OSCILLOQUARTZ

An ADVA Optical Networking Company

Time and Phase Delivery and Assurance for TD-LTE and LTE-A

Gil Biran
General Manager
WSTS, June 2014, San Jose

Agenda

- Delivering time and phase in Mobile Backhaul networks
- Addressing the LTE-A challenges
- Implementing Synchronization Delivery and Assurance in Brownfield Mobile Backhaul Networks
- Sync Manager Requirements
- Summery

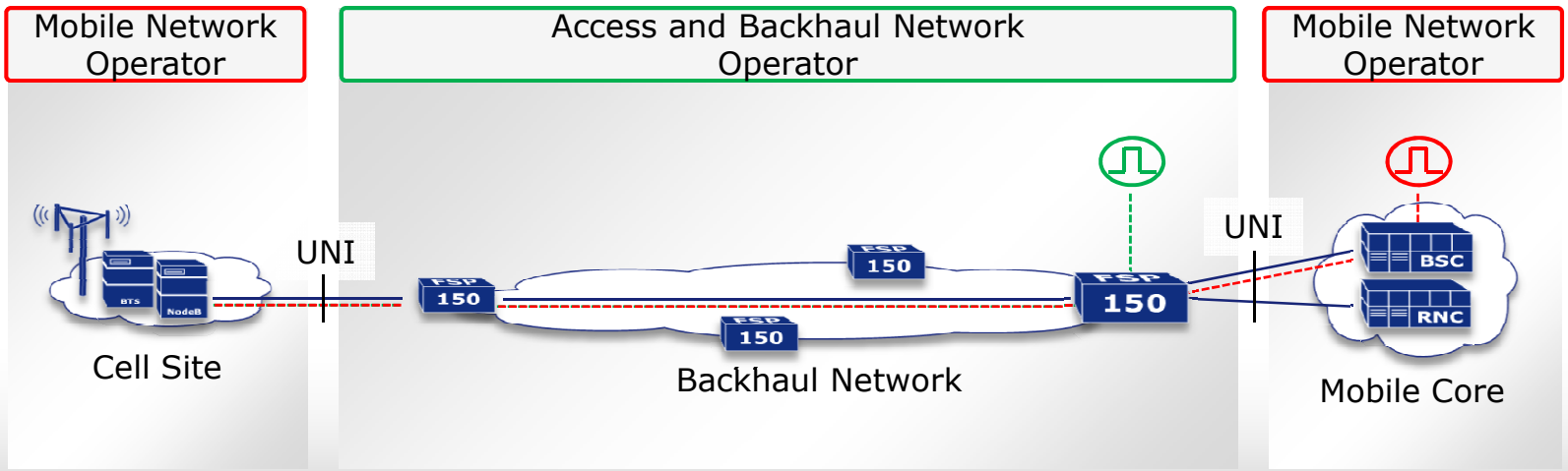
clock tower in old city of Neuchatel

OSCILLOQUARTZ
An ADVA Optical Networking Company

Delivery and Assurance of time and phase in Mobile Backhaul networks

OSCILLOQUARTZ
An ADVA Optical Networking Company

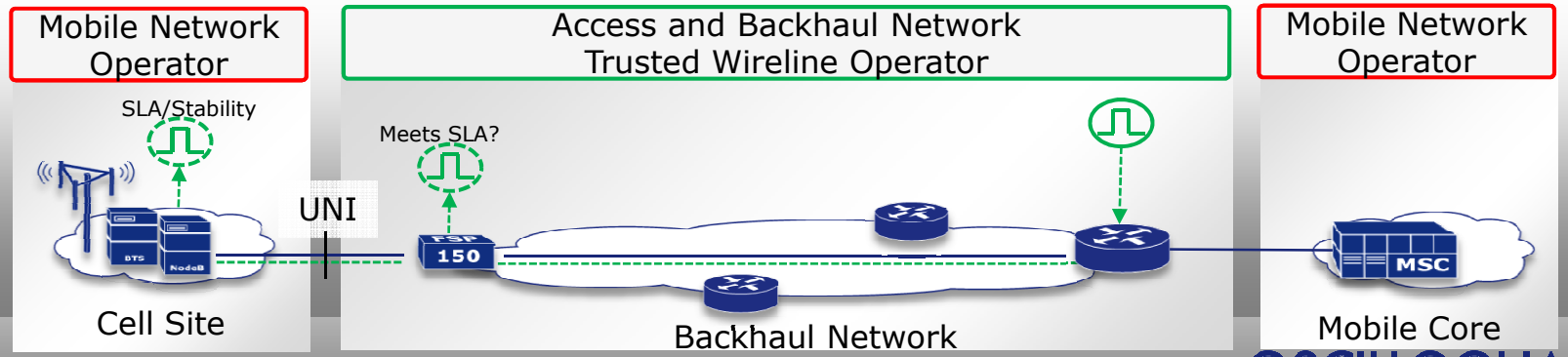
Synchronization as a Service Scenarios



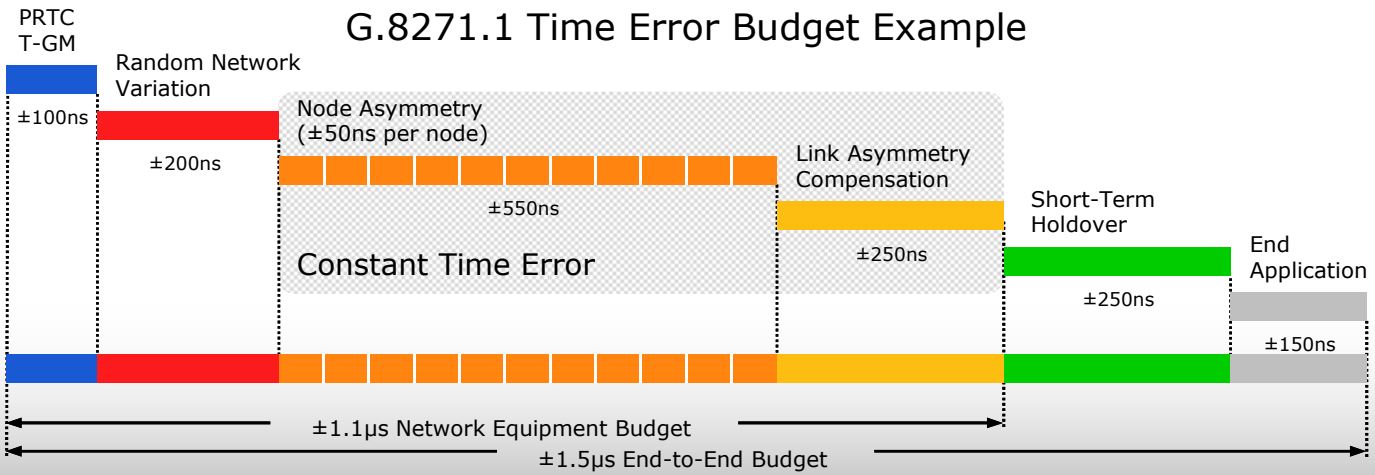
- Mobile Backhaul Network Scenarios in North America
  - Owned by the MNO transport division or MNO sister company – Not popular
  - Owned by 3rd party Mobile Backhaul wholesale provider – Most popular

Timing Distribution and Verification

- GPS timing distribution is not reliable, costly to install and maintain
- Trusted wireline provider may provide synchronization as a service
- Mobile operator may distribute synchronization over-the-top
- Both need tools to deliver timing and monitor quality
  - Prove accuracy at time of network deployment
  - Monitor stability in normal operation
  - Diagnose problem if things go wrong

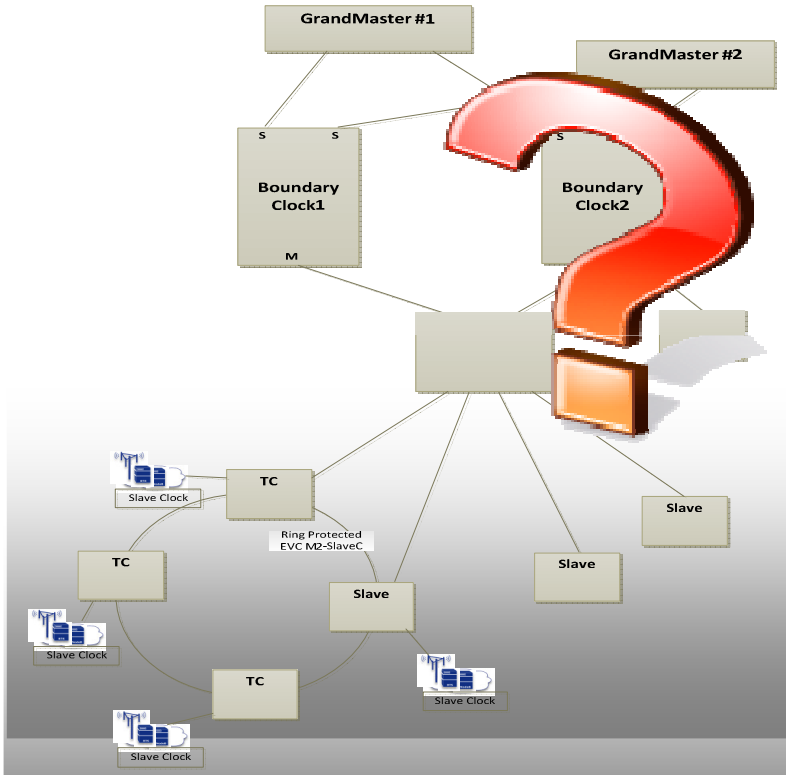


Network Performance Challenge



Constant time error uses up 70% of the network equipment budget

Time and Phase Assurance Objectives in Mobile Synchronization Network



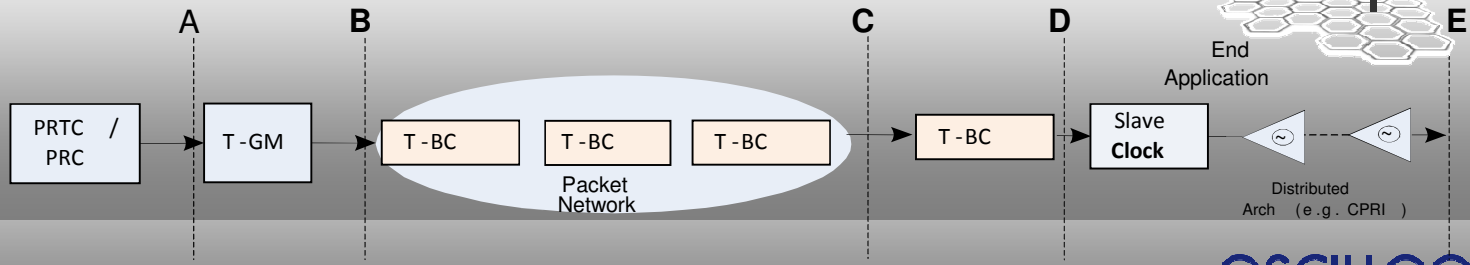
- What does the topology of my synchronization network look like?
- Are my Slave clocks synchronized to the Master?
- What is the quality of the clock recovered at end of my synchronization chain?
- What is the performance of my clock elements?
- What is the performance of my PTP distribution network?
- …

OSCILLOQUARTZ
An ADVA Optical Networking Company

Addressing the LTE-A challenges

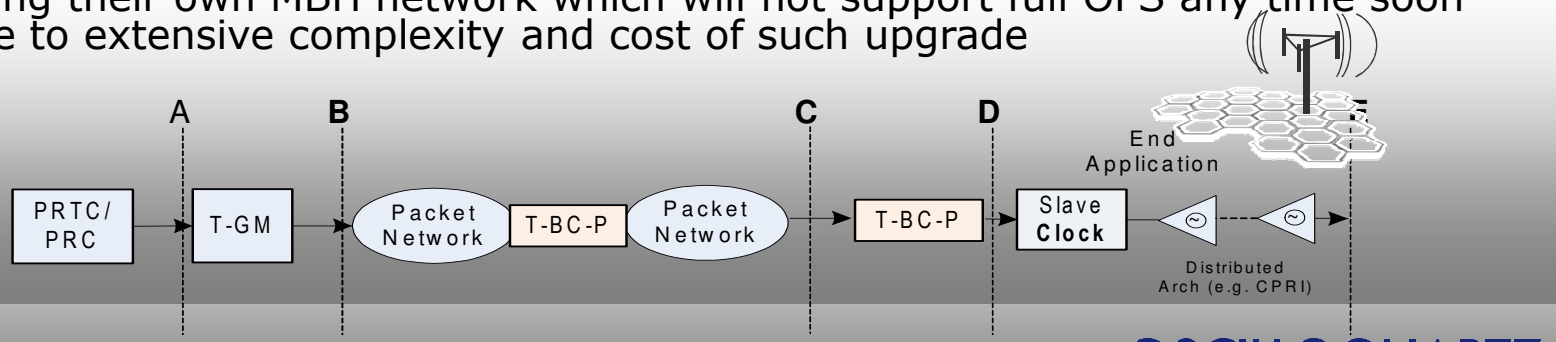
G.8275.1 Synchronization Model

- Synchronization model set forth in G.8275.1 mandates for full On Path Support of PTP plus SyncE
  - Timing support from the network is required to meet the stringent requirements for time/phase accuracy (500nsec?) in mobile networks
- On Path Support may require
  - Hardware swap out, or
  - A completly new network (Greenfield)
- G.8275.1 architecture may require major CAPEX to upgrade existing networks forcing service providers to look for more cost effective alternatives



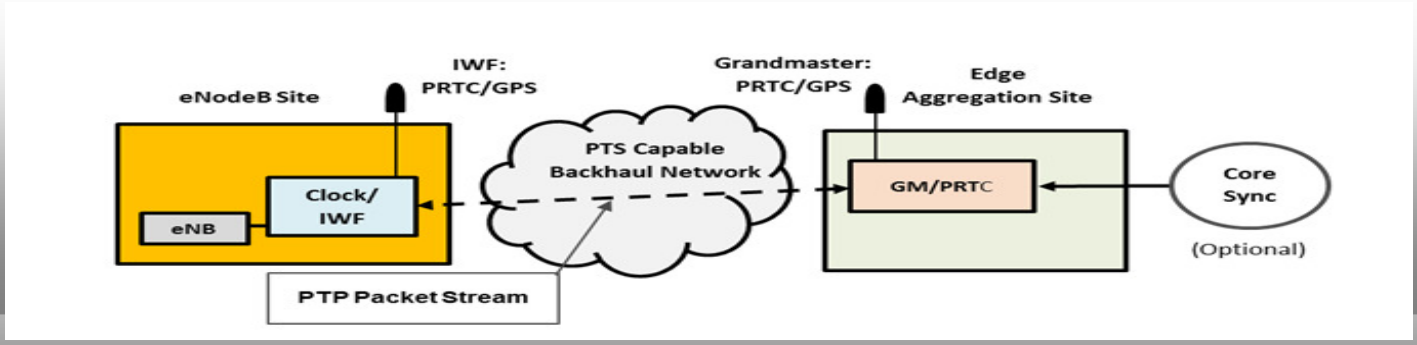
G.8275.2 Synchronization Model

- Synchronization model set forth in G.8275.2 (under study) is calling for Two options for Partial On Path Support
  - Pure Partial Timing Support as described below
  - Assisted Partial Timing Support as describe in next slides
- Pure Partial Timing Support without PRTC support near the Cell Site
- Assisted Partial Timing Support with PRTC support near the Cell Site
- G.8275.2 architecture address a real pain of Mobile Operators
  - Using multiple 3rd party MBH wholesale providers without full OPS
  - Using their own MBH network which will not support full OPS any time soon due to extensive complexity and cost of such upgrade



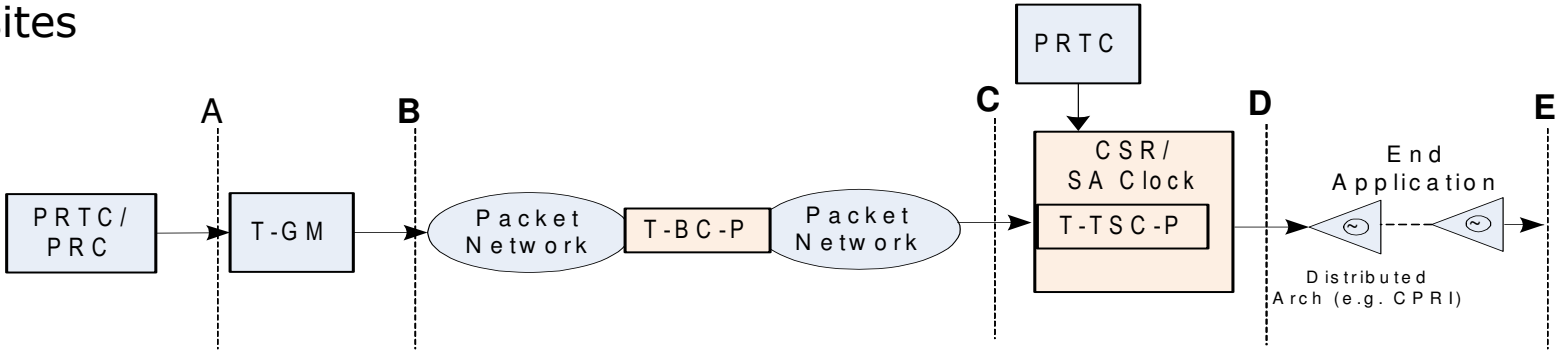
Assisted Partial Timing Support (APTS)

- The concept was introduced by Sprint at SG15/Q13 ITU meeting in Kansas on 10/2013
- Some operators already have GNSS (GPS) for synchronization of base stations for legacy network synchronization
- Known vulnerability of GNSS causing operators to seek for methods of backing up local GNSS failures with PTP
- The presence of a GNSS reference provides accurate frequency and time information that may be utilized by the PTP clock in the event of a GNSS failure. This is referred to as Assisted Partial Timing Support (APTS)

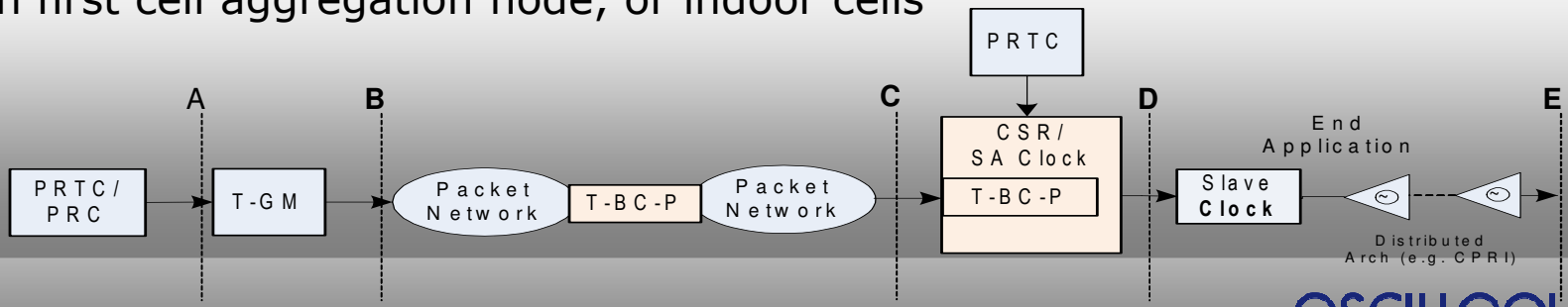


MiniGM Deployment Cases (APTS)

- The PRTC is co-located with the Slave Clock - Legacy deployment of GPS in cell sites



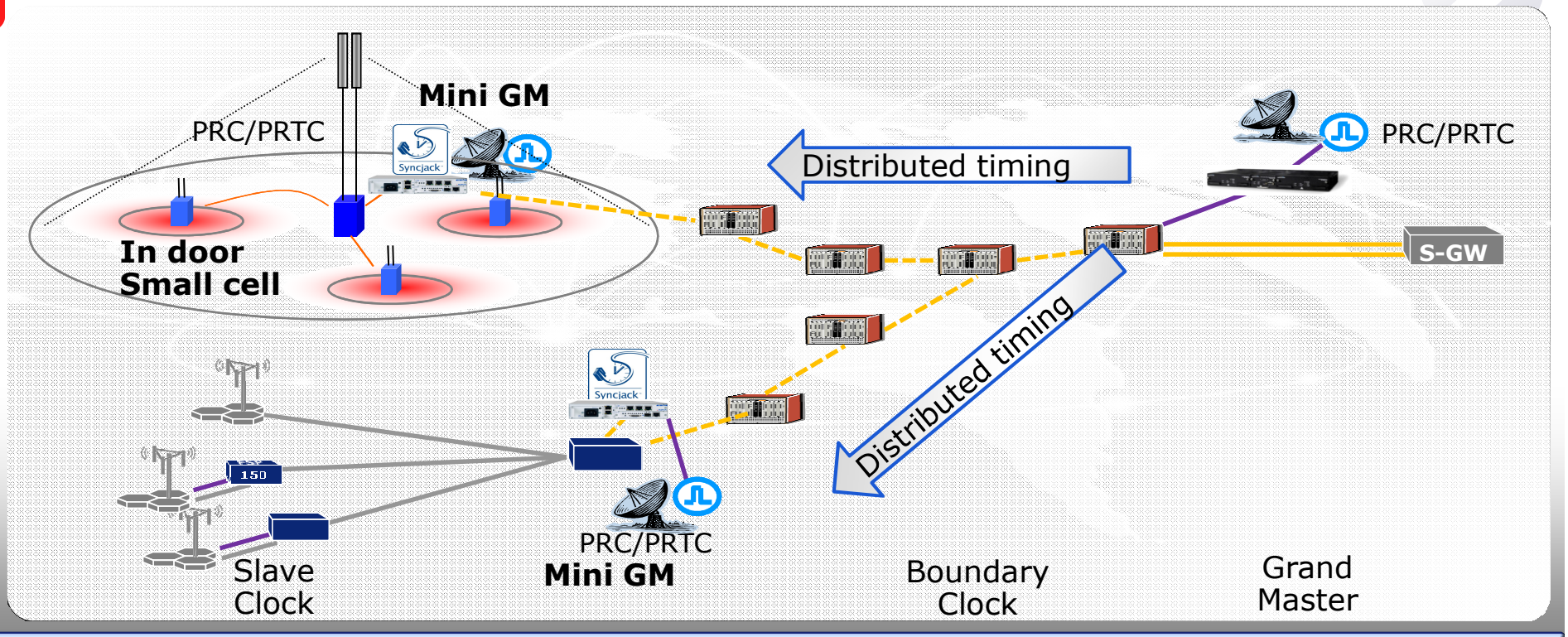
- The PRTC is co-located with the Boundary Clock – Greenfield deployment of GPS in first cell aggregation node, or indoor cells



Implementing Synchronization Delivery and Assurance in Brownfield Mobile Backhaul Networks

OSCILLOQUARTZ
An ADVA Optical Networking Company

APTS Mini Grand Master Plus Deployment



GNSS/GPS as primary reference and PTP/PTP+SyncE as secondary reference(i.e. APTS) or Vice Versa, depend on PTP reliability and accuracy

OSCILLOQUARTZ
An ADVA Optical Networking Company

Main Requirements for Mini GM Plus

- Frequency, phase and time delivery with Mini GM/BC
  - Reference A : GNSS based PRTC – G.8272
  - Reference B : PTP or PTP+SyncE
  - Ref A as Primary and Ref B and Secondary clock source without good PTP On Path Support for APTS
    - Or vice versa with full On Path Support
  - Support relevant holdover requirements during GNSS outage
  - GNSS based asymmetric delay calibration which improve PTP accuracy
- Frequency, phase and time assurance with Mini GM/BC
  - Measurement of the relevant KPI related to Network and PTP recovered clock/phase/time
    - BC quality in the same node
    - Slave clock quality in the remote Macro and Small Cells nodes
  - Collect slave clock quality of multiple eNB at a time by using multiple PTP passive probes in one device

OSCILLOQUARTZ
An ADVA Optical Networking Company

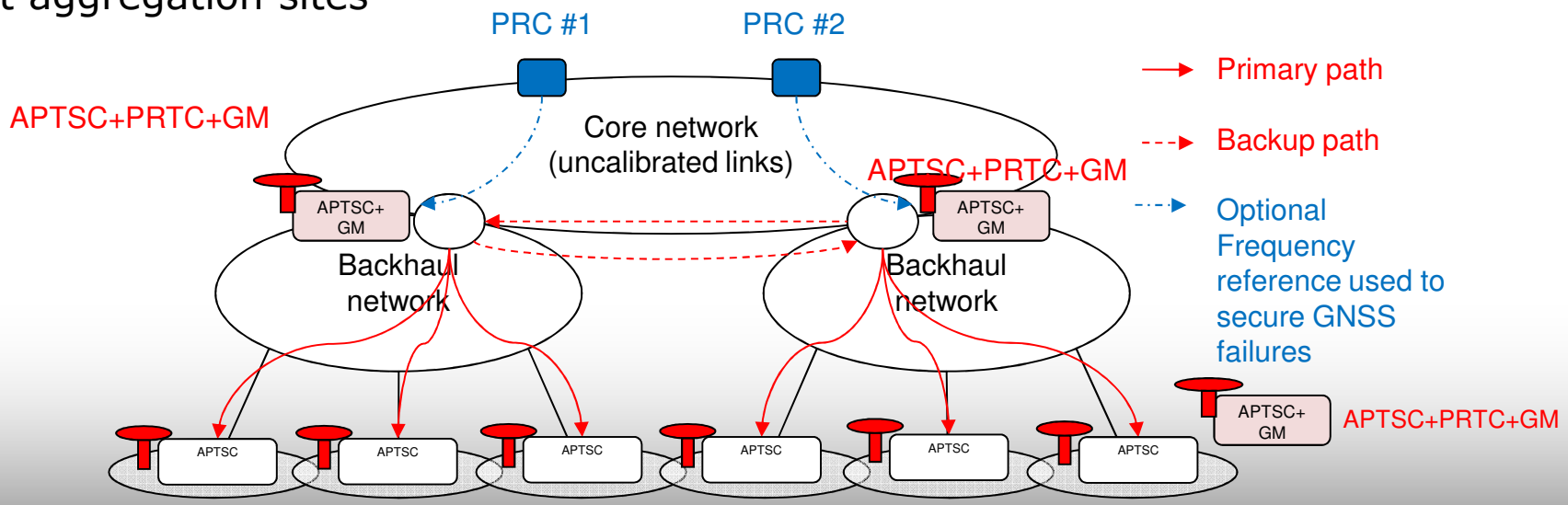
eNB Sync Key Performance Indicators

- The GNSS/GPS reference can be used for calculation of the relevant sync KPI
- Clock related KPI
  - TIE and MTIE Masks
  - Maximal Time Error (TE)
- Clock related KPI measurement can be done in 2 ways
  - Based on measurement of physical clock (i.e. 1PPS)
  - Based on measurement of packet timing signal (i.e. Passive Probe)
- PTP Network related KPI
  - PTP Packet counters (received /lost)
  - Network Asymmetry
  - Path delay /Mean path delay (min, max, average)
  - Floor Packet Percentage (based on G.8260)

OSCILLOQUARTZ
An ADVA Optical Networking Company

Mini-GM Location Option 1 - APTS

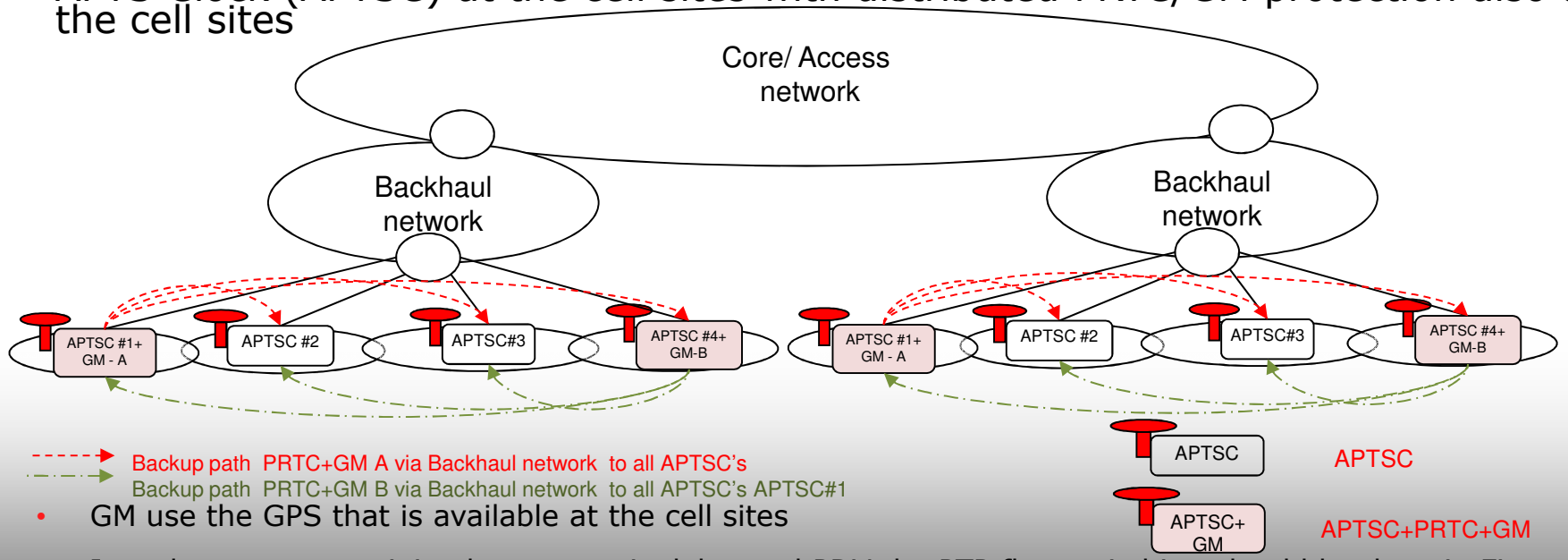
- APTS Clock (APTSC) at the cell sites with distributed PRTC/GM/BC protection in First aggregation sites



- In order to assure minimal asymmetric delay and PDV the APTSC(BC)+PRTC+GM should be deploy in First aggregation node
- Protection of the cell site GPS outage with PTP flow from the GM in First aggregation node with optional SyncE from the core

Mini-GM Location Option 2 - APTS

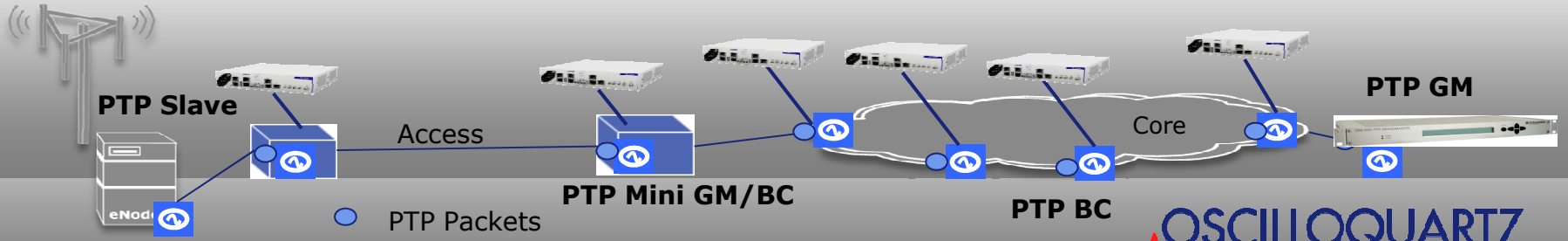
- APTS Clock (APTSC) at the cell sites with distributed PRTC/GM protection also at the cell sites



- GM use the GPS that is available at the cell sites
- In order to assure minimal asymmetric delay and PDV the PTP flow switching should be done in First aggregation node
  - The X2 EVC in LTE-A can be used if available
- Protection of the cell site GPS outage based on PTP flow from distant GM in another cell site of the same cell site cluster

Hybrid Synchronization Network without a pain

- The majority of the Mobile Backhaul (MBH) Networks has limited support of Phase Synchronization if at all
- Sync tool box as add on to Existing (Brownfield) mobile backhaul networks
  - Fits Mobile Backhaul Operators and Mobile Network Operators
  - Allows delivery and assurance of the synchronization services
- Sync tool box which operate as TS, BC or GM and attached to existing Network Nodes
  - Enabling PTP overlay on top of existing MBH Networks
- Low cost, ease of installation and operation, PTP performance monitoring and diagnostic, Synchronization management



Sync Manager Requirements

OSCILLOQUARTZ
An ADVA Optical Networking Company

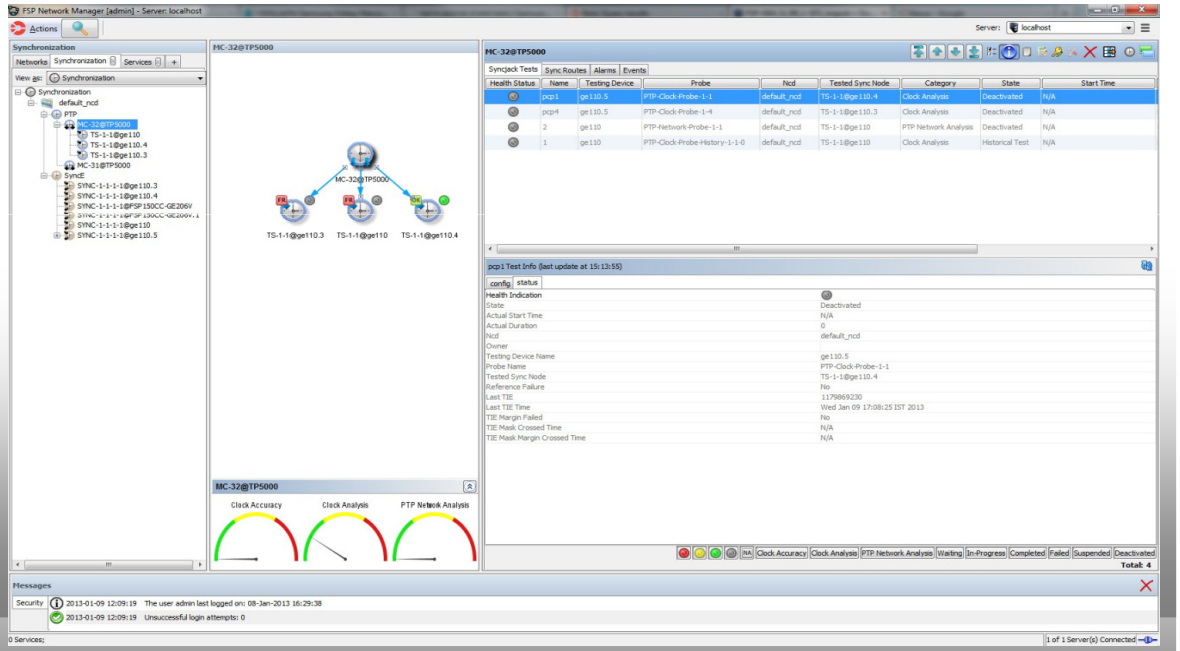
Sync Manager requirements overview

- Sync Manager need to learn, monitor, configure and display synchronization network topologies (IEEE 1588/PTP, SyncE and hybrid), a.k.a. Sync Map
- Sync Manager need to displays *Sync Routes* in order to identify an active clock stream from Master to Slave
- The *Sync Routes* should enable to identify problems in any of the nodes and also allows recognizing loops
- Sync Manager should allow user to initiate, configure, schedule, and display Sync probe tests and test results
- Sync Manager should present Sync Health status per Sync Node and also aggregated Sync Health status e.g. in Network Clock Domain (NCD) or in selected Master-Slave Hierarchy.

Sync Manager functions

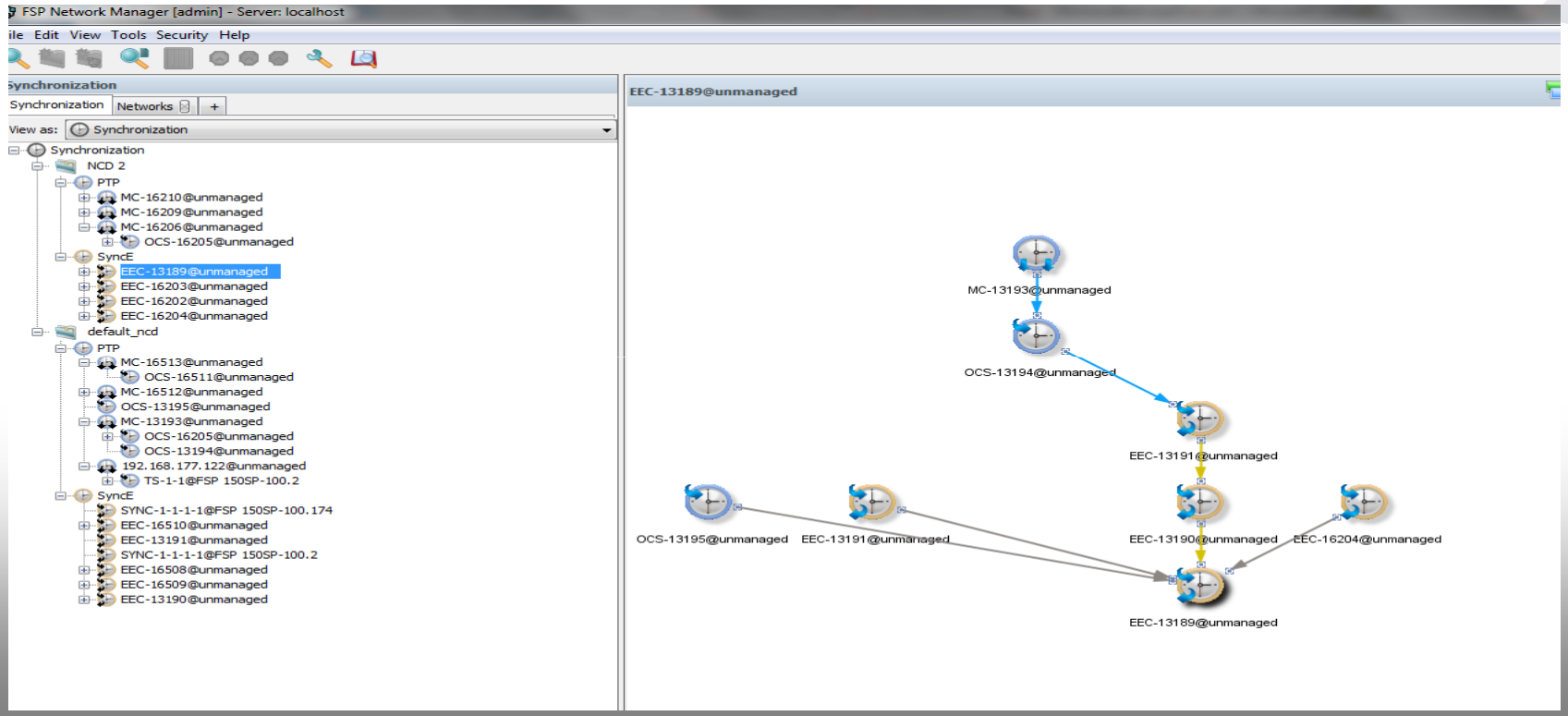
- Sync Map
  - Topology Map and Tree
  - Hierarchy and clock distribution
  - Clock status
  - Sync Health
- Sync Routes
  - Route Info
  - Route alarm and status
  - Route Statistics
- Sync Components
  - SyncE Node
  - PTP BC
  - PTP MC
  - PTP OC-S
  - Network Clock Domains

- Monitoring and diagnostics for Clock Accuracy, Clock Analysis, PTP Network Analysis



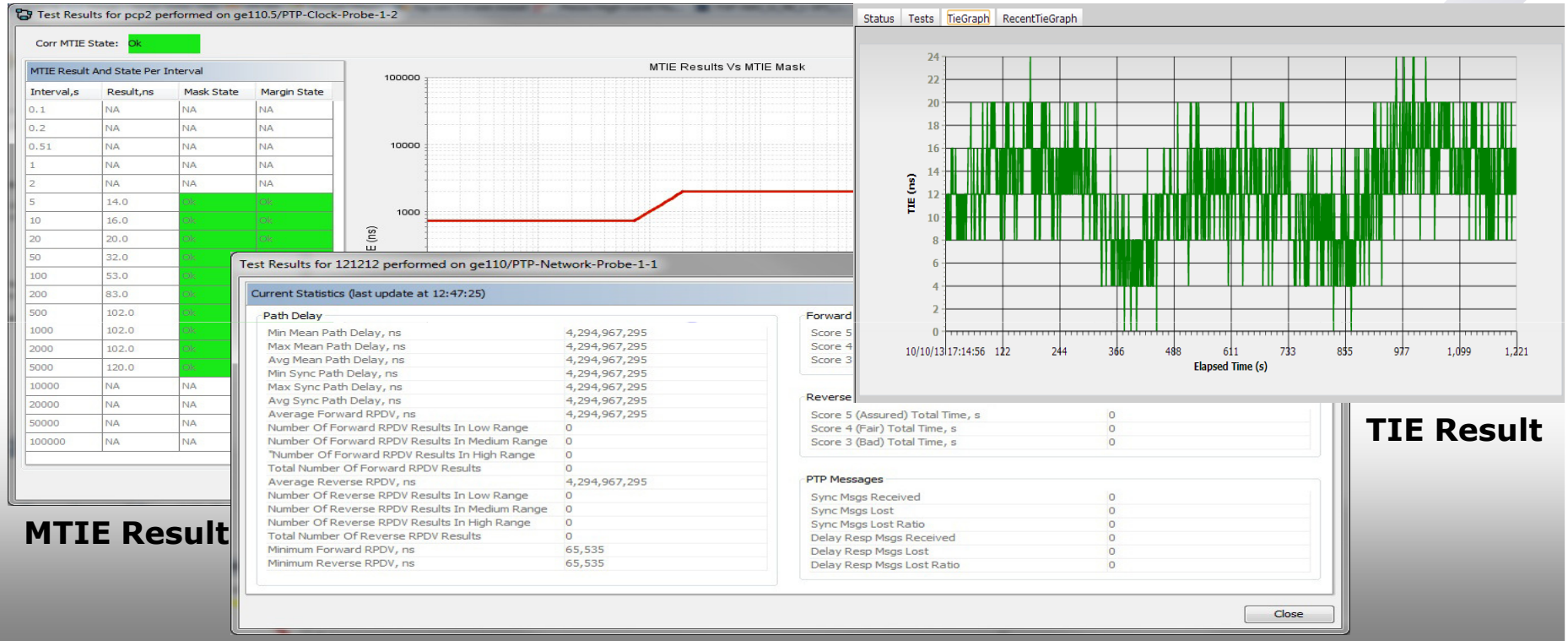
OSCILLOQUARTZ
An ADVA Optical Networking Company

Sync Map with active Sync Route



OSCILLOQUARTZ
An ADVA Optical Networking Company

Sync Manager – Test Results Display



MTIE Result

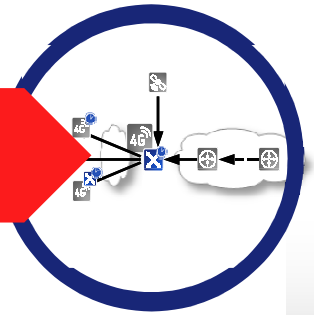
TIE Result

PTP Network Statistics Results

OSCILLOQUARTZ
An ADVA Optical Networking Company

Summery

The need



- Phase Delivery
- Phase Assurance
- In Service Monitoring

The Options

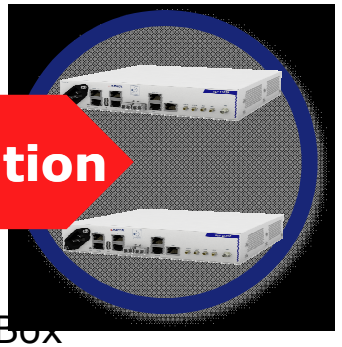
G.8275.1

ITU

G.8275.2

- Full On Path Support
- Partial On Path Support
- Assisted Partial Timing Support

The Solution



- Sync Tool Box
- One Device for all Options
- End-to-End Assurance
- Built in Monitoring

There is a need for smooth migration from legacy to next-generation networks

OSCILLOQUARTZ
An ADVA Optical Networking Company

OSCILLOQUARTZ

An ADVA Optical Networking Company

Thank You

osa@oscilloquartz.com