IEEE-1588 and Synchronous Ethernet – the Whole is Greater Than Its Parts

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Introduction

- Delivery of Frequency via Synchronous Ethernet
- Methods for delivering phase
  - Phase over Unaware networks
  - Phase over Partially aware network
  - Phase over Aware networks
- Comparison of results using different methods
Use case – SyncE for frequency distribution

**Advantages**

- Synchronous Ethernet extends the SONET/SDH timing model to Ethernet
- Meets all existing frequency requirements via the bit rate of the Ethernet physical layer
  - Independent of packets and loading
- Need to upgrade equipment in the Ethernet packet chain to support SyncE
- Need unbroken chain of SyncE equipment from frequency source to end application
  - May use SONET or PDH to add timing to Ethernet at some intermediate point in the network (i.e. at egress from SONET over packet network to Ethernet network)

**Fully approved in ITU-T G.8262**
SyncE Syntonization
Transition from Frequency to Frequency and Phase
Terminology: Aware networks

- **Aware**
  - Addition of Boundary clock at each node in the network
    - According to ITU model current under study
  - Split up the network into smaller pieces
  - Needed for end-to-end time of day performance

From IEEE Std 1588-2008 page 32
Network Types

- **Unaware networks**
  - No processing of the PTP packets at intermediate nodes by Boundary Clocks

- **Partially Aware**
  - Some Boundary Clocks in the network but not at every node
  - May be needed for existing networks during transition
  - May allow phase transfer without upgrading all network elements in network

- **Aware Networks**
  - All nodes in the network have Boundary Clocks
Network Types

- Unaware
- Partially Aware
- Aware
Unaware No On-Path Support

IEEE1588 Server

IEEE1588 Telecom Slave

PRS/PRC

G.811 PRC
G.8272 PRTC
G.811 PTM
G.8263 Opt. 2
G.8273.2 BC
"G.8261" OC
End Application
ITU-T G.8265., Precision time protocol telecom profile for frequency synchronization

- Published in October 2010
- Includes the set of PTP options to allow frequency transport
  - Integrate with the existing G.781 selection mechanism using SSM and existing frequency sources
Use case
Phase over Partially aware networks

- Not currently under study in standards
- Too many network types and configurations
- Unaware phase profile
- Unaddressed in standards
- Challenges
- May be possible in a managed network
  - Single carrier with careful engineering of link utilization and routing
Aware Network
Partial On-Path Support without SyncE Syntonization

PRS/PRC

PRTC

IEEE1588 Server

IEEE1588 Client and SyncE EEC

G.811 PRC
G.8272 PRTC
G.811 PTM
G.8263 Opt. 2
G.8273.2 BC
“G.8261” OC
End Application
Results pending
Aware Network
Partial On-Path Support with SyncE Syntonization

PRS/PRC
SONET/SyncE Distribution
PRTC
IEEE1588 Server
IEEE1588 Client and SyncE EEC

G.811 PRC
G.8272 PRTC
G.811 PTM
G.8263 Opt. 2
G.8273.2 BC
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End Application

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Power Matters.
Results pending
Network Types

- Unaware
- Partially Aware
- Aware
Aware Network
Full On-Path Support without SyncE Syntonization

PRTC
IEEE1588
Server
PRS/PRC
SONET/SyncE
Distribution
IEEE1588
Client
and SyncE EEC

G.811 PRC
G.8272 PRTC
G.811 PTM
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End
Application

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Results pending
Aware Network
Full On-Path Support with SyncE Syntonization

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Results pending
Summary

- Phase transfer results for various networks as shown in this presentation
- The use of aware network with SyncE support give the best performance
- The use of SyncE provides improvement in the partially aware case
- SyncE and IEEE-1588 together gives the best performance

<table>
<thead>
<tr>
<th>Phase transfer (ns)</th>
<th>Partially Aware</th>
<th>Aware</th>
</tr>
</thead>
<tbody>
<tr>
<td>No SyncE support</td>
<td>-</td>
<td>Better</td>
</tr>
<tr>
<td>With SyncE support</td>
<td>Good</td>
<td>Best</td>
</tr>
</tbody>
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