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Leading the world in precise time solutions.

TimeProvider® 2700 and TimeProvider® 2300

Edge Master Clocks for Small Cell and LTE Networks

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Agenda

- Introduction
- Synchronization, Standards and Requirements
- Small Cell and LTE Network scenarios: the Need for a New Category of Synchronization Equipment
- TimeProvider 2700 and TimeProvider 2300 Products

The Emerging Synchronization Problem

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Small cell deployments, uncertain backhaul situations and evolving LTE synchronization requirements present new timing challenges, both technical and economic, that cannot be solved with current equipment and traditional deployment practices.

A new solution is needed…

…but

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One solution does not fit every scenario.

- Selection of technology (3G small cells, LTE-FDD, LTE-TDD, LTE-Advanced) drives different synchronization requirements
- Cell site locations and mobile network equipment selection define what can and cannot be done (particularly for small cells)
- Backhaul network technologies, topology and performance drive decisions for sync equipment selection and deployment locations

Edge Master clocks enable a variety of synchronization distribution architectures for a variety of network scenarios

Introducing New Edge Master Clocks

TimeProvider 2700
Edge Grandmaster Clock

TimeProvider 2300
Edge Boundary Clock

Scaled and optimized for deployment at the network edge

Synchronization, Standards and Requirements

Frequency, Phase and Time Synchronization

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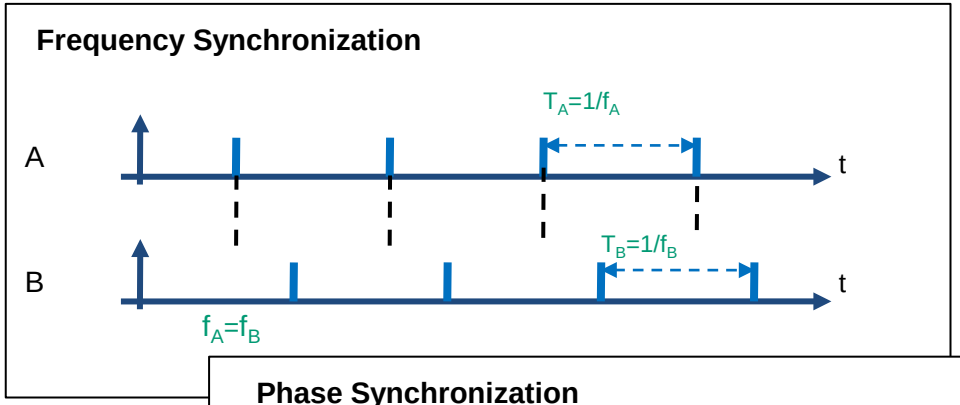
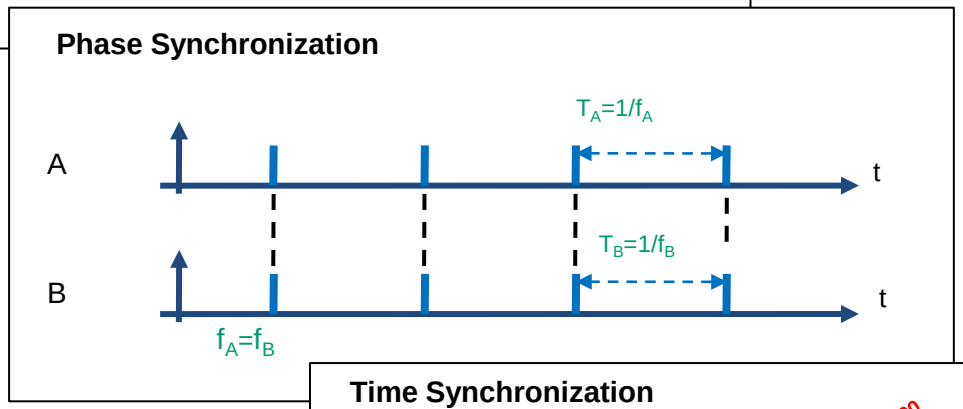
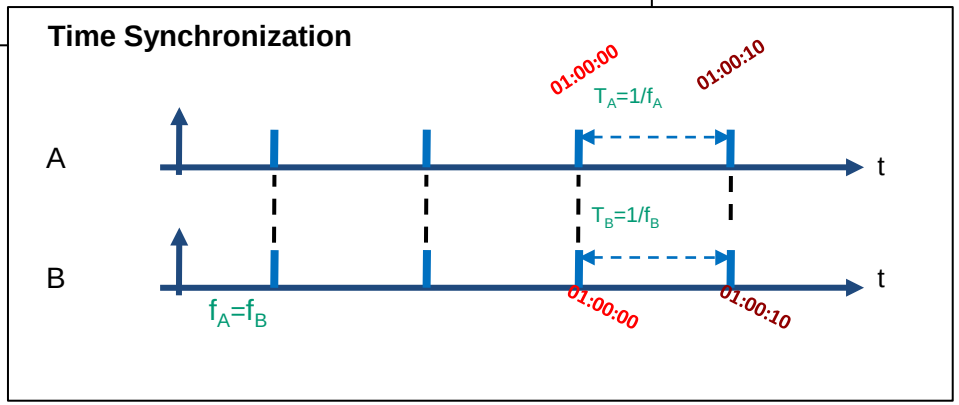


Leading edge of the pulses are at same pace, but not at the identical moment.

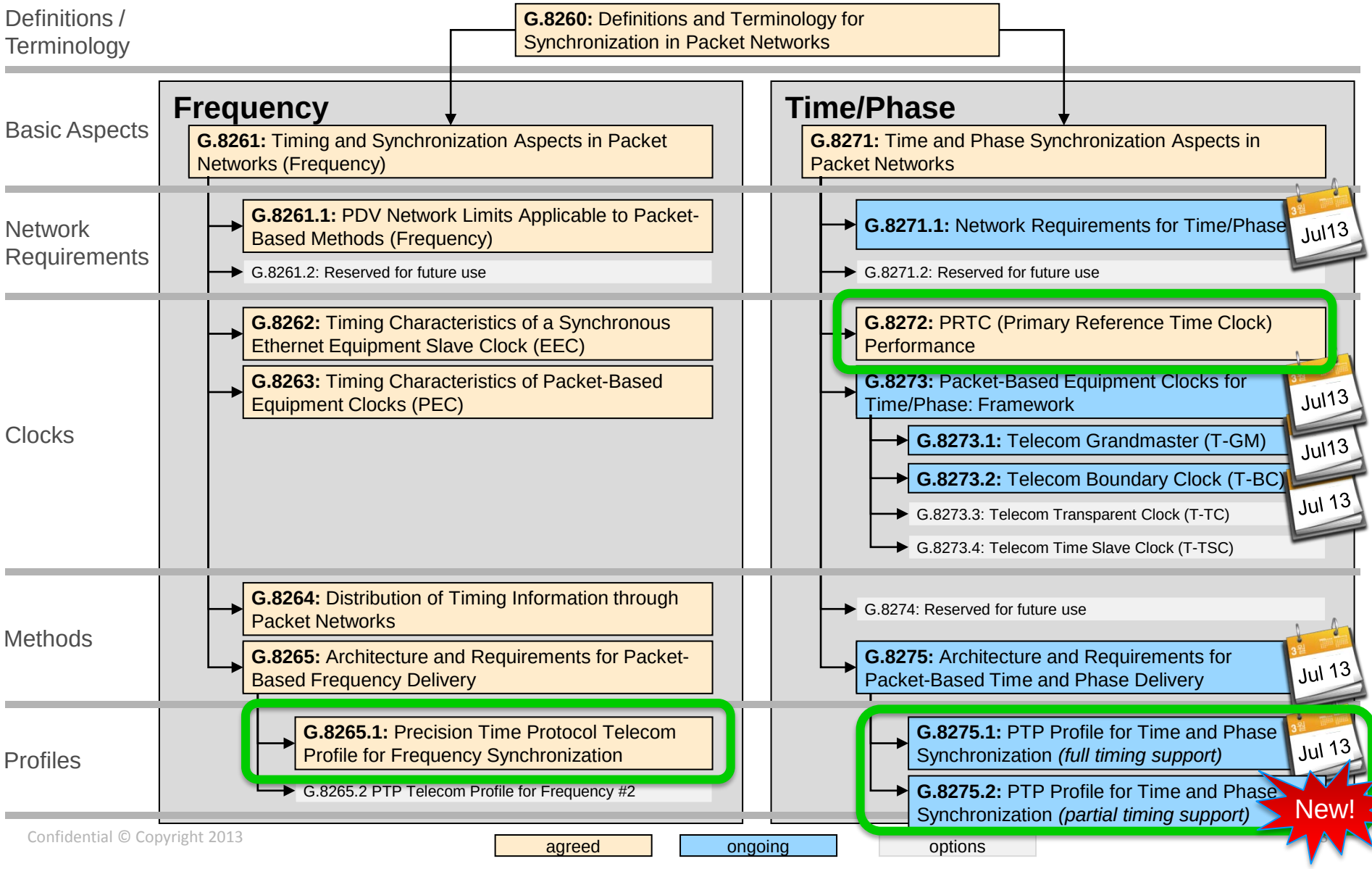


Leading edge of the pulses are at identical moment.



Leading edge of the pulses are at the identical moment and identical time setting.

Structure of ITU-T Recommendations



Synchronization Requirements

Application	Frequency Network / Air	Phase	Note
2G/3G, LTE – FDD	16 ppb / 50 ppb	NA	---
LTE – TDD	16 ppb / 50 ppb	± 1.5 µs	≤3 km cell radius
		± 5 µs	>3km cell radius
LTE MBMS (LTE-FDD & LTE-TDD)	16 ppb / 50 ppb	± 10 µs	inter-cell time difference
LTE- Advanced	16 ppb / 50 ppb	± 1.5 µs to ± 5 µs	In discussion by members of the 3GPP

New ± 1.5 µs to ± 5 µs phase timing requirements require new synchronization distribution architectures

New requirements drive to a new solution:

A solution that moves synchronization equipment from central locations toward the network edge.

4 Basic Network Scenarios

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1. Frequency sync, managed Ethernet backhaul (G.8265.1)

– Consistent, known backhaul performance

2. Frequency sync, high PDV, noisy backhaul (G.8265.1)

– Diverse transport technologies, 3rd party, many hops

3. Phase sync, retrofit or new Ethernet backhaul (pre-G.8275.1)

– SyncE and Boundary Clocks in every network element

4. Phase sync, existing backhaul (pre-G.8275.2)

– No BC, possibly SyncE, diverse transport, 3rd party

1. Frequency Synchronization: G.8265.1 Basic Architecture

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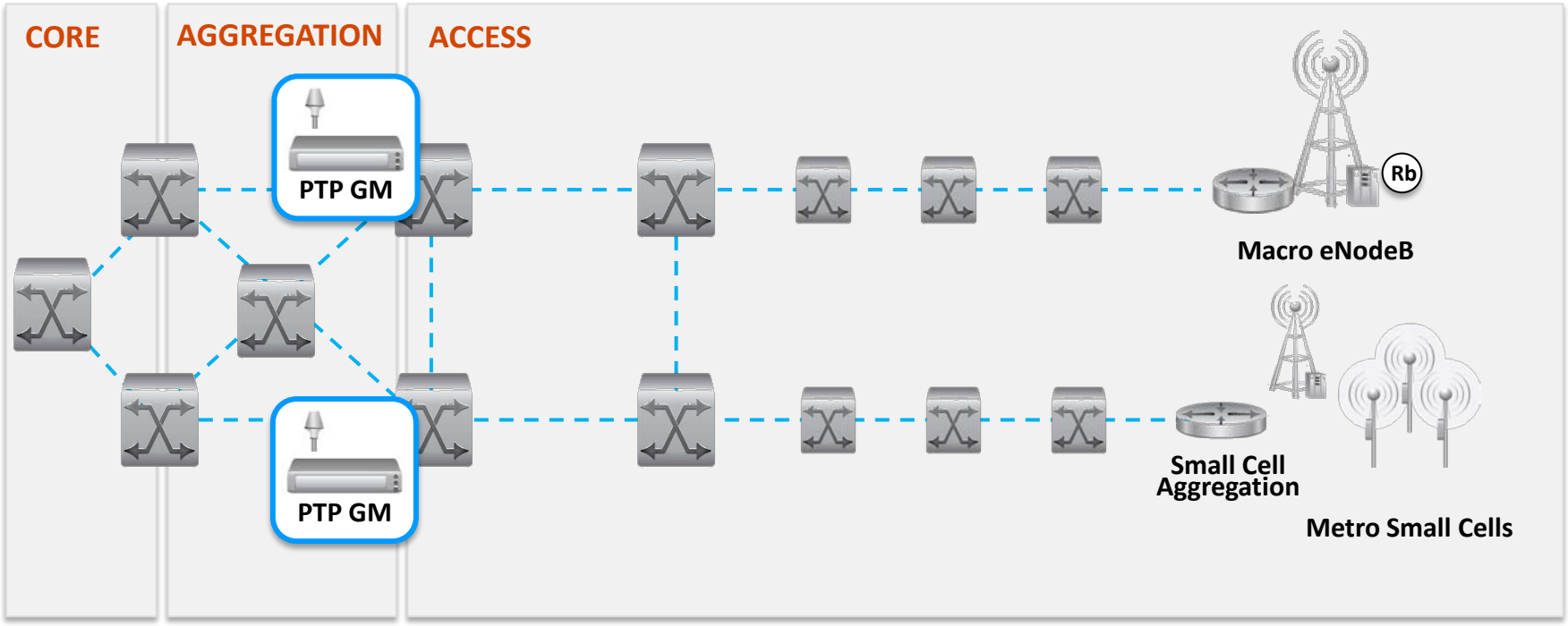
Managed Ethernet backhaul
consistent, known performance

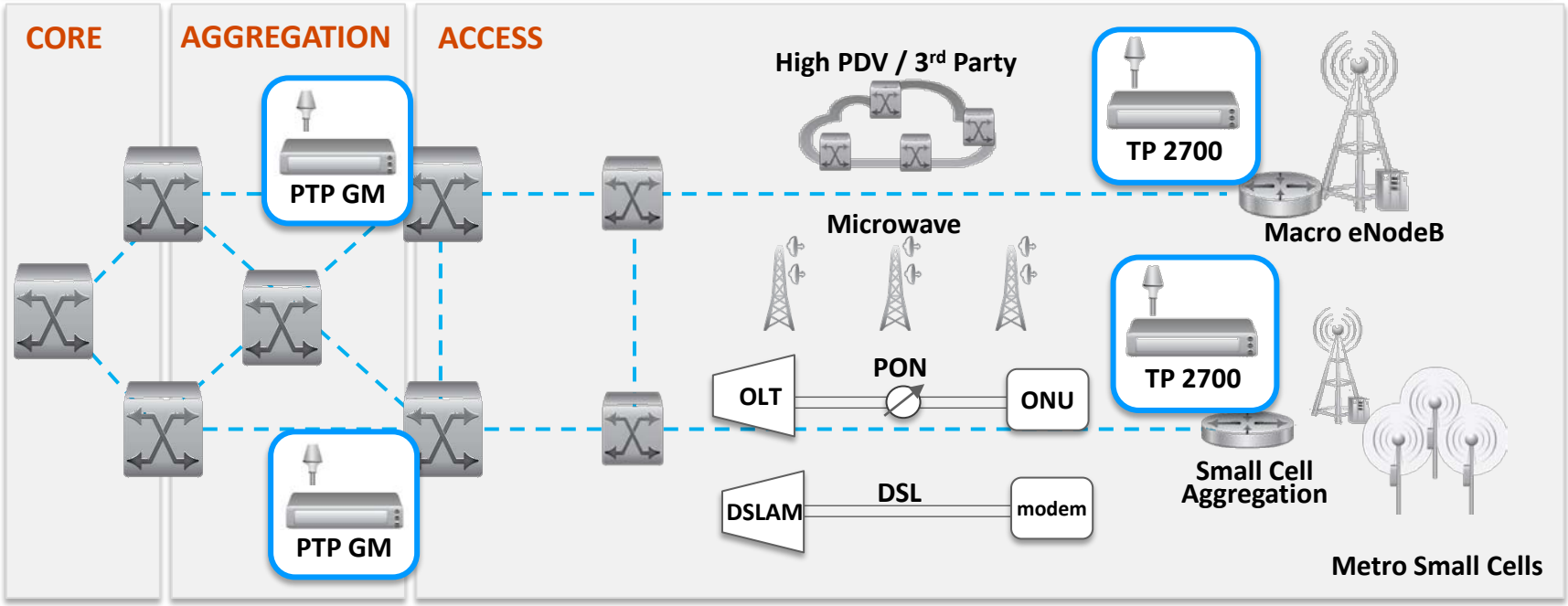


- Central deployment of high capacity PTP grandmaster
- Common deployment model today: 100s of networks worldwide

2. Frequency Synchronization: G.8265.1 Edge Architecture

Uncertain performance, noisy backhaul

Multiple technologies, many hops/paths, high packet delay variation, 3rd party access vendors, etc.



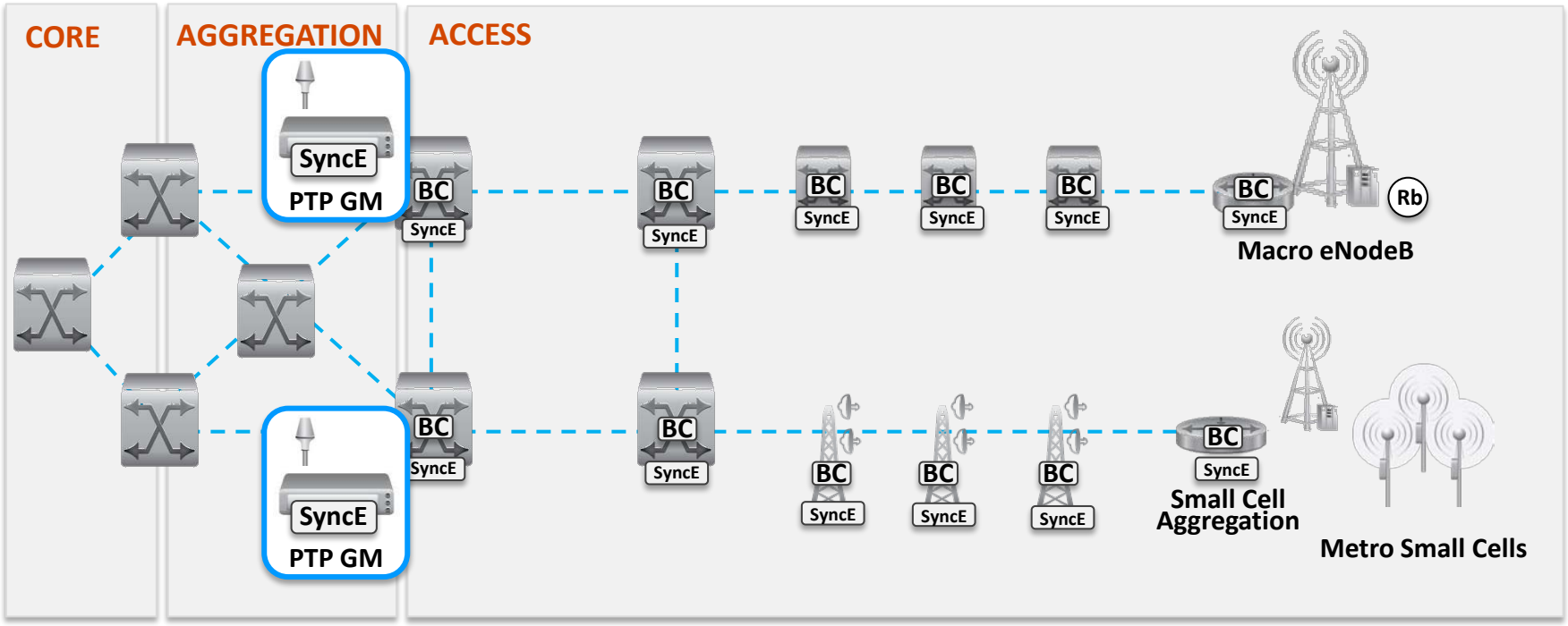
TimeProvider 2700 deployment case.

- Deploy PTP Grandmaster at or near the edge to eliminate backhaul performance issues. May be supported with existing, centralized GM.

3. Phase Synchronization: G.8275.1 Full On-Path Support

Retrofit existing equip. or build new network

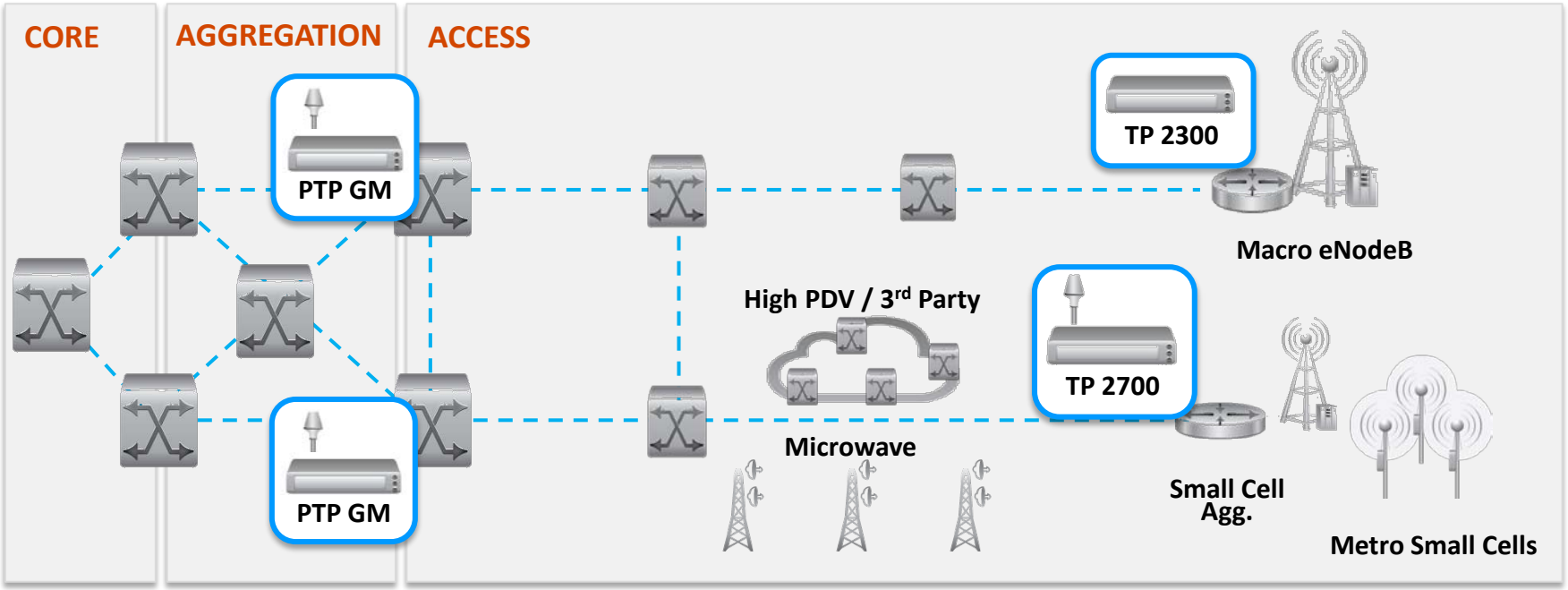
Managed Ethernet, synchronous Ethernet, boundary clocks



- Rebuild to include boundary clocks in every network element
- Possibly revise MPLS network design practices

4. Phase Synchronization:
G.8275.2 Partial On-Path Support or Edge GM

Existing backhaul, diverse tech and/or noisy
Multiple technologies, many hops/paths, high PDV, 3rd party, etc.

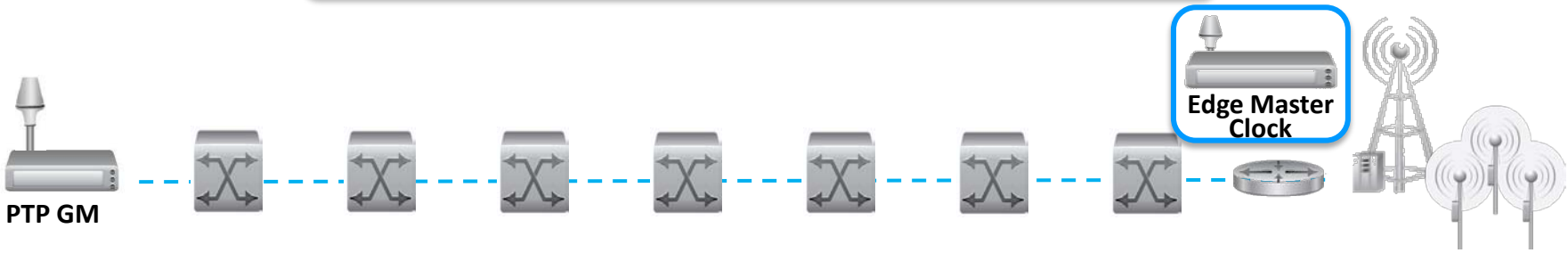


TimeProvider 2700 and Time Provider 2300 deployment cases.

- Provide partial on-path support with advanced boundary clock
- Deploy PTP grandmaster “at or near the edge”

Advantages of the G.8275.2 Architecture

Cost Effective Alternative



- No change in network hardware
- Operated over existing MPLS / CE network
  - Preserves MPLS value proposition
- No change to back office engineering and operations processes
- Mitigates asymmetry as an issue
- Sync not dependent on embedded NE
  - Quality of BC design not an issue

- Can leverage existing PTP GM deployments
- Can leverage existing GPS at eNodeB
- Compliant to existing sync standards
  - compatible with G.8265.1 profile
- Simple and easy to deploy for all LTE architectures

G.8275.2 Profile for Time and Phase

- This architecture has been proposed to the ATIS / ITU standards bodies:

  “a new profile to support time and phase distribution over existing deployed networks…compatible with the PTP profile for frequency distribution defined in G.8265.1”

- Contribution submitted by: Symmetricom, AT&T, Verizon, Sprint Nextel, and T-Mobile-USA

Introducing the TimeProvider® 2700 and 2300 Edge Master Clocks

Robert Olstad

TimeProvider® 2000 Series Edge Master Clocks

TimeProvider 2700

TimeProvider 2300

- Precise network timing solutions for small cells and 4G/LTE
  - Optimized to deliver precise timing that meets new, stringent requirements
  - Scaled to support 8 to 64 PTP unicast clients
  - Cost-effective deployments in existing backhaul networks (pre-G.8275.2 profile for phase)
- TimeProvider 2700 “Edge” Grandmaster Clock
  - IEEE 1588-2008 (PTP v2) Grandmaster for deployment at the networks edge
  - Primary Reference Time Clock (PRTC, G.8272) time/phase accuracy within 100ns of UTC
  - Primary Reference Clock (PRC, G.811) frequency accuracy to within 1 x 10^{-11}
  - GNSS support for GPS and GLONASS systems
- TimeProvider 2300 “Advanced" Boundary Clock
  - Standalone PTP boundary clock with advanced features for partial on-path support
  - PTP client provides outstanding performance in “noisy” networks
  - Multi-sync capability uses multiple inputs (PTP, Sync-E and/or E1/T1) to create a highly precise PTP sync output (G.8265.1 Telecom Profile)
- Common software architecture, advanced timing algorithms, hardware time stamping, and high quality oscillators together deliver best-in-class performance.

Time Provider® 2700 Edge Grandmaster Clock

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- TimeProvider 2700 PTP Grandmaster
  - GNSS (GPS or GLONASS) L1 input,
    - PRTC-level performance
  - Two gigabit Ethernet combo ports
    - 100/1000 Base-T (copper RJ45) or 1000 Base-X (optical SFP)
    - PTP and SyncE (input/output)
    - Configure for 2 outputs, or 1 output and 1 input
  - PTP output supports 8 to 64 clients
  - OCXO or rubidium oscillator models
  - One Time-of-Day (TOD) RS422 output, RJ45
  - One 10 MHz or 1PPS programmable output, BNC
  - Dual DC power feed or single AC feed models
  - 1RU, 19” rack, 224mm deep
  - Designed for ANSI, ETSI compliance
  - Extended temperature range
    - OCXO models -20°C to +60°C
    - Rubidium models -5°C to +55°C

Dual DC model

AC model

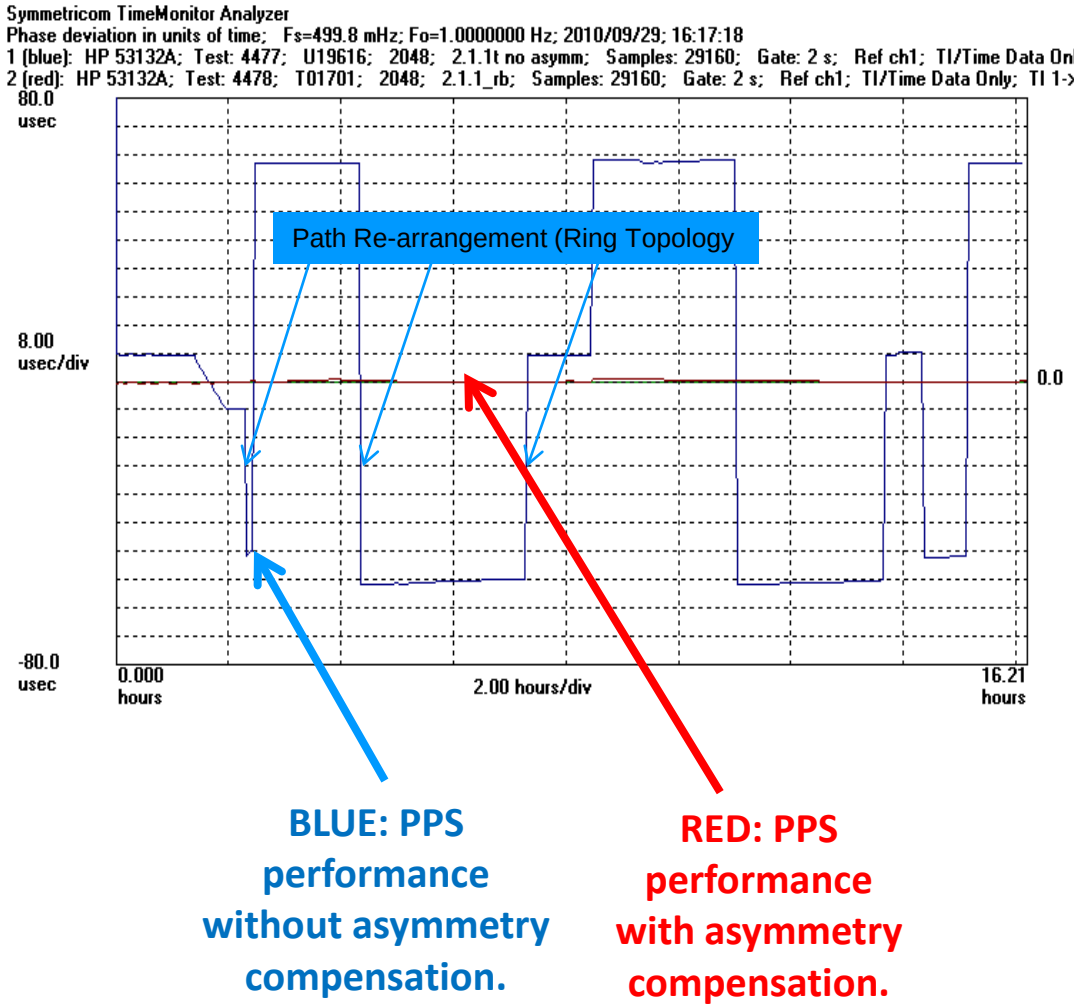
PTP Grandmaster for the Network Edge

- SW License Options
  - PTP client capacity: 16, 32 or 64
  - Enable PTP input
    - Alternate or backup to GNSS
    - Automatic Path Asymmetry Compensation mitigates impact of physical path asymmetry
  - Enable T1/E1 port (input or output)
  - Enable concurrent GPS and GLONASS
  - Enable multicast and 2-step clock

Automatic Path Asymmetry Compensation

- Automatic Path Asymmetry Compensation algorithm supplies external compensation factor as allowed in IEEE 1588 standard.
- Algorithm learns path asymmetries to the north-bound master … even while system may using GNSS as the primary clock source.
- In the event of a GNSS failure, the system will operate revert to using asymmetry corrected PTP.
- Feature available with the TimeProvider 2700 PTP Input SW License.

Customer network test environment



Time Provider® 2700 Edge Grandmaster Clock

Ground

AC Power (alternative to DC, not shown)

-48 VDC Dual Feeds

Reset Button

Serial Craft Port

Ethernet Mgmt.

2x GigE Ports Copper or Optical

E1/T1 TOD Ports

10MHz or 1PPS Port

GNSS GPS and/or GLONASS

Ground

TimeProvider® 2700 Models and Options

TimeProvider 2700 Grandmaster	16 Models			
Client Capacity	8	16	32	64
Oscillator	OCXO	Rubidium		
Power	DC	AC		

Software Options
PTP Client Capacity Expansion: to 16, 32 or 64 clients
PTP Input, Boundary Clock
E1/T1 Input / Output
Concurrent GPS/GLONASS support
Multicast Profile & 2-Step Clock

TimeProvider® 2300 Edge Boundary Clock

- TimeProvider 2300 PTP Boundary Clock
  - Two gigabit Ethernet combo ports
    - 100/1000 Base-T (copper RJ45) or 1000 Base-X (optical SFP)
    - PTP and SyncE (input/output)
    - Configure for 2 outputs, or 1 output and 1 input
  - PTP output supports 8 to 64 clients
  - OCXO or rubidium oscillator models
  - One Time-of-Day (TOD) RS422 output, RJ45
  - One 10 MHz or 1PPS programmable output, BNC
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  - Designed for ANSI, ETSI compliance
  - Extended temperature ranges supported
    - OCXO models -20ºC to +60ºC
    - Rubidium models -5ºC to +55ºC

Dual DC model

AC model

Advanced PTP Boundary Clock

- SW License Options
  - Increase PTP output client capacity license: 16, 32 or 64
  - Enable T1/E1 port (input or output)
  - Enable multicast and 2-step clock

What is an “Advanced” Boundary Clock?

- Advanced features enable “partial” on-path support as anticipated in the ITU-T G.8275.2 PTP profile for telecommunications
- Embedded boundary clocks are designed for a “full” on-path synchronization distribution architecture as proposed in the G.8275.1 profile
  - Adds cost to every network element
  - Deals only with delay or asymmetry through the equipment
- TimeProvider 2300 advantages
  - Lower total network cost: locate only where needed
    - Deploy at few purpose-built designs rather than upgrade every network element
    - Deploy at network edge where GNSS is not available
    - Deploy at network edge where base station boundary clocks performance is insufficient
  - Advanced PTP client software
    - Adapt for load asymmetry in partial on-path support networks
    - Superior clock recovery algorithms
    - Faster clock recovery and convergence times
  - Multi-sync feature, uses multiple inputs for greater accuracy and stability: PTP and SyncE or T1/E1
  - Superior holdover with oscillator upgrades

TimeProvider® 2300 Edge Boundary Clock

Ground

AC Power (alternative to DC, not shown)

-48 VDC Dual Feeds

Reset Button

Craft Port

Ethernet Mgmt.

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Ground

TimeProvider® 2300 Models and Options

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Client Capacity	8	16	32	64
Oscillator	OCXO	Rubidium		
Power	DC	AC		

Software Options
PTP Client Capacity Expansion: to 16, 32 or 64 clients
E1/T1 Input / Output
Multicast Profile & 2-Step Clock

Summary

- LTE technologies drive new requirements for synchronization
- Backhaul network technologies, topology and performance drive synchronization equipment and deployment decisions

- "Boundary Clock in every network element" will work for some scenarios—but not feasible for all.
- "GNSS at every base station" requires back up and is not feasible for many deployment scenarios, especially small cells

- Symmetricom's **TimeProvider 2700 Edge Grandmaster Clock** and **TimeProvider 2300 Edge Boundary Clock** provide economical and easy-to-deploy solutions for emerging small cell and 4G/LTE network scenarios

Thank You.

TimeProvider 2700 Edge Grandmaster Clock

and

TimeProvider 2300 Edge Boundary Clock

Kris Sowolla, Joe Neil and Robert Olstad

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