous Ethernet levels quickly, solve issues quickly, reduce system downtime and customer churn, and cut operating costs for mobile operators.

Ordering Information MT1000A

Mainframe	
MT1000A	Network Master Pro
Test Module	
MU100010A	10G Multirate Module
Options	
MU100010A-001	Up to 2.7G Dual Channel
MU100010A-012	Ethernet 10G Dual Channel

Ordering Information MT1100A

Mainframe	
MT1100A	Network Master Flex
Test Modules	
MU110010A	10G Multirate Module
MU110011A	100G Multirate Module
Power Supply Module	
MU110001A	Power Supply Module AC/DC
MU110002A	High Power Supply Module AC
Options	
MU110010A-001	Up to 2.7G Dual Channel
MU110010A-012	Ethernet 10G Dual Channel
MU110011A-003	Up to 10G Dual Channel

Note: Screen shots in this application note are made using the MT1000A. You can make similar screen shots with the MT1100A

Note

Specifications are subject to change without notice.

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