Synchronization strategy for mobile network today

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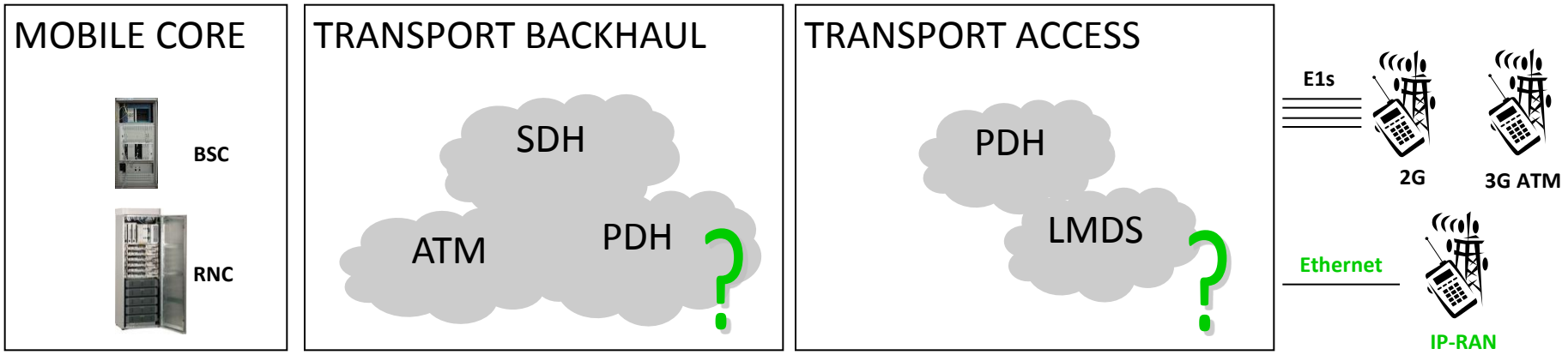
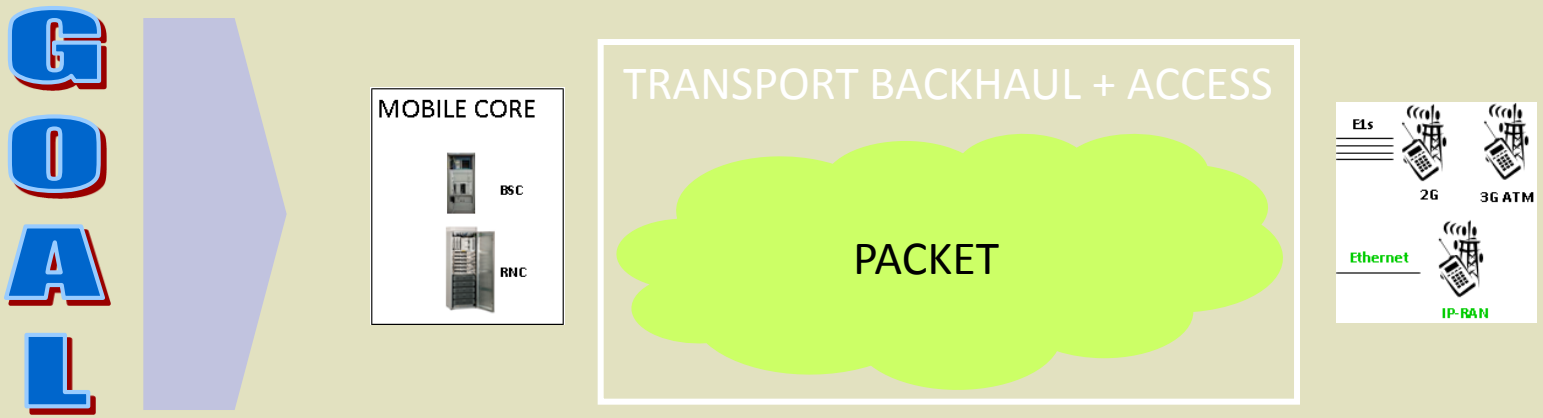
Legacy Network



- Current BTSs and ATM NodeBs require E1s connectivity
  - Legacy transport systems are adequate for this requirement
- New traffic boom (data) requires different approaches
  - IP-RAN NodeBs that require more bandwidth and Ethernet interfaces
  - How to transport this “new” traffic?

Packet Network

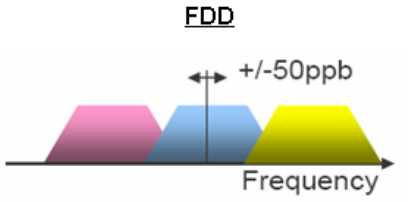


- Single Network
  - Any client
  - Any interface
  - Any traffic
- Increased Capacity
  - Statistic gain
  - QoS
- OAM
  - E2E management
  - E2E provisioning

Mobile Network Requirements (source: VF R&D)

Frequency Sync

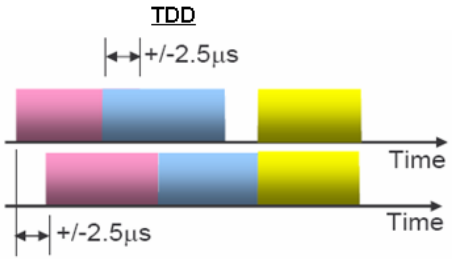
Reduce Handover Failures
Drive oscillators in the base station to produce accurate frequency signal over air interface (FDD systems)



Requirements
- **3G FDD, GSM, LTE-FDD**
  - **+/- 50 ppb** (macro cells)
  - **+/- 100-250 ppb** (pico/femto)

Phase Sync

Increase System Efficiency
Frame alignment to minimize timeslot interference (reduce guard interval) in adjacent base stations (TDD systems)



Requirements
- WCDMA **TDD** systems
  - **+/-2.5 µs** (micro second) between base stations is required **(+/- 1.25 µs between ref and BTS)**
  - CDMA 2000: +/-3 µs time alignment
- Mobile WiMAX
  - **< +/-1.4 µs** (**+/- 1.0 µs for some WiMAX profiles**)

Frequency Sync for Real Time Applications

Guarantee good user experience
Avoid pixilation, waves, video freeze, etc.

Requirements
- Voice – 32 ppm
- Two way video – 50ppb
- HDTV – 100 ppb

Drivers & Standards for sync

Why Synch over Packet ?

- E1 services will continue to be required for a long time
- But transport based on TDM is being replaced by ethernet
- Ethernet is asynchronous

  (… or at least used to be!)

What's going on all Mobile operators?

- All mobile operators are building fibre based metro ethernet networks and deploying IP MW to prepare for IP NodeBs, HSPA+ and LTE

→ We need to synchronise the cell sites

Which technologies / standards ?

- Adaptive Clocking
- NTPv3
- Synch-Ethernet

→ IEEE1588v2
(PTP – precision time protocol)

The target Synch-over-packet architecture for macro cells is a mixed of SynchE and PTP

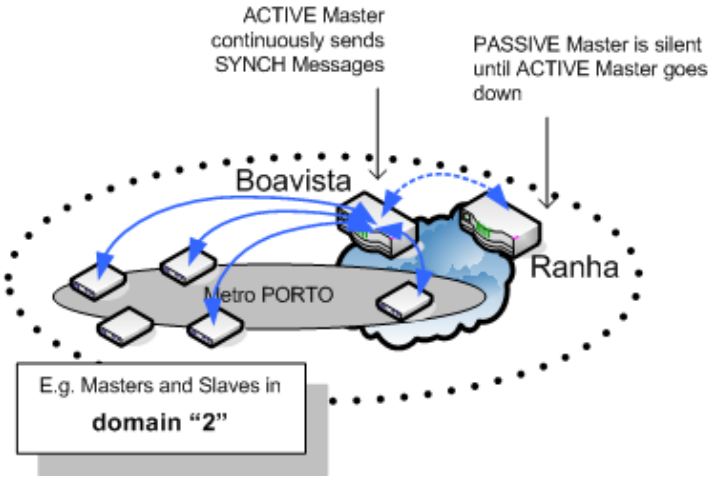
Synchronization strategy for packet network today

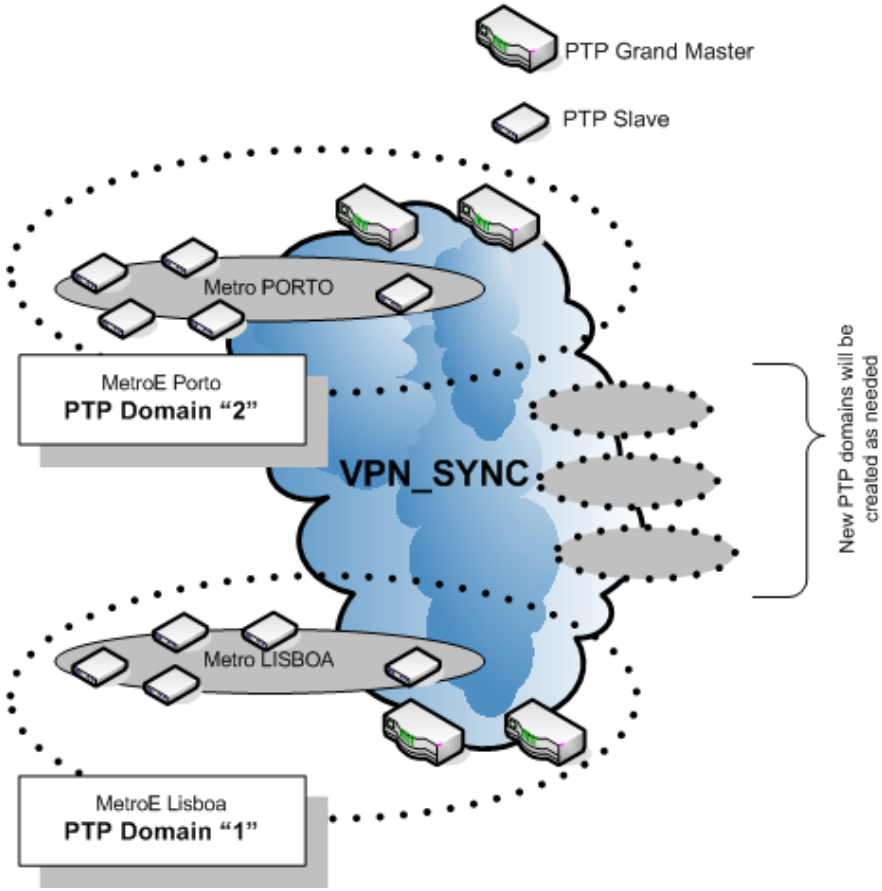
- For this new packet network it will be require to use the following Sync techniques:
  - **First option should be always SyncE**
    - if it is only required Synchronization in frequency. Deploy Synchronous Ethernet interfaces on access and backhaul transport using self built transmission.
  - **Second option should be 1588V2 UDP/IP**
    - unicast in both ways (Master to slave and slave to master) - (ITU-T G.8265.1). For those backhaul cases where we are forced to use legacy or leased Asynchronous Ethernet.
- Time of Day or Phase distribution is not necessary for now (just FDD schemes are applicable). If **TOD or Phase has to be delivered then 1588V2** shall be used for this purpose.
- For **smallcells** (pico and Femto) we can consider **NTP**.

How to implement 1588V2

1588V2 Implementation

Best Master Clock (BMC) algorithm

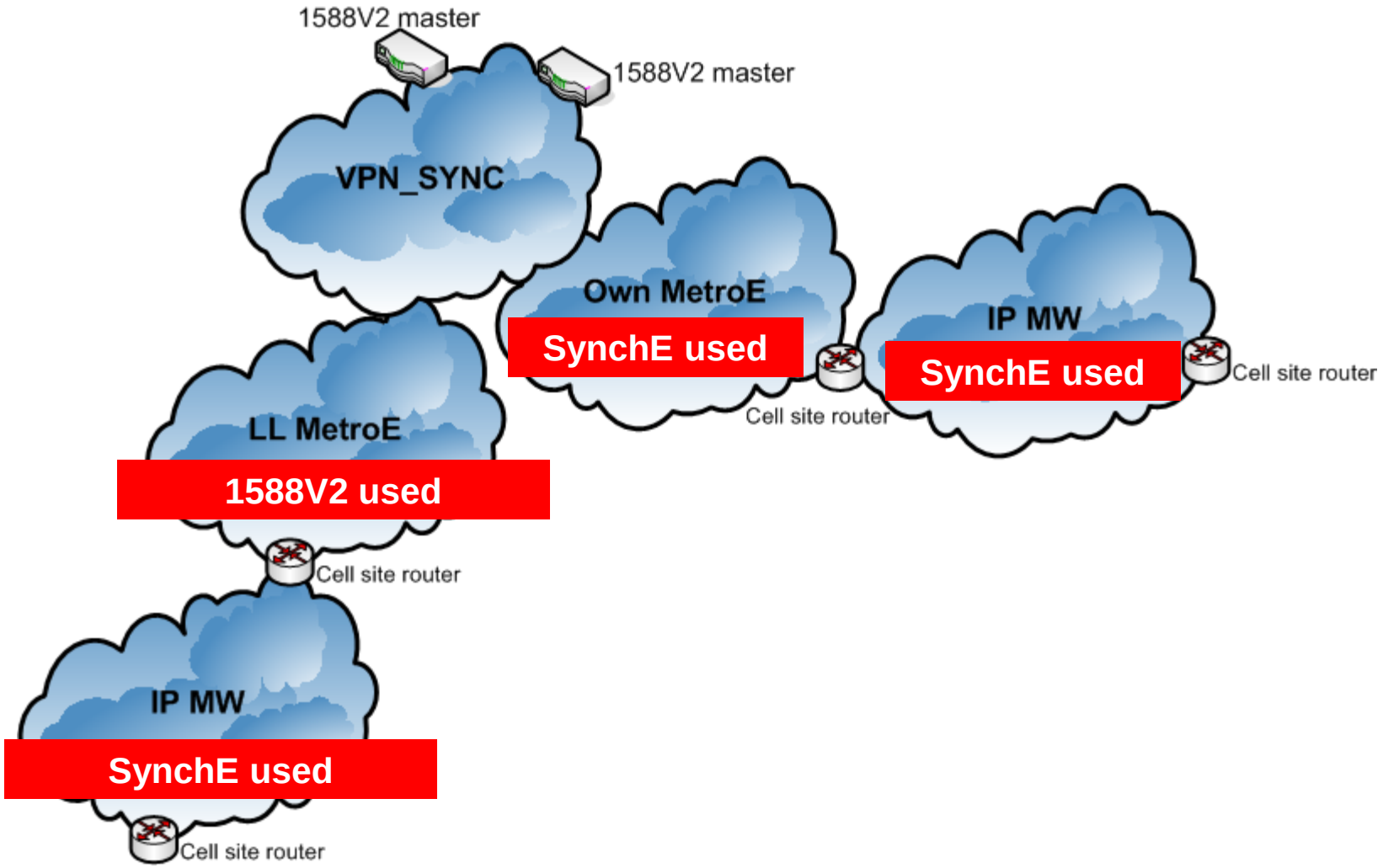




PTP Domains Dimensioning concerns today

- The network was designed trying to maintain a low number of hops between master and slave (typically 1-2 L3 and 10-15 L2)
- 1588v2 traffic is DSCP marked with ‘EF’ for QoS management and goes through priority VLAN in Metro rings
- New PTP domains may be required if:
  - The number of hops between a slave and its masters is too high
  - The max number of slaves per master is reached

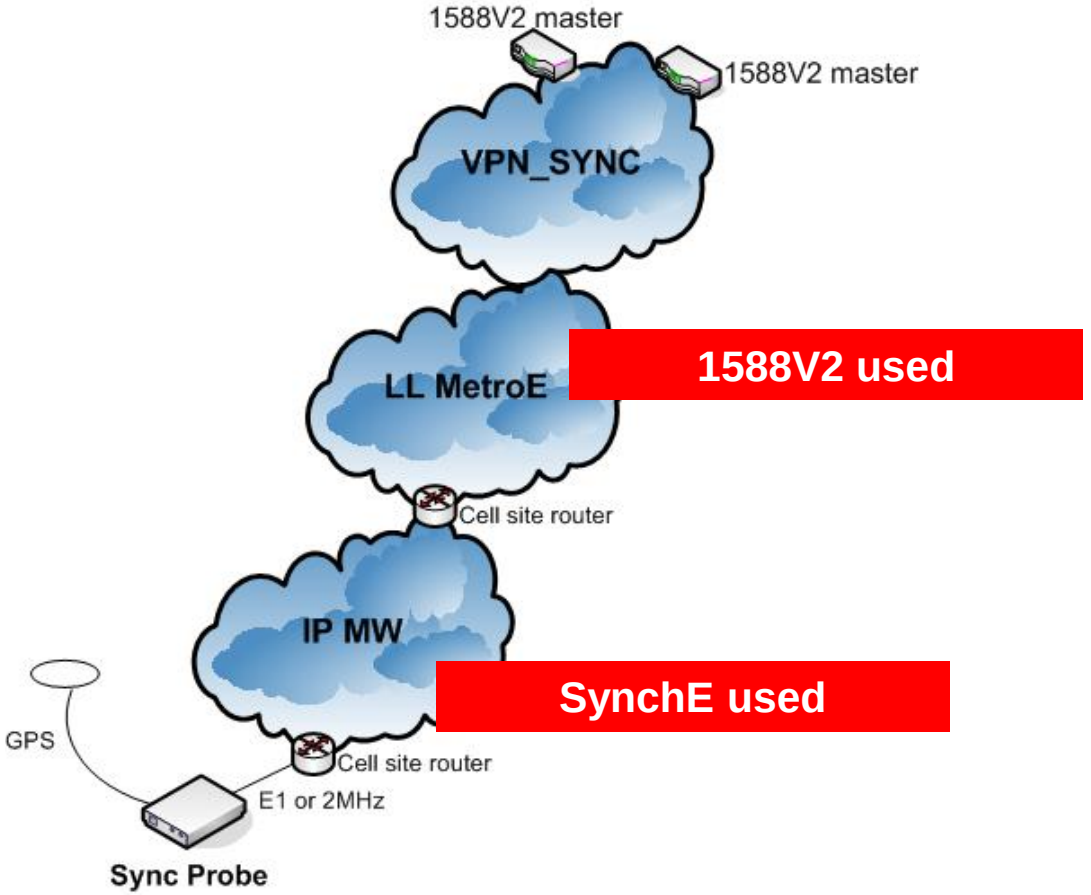
Sync rollout scenarios examples



Performance

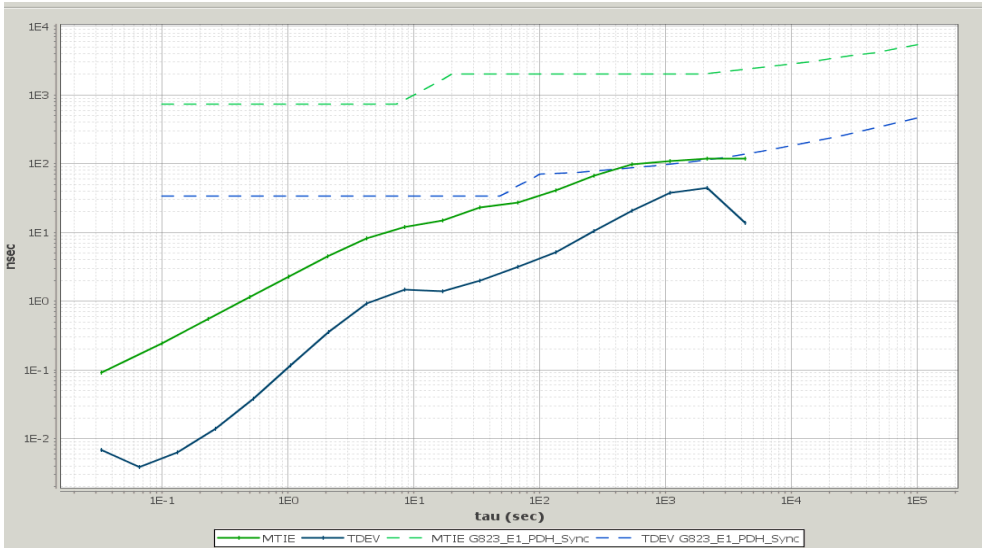
How to check if sync quality is good?

- Check if handover failure rate increases in a certain cellsite
- Some sync probes deployed in certain areas is good to have a sample of the sync quality in our network

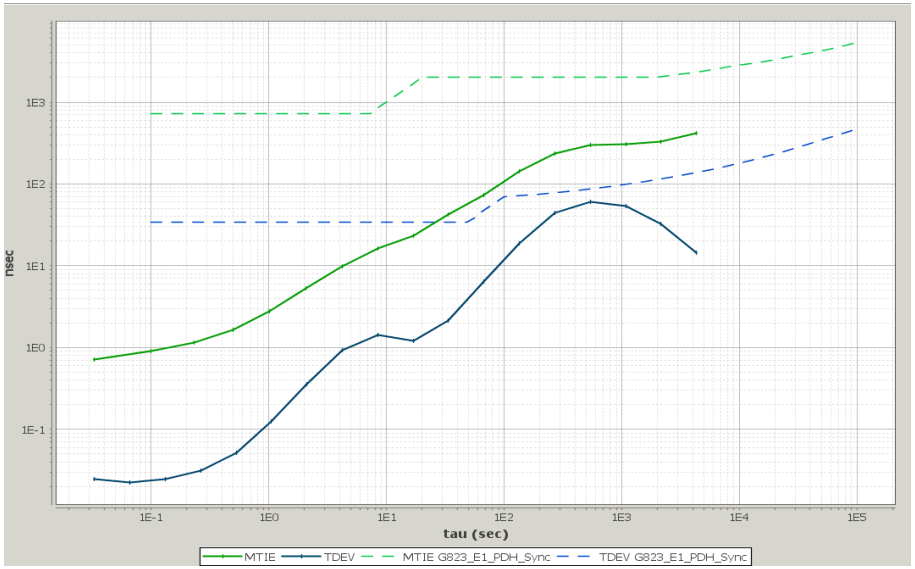


Live Network Synch-over-packet Performance

Slave 1588V2 supplier A in fibre



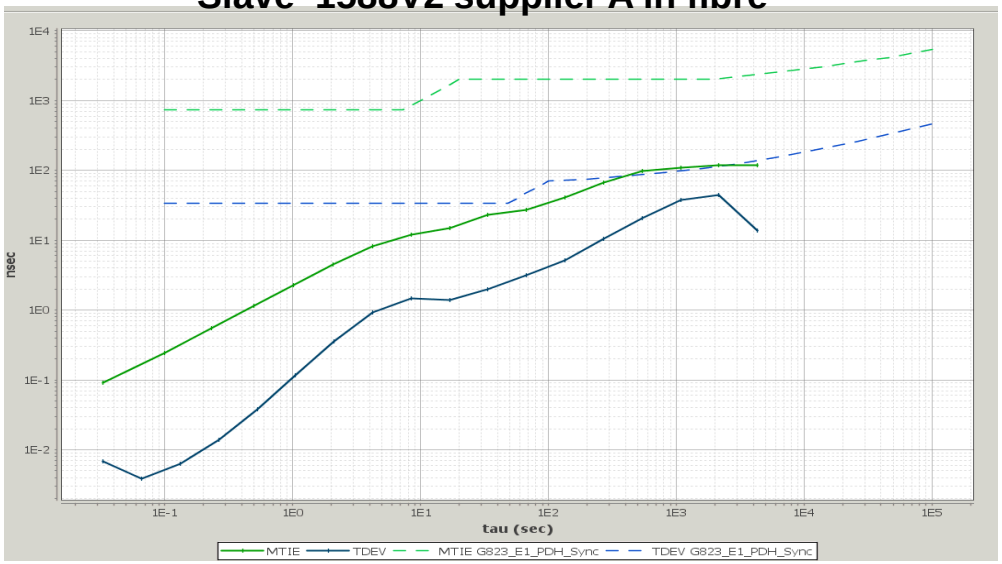
Slave 1588V2 supplier B in fibre



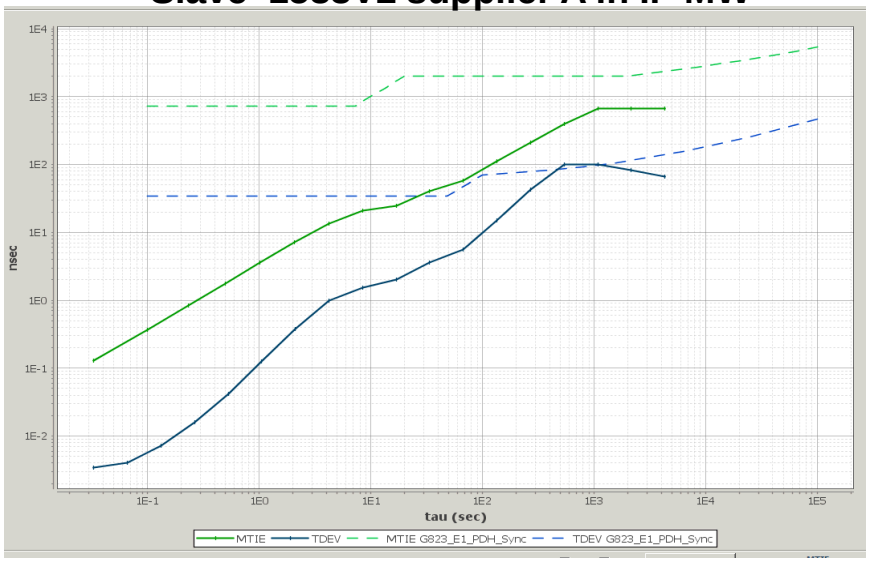
-We can see that supplier B slave has lower performance than A

Live Network Synch-over-packet Performance (2)

Slave 1588V2 supplier A in fibre



Slave 1588V2 supplier A in IP MW



-Performance of 1588V2 in IP MW is much worse than fibre

Lessons Learned and looking Forward

Major issues found until today

- GPS issue in the receiver of the 1588V2 master after a upgrade in the GPS system made by the US army
- SyncE issues because of lack of support of SyncE in certain cards (some cards/equipments can only give SyncE but not to receive)
- SyncE misconfiguration
- In Femtocells when using NTP sometimes depending if the jitter of the transmission (internet or unlicensed MW) is very high we can have issues (“sleeping cells”)

Lessons learned

- When deploying 1588V2:
  - Avoid to only to deploy only GPS as Sync source to the master at least in one of the masters of the domain
  - Beware with sync quality over IP MW it is depedent of several factors
- When deploying SyncE
  - always make sure that all the equipment supports SyncE (IN and OUT)
  - In a Ring make sure that your equipment support SyncE ESMC
  - In a ring using DWDM, often people forget that even though DWDM is Synchronous the client interfaces (GE or 10GE) could not be, it depends if the client card supports SyncE

Sync Concerns for the near future

- Will it be necessary time and phase synchronization for LTE-A even in FDD?
  - LTE-A Hetnet Coordination (eICIC)
  - LTE-A CoMP (Network MIMO)
  - If yes, what will be the sync requirements?
  - How to assure the needed sync quality?
  - Will today's 1588V2 masters be enough to assure the Sync quality?
- With all nodes going to full IP, what will be the core nodes that will still need synchronization?
  - Examples: Depending of the supplier BSCs will not need Synchronization, RNCs will still need Synchronization in frequency because of handovers