ETHERNET TIME & SYNC

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

WSTS, San Jose, June 2014

PTP Profiles

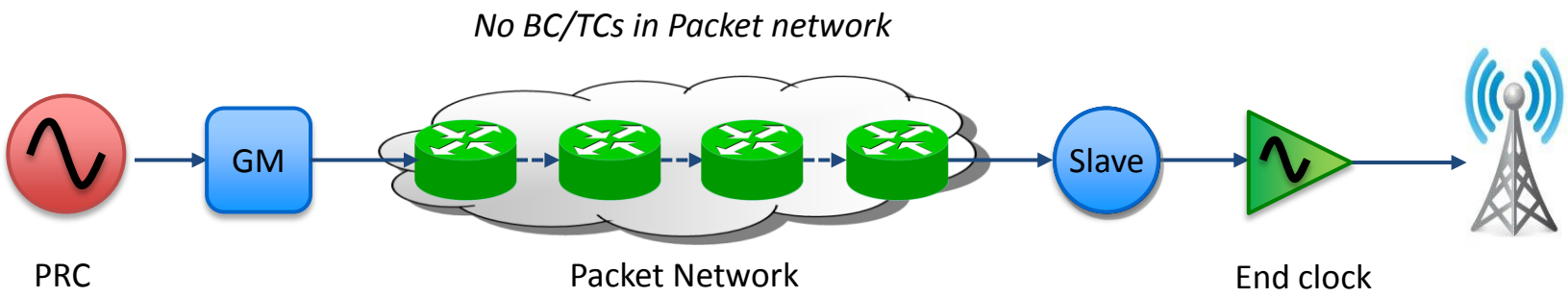
IEEE 1588 states in clause 19.3.1.1:

> *"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

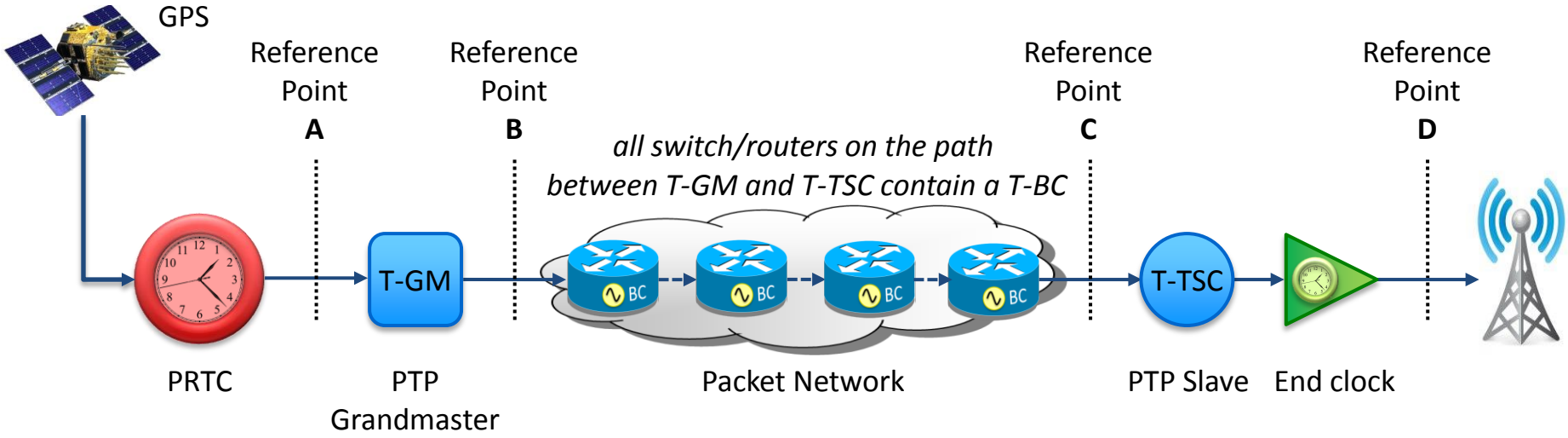
PTP with No Timing Support (G.8265.1)



Features

- Packet timing protocols such as PTP or NTP used to deliver frequency
- Aims to deliver at least same quality of timing as TDM

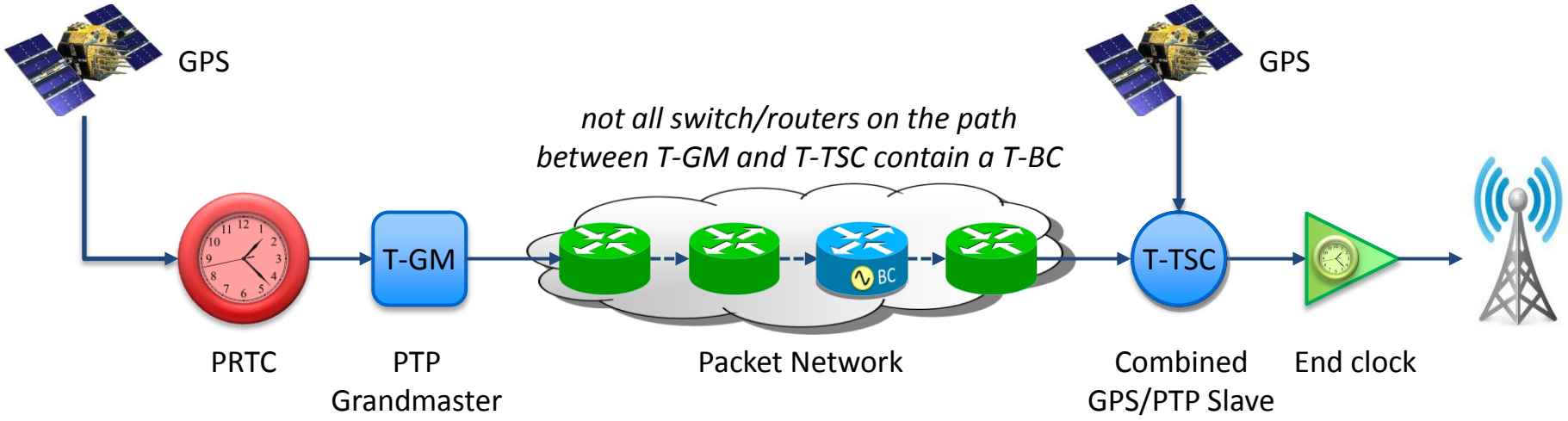
PTP with Full Timing Support (G.8275.1)



Features

- Every network element in the path must be “PTP aware”
- Each node contains a Telecom Boundary Clock (T-BC), avoiding accumulation of PDV along the path
- Can use a combination of SyncE & PTP, where SyncE provides the frequency and the PTP the phase/time

PTP with Assisted Partial Timing Support



Features

- Objective is backup to GPS: i.e. “assisted holdover”
- Can use GPS when in service to monitor PTP service quality and measure network asymmetry
- PTP can maintain timebase when GPS is out of service (e.g. due to jamming or antenna failure)

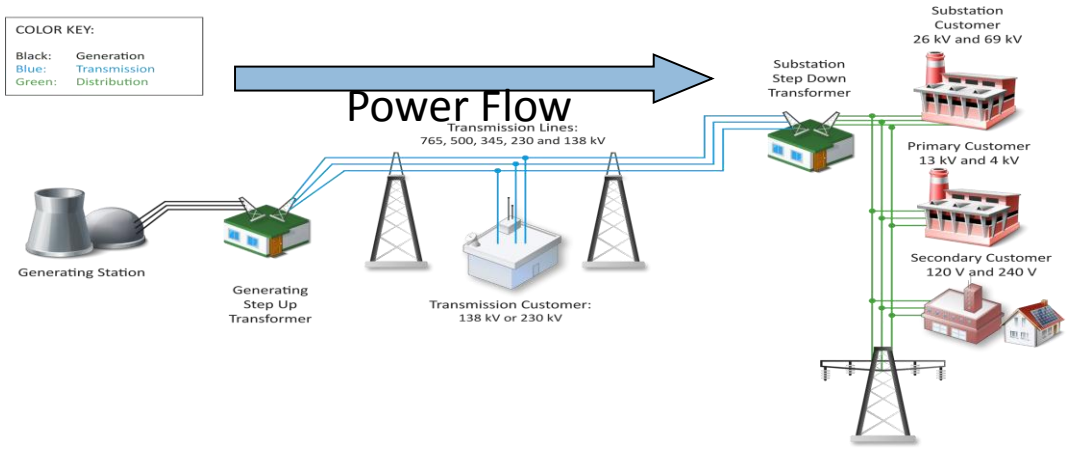
Power

Power – the need for Sync

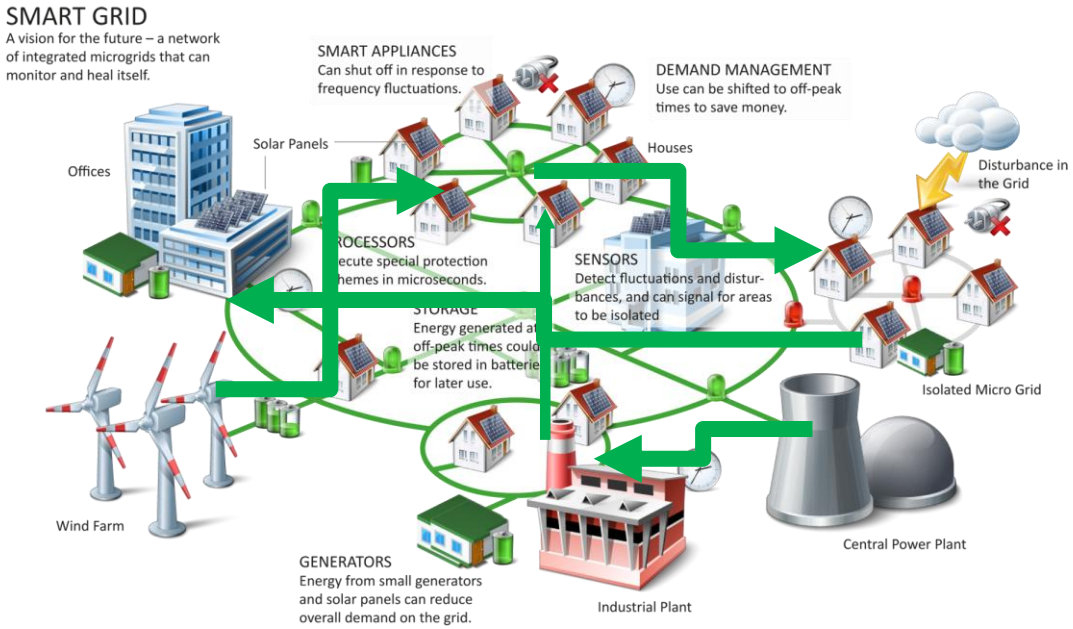
- "The Power Grid" is one of the world's largest infrastructures

- High synchronization requirements due to distributed nature of the grid and the critical balance between power generation and consumption
  - Power can't be stored easily so Grids Generate according to Demand
  - Need good Comms and Sync to correlate Demand and Generation
  - Has evolved from seconds to milliseconds and will evolve to microseconds → **Greater Efficiencies**
  - Also enables the **Greater Diversity** of the Smart Grid

Power Grid vs Smart Grid



Simple topology means sync is needed but milliseconds is ok

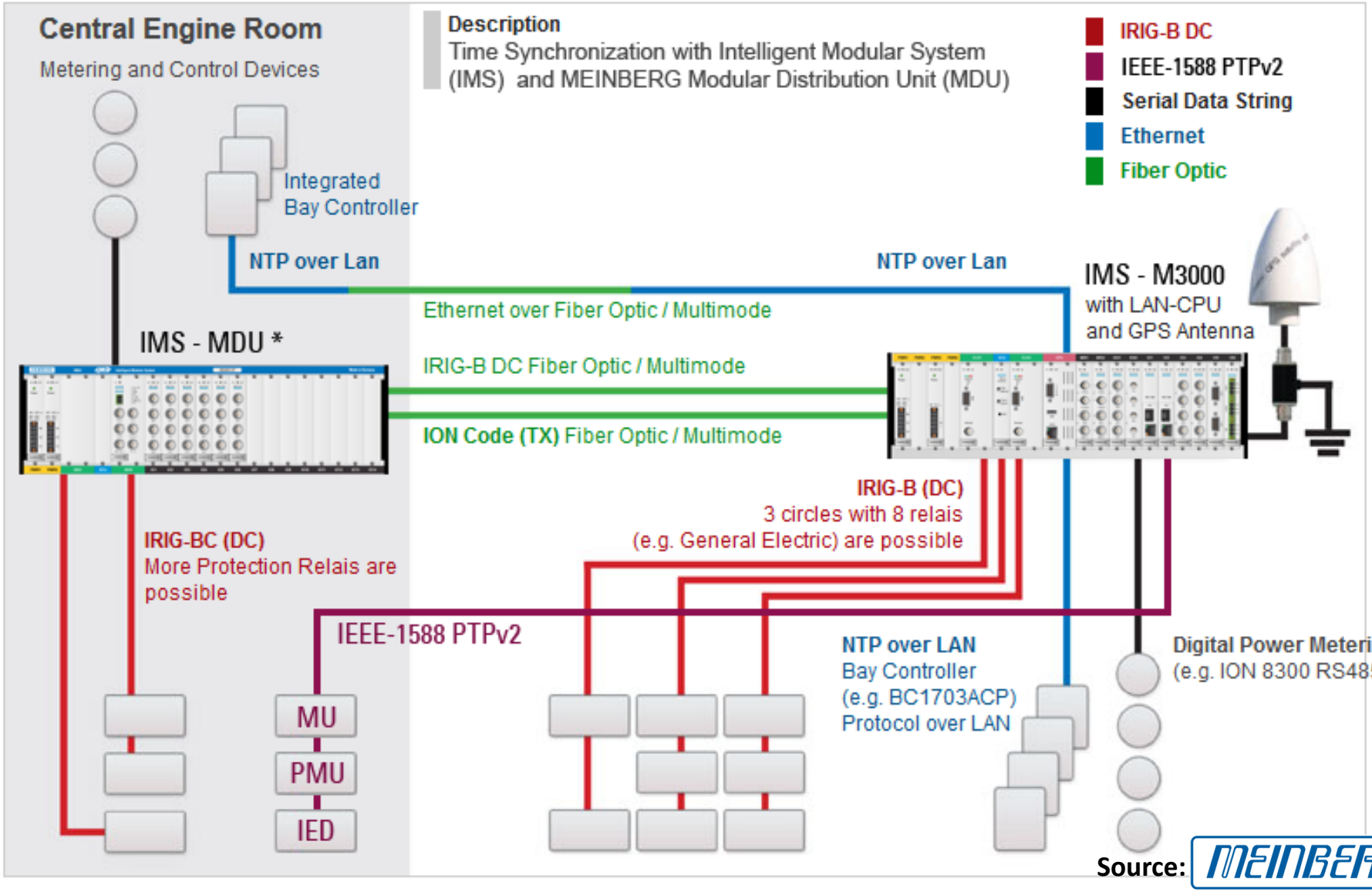


Greater complexity and diversity plus less predictability drives the need for better sync

Source:

1588v2 for Substation Communications

Calnex

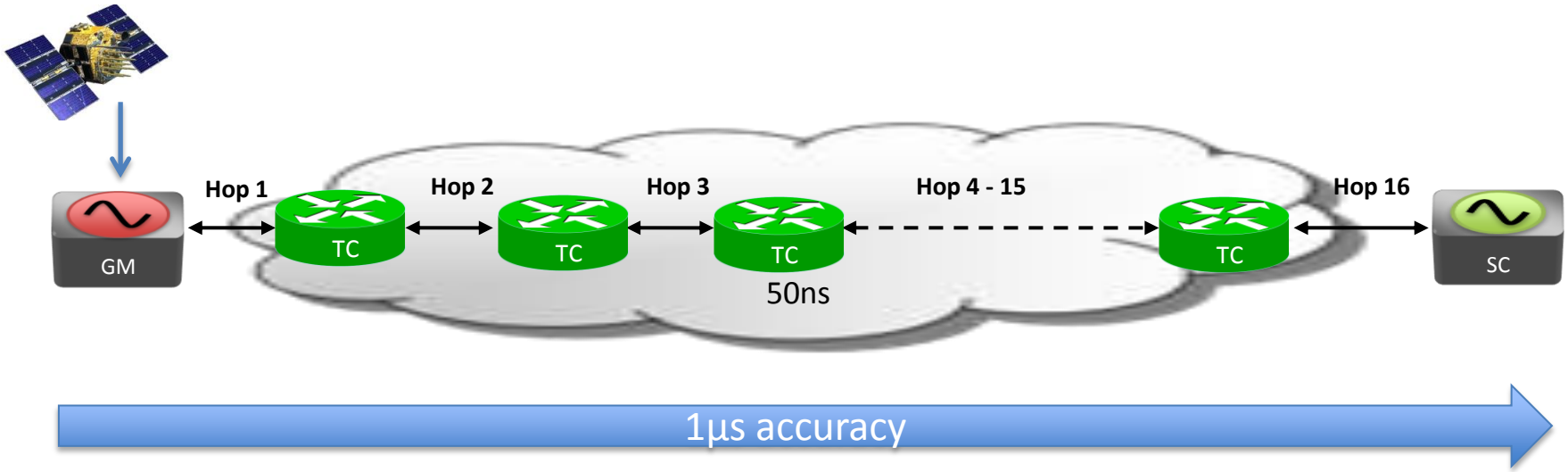


Source: MEINBERG

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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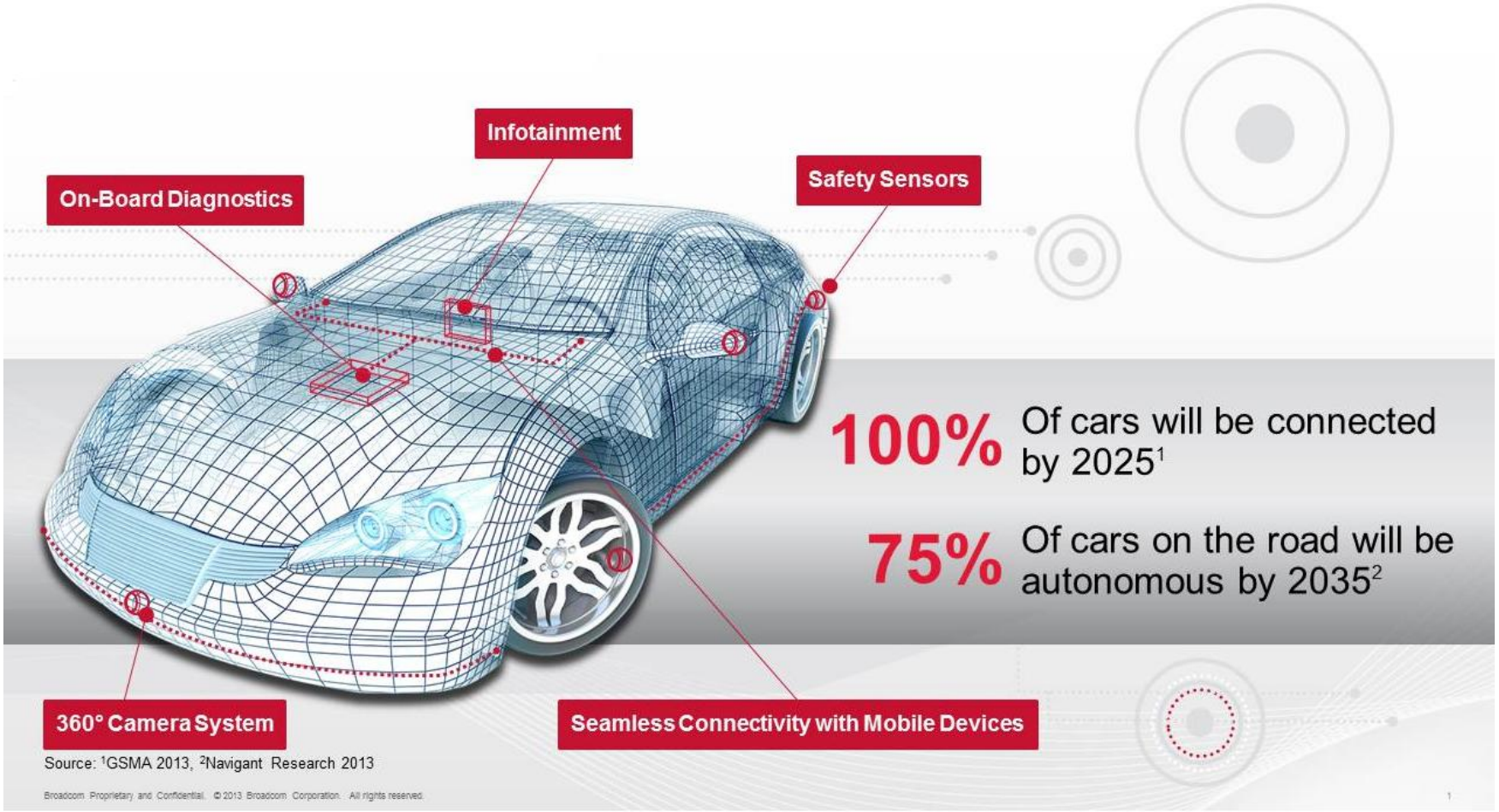
Automotive

The Connected Car



Moving to new Applications

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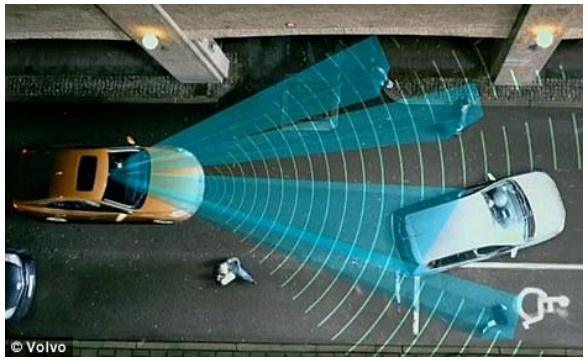
Assisted Parking

© forcegt.com / Ford

Object Detection



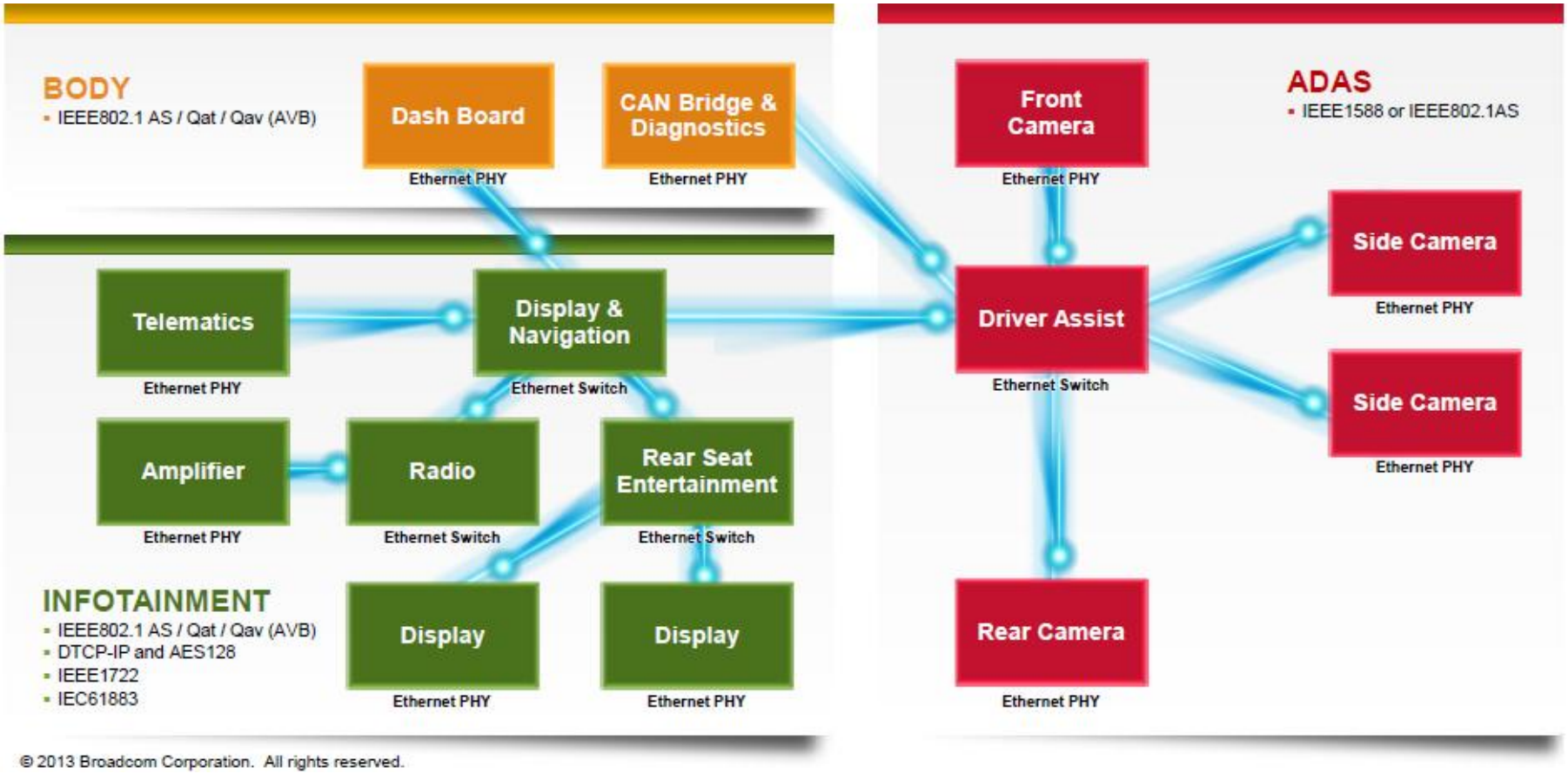
© Volvo

Self Driving Vehicles

© Google

All these new Applications need Cameras and Sensors with control systems that need accurate timing

In-Car Communications - Tomorrow



New Automotive Ethernet Technology

- OABR – OPEN Alliance BroadR-Reach
  www.opensig.org
  http://en.wikipedia.org/wiki/BroadR-Reach_Ethernet_standard

- 2-wire unshielded twisted pair copper instead of 8-wire shielded twisted pair

- Today 10/100 Mbit/s (1 Gbit/s in planning)

- Easy and less expensive to install (reduce connectivity cost 80%)

- Weight reduction up to 30%

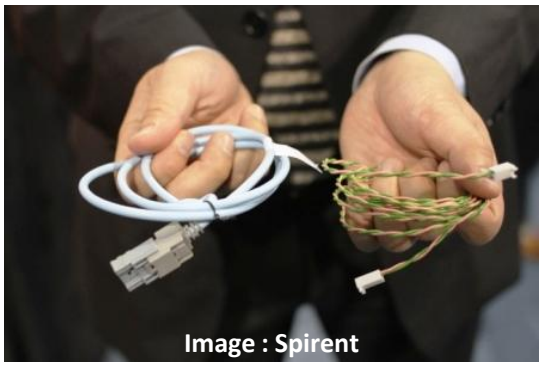


Image : Spirent

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
  - Ethernet
  - Multicast
  - Transparent Clock switches
  - Single Master Clock
  - Pdelay_Req mechanism (Not mandatory to use)
  - VLANs can be used

- Standard being used in Automotive

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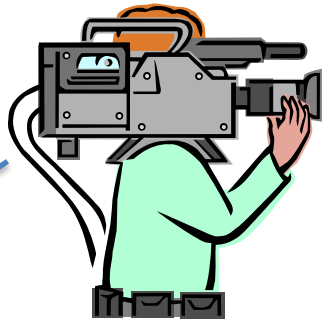
Broadcast

Broadcast Studios



Ethernet

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

Broadcast PTP Profile

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SMPTE standardising on use of PTP for synchronisation

- Replacing analog genlock
- 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 has gone to ballot:

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

Finance

The need for Sync in Financial Networks

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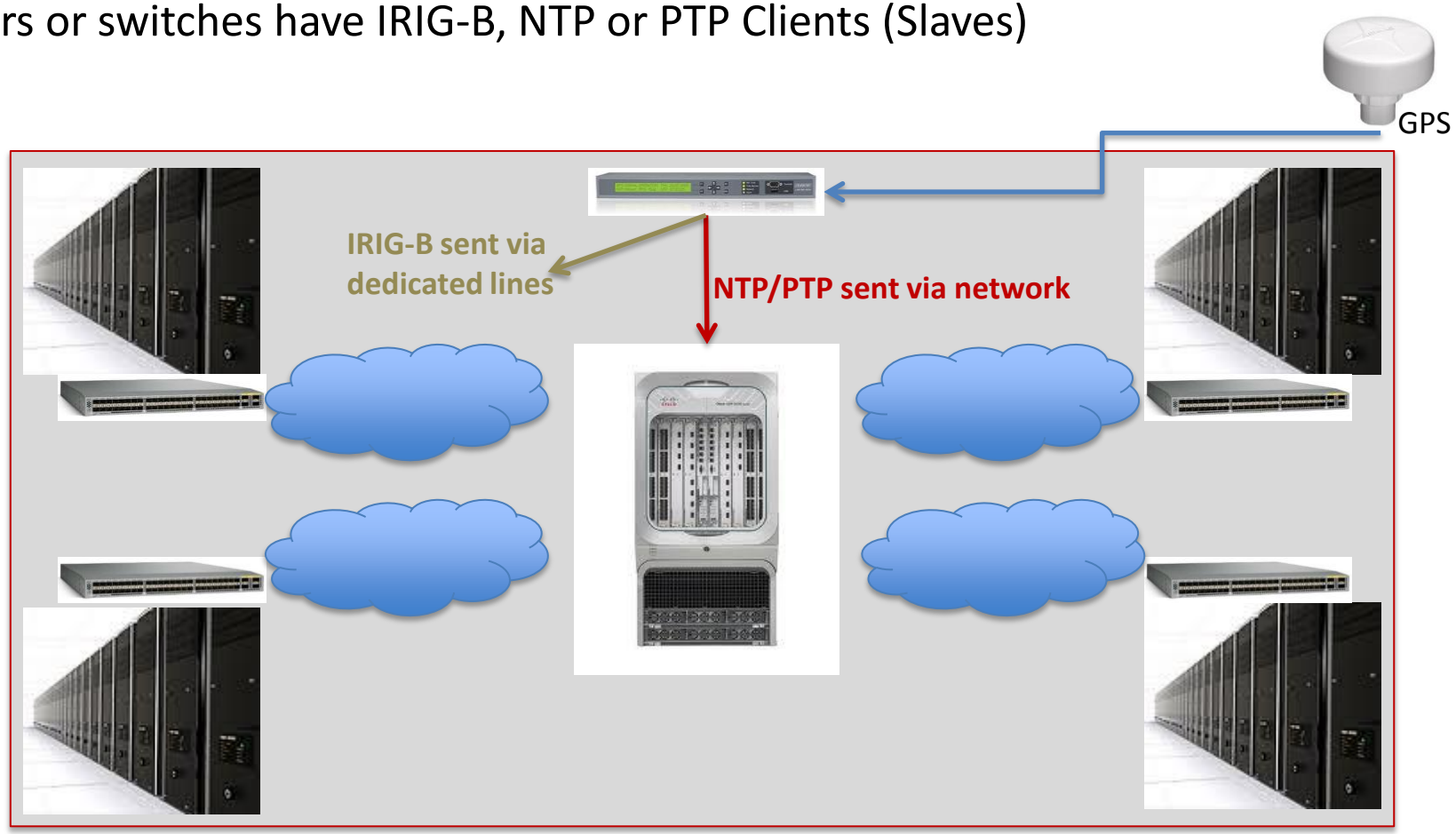
- High-Frequency Trading (HFT) requires accurate timestamping of trades for:
  - Accurate records of transactions during playback regression to improve trading algorithms
  - Reporting and regulatory purposes, disputes, etc.
- GPS has primarily been used for this but faces issues:
  - Coverage and signal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

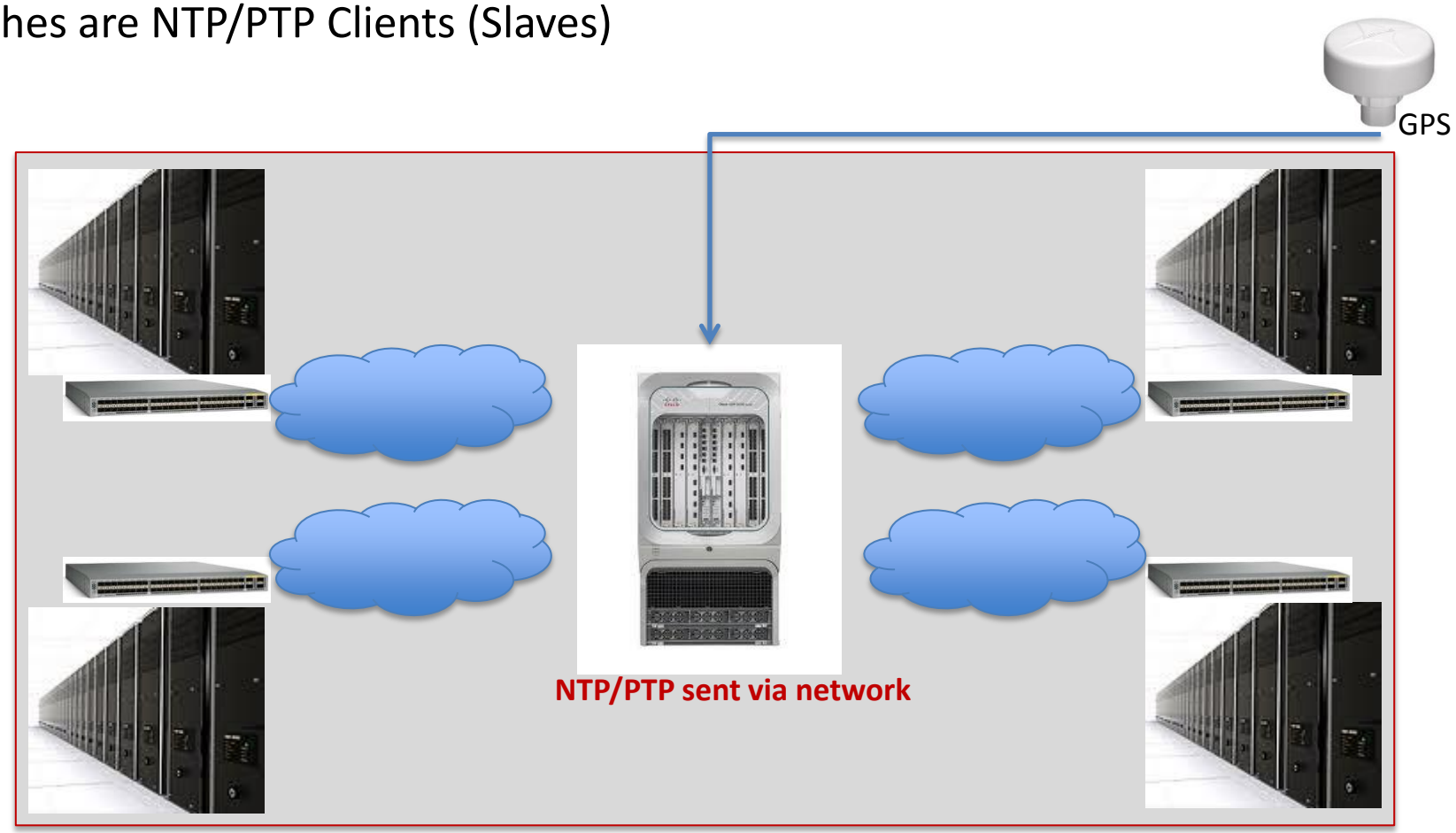
Sync in the trading floor

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)



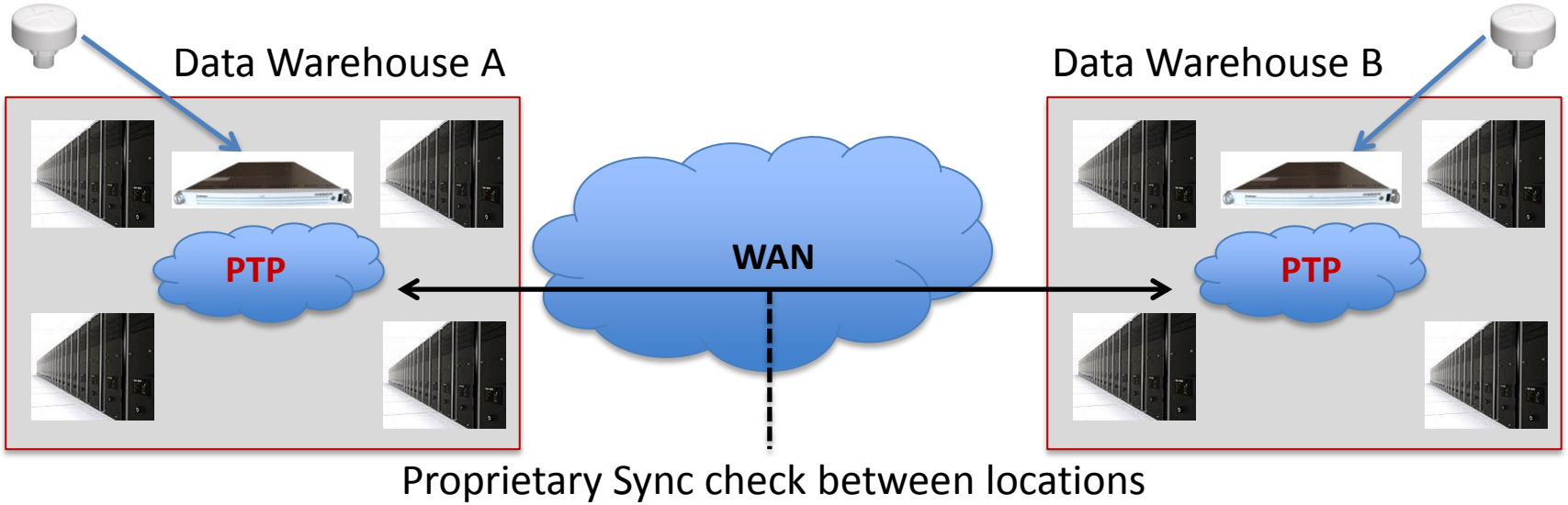
Sync in the trading floor

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)



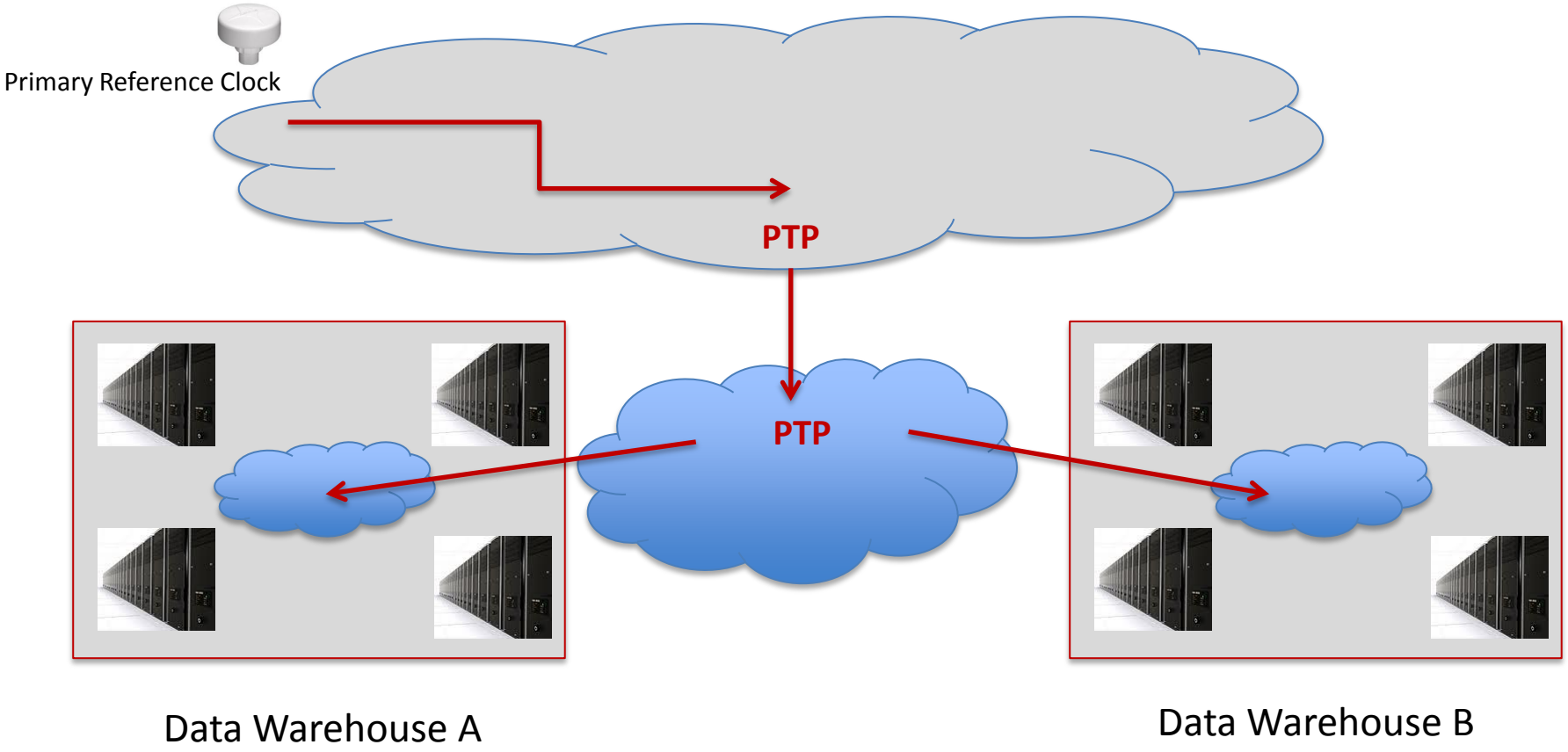
Sync in the trading floor

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
- PTP Profile
  - IETF: Draft Enterprise Profile for PTP

THANK YOU

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