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An ADVA Optical Networking Company

Small and Macro Cell deployment Mobile Operator- A case Study

Anil K Reddy
Director BD APAC
areddy@advaoptical.com

Why Small cells?

While Small cells are not new to mobile world, LTE is an indispensable driver for small cells mainly due to its spectral efficiency today and tomorrow (LTE-Advanced).

Small cells key purposes:

• Increasing capacity and Coverage in areas with high user densities, mostly in (indoor) public places in dense urban areas and inside buildings with a high subscriber density

• Reutilization of spectrum, Improving throughput, data rates and service quality in important, user-dense, marginal-coverage areas that cannot be adequately reached by macro cells both outdoors and indoors

• Extending handset battery life since higher-order modulations, broader bandwidth, MIMO, and enhanced processor power all drive up handset power consumption while smaller cells reduce power consumption

Timing requirements for Small and Macro cell

The demands for timing is clearly evident

- Network operators typically mandate tighter timing requirements for public access small cells much stringent than the standards demand and better than often specified for residential femtocells.
- The 250ppb limit for 3G femtocells is often tightened to the 50ppb used in macrocells.
- LTE-FDD requires 16ppb frequency tolerance on the transport.
- LTE-TDD requires phase alignment as well as frequency accuracy, with a tolerance of 1.5uS. Specific LTE-Advanced features, such as Co-Ordinated Multi-Point (CoMP), require phase alignment of 0.5uS.

Common Considerations for Small Cell Sync

a) GPS: Best for frequency and phase, comes with its own challenges of Cost, Vulnerability, LoS in indoor and outdoor small cells.

b) SONET/SDH: Reliable model but is in phase out mode - Support frequency only.

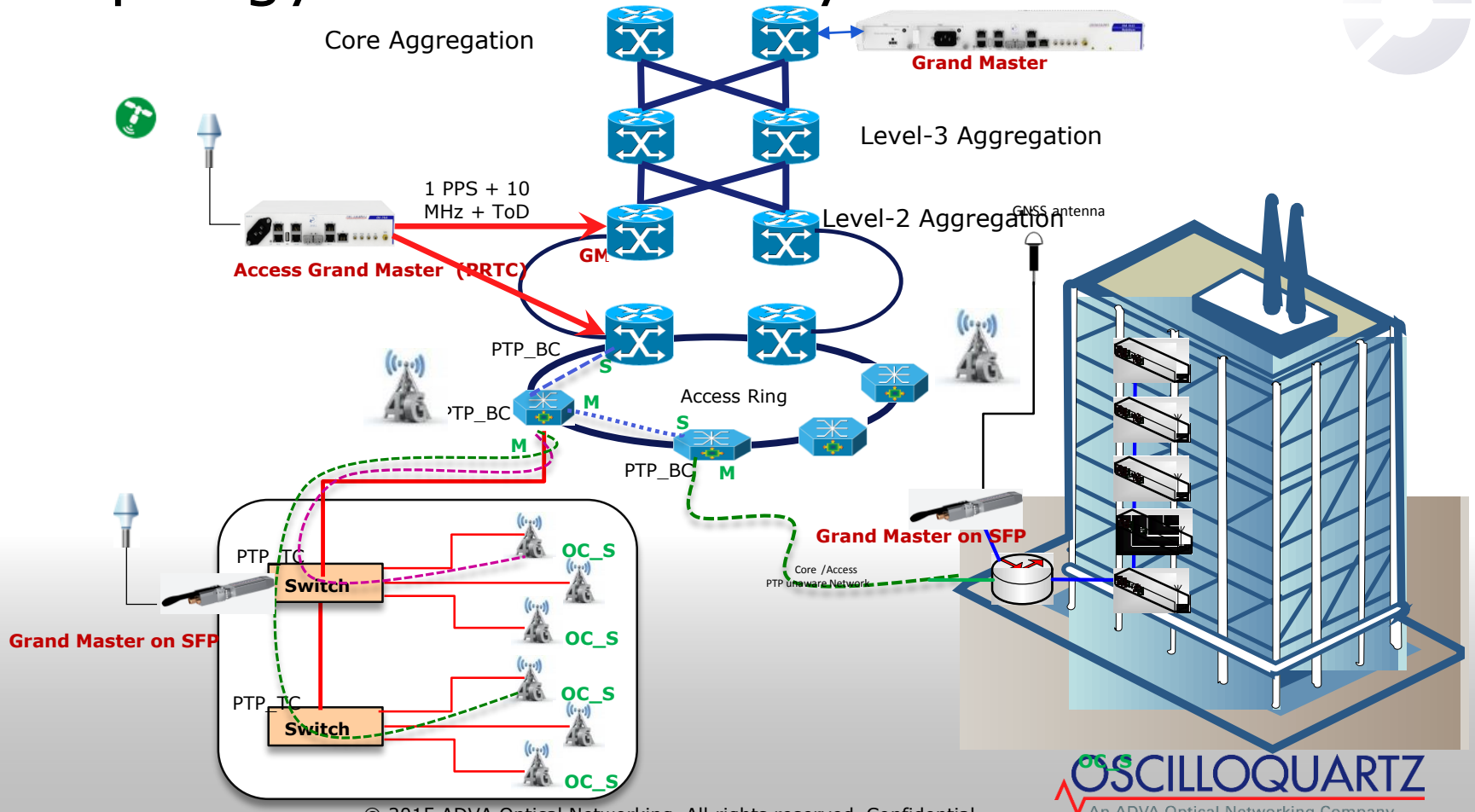
c) Synchronous Ethernet (SyncE): Good Frequency distribution model, (donot support phase) synchronisation. Challenge in Heterogeneous network

d) NTP (Network Timing Protocol), The low cost solution is attractive. Challenge to offer highly accurate phase requirements.

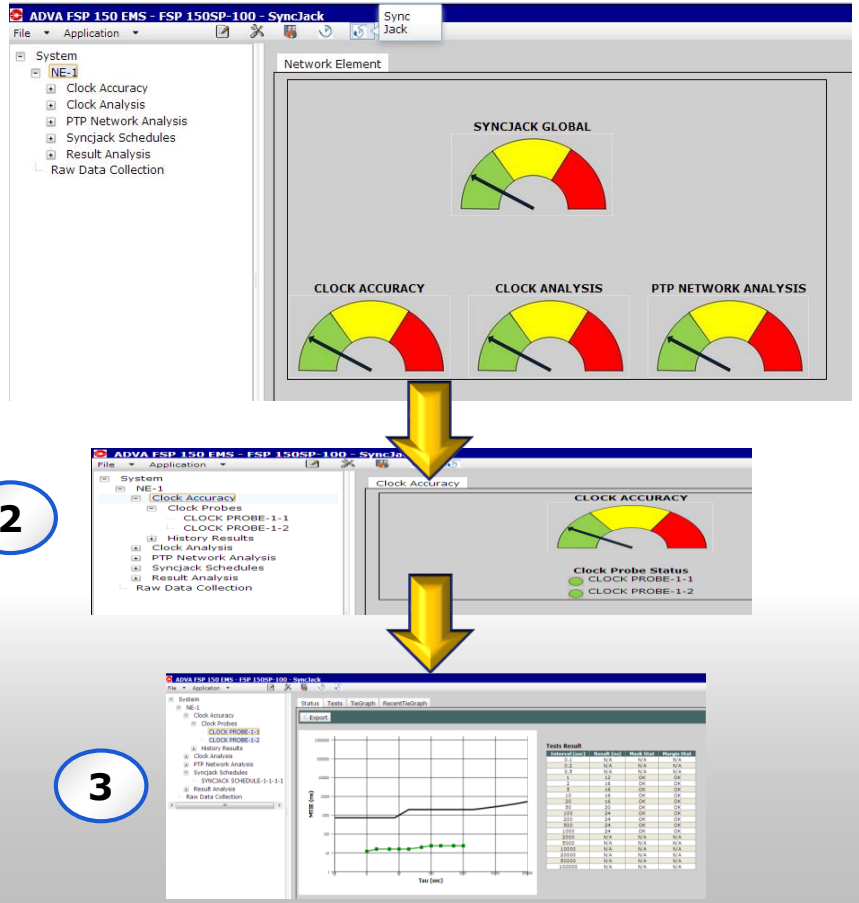
e) Precision Time Protocol (PTP) IEEE 1588v2: A packet timing scheme provides both accurate frequency and phase timing. Probably the best and low cost solution for both Macro and Small cell when combined with Sync E provide the below benefits.

- Accuracy
- Holdover time: .
- Resiliency
- Cost:
- Operational Flexibility

Topology – Small cells Sync



Sync Probing and Assurance



- Several layers of indicators allowing for step by step monitoring and troubleshooting
- First layer provides global indication of the Synchronization status
- Second layer shows performance indication of each reporting tool
- Third layer provides detailed information for fault localization of performance analysis

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Salient features implemented

- Access Grand Master approach
- APTS implemented for resiliency.
  - Asymmetric Delay Compensation.
- BMCA Implementation
- Better Holdover achievement on SYNC-E and APTS
- Sync probing and assurance
- Multiple profiles implemented on the same GM.
  - Frequency profile 8265.1 for FDD based Small Cells
  - Phase Profile (Default phase now and 8275.1 in preparation)
  - Translation of Frequency profile to Default Phase profile and vice versa Non Standard implementation.

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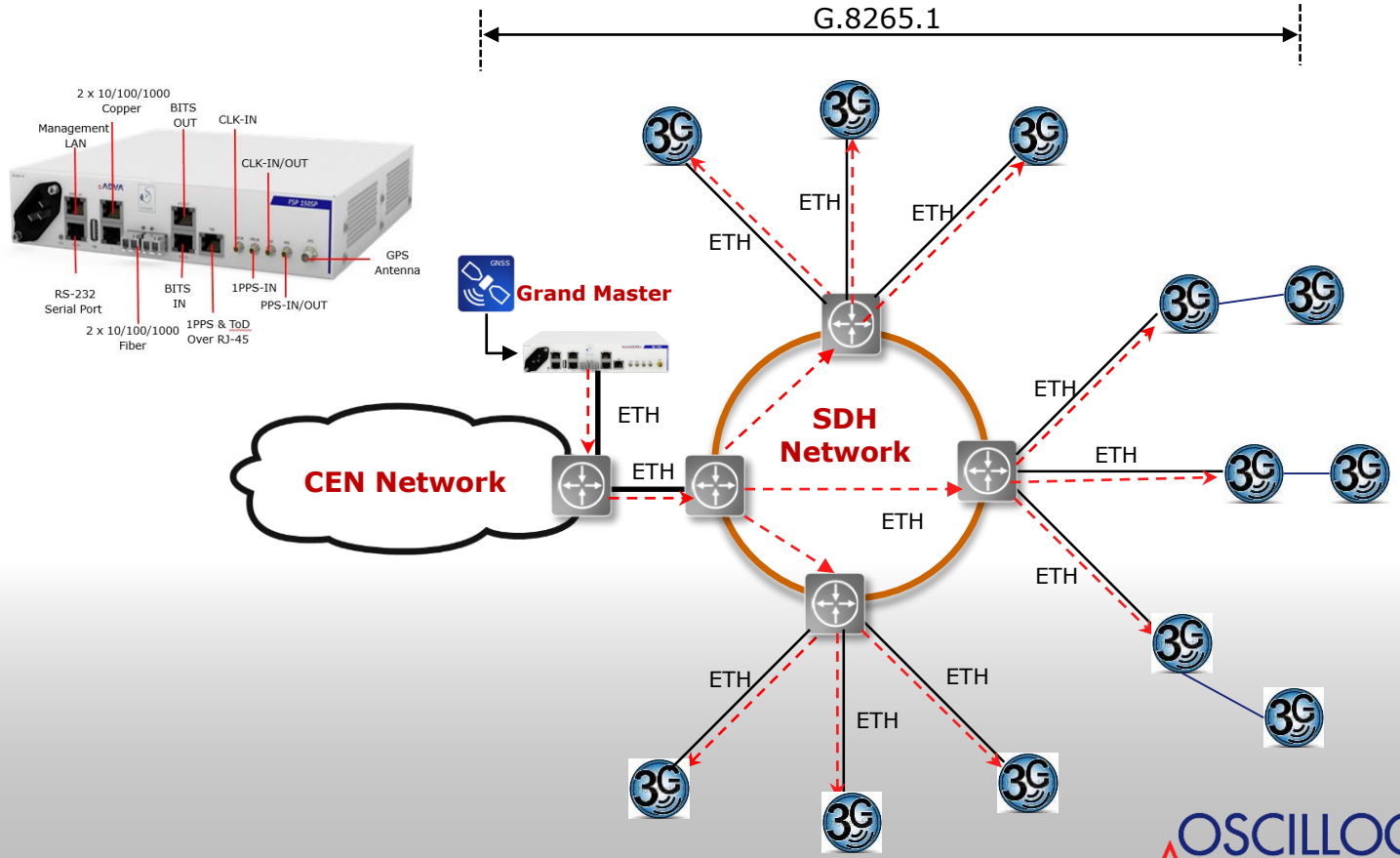
Small Cell Sync Frequency based

Access Grandmaster at First Aggregation



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Customer challenges and a working solution

Customer Challenge:

- Customer was using Sync-E in their CEN (carrier Ethernet Network) network to Synchronize the 3G Small cells
- There are few locations where they do not have CEN presence, where it becomes very difficult to provide Sync

Agreed Deployment Plans

A) Edge GM at the Access

1) Placing an Access GM at the EoSDH access network.
2) The edge GM will provide G.8265.1 Sync to the connected small cells 3G Small cells

B) Access GM at the aggregation

1) Placing Access GM at the CEN aggregation location.
2) The Access GM will serve all the 3G small cells which are aggregated and backhauled through EoSDH network.

Solutions for 4G Small cell connectivity over Copper (SHDSL.bis Technology)

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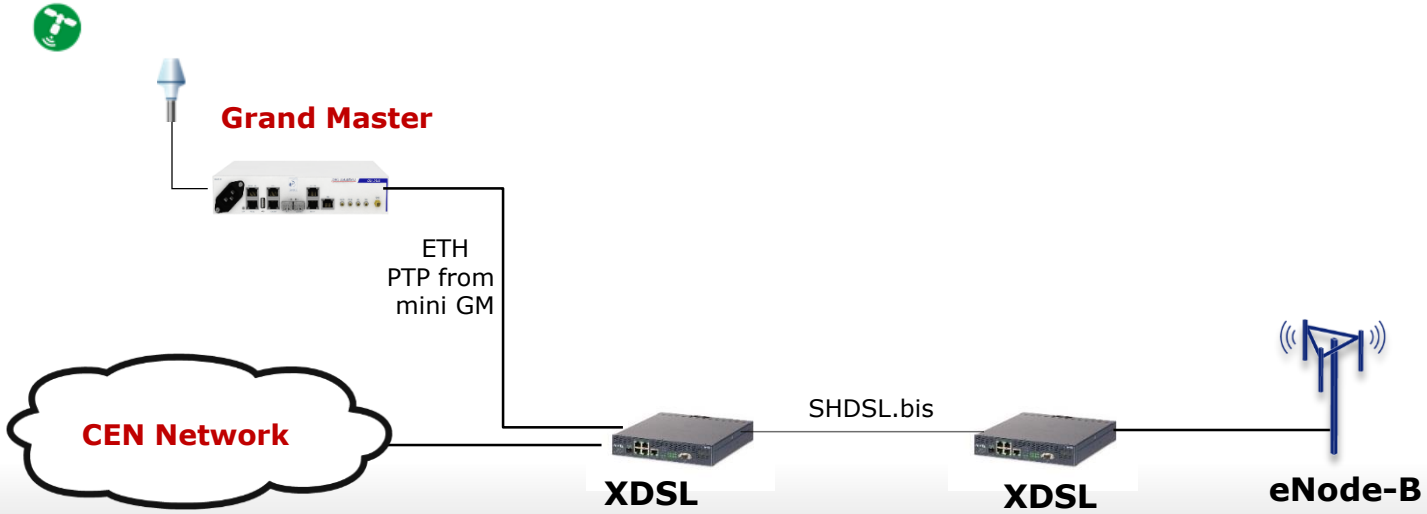
Phase Sync for 4G small cells over Copper



Customer challenges and working solution

Customer's Challenge:

- No fiber access to all Small Cell locations.
- Prefer to use the existing copper infrastructure in the ground
- Hence, they are forced to look for some solution to serve the small cells using copper pairs to roll out the services at a faster manner

Solution:

1) Access Grandmaster at the DSL POP location
2) Ethernet multicast profile as the small cells
3) PTP VLAN Flow tag PTP packets on a specific VLAN
4) XDSL modems which are used between the POP and the cell site will prioritize the PTP traffic using the VLAN marked by the Grandmaster

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Questions?

Thank you!

info@advaoptical.com

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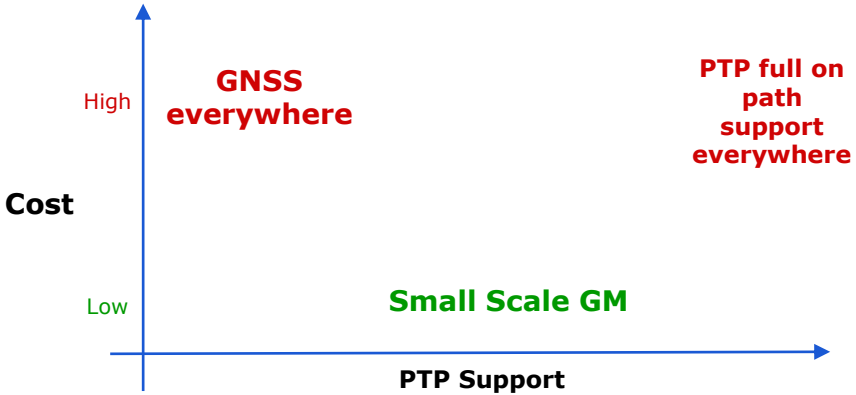
Small Scale GM Protection

How can the Small Scale GM be protected against local GNSS outage?
Secondary sources

1. Sync-E (time holdover) for core network or adjacent PTP GM
2. PTP input (Slave) locked to core or adjacent PTP GM (APTS)
   - Can be used as secondary frequency and/or time source

Business Case - Small Scale GM Vs. GNSS everywhere



- Only one GNSS antenna is needed every N base stations (I.e. N=4..64)
- (Cost of small scale GM divided by N + one antenna installation) << (N x Cost of GNSS antenna installation)

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