ETHERNET TIME & SYNC

In Telecoms, Power, Broadcast, Finance, ...

ITSF, Lisbon, November 2013

PTP Profiles

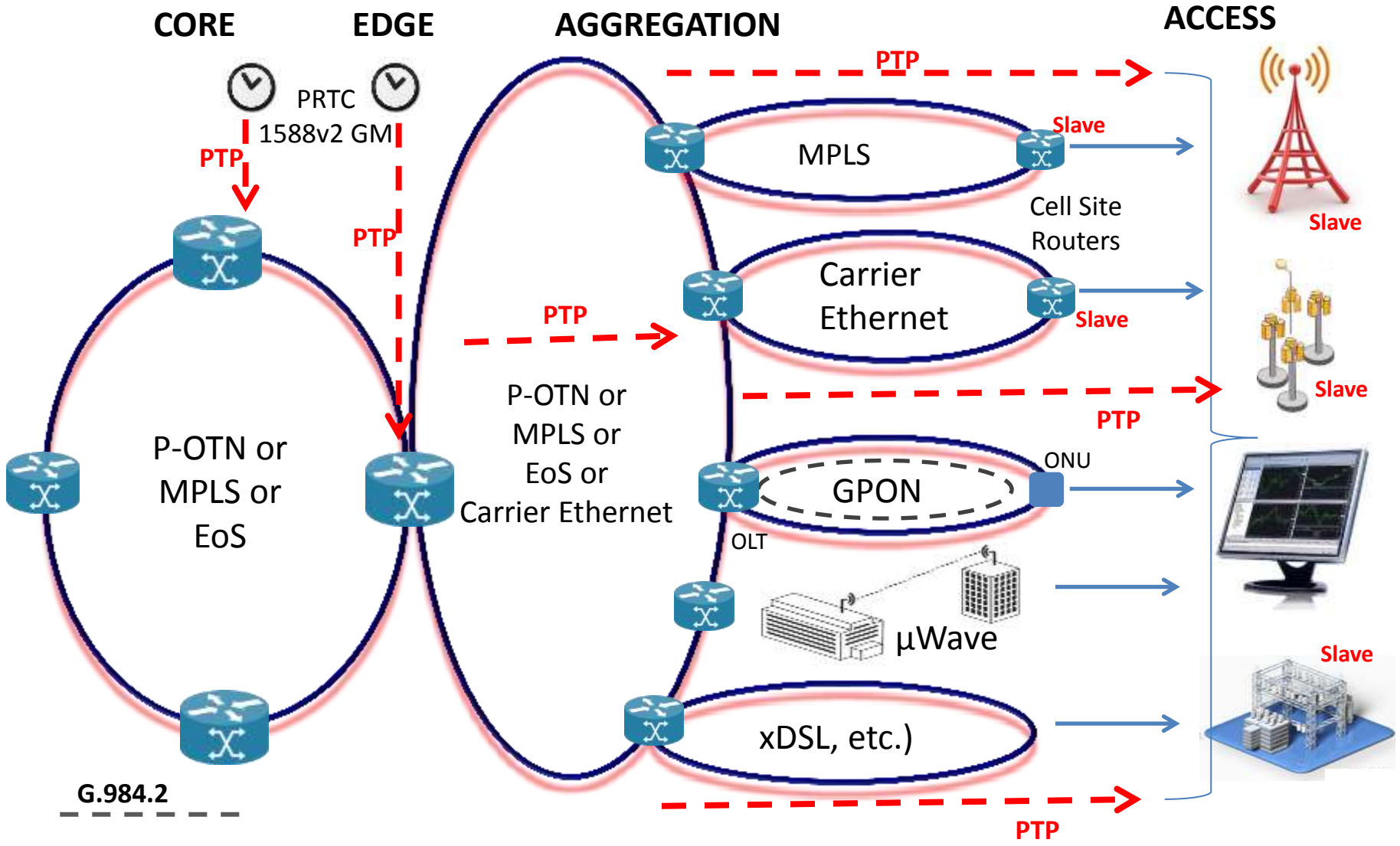
IEEE 1588 states in clause 19.3.1.1:

> *"The purpose of a PTP profile is to allow organizations to specify specific selections of attribute values and optional features of PTP that, when using the same transport protocol, inter-work and achieve a performance that meets the requirements of a particular application."*.

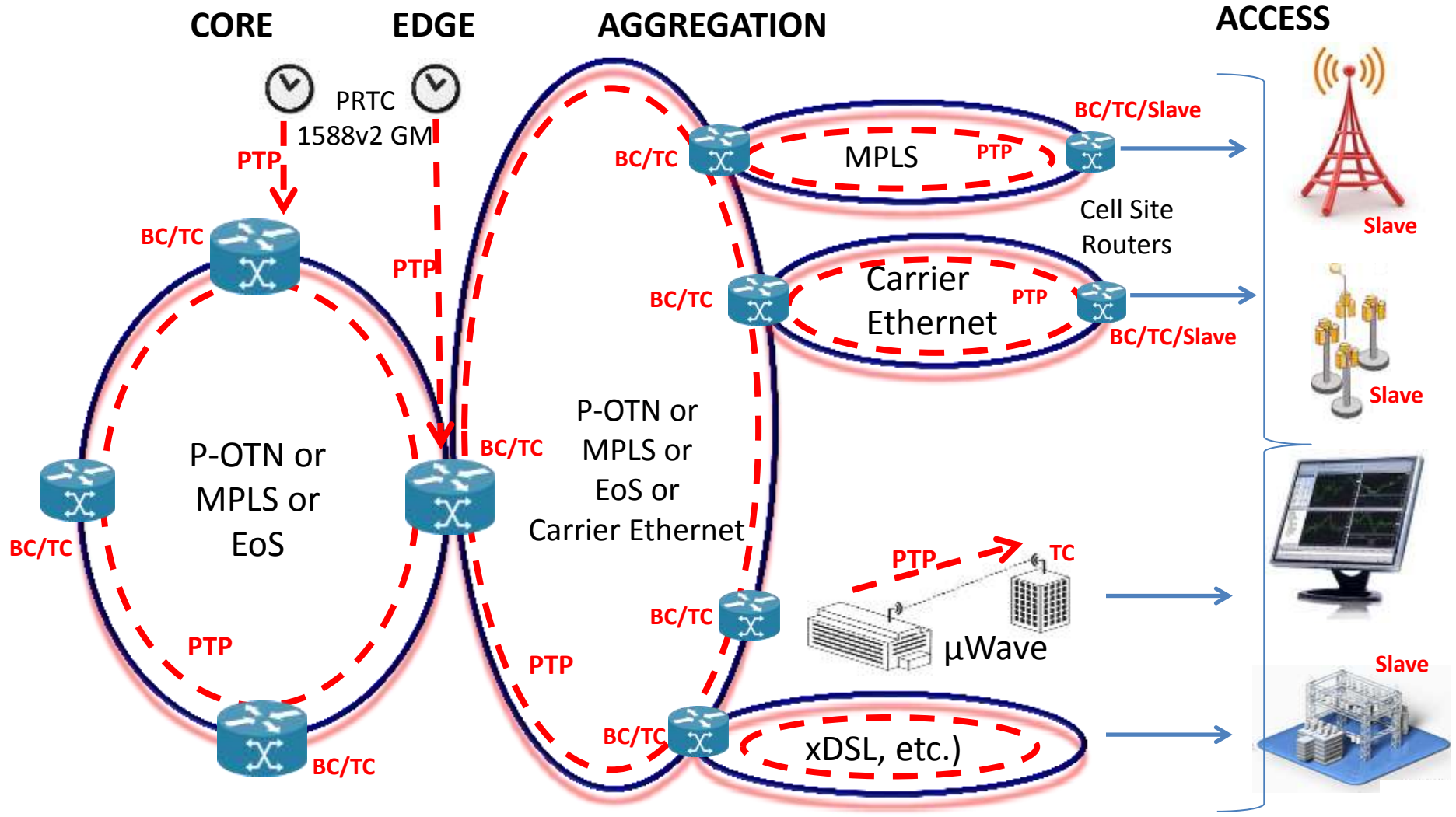
Telecoms

Specifically Mobile Backhaul

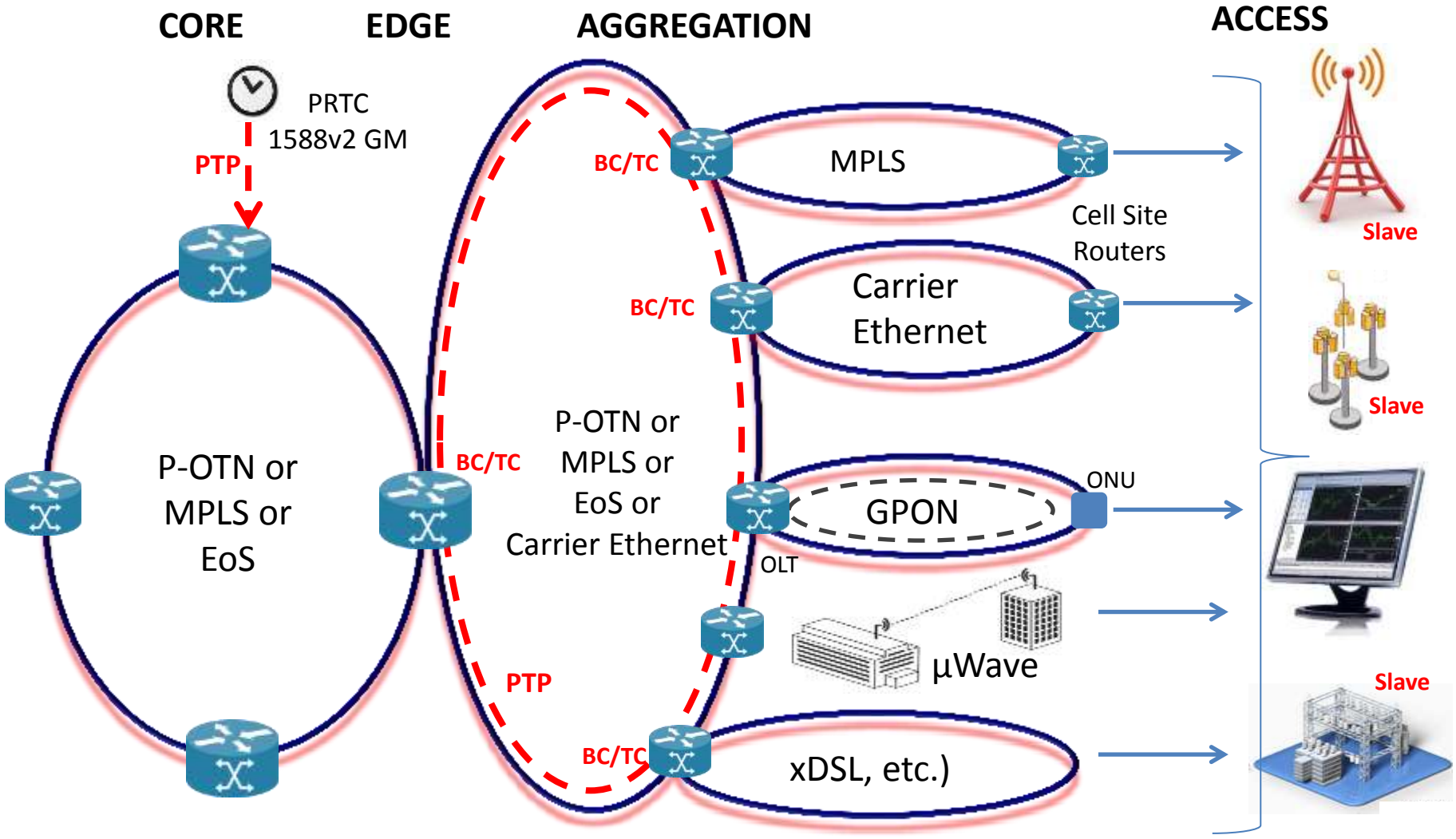
G.8265.1 - 1588v2 for Frequency



G.8275.1 - 1588v2 for Phase/Time



G.8275.2 - 1588v2 for Phase/Time



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

Power

Smart Grid – One term, many meanings

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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.

Synchrophasor/Phasor Measurement Unit (PMU)

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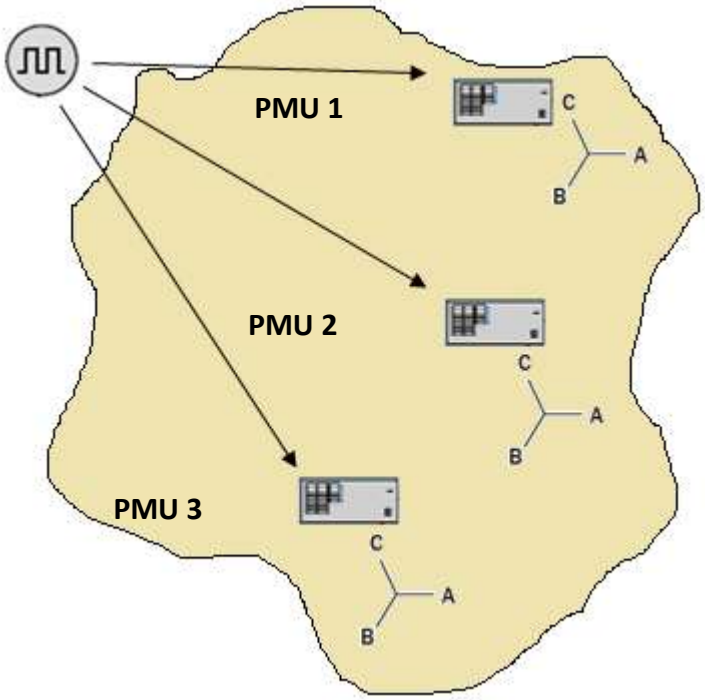
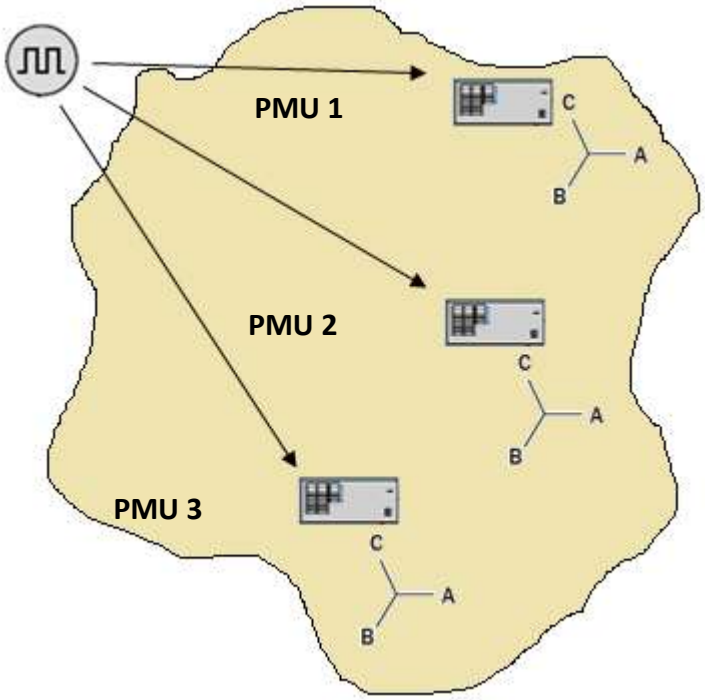
- Provides power system monitoring, protection, operation, and control
- Time synchronisation allows synchronized real-time measurements of multiple remote measurement points on the grid
- Extracts parameters 1000's times/second from its input
  - Magnitude
  - Phase angle
  - Frequency
  - Rate of change of frequency (ROCOF)



*** IEEE C37.118. 1-2011: IEEE Standard for Synchrophasor Measurements for Power Systems**

Synchrophasors need 1µs accuracy

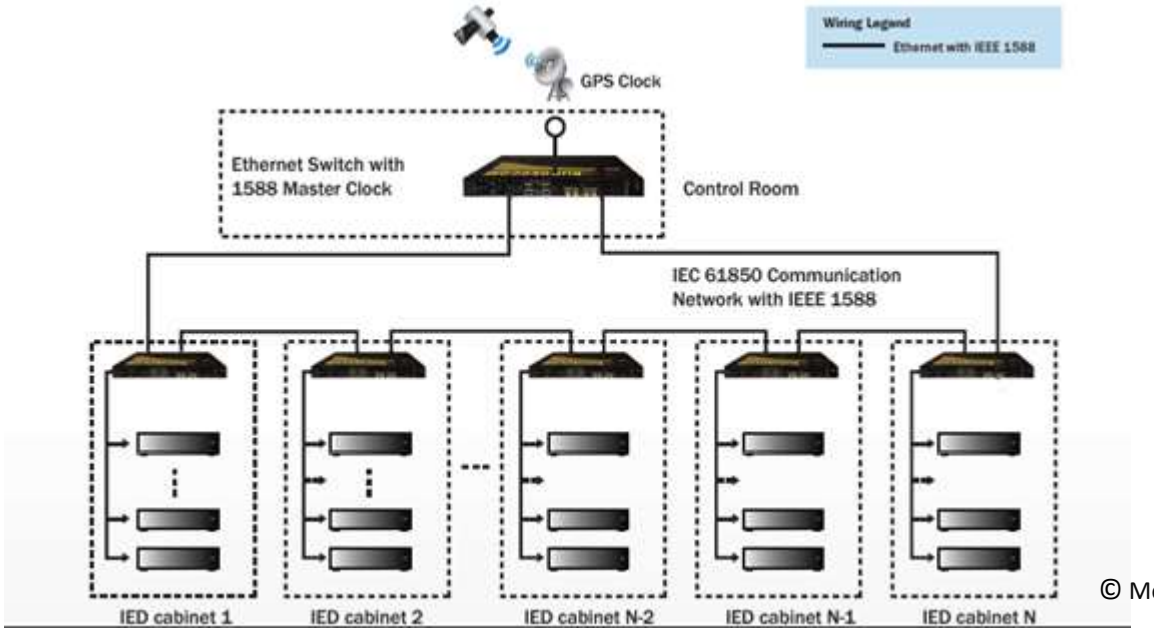
- Time error of 1 µs corresponds to a synchrophasor phase error of 0.022 degrees for a 60 Hz system and 0.018 degrees for a 50 Hz system.
- A phase error of 0.57 degrees (0.01 radian) will cause 1% TVE. This corresponds to a time error of **±26 µs for a 60 Hz** system and **±31 µs for a 50 Hz** system.
- A time source that reliably provides time, frequency, and frequency stability at least **10 times better** than these values corresponding to 1% TVE is highly recommended.



*** IEEE C37.118. 1-2011: IEEE Standard for Synchrophasor Measurements for Power Systems**

1588v2 for Substation Communications

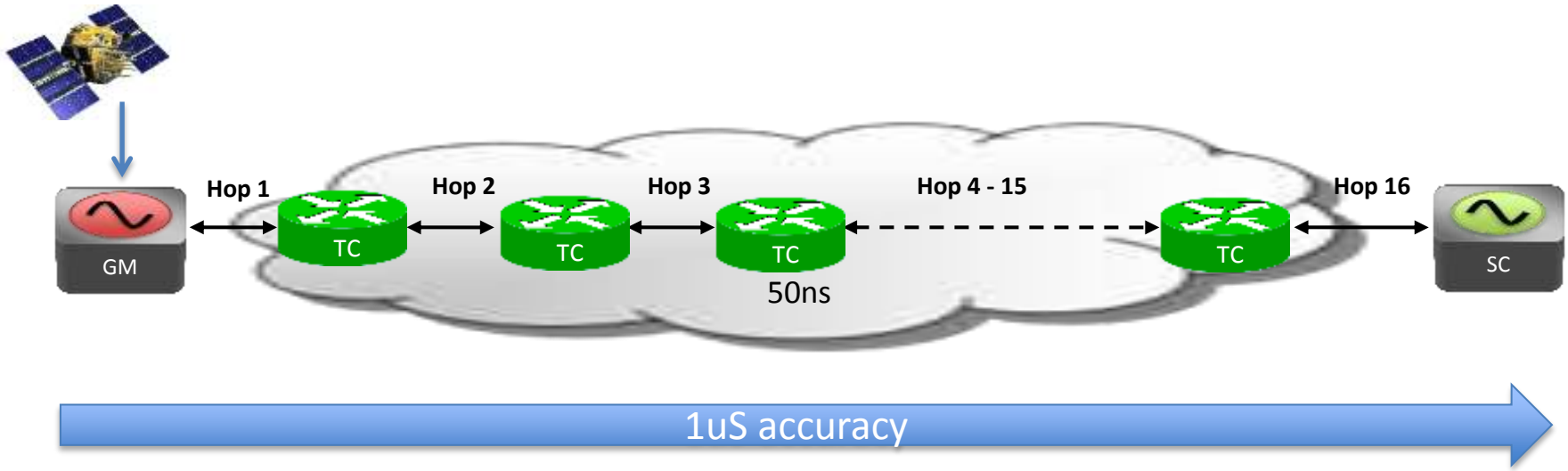
- Synchronisation requirements can be met with 1588v2
- No need for dedicated lines (IRIG-B, 1pps, Serial)
- Scales well
- Expected to be included in future editions of the IEC 61850 standard



Power Profile – IEEE C37.238-2011

- LAN (Layer 2 Ethernet Mapping)
- IEEE 802.1Q VLAN tags
- Multicast addressing
- Switches are Transparent Clocks
- Peer-to-peer delay measurement
- Time transfer accuracy and holdover time defined
- Message Rates
  - Sync (& optional Follow_up) - 1 per second
  - Announce – 1 per second
  - Peer Del_Req, Peer Del_Resp, - 1 per second

PTP Power Profiles – IEEE C37.238-2011



- Maximum 16 hops
- Network loads up to 80% wire-speed (line rate) on each link.
  - Random-length Ethernet frames shall be used: 80% with priority 4 and 20% with lower priority

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IEEE 802.1AS,.

IEEE 802.1AS

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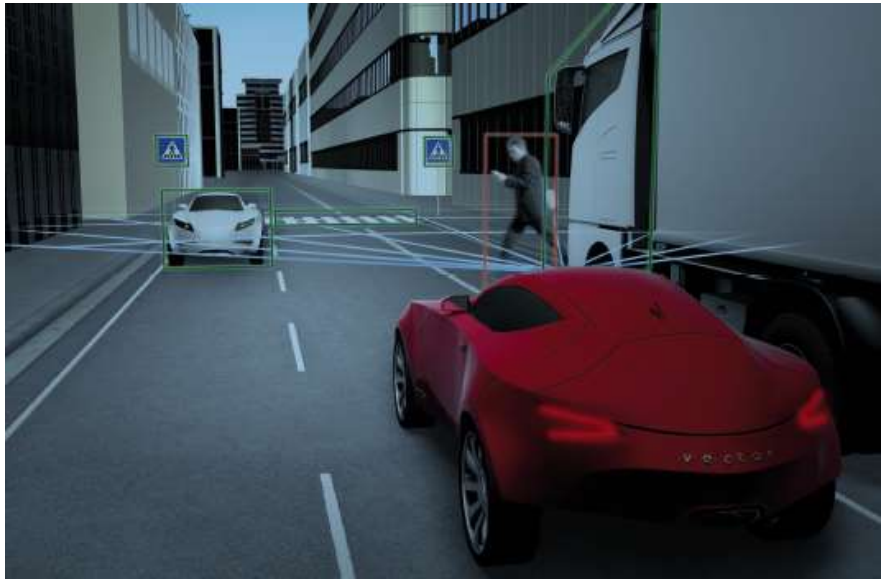
- The standard for transport of precise timing and sync in Bridged LANs, e.g. Audio/Video Bridging (AVB) networks
- Includes a PTP profile
- Seeing adoption in other areas – for example Data Center Bridging
- Other Audio/Video apps that need sync...*next slide*

In-Car 1588v2



© Vector

- 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!

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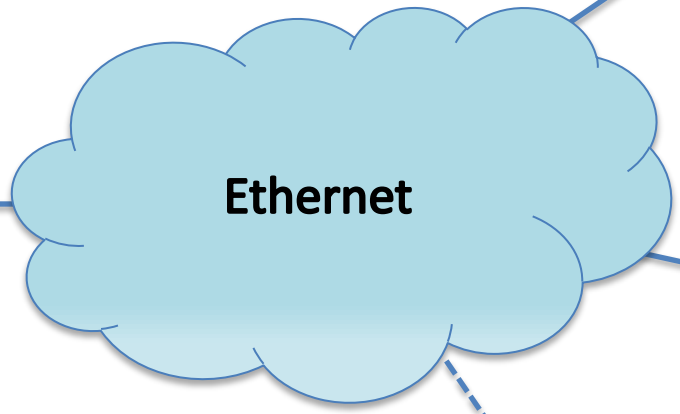
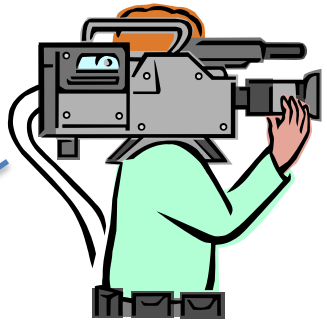
Broadcast

Broadcast Studios





- Increasingly, studio equipment connected via Ethernet
- Digital TV studio needs synchronization to within 1μs

Broadcast PTP Profile

SMPTE standardising on use of PTP for synchronisation

- Most equipment has two Ethernet connections:
  - “essence” (i.e. the media stream)
  - Control/management interface
- Proposal to run PTP over the control/management connection
- For large studios, transparent clocks needed to reduce PDV

SMPTE PTP Profile just recently went to ballot:

- Draft ST 2059-2: “Precision Time Protocol SMPTE profile for time and frequency synchronization in a professional broadcast environment”
- Now in comment resolution phase

Finance

The need for Sync in Financial Networks

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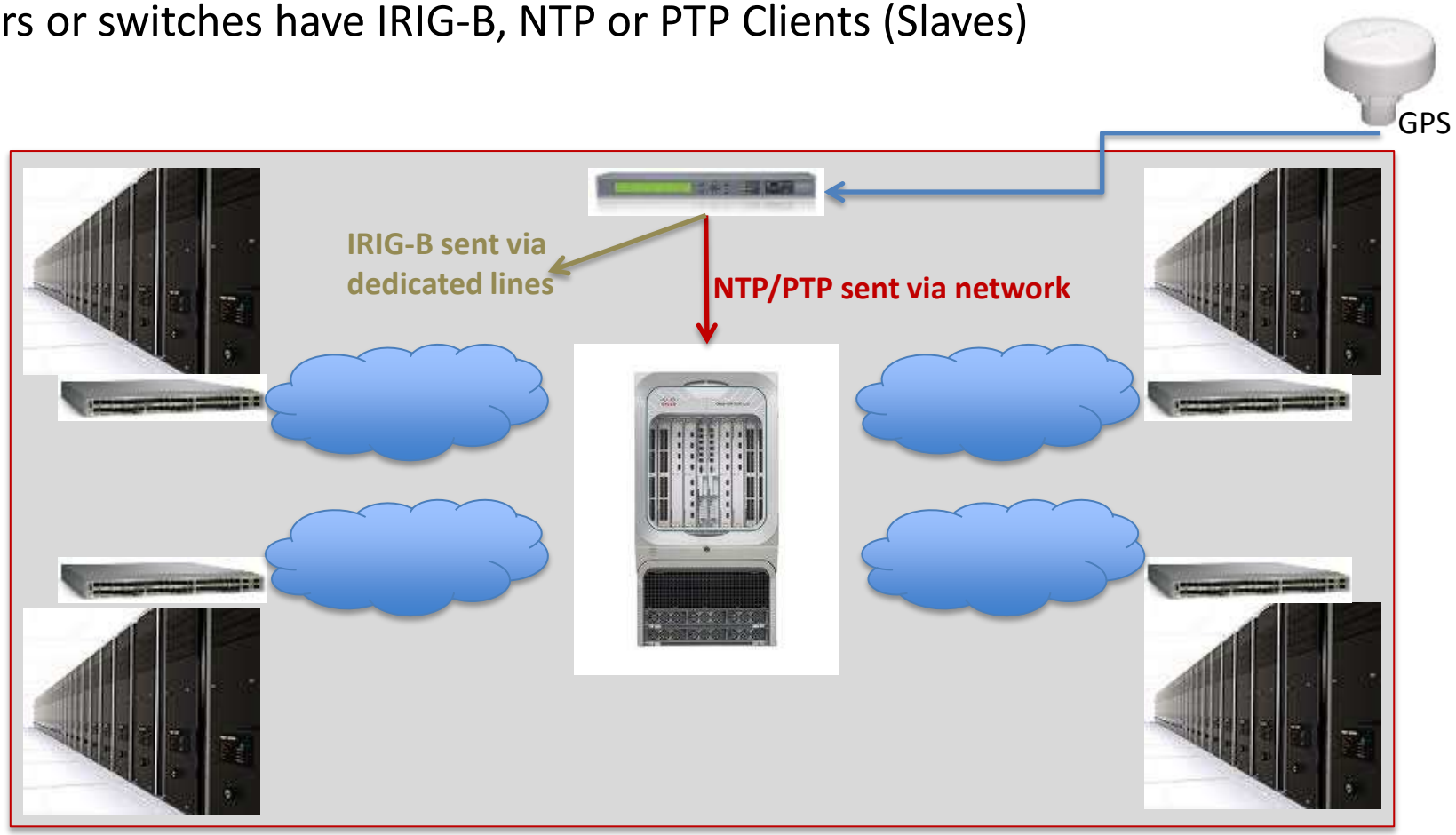
- High-Frequency Trading (HFT) requires accurate timestamping of trades for:
  - Accurate records of transactions during playback regression to improve trading algorithms
  - Reporting and regulatory purposes, disputes, etc.
- GPS has primarily been used for this but faces issues:
  - Coverage and signal 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

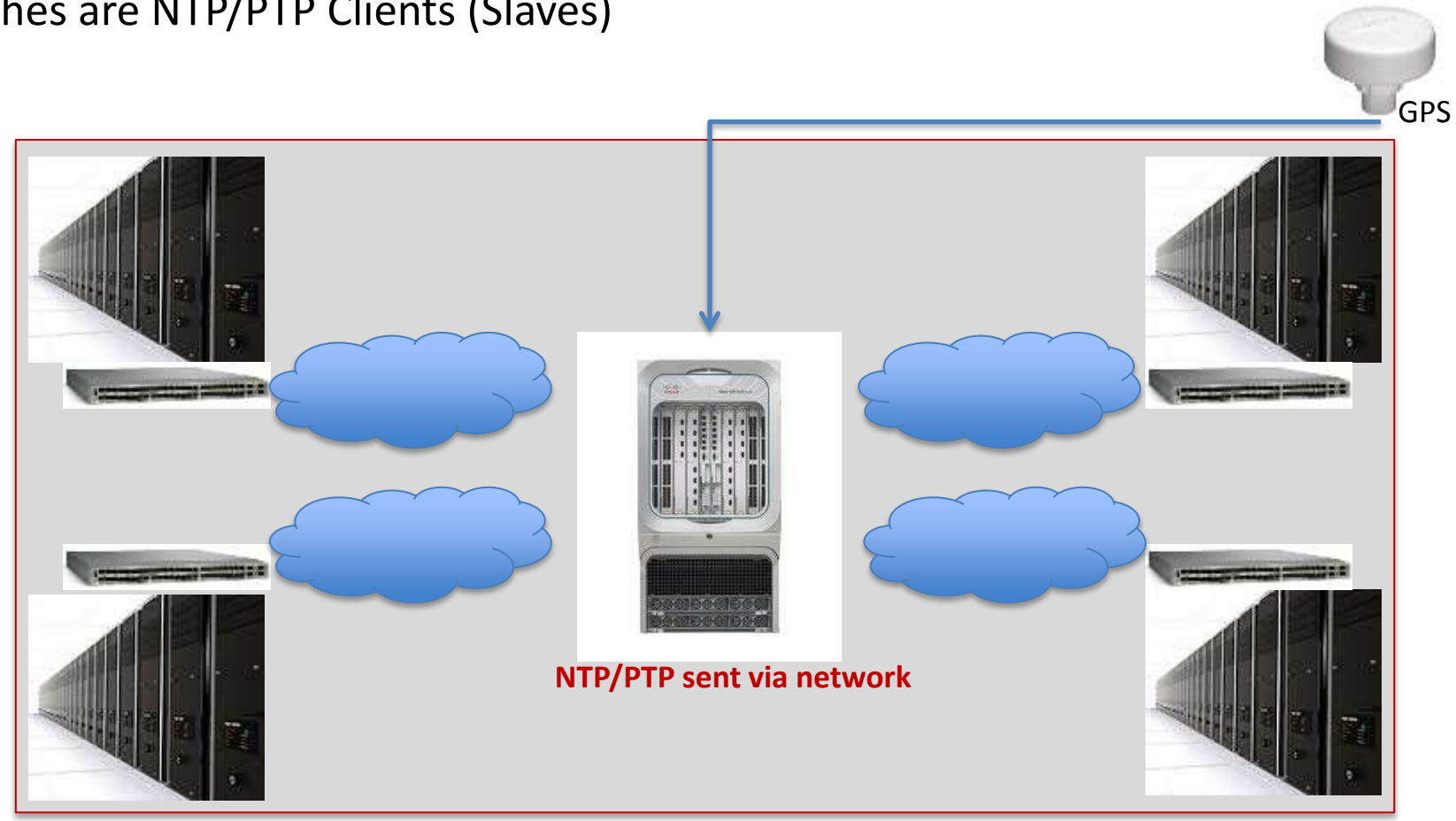
Sync in the trading floor

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)



Sync in the trading floor

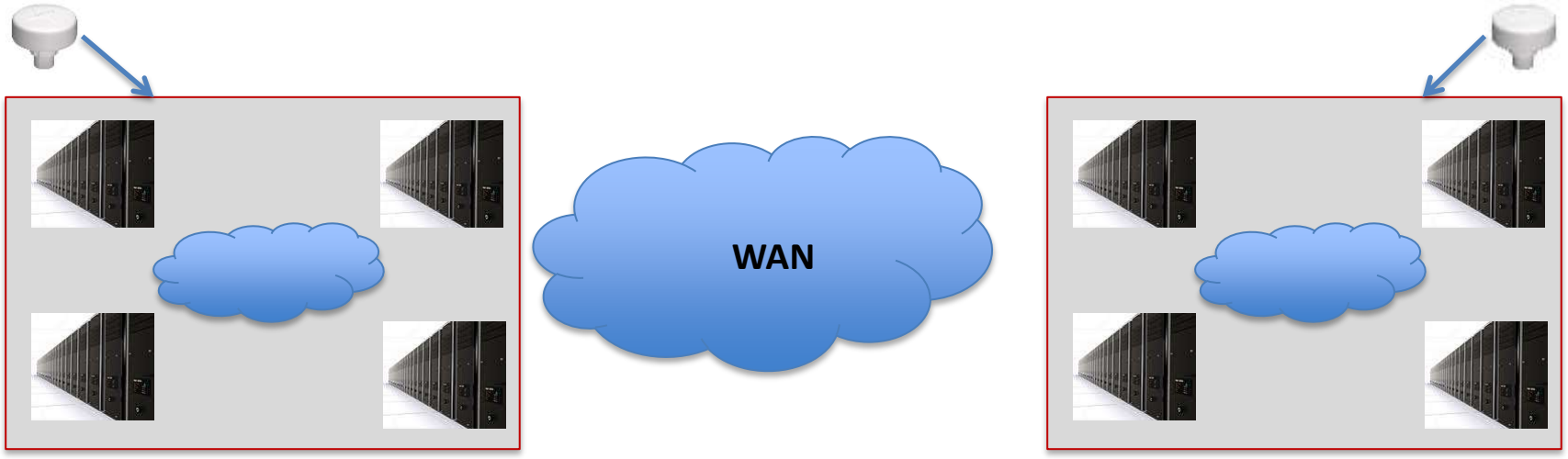
Scenario 2 – all servers co-located in the Trading Exchange or Data Warehouse
GPS-locked Router is 1588v2 PTP Master
Switches are NTP/PTP Clients (Slaves)



Sync in the trading floor

Calnex

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)



Data Warehouse A

Data Warehouse B

Sync in the trading floor

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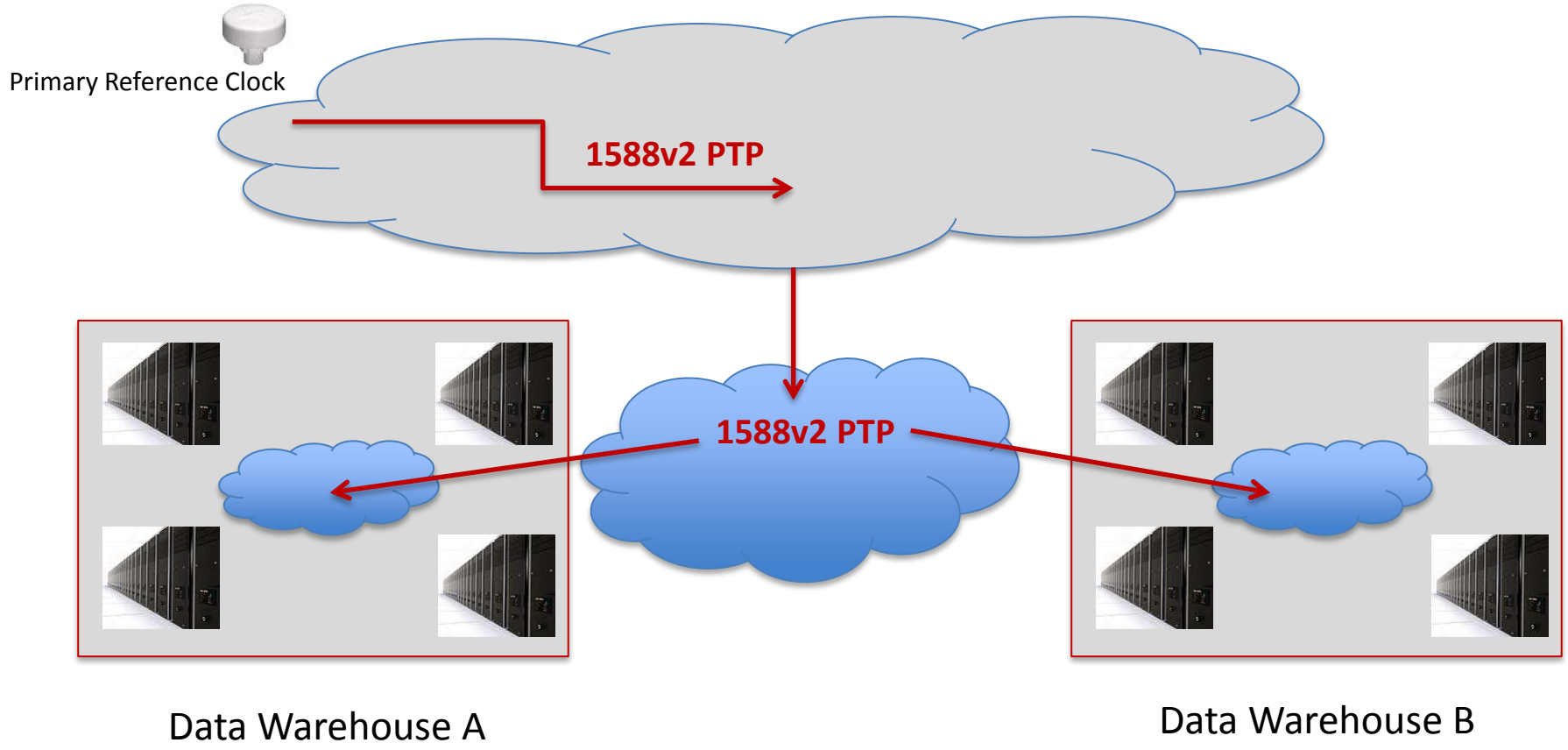
Scenario 4 –servers located in multiple locations
1588v2 PTP (Timing Service) from Telco Carrier



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
- PTP Profile
  - IETF: Draft Enterprise Profile for PTP

THANK YOU

See you at dinner tomorrow!