Telecoms
Specifically Mobile Backhaul
G.8265.1 - 1588v2 for Frequency

CORE
- PRTC
- 1588v2 GM
- P-OTN or MPLS or EoS

EDGE
- P-OTN or MPLS or EoS or Carrier Ethernet

AGGREGATION
- MPLS
- Carrier Ethernet
- GPON
- xDSL, etc.

ACCESS
- Slave

G.984.2
G.8275.1 - 1588v2 for Phase/Time

**CORE**
- P-OTN or MPLS or EoS
- PRTC 1588v2 GM

**EDGE**
- PTP
- BC/TC

**AGGREGATION**
- P-OTN or MPLS or EoS or Carrier Ethernet
- BC/TC
- Cell Site Routers
- Carrier Ethernet
- MPLS
- xDSL, etc.
- μWave

**ACCESS**
- Slave
- Slave
- Slave
G.8275.2 - 1588v2 for Phase/Time

CORE

- PRTC 1588v2 GM
- P-OTN or MPLS or EoS
- PTP

EDGE

AGGREGATION

- BC/TC
- P-OTN or MPLS or EoS or Carrier Ethernet
- PRTC
- 1588v2 GM
- PTP

ACCESS

- Cell Site Routers
- Carrier Ethernet
- GPON
- xDSL, etc.

Note: This is just a sample representation of Partial On-Path Support

Carrier Ethernet

ONU

OLT

μWave

Note: This is just a sample representation of Partial On-Path Support

Slave

Slave

Slave

Slave
Power
Consumer Requirements for Electrical Power are changing:

• Often drawn from decentralised locations.
• Must be responsive to real-time need.
• High demand for low cost, extremely reliable power.

To provide responsive, reliable, low-cost power, existing power grids must evolve.

In general, ‘Smart Grid’ refers to any improvement/change in Technology, Distribution or Transmission for Power.
Synchrophasors need 1µs accuracy

- Phasor Measurement Units (PMUs) need to provide Phasor information with total vector accuracy up to 1 degree at 60Hz = 47µs (IEEE C 37.118.1)
- Time accuracy is a factor for these measurements.
- Meeting vector accuracy needs PMU synchronisation up to 1µs.
- This must be to absolute time.
  - The aim is to have accurately timestamped information at each site – This is then collated e.g. regionally
  - Ultimately, Synchrophasors are intended to be the information providers for system control.
Substation Communications

- Timing must also be distributed accurately within substations:
  - Sequence of Event Timing, Process Bus (IEC 61850)

- IEDs, e.g. Instrument Transformers can require up to 1µs accuracy

- Synchronisation can be delivered to devices by dedicated lines (IRIG-B, 1pps, Serial)

This incurs cost for both cabling and equipment
1588v2 for Substation Communications

- Synchronisation requirements can be met with 1588v2
- No need for dedicated lines (IRIG-B, 1pps, Serial)
- Scales well
- Expected to be included in future editions of the IEC 61850 standard
Finance
The need for Sync in Financial Networks

- High-Frequency Trading (HFT) requires accurate timestamping of trades for:
  - Accurate records of transactions during playback regression to improve trading algorithms
  - Reporting and regulatory purposes, disputes, etc.
- GPS has primarily been used for this but faces issues:
  - Coverage and signal loss is a significant and expensive issue
  - Security - a US$20 device can jam GPS signals
- 1588v2 PTP is getting a lot of interest
  - Time can be delivered via the Ethernet network
  - However accuracy needs to be verified during trials and monitored in-service
Sync in the trading floor

Scenario 1 – all servers co-located in the Trading Exchange or Data Warehouse
GPS-locked Time-master, feed to servers via IRIG-B, NTP or 1588v2 PTP
Servers or switches have IRIG-B, NTP or PTP Clients (Slaves)

- GPS
- NTP/PTP sent via network
- IRIG-B sent via dedicated lines
- NTP/PTP sent via network
Sync in the trading floor

Scenario 2 – all servers co-located in the Trading Exchange or Data Warehouse
GPS-locked Router is 1588v2 PTP Master
Switches are NTP/PTP Clients (Slaves)
Sync in the trading floor

Scenario 3 – servers located in multiple locations
GPS at every location, either Scenario 1 or Scenario 2 at each location
Switches are NTP/PTP Clients (Slaves)
Sync in the trading floor

Scenario 4 – servers located in multiple locations
1588v2 PTP (Timing Service) from Telco Carrier
The Requirement and The Options

Requirement

• Conventional wisdom is:
  • The applications need 1ms, so the hardware needs 1μs

Options

• GPS and IRIG-B
  • IRIG-B is old technology (limited support) and needs a costly dedicated link
  • Used in older installs
• GPS and NTP
  • Not accurate enough - deliver 1ms rather than 1μs
  • Used when 1ms is sufficient
• GPS and 1588v2 PTP (or PTP-only)
  • Loading changes cause PDV and Asymmetry, which cause inaccuracy
  • Ongoing trials and investigations
IEEE 802.1AS, Broadcast, etc.
IEEE 802.1AS

• The standard for transport of precise timing and sync in Bridged LANs, e.g. Audio/Video Bridging (AVB) networks
• Seeing adoption in other areas – for example Data Center Bridging
• Other Audio/Video apps that need sync...next slide
• CAN, LIN, MOST, FlexRay are bus technologies for In-Car comms
• See www.autosar.org/ - AUTomotive Open System Architecture
• Intend to use Ethernet and 802.1AS, for 802.1AS probably a subset as only 1 Master (BMCA not needed), static networks, etc.
• Applications include Brake by Wire, Camera Drive Assistance, etc.
• In the future – Car2x – Vehicle-Infrastructure comms – could get exciting!
Broadcast Sync

• Between broadcast stations:
  • E.g. – 7am feed from Tokyo, 8am feed from Osaka

• Within broadcast centres or OB vans
  • See next presentation from Cisco!
THANK YOU

See you at dinner tomorrow!