ERICSSON

PROGRESS IN TIME SYNC STANDARDIZATION IN Q13/15: G.8271/G.8271.X

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- Introduction on G.8271, G.8271.1 and G.8271.2
- Definition of time sync network limits for full support
- New work item on network limits for partial timing support
- Conclusions

TIME SYNC: Q13/15 RECOMMENDATIONS

- Analysis of Time/phase synchronization in Q13/15:
  - G.8260 (definitions related to timing over packet networks)
  - G.827x series
  - Both G.8271 Amd1 and G.8271.1 approved this year. New work item on G.8271.2

	Frequency	Phase/Time
General/Network Requirements	G.8261	G.8271
	G.8261.1	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.8262	G.8272
	G.8263	G.8273,.1,.2,.3

G.8271

TIME AND PHASE SYNCHRONIZATION ASPECTS OF PACKET NETWORKS

- G.8271 provides the basic requirements and framework
  - Target requriements
  - Noise sources
  - Time sync Interface
- Updated version this year
  - Details on the time synchronization interface
  - Details on time-stamping granularity (characteristics of the noise sources)
  - Details on the time error accumulations
  - General Improvements and alignment with the new G.8271.1
- Time sync interface details moved into G.703

TARGET APPLICATIONS

Level of Accuracy	Time Error Requirement (with respect to an ideal reference)	Typical Applications
1	500 ms	Billing, Alarms
2	100 μs	IP Delay monitoring
3	5 μs	LTE TDD (cell >3km)
4	1.5 μs	UTRA-TDD, LTE-TDD (cell ≤ 3Km) Wimax-TDD (some configurations)
5	1 μs	Wimax-TDD (some configurations)
6	< x ns (x ffs)	Location Based services and some LTE-A features (Under Study)

Small cells coordination features generally addressed by Class 4 !

TIME SYNC INTERFACE (G.703/G.8271)

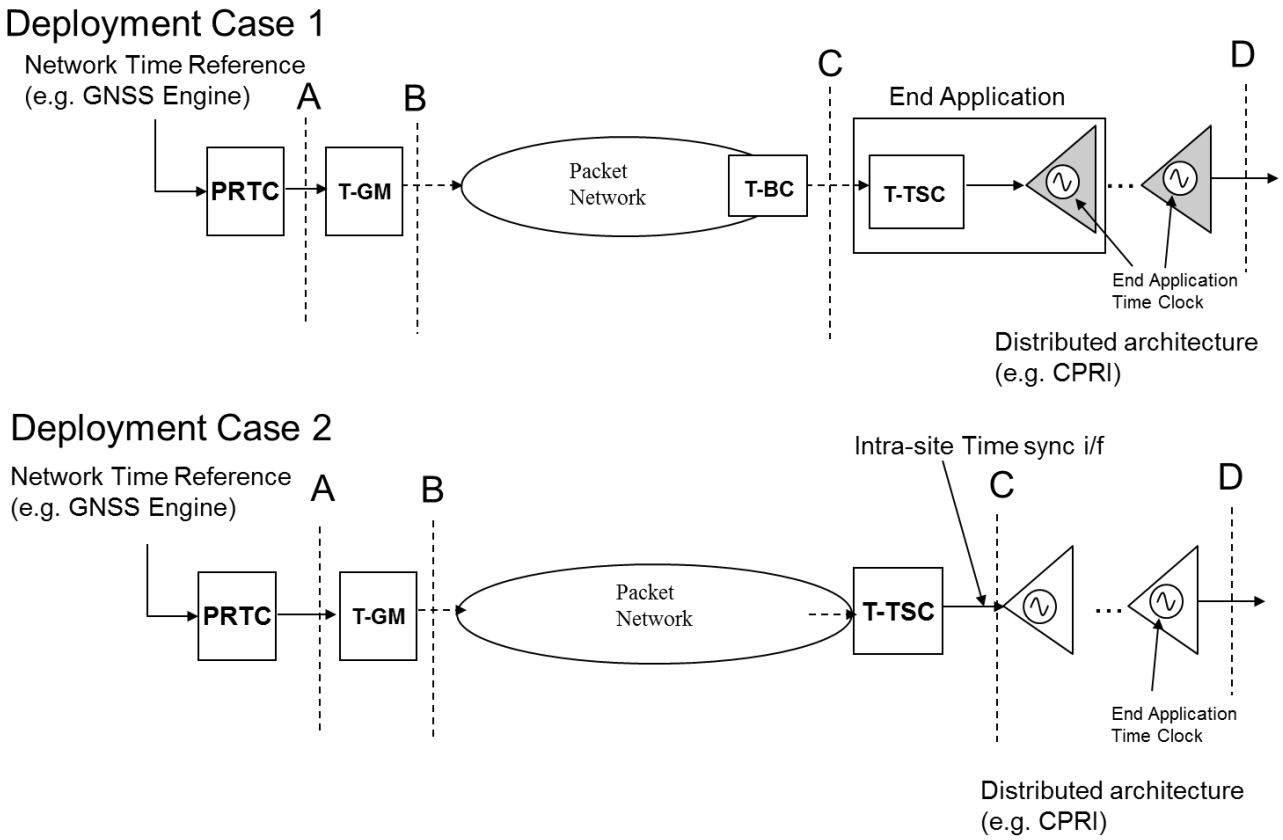
- G.8271 introduces the functional aspects of a 1PPS time sync interface
  - Typically used for test measurement (output port). V.11/RJ45 also for possible time sync input (e.g. From GPS)
- New clause in G.703 on Time synchronization interfaces
  - V.11 1PPS
  - 1PPS 50 phase synchronization measurement interface
- G.703 specifies:
  - Pulse characteristics
  - perfomance objectives and, in case of V.11, Pin Out

PIN	Signal name	Signal definition
1	Reserved	FFS
2	Reserved	FFS
3	**1PPS_OUT-**	Tx 1PPS negative voltage
4	GND	V.11 signal ground
5	GND (Note 1)	V.11 signal ground
6	**1PPS_OUT+**	Tx 1PPS positive voltage
7	**TX-**	Tx TOD time message negative voltage
8	**TX+**	Tx TOD time message positive voltage

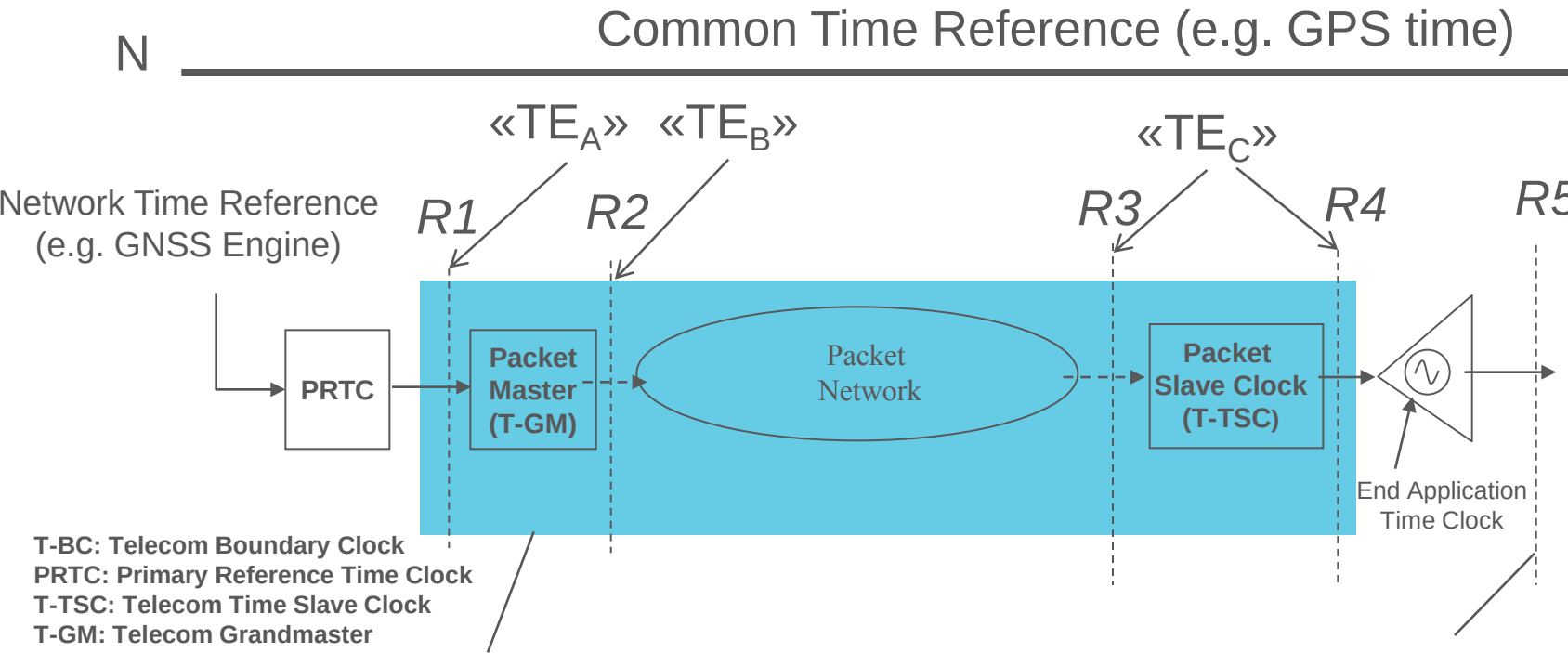
TIME SYNC NETWORK LIMITS

- Full timing support
- Definition of the Network Limits
  - Reference network (HRM)
  - Metrics
  - Noise Components
  - Failure conditions
    - Network Rearrangements
    - Time Sync Holdover

Deployment cases



NOISE (TIME ERROR) BUDGETING ANALYSIS



Simulation Reference Model:

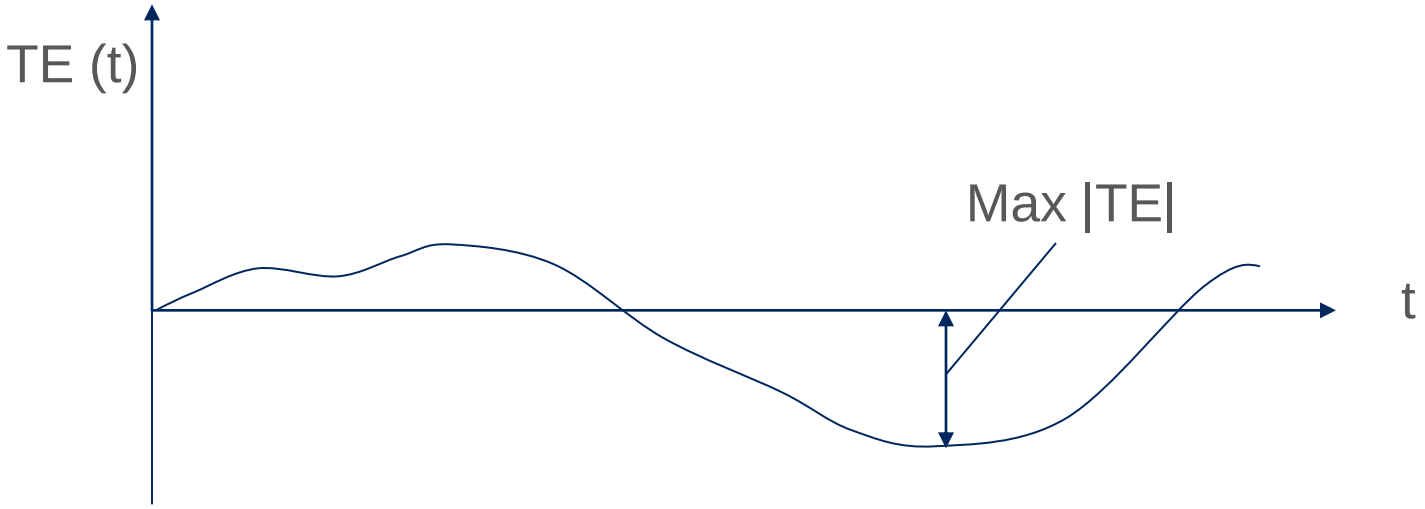
- chain of T-GM, 10 T-BCs, T-TSC
- with and without SyncE support

Typical Target Requirement «TE$_D$» < 1.5 µs in terms of max |TE|

Same limit applicable to R3 and R4 (limits in R4 applicable only in case of External Packet Slave Clock)

METRICS

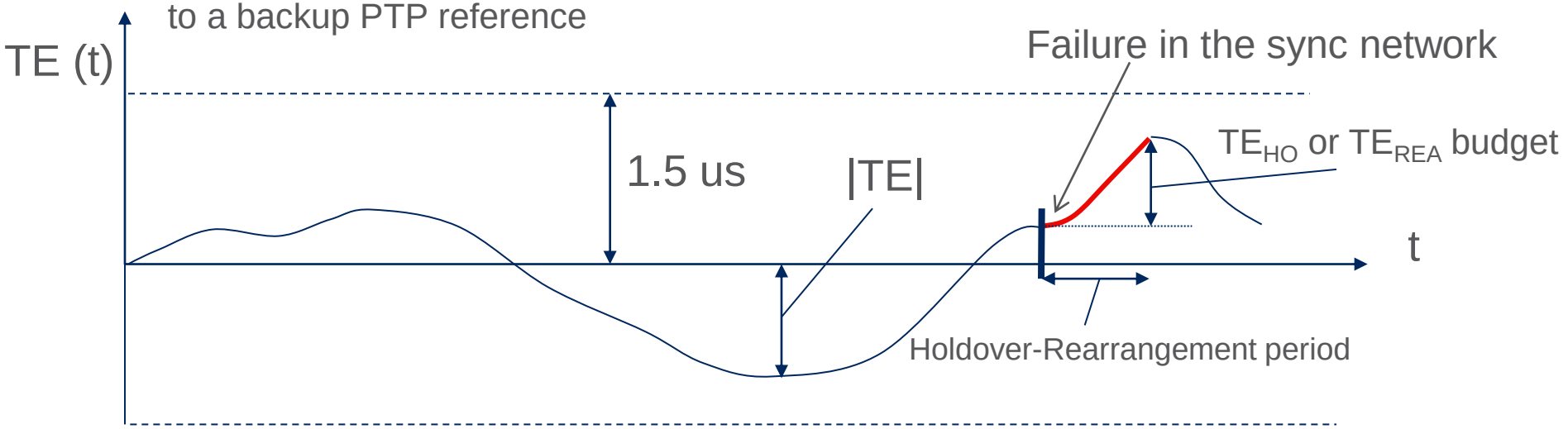
- Main Focus is Max Absolute Time Error (Max |TE|) (based on requirements on the radio interface for mobile applications)
  - Measurement details need further discussion



- Stability aspects also important
  - MTIE and TDEV
  - Related to End Application tolerance
- Same limits irrespectively if time sync is distributed with SyncE support or not ?
  - Probably yes, as the same overall objective applies

REARRANGEMENTS AND HOLDOVER

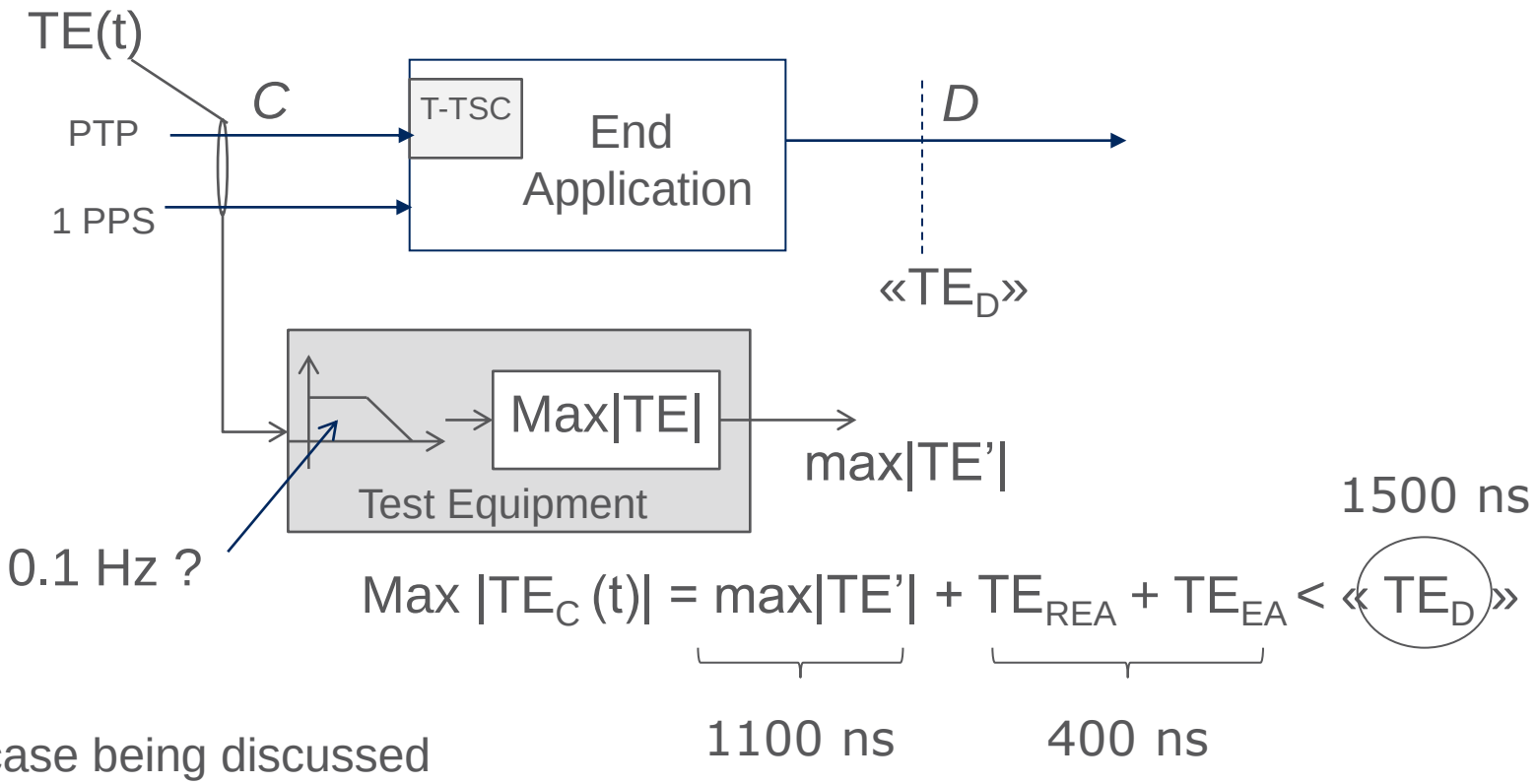
- The analysis of time error budgeting includes also allocating a suitable budget to a term modelling *Holdover and Rearrangements*
- Time Sync Holdover Scenarios
  - PTP traceability is lost and and the End Application or the PRTC enters **holdover** using SyncE or a local oscillator
- PTP Master Rearrangement Scenarios
  - PTP traceability to the primary master is lost; the T-BC or the End Application **switches** to a backup PTP reference



TE_{HO} applicable to the network (End Application continues to be locked to the external reference)
TE_{REA} applicable to the End Application (End Application enters holdover)

G.8271.1: TIME SYNC LIMITS

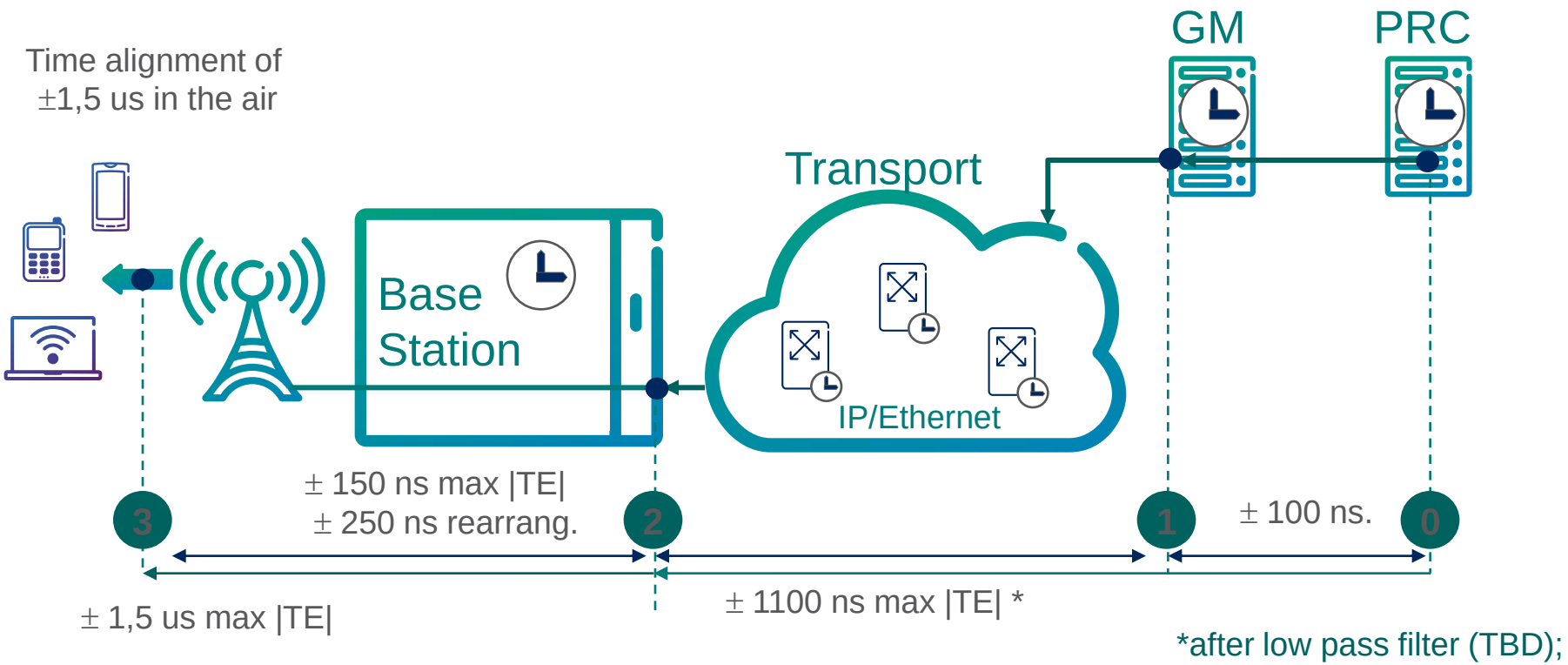
- Max|TE_C| < 1.1 us
- There might be some high frequency noise above 1.1 us
  - The measurement might need to be done on pre-filtered signal (e.g. 0.1 Hz). This is under discussion
- End Application is only required to support short rearrangements (e.g. 1 min)



- Second use case being discussed
  - holdover provided by the network; RBS always locked to PTP
- Specification in terms of MTIE/TDEV (wander) and Jitter under study

TIME SYNC BUDGETING:
MAIN CASE

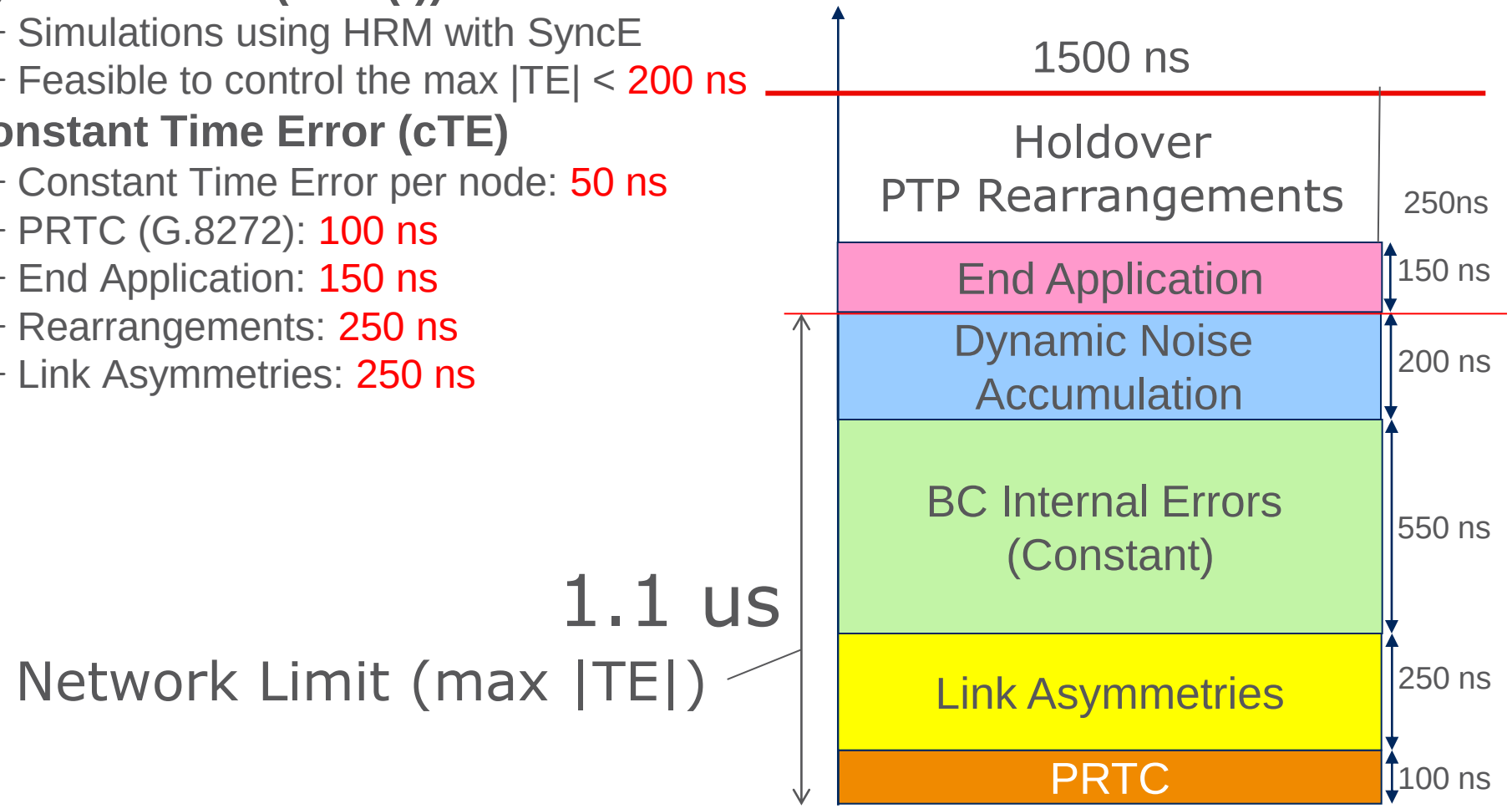
Rearrangements handled by the end application (e.g. Base Station)



TIME ERROR BUDGETING

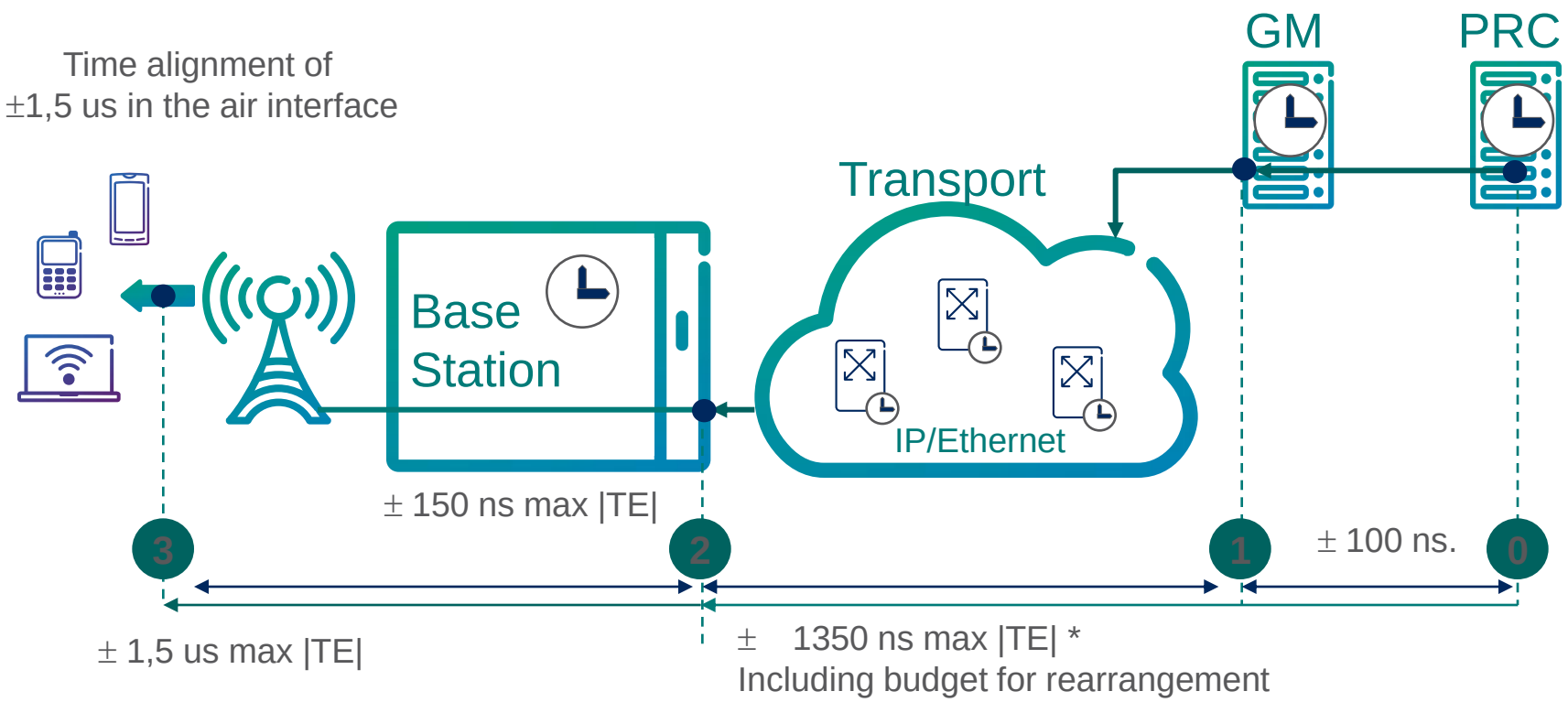
Budgeting Example (10 hops)

- **Dynamic Error (dTE (t))**
  - Simulations using HRM with SyncE
  - Feasible to control the max |TE| < 200 ns
- **Constant Time Error (cTE)**
  - Constant Time Error per node: 50 ns
  - PRTC (G.8272): 100 ns
  - End Application: 150 ns
  - Rearrangements: 250 ns
  - Link Asymmetries: 250 ns



ADDITIONAL EXAMPLES
REARRANGEMENTS HANDLED BY THE NETWORK

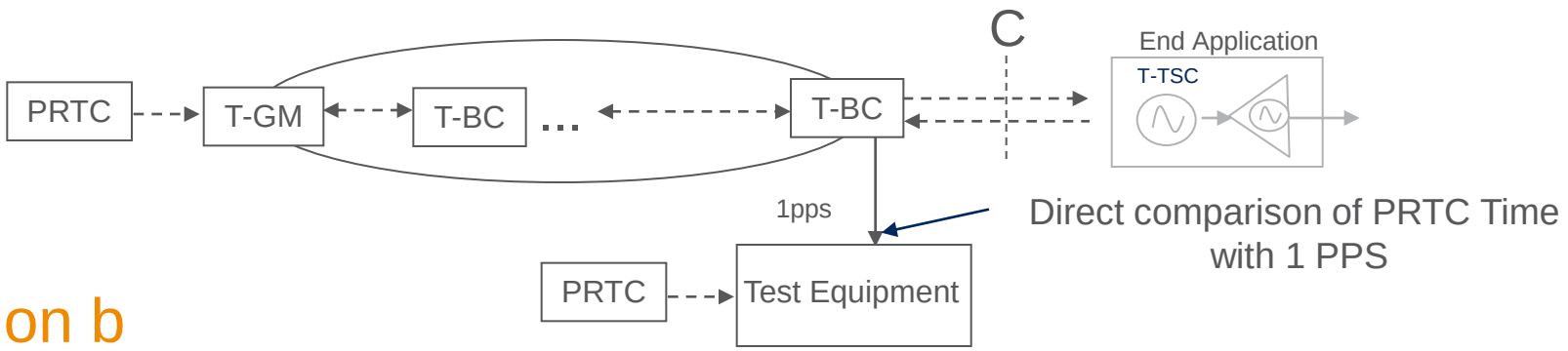
Base Station continuously locked to the incoming PTP reference



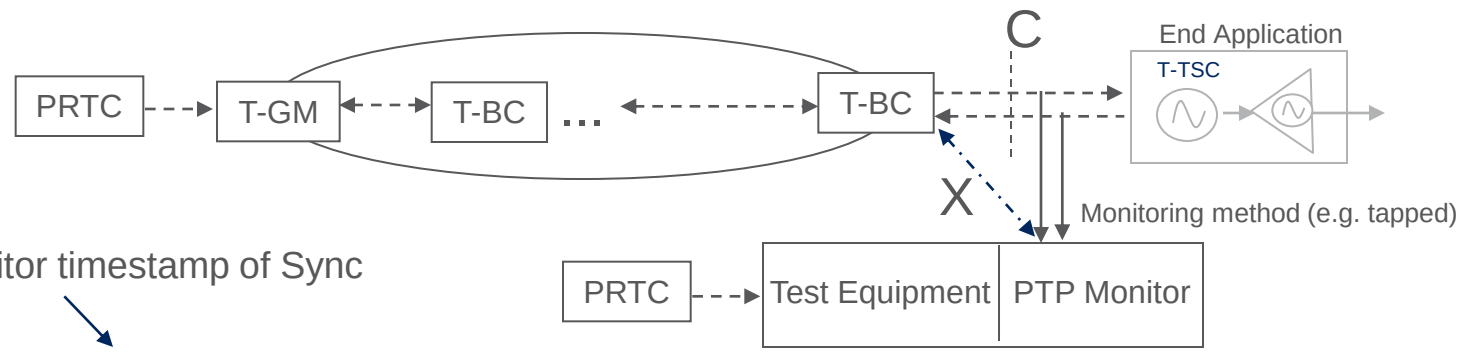
*after low pass filter (TBD)

MEASUREMENT OF NETWORK LIMITS

Option a



Option b



Monitor timestamp of Sync

$$TE = TM1 - T1 - X = TM4 - T4 - X$$

Sync timestamp

Monitor timestamp of Delay Request

Delay Resp (t4 timestamp)

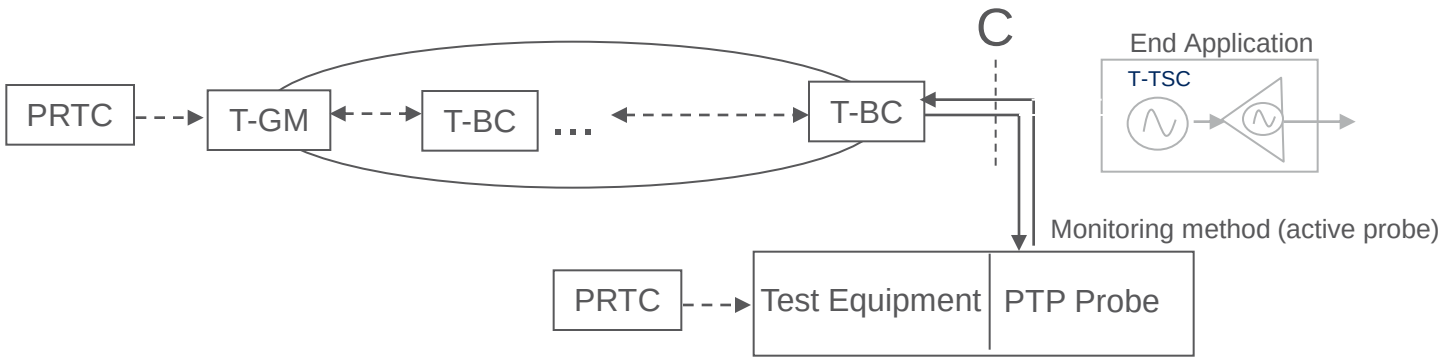
In alternative the 4 timestamps could be used:

$$TE = (TM2 - T1 - T4 + TM3)/2$$

MEASUREMENT OF NEWTORK LIMITS, CONT.

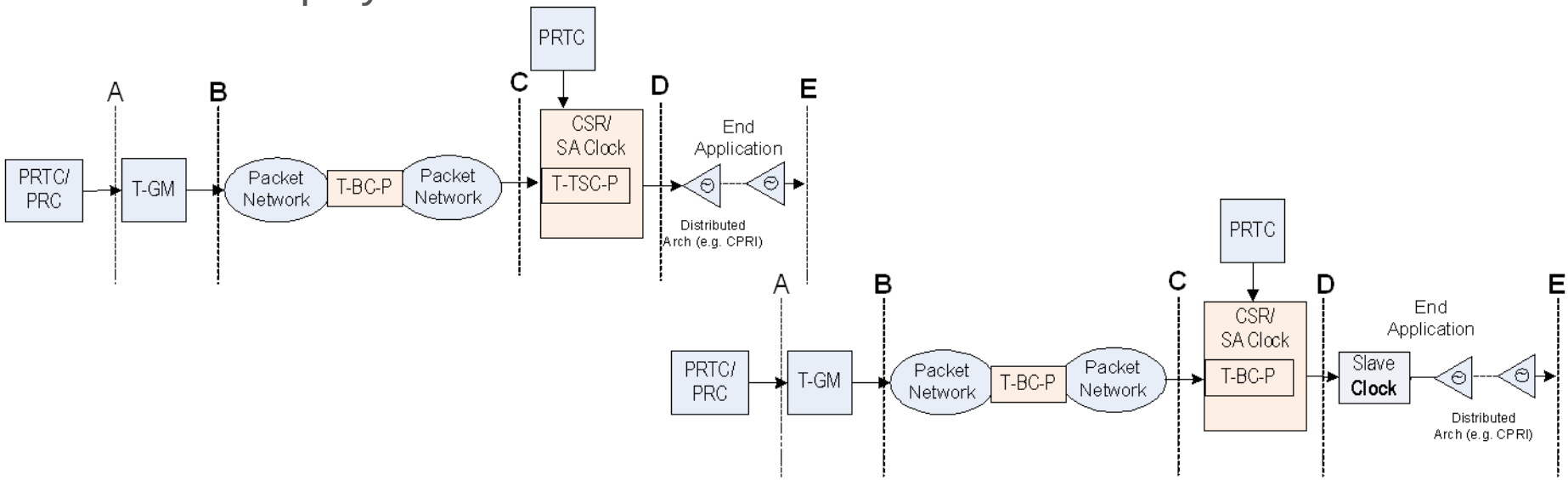
Option c

from the two-way PTP flow via an active measurement probe
(e.g. prior to the start of the service, or connecting the active monitor to a dedicated port of the T-BC).



PARTIAL TIMING SUPPORT

- At last Q13 meeting it was agreed to focus on a special case: «Assisted Partial Timing Support»
- PTP is used only as back up to GNSS
  - Increased concerns with GNSS vulnerability
  - Frequency reference is sufficient
  - Asymmetry is taken care of the GNSS when in operation
- Network limits and HRM to be defined in G.8271.2
- Two main deployment cases to start with:



APTS: ITEMS FOR STUDY

- HRM : in terms of number of nodes or budget for the network?
- What is the budget for the T-BC-P and T-TSC-P?
- What is the role of the T-BC-P in the network
  - address only scalability or also noise filtering?
  - has the slave side of the T-BC-P have the same spec as the T-TSC-P?
- Different types of T-BCs (e.g. middle of the network, and at the end of the network)? How many T-BC ?
- Timing transport via one-way (sync messages only) frequency transfer, or two-way (sync , delay_req, and delay_resp messages) time transfer, or two-way freq. transfer?
- Clock characteristics, e.g. “PDV tolerance” (when a ‘Packet network’ is good enough?)

SUMMARY

- G.8271.1 approved this year
  - Max |TE| Time sync limits have been defined (full timing support)
- G.8271 and G.8271.1 provide the basis for the development of other relevant recommendations
  - G.8273.2 (BC); G.8273.3 (TC)
- Still some important topics need to be completed
  - Stability requirements (MTIE, TDEV)
- New work item on partial timing support (G.8271.2)
  - APTS as first application