Sync as an enabler

Warsaw, 07.11.2017.
ITSF forum

vip

Sync as enabler

Introduction

Looking at the past

Where do we go?

Profiles o profiles

Different applications

Finals

Introduction

Looking at the past

- More than a decade dependant on incumbent sync sources
- Life was easy, we were careless
- Some years ago decision was to have own sync equipment, soon we had it
- First glimpse of the sync and how it operates
  - Introduction of SyncE
- Fear of unkown was the main obstacle to embrace new equipment

- „Synchronisation is a myth, mobile base stations can run without sync" (my manager, guru of many things ☺)

Where do we go

Where do we go

Trends

- New requirements in 4G networks drive the need for phase synchronization
  - LTE advanced as a primar driver
  - Number of features candidates
- Some mobile providers require phase sync for 2G

- Some other techologies also require phase synchronisation
  - Requirements not so strict
  - Unlike in most features for LTE-A, here phase sync is basic functionality

Where do we go

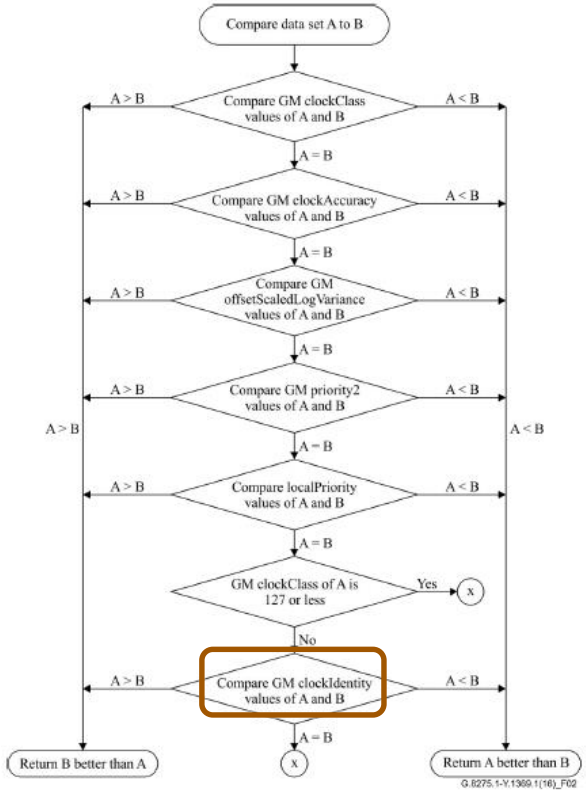
- NTP was a predecessor to precision time protocol
  - Not able to sustain timing accuracy
- IEEE 1588 PTP was originally developed for measurement and automation application
- ITU began to develop their own standards due to new requirements
  - Distribution of frequency, phase and ToD
- Telecom industry starts adopting ITU standards
  - Question remains on the wide usage

Standard	Message negotiation	Time/frequency
IEEE 1588-2002	Multicast	Time
IEEE 1588-2008	Unicast	Time
G.8275.2/Y.1369.2	Unicast	phase and time
G.8275.1/Y.1369.1	Mulitcast	phase and time
G.8265.1	Phy layer	Frequency

Profiles o profiles

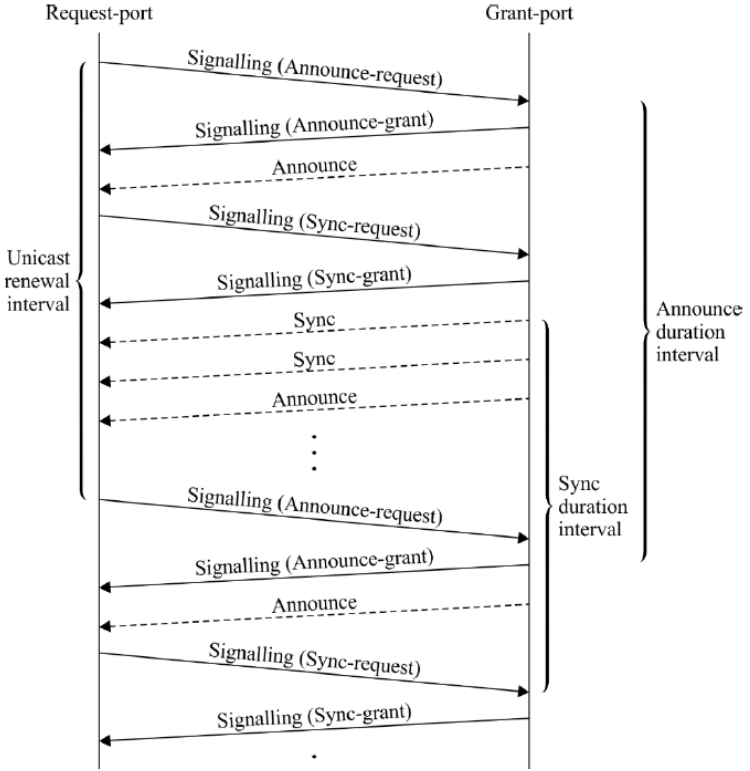
ITU-T G8275.1

- full timing support
  - Similar to SyncE
- New abbreviations introduced
  - T-GM, T-BC, T-TC, T-TSC
  - PRTC (primary reference time clock)
- PTP domains include range of applicable PTP domain numbers (24-43)
- Ethernet multicast in forwardable and non-forwardable multicast address
  - PTP frames are carried over network untagged
- Only two way ptp operation is allowed in this profile
- Alternate BMCA specifies multiple clocks to be active simultaneously (see the data set comparison algorithm on the right)
  - Automatic vs manual network planning



ITU-T G8275.2

- Partial on path support
- IP unicast
- PTP domains include range of applicable PTP domain numbers (44-63)
- T-GM-P, T-BC-P, T-TC-P, T-TSC-P
  - T-TSC-P may be assisted by having PRTC (e.g., GNSS) support
- message types: Sync, Delay_Req, Announce, Delay_Resp and Follow_Up
- Only one way operation used

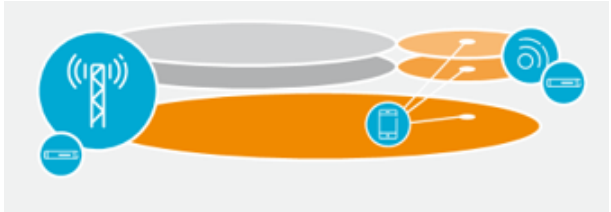


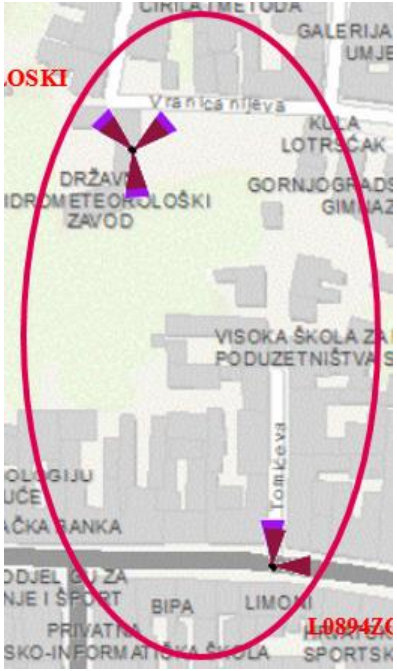
Different applications

LTE-A in focus

- The best known fact that has to be met is 1.5us at the air interface
- There is number of features requiring phase synchronisation
- One of the features chosen for trial was Inter eNodeB carrier aggregation
  - Applicable where different bands are used
  - One band for coverage, second is capacity layer
  - Candidates for this feature are capacity layer sites
  - Downlink gain estimation ranges from 60%-80%

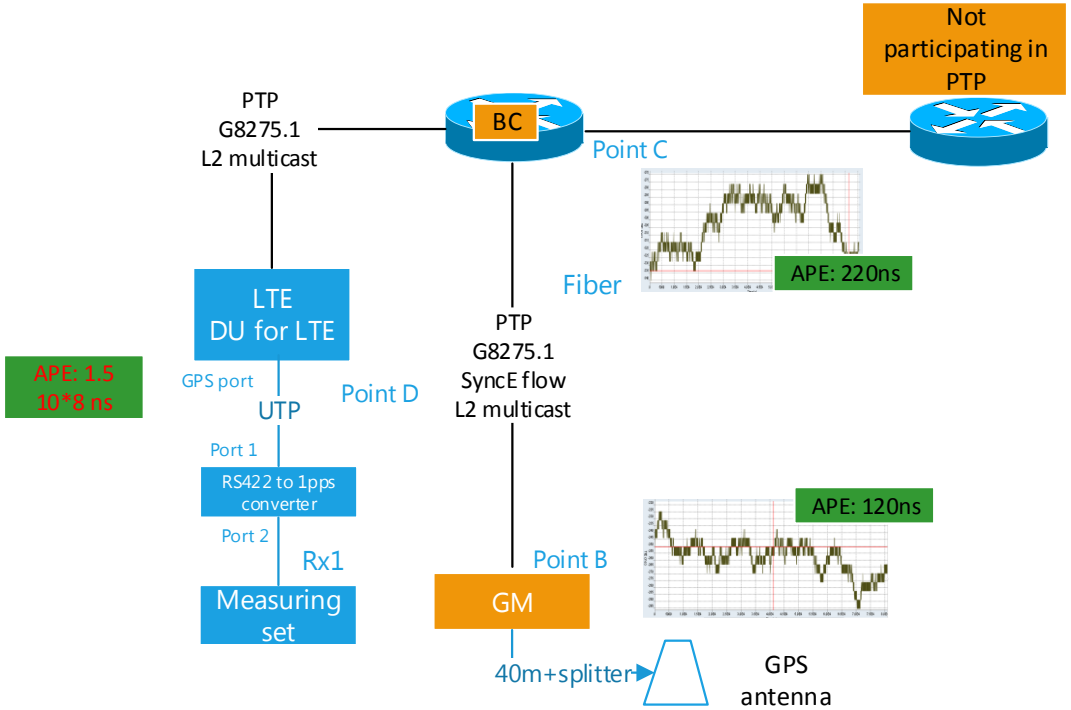
- Big interference between sites





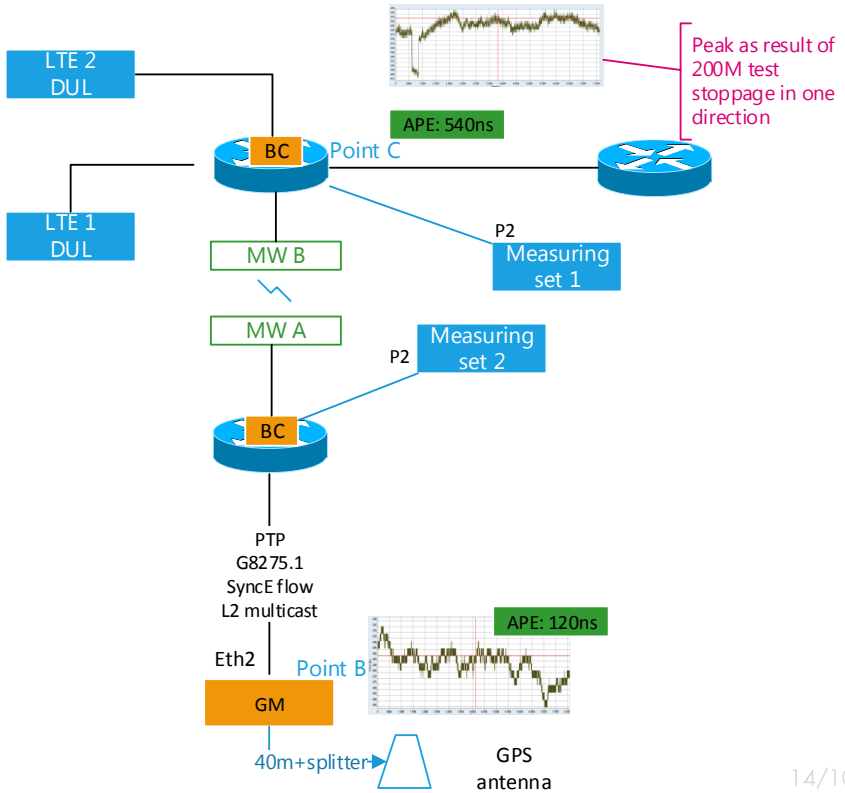
Testing G8275.1 in lab

- For this purpose a environment in the lab was setup
  - One GM, two routers with enabled G8275.1 profile
  - Several E-Node BS's
  - SyncE was provided to the BC together with the PTP
  - Initial results showed 100 ns of phase error between the GM and BC
  - We wanted to test phase error on GPS port on Digital Unit but without success



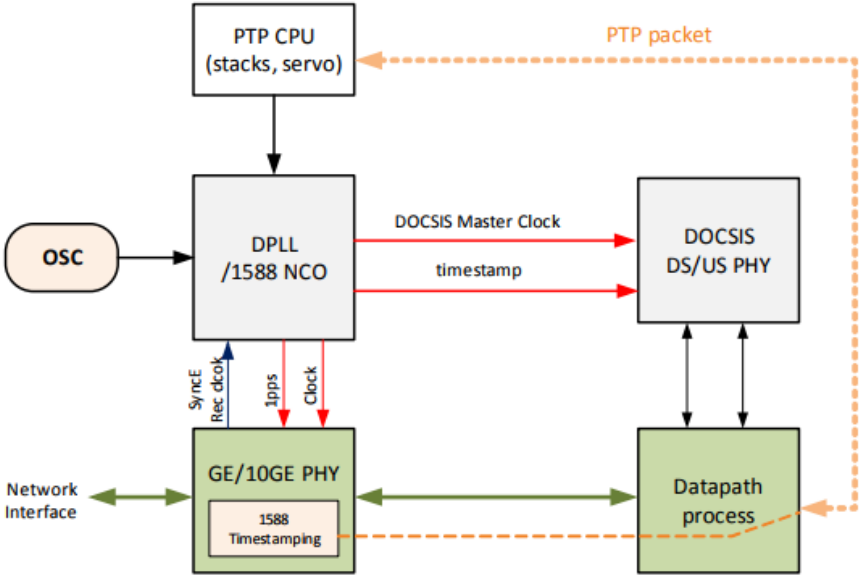
Testing G8275.1 in lab

- Different tests were performed to prove quality of the BC
- With second router APE was not significantly increased
- 3rd test was done using microwave equipment
  - PTP would not work with link capacity below 100M
  - After initial troubles, results showed large increase in absolute phase error
  - This would imply that three hops could not satisfy 1.5us requirement



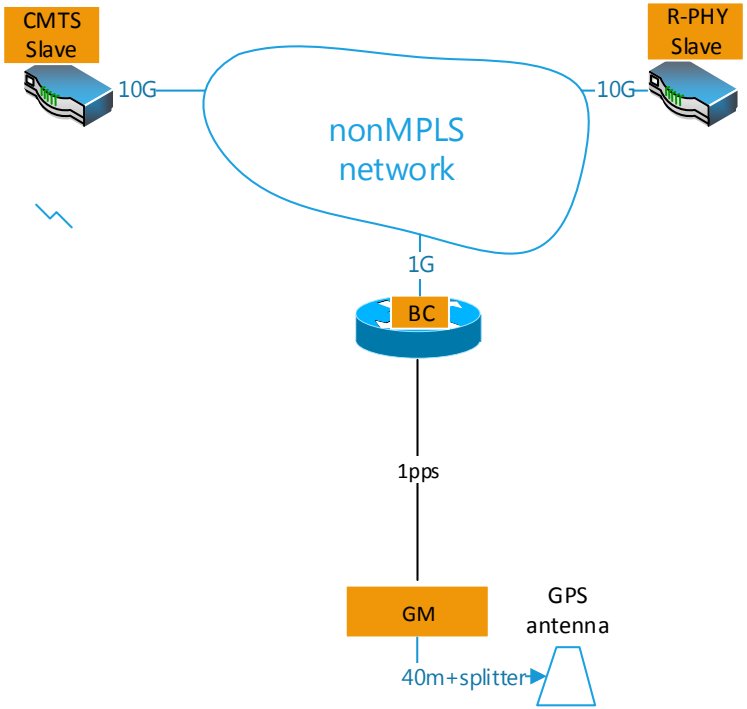
DOCSIS phase synchronisation implementation

- Modular Headend Architecture v2 (MHA v2) requires use of phase sync
- Lower operational cost by moving PHY from CCAP at headend to the optic node
- The specification of R-PHY architecture standardized by CableLabs and vendors
- The accuracy requirements of the PTP synchronization are application-dependent
  - Phase alignment <= 1ms
  - Frequency accuracy <= +/- 5ppm
  - Typical TCXO timing and frequency accuracy up to 1.5 hours without a single 1588 messages exchanges.



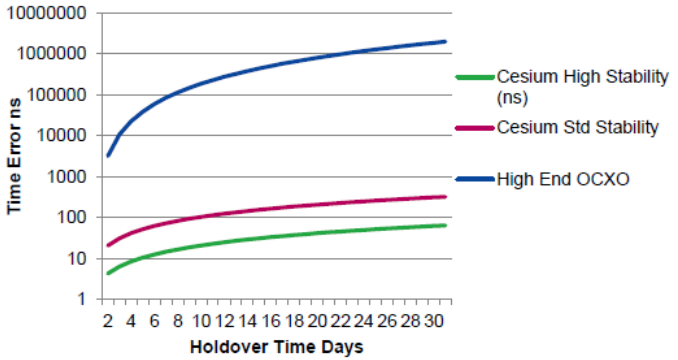
DOCSIS phase synchronisation implementation

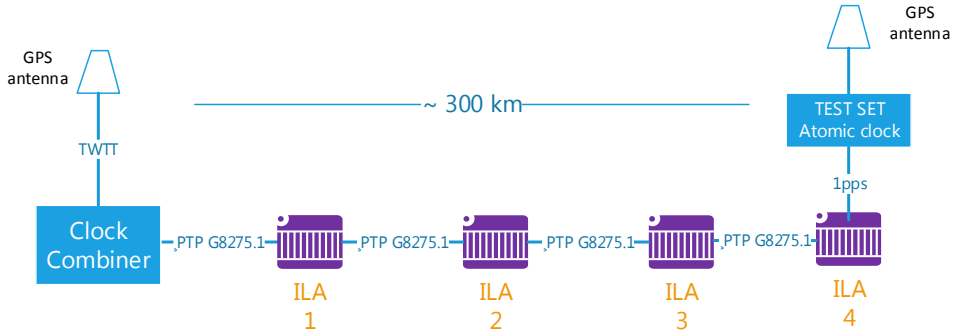
- Testing was setup under some tight time schedule
- First scope was to setup G8275.2 up and running between GM and its slaves
- Trial and error (lot of emails shared), we managed to get the PTP flow running
- PHASE_ALIGNED STATE, everybody loved it
  - Remember that R-PHY device requires PTP to boot
  - During setup we realized that current implementation does not support MPLS
- Everyone was happy that it worked that somehow 1pps signal was not connected
  - Later attempts not successful
- Booting time over time increased, after some ten days in free run on BC
- Ordinary clock with domain 0 was final solution



Future Inter network phase sync domains

- ePRTC according to ITU-T G.8272.1: Cs + GNSS
- Cesium "Time Keeping" Performance critical to delivering 30ns budget
  - This value includes all the noise components, i.e., the constant time error (cTE) and the dynamic time error (dTE) noise generation.
- How to measure phase error in DWDM applications?
  - PTP packets carried over a special out-of-band Channel
  - PTP processing required on each node, including ILA sites
  - Link asymmetry auto-measured and compensated





Vipnet in few bullets

> Who remembers what was on the first slide?
> Vipnet as a company as encouraging its employees and also community to be envolved in different kind of activities
> Strives to be agile enviromentally friendly company
> Honest and fair are our moto
> 40% employees are women

> Last: We are all in the some kind of run towards all phase transport networks to fullfill future 5G

Thank You!

vip