# The importance of defining “Network Limits” and Partial Timing Support Challenges

**WSTS–2015, San Jose**

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# CONTENTS

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- The importance of defining network limits
- Limits for full timing support
  - done?
- Limits for partial timing support
  - what are the challenges?
- Conclusions

# NETWORK LIMITS

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- ITU-T recc. G.8271.1 specifies
  - maximum *network limits* of phase and time error that shall not be exceeded
  - *minimum equipment tolerance* to phase and time error at phase and time synchronization interfaces
- Why:
  - to ensure interoperability of equipment produced by different manufacturers and a satisfactory network performance
  - Operator perspective: Reference Network
  - Equipment perspective: NEs noise generation/tolerance

# TIME SYNC NETWORK LIMITS: Q13/15 RECOMMENDATIONS

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- Analysis of Time/phase synchronization in Q13/15:
  - G.8260 (definitions related to timing over packet networks)
  - G.827x series

| | Frequency | Phase/Time | |
|---|---|---|---|
| **General/Network Requirements** | G.8261 | G.8271 | 2016 ? |
| | G.8261.1 | 2013/14 G.8271.1, | G.8271.2 |
| **Architecture and Methods** | G.8264 | G.8275 | |
| | G.8265 | | |
| **PTP Profile** | G.8265.1 | G.8275.1, G.8275.2 | |
| **Clocks** | G.8266 | G.8272, G.8272.1 | |
| | G.8262, G.8262.1 | G.8273,.1,.2,.3, 4 | |
| | G.8263 | | |

# FULL TIMING SUPPORT VS. PARTIAL TIMING SUPPORT

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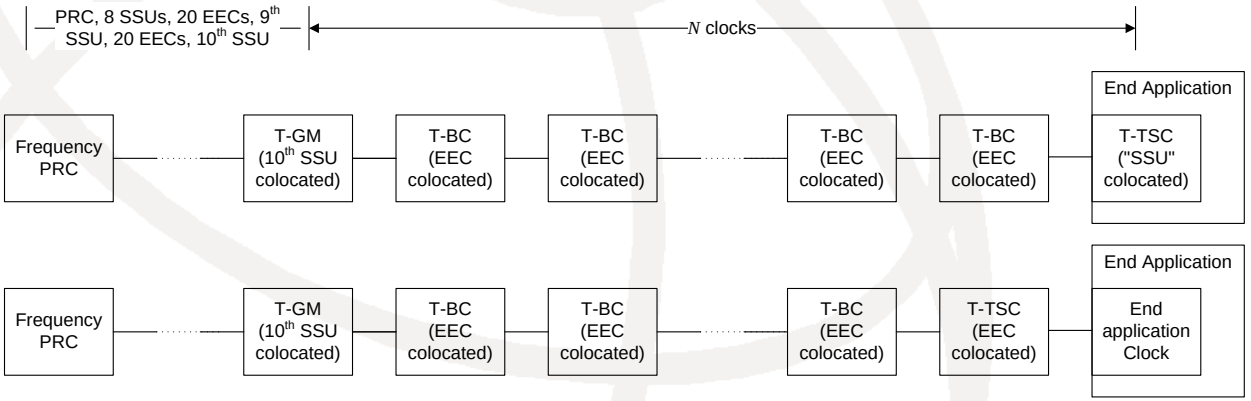
- Recommended architecture with «PTP support» in every node (currently BCs-based); N=10 or 20; different T-BC classes
  - Analysis similar to traditional «TDM» studies (PLL in every equipment, etc.)




- In order to address specific needs, and already deployed networks, «partial timing support» networks are being considered as well
  - Nodes not supporting PTP in the sync distribution chain
  - Different issues in defining network limits, etc.
  - PDV, Asymmetry created by traffic load, etc.

# G.8271.1: LIMITS IN FULL TIMING SUPPORT

- Various parameters have been considered:
  - Contant vs. Dynamic TE
- max |TE| to limit constant error (actually including both *dynamic* and *constant* error)
  - Easy to compare with the 3GPP requirements: +/- 1.5 us
  - Budget for the End application and for failure conditions
- *Dynamic part* of the TE noise based on simulations:
  - Ring rearrangements and combination of SyncE/PTP noise
  - MTIE mask defined (noise components < 0.1 Hz)
  - High frequency noise (noise components > 0.1 Hz)

# TIME SYNC BUDGETING (MAX |TE|): MAIN CASE

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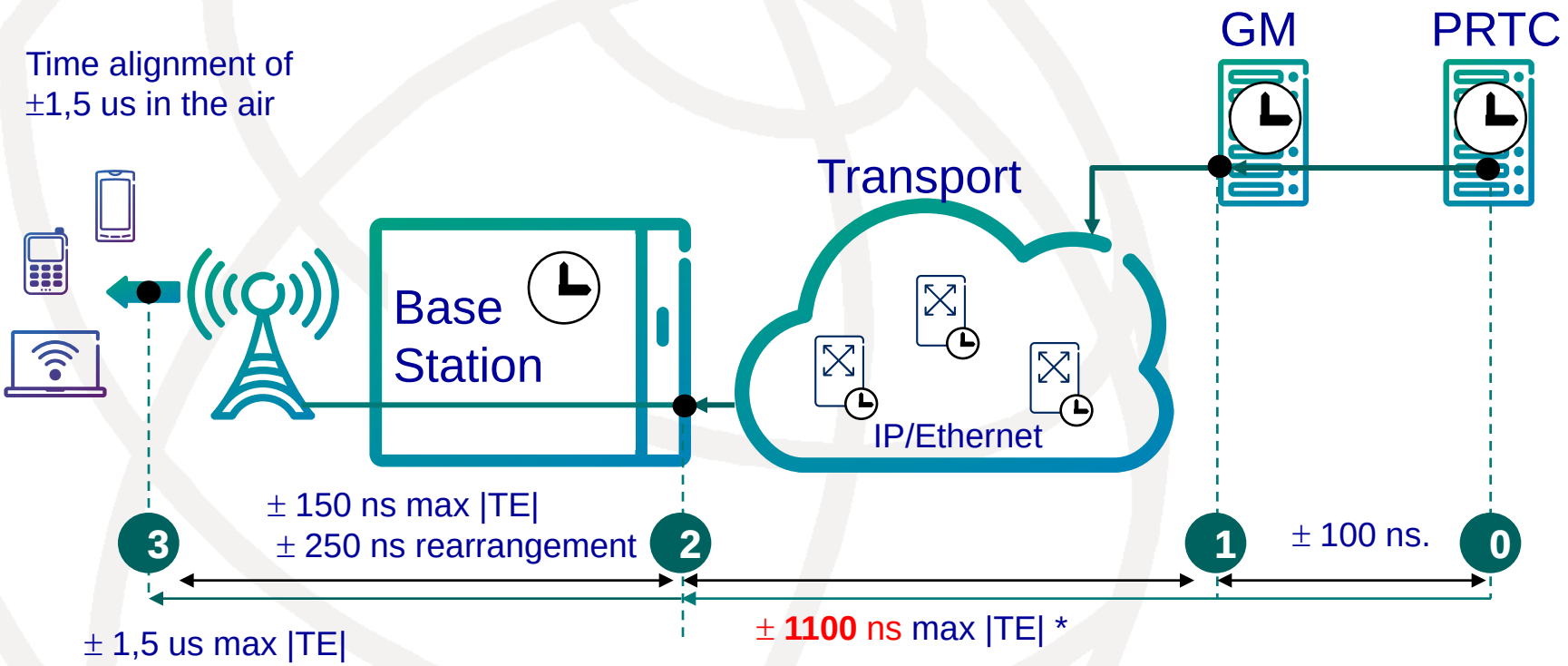
Rearrangements handled by the end application (e.g. Base Station)




*after low pass filter (0.1 Hz);

# DYNAMIC TIME ERROR: MTIE, TDEV, «JITTER»

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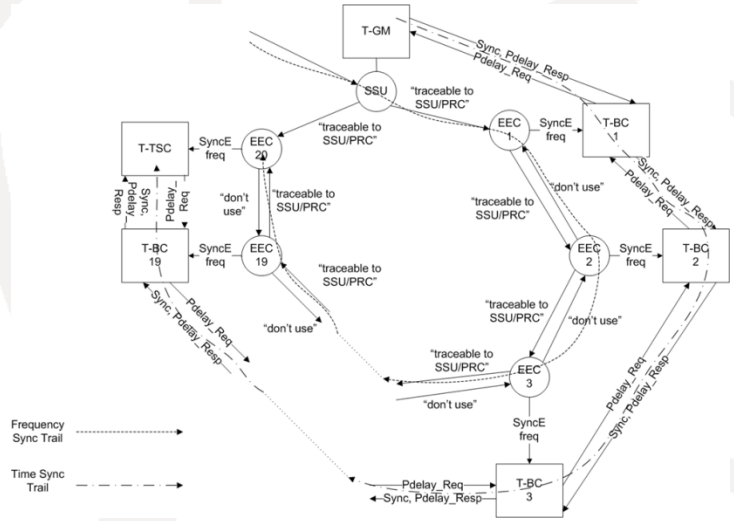
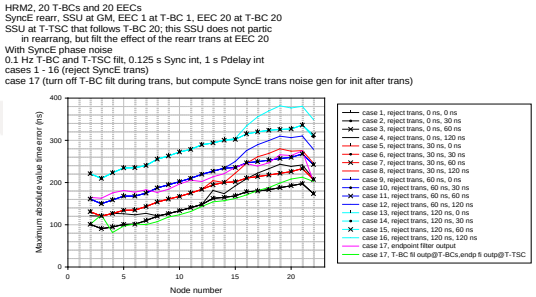
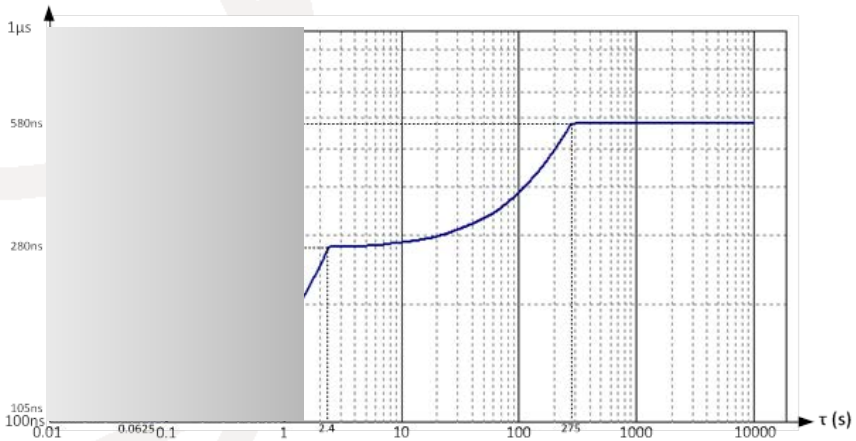
- MTIE mask has been defined based on the worst case:
  - Congruent scenario , with SyncE ring rearrangements




From WD30, (Boulder, March 2012)



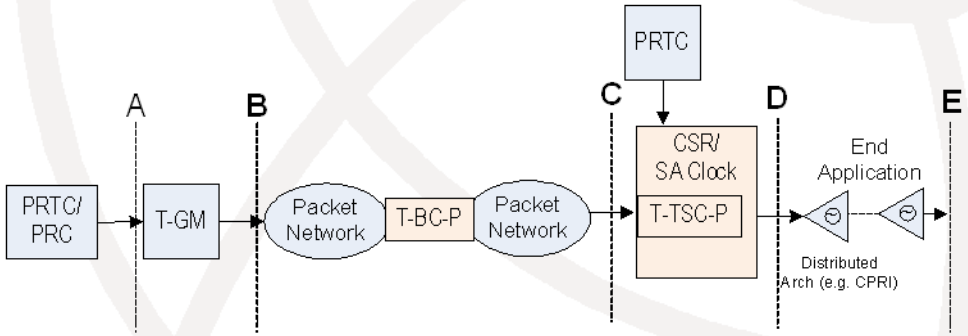

From C238, (July 2013)

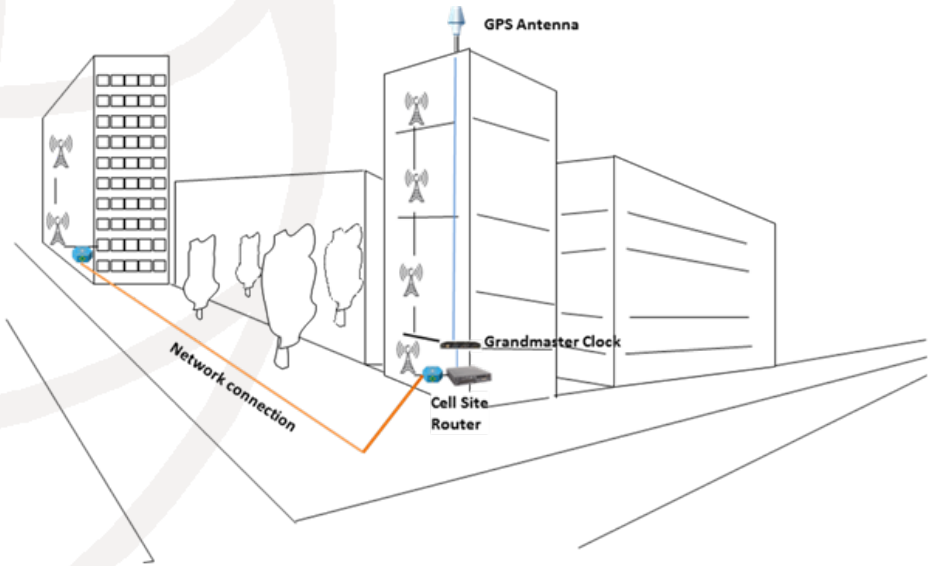



- This mask defines dynamic noise in the «time wander» region (< 0.1 Hz); Recently updated (December 2014)
- High frequency noise (> 0.1 Hz): < 200 ns p-t-p

# PARTIAL TIMING SUPPORT

- Two main scenarios should be addressed:
  - APTS (Assisted Partial Timing Support)
  - Pure PTS (e.g. for small cells)



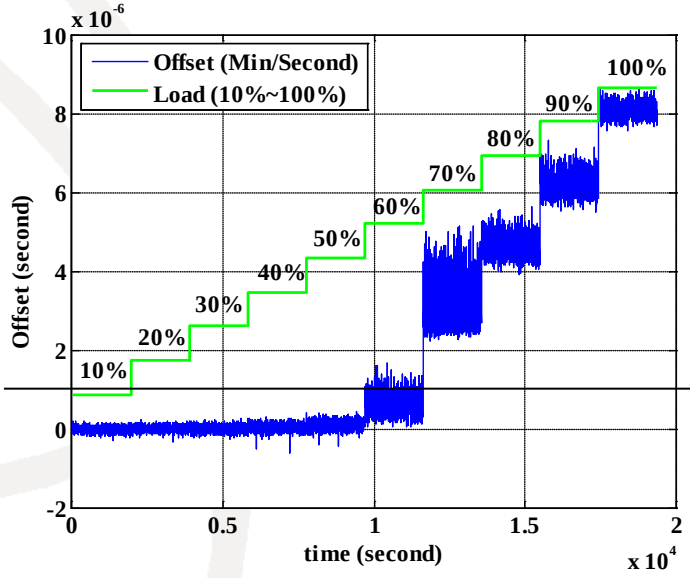




From WD20 (Sophia Antipolis 2014)

# HRM IN APTS/PTS ?

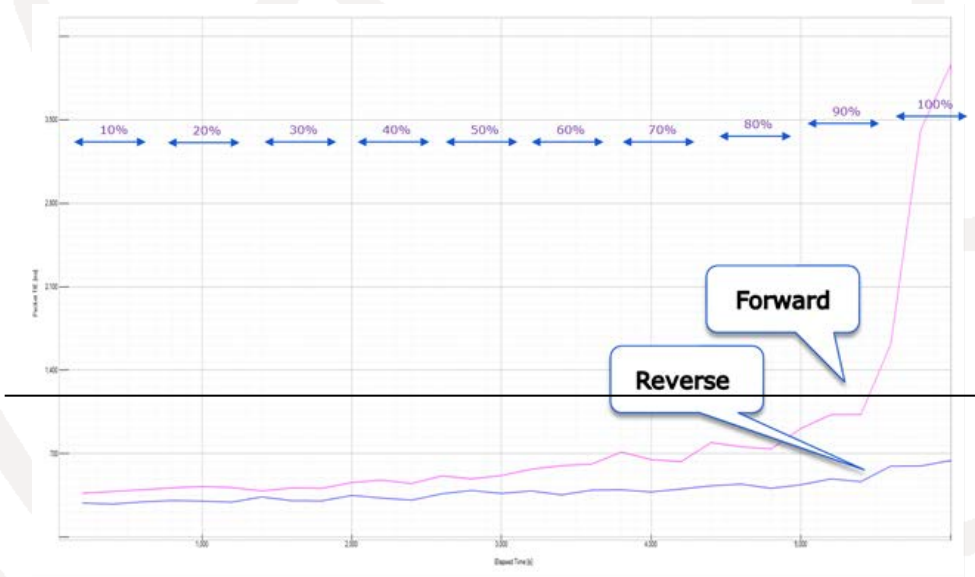
- Different results when using different nodes
  - Non-standard behaviour
  - Predictable results ? (depends on traffic load and traffic mix)

From WD33 (San Jose 2015)




1 us

From WD39 (San Jose 2015)

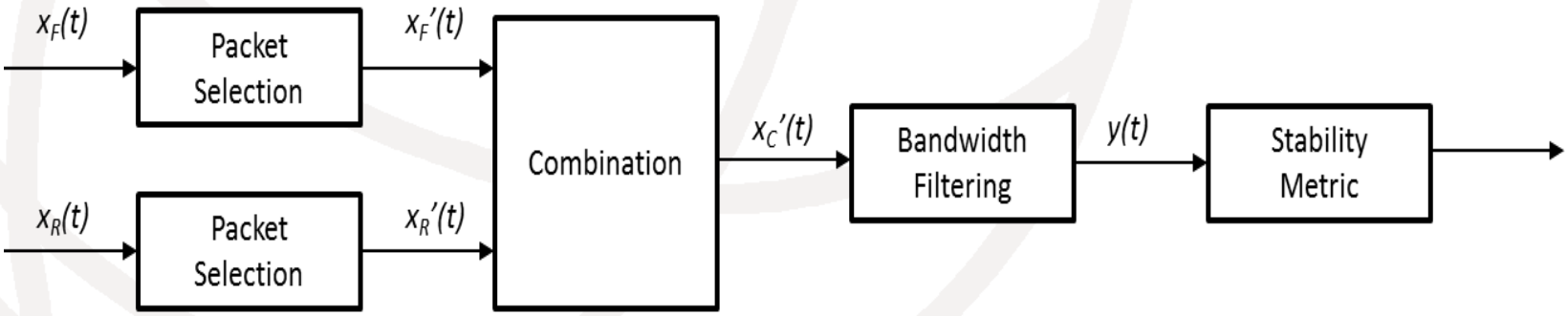



1 us

- HRM important for operators for building networks
  - Some worst case might need to be defined (e.g. 3 hops;x% load)

# WHICH METRIC?

- Frequency sync sufficient for APTS
  - 1-way or 2-way stability metrics
- 2-way stability metrics is needed for PTS
  - time sync is delivered by the Packets (no GNSS)
- 2-way FPP (floor packet percentage) proposed (FPP constrained with the same limit on both directions)
  - too conservative ?
- Alternative approach with a more accurate metric have also been proposed:
  - «pktselected offset» («Max Time Error» for PTS or «MTIE» for APTS)



# NETWORK LIMITS ?

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Example based on table in WD115-San Jose

| Budget Component | Assisted partial timing support G.8271.2 (WD14, 12-2013) | Partial timing support G.8271.2 |
|---|---|---|
| PRTC | ±100 ns | ±100 ns |
| Holdover and Rearrangements in the network | NA ? | NA ? |
| Dynamic time error | **±800 ns (p-p)** | **±1000 ns** |
| Node time error 80 ns per non-aware node, 20 ns per BC) | NA | |
| Asymmetry compensation error (GPS timing error, 200 ns, in slave clocks, two times, plus and minus) | **±200 ns** | |
| Link asymmetry, 20 ns per hop | NA | |
| Rearrangements and short holdover in the end application | ±250 ns | ±250 ns |
| End application | ±150 ns | ±150 ns |
| Total ($TE_D$) | ±1500 ns | 1500 ns |

- Identification of the limits may not be too difficult …

# SUMMARY

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- G.8271.1 finalized (almost)
  - Max |TE|, MTIE and “jitter” time sync limits
- What is missing?
  - TDEV , Pure PTP (is it relevant?)
- G.8271.1 provides the basis for other relevant recommendations
  - G.8272 (PRTC), G.8273.2 (T-BC/T-TSC), G.8273.3 (T-TC)
- Ongoing study on partial timing support
  - APTS as first application
  - Simplified «PTS» for small cells applications as second step
- Network Limits may not be difficult to be defined
  - What about HRM??