Synchronising Small Cells

Calnex

Tim Frost,
Strategic Marketing
Manager

www.calnexsol.com

Presentation overview

- Small Cell Sync Requirements
- Indoor Deployment
- Outdoor Deployment
- Measuring Small Cell Synchronisation

Calnex

Small Cell Sync Requirements

"Air Interface" Sync Requirements

Frequency requirements:

- Carrier small cell: 100ppb
- Residential small cell: 250ppb

Time requirements:

- LTE FDD with no co-ordination: no requirement
- LTE TDD with no overlapping coverage: no requirement
- LTE TDD with overlapping coverage: ± 1.5µs
- LTE FDD or TDD with eICIC or CoMP: ± 0.5 – 5µs *
- E911 OTDOA (Observed Time Difference of Arrival): ± 0.1µs

* Depends on technology and throughput requirements
3GPP have stated it will never ***require*** better than ± 1.5µs

Frequency Sync Delivery Requirement

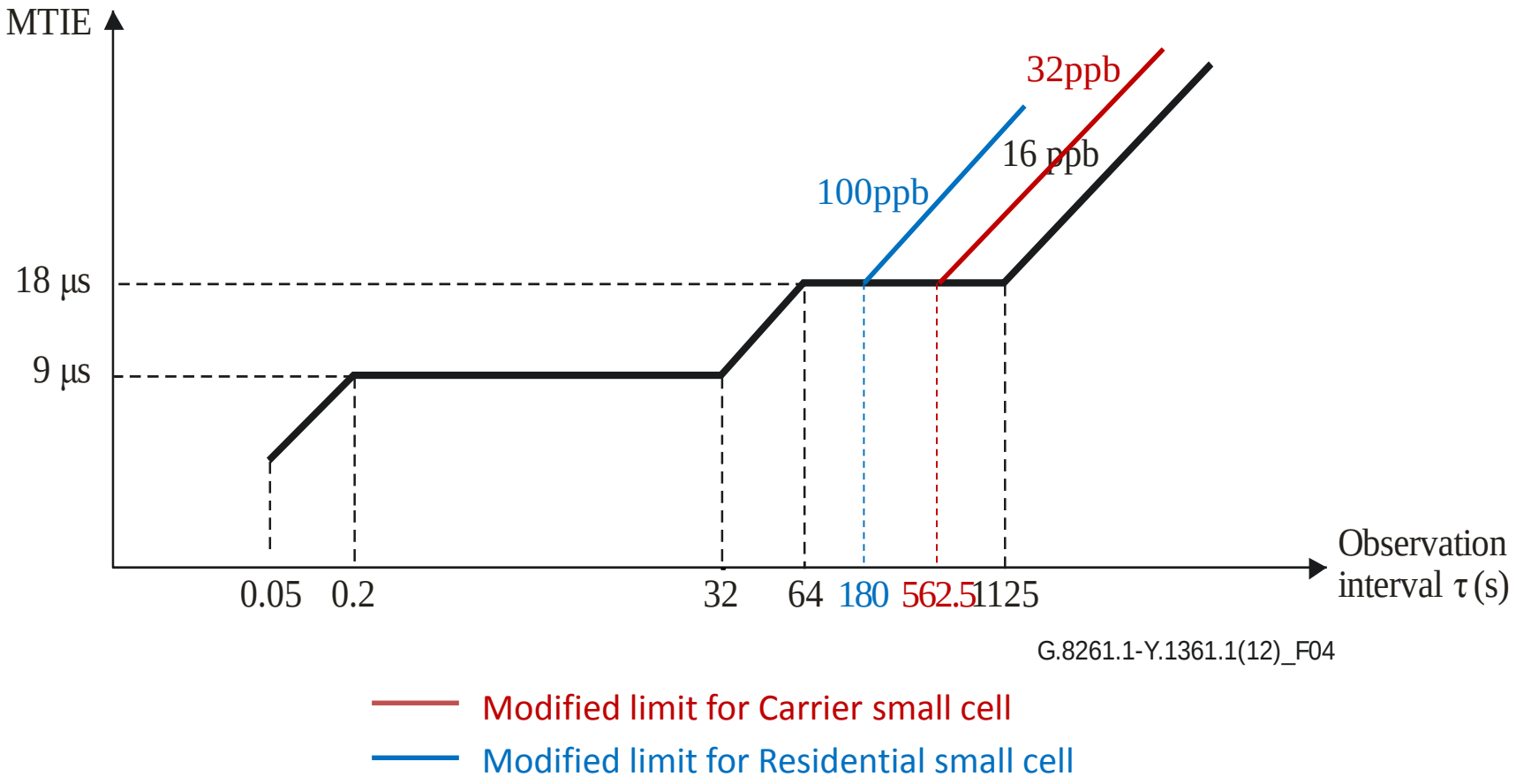


Figure 4/G.8261.1 – Output wander network limit for case 3 based on [ITU-T G.823]

Time Sync Delivery Requirement

Air interface requirements, less:

- 150ns for basestation internal tolerances
- 250ns for short term holdover (e.g. to allow reference switch)

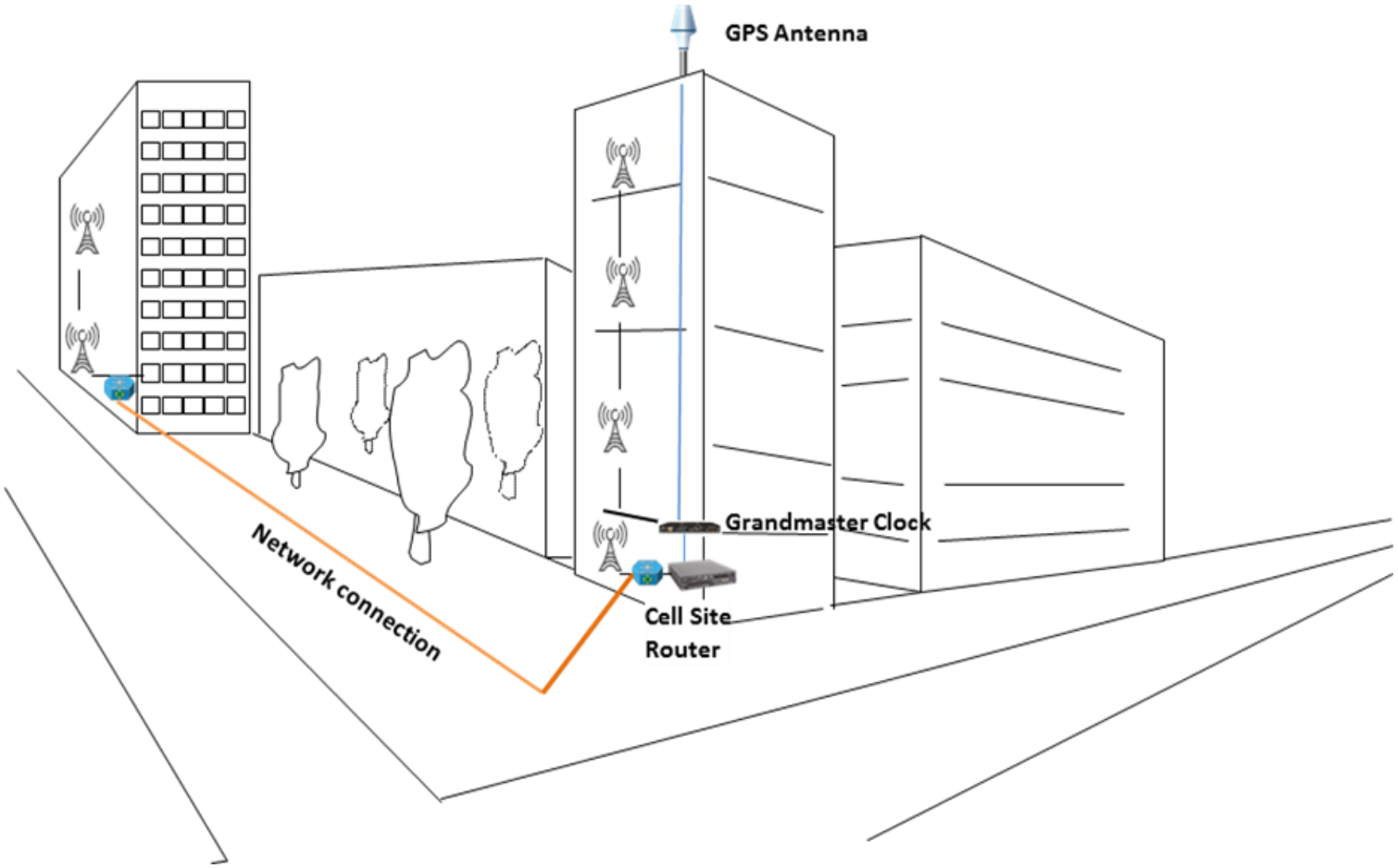
Example for LTE TDD:

- ±1.5μs at the air interface
- ±1.1μs at the network interface

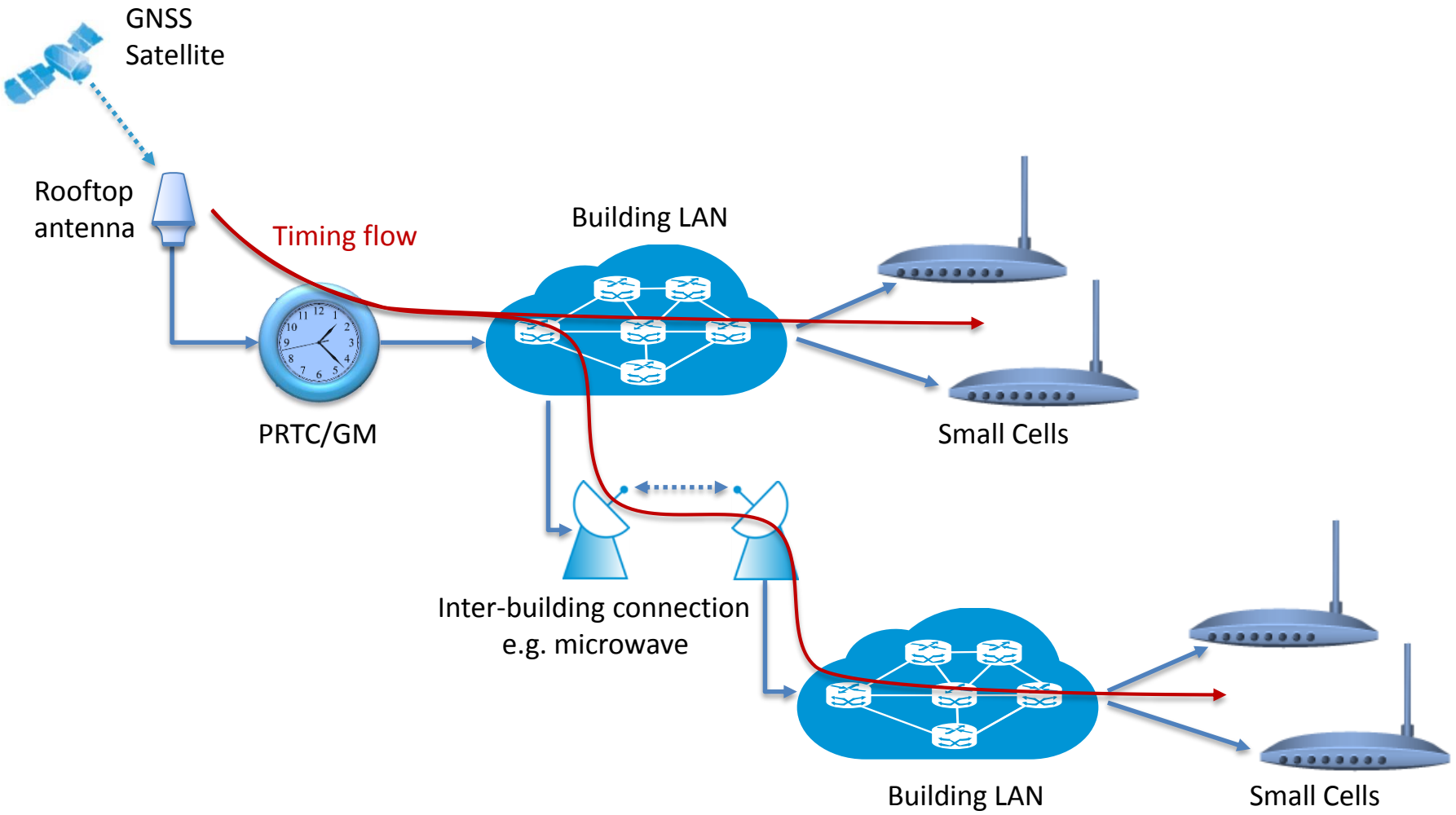
Calnex

Indoor Deployment

AT&T In-Building Proposal

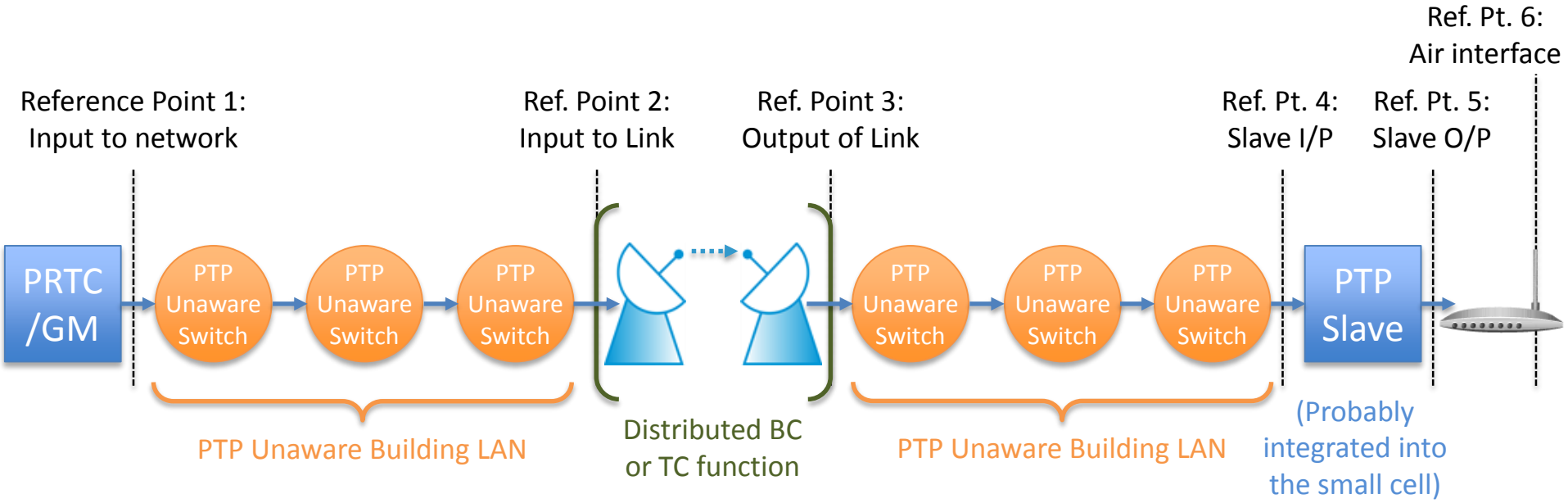


Network Diagram

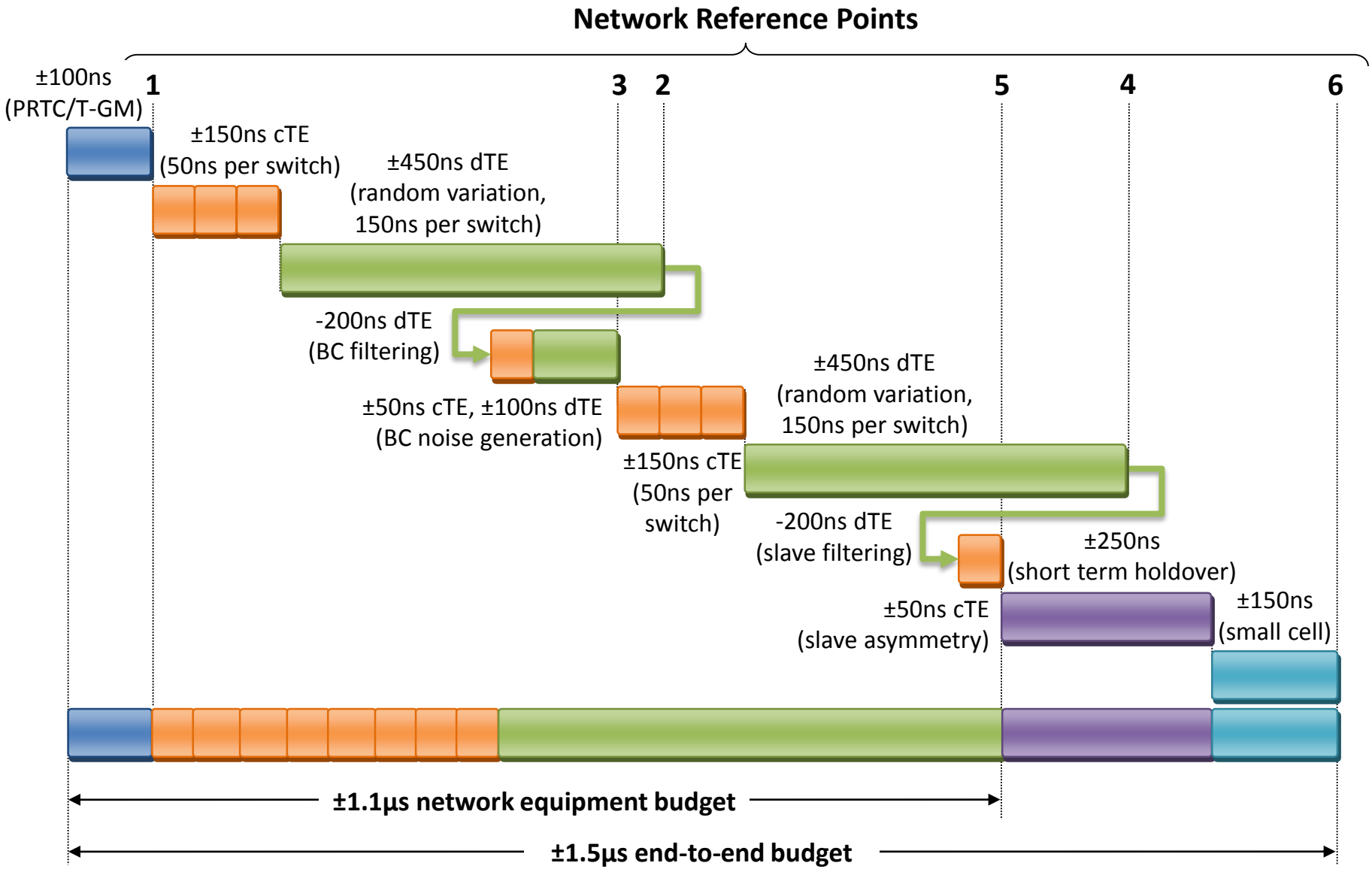


Hypothetical Reference Model

- ITU uses “hypothetical reference models” to analyse the noise in a network
- These allow the performance at various points in the network to be quantified, and network limits to be set
- Possible hypothetical reference model for indoor deployment:



Possible Time Error Budget - Indoor

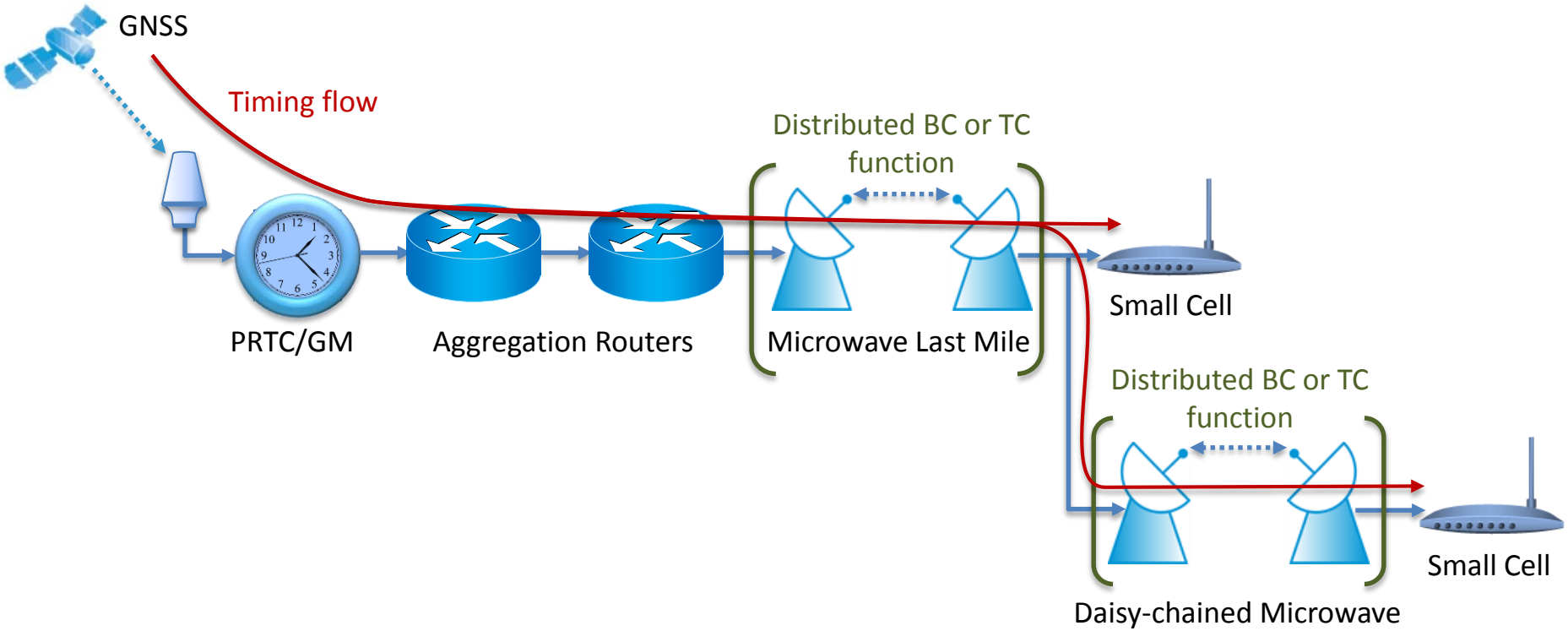


Calnex

Outdoor Deployment

Small Cell Microwave Backhaul

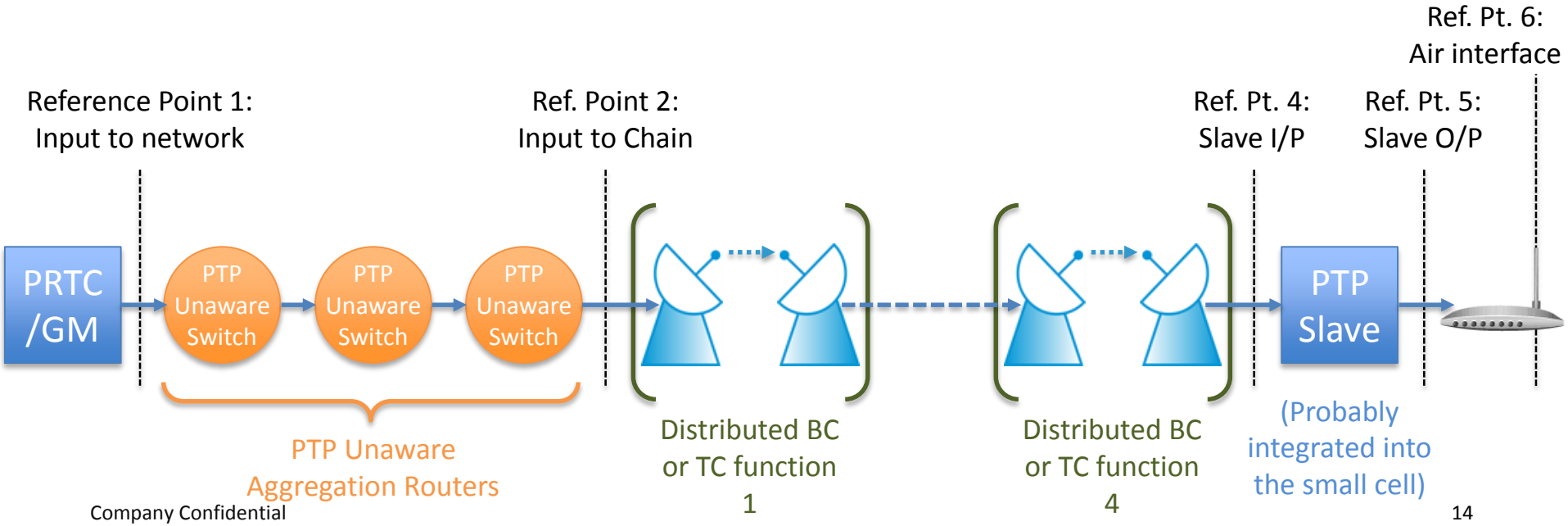
- Small cells often use microwave for last-mile backhaul
- Microwave equipment often includes PTP support, e.g. BC or TC



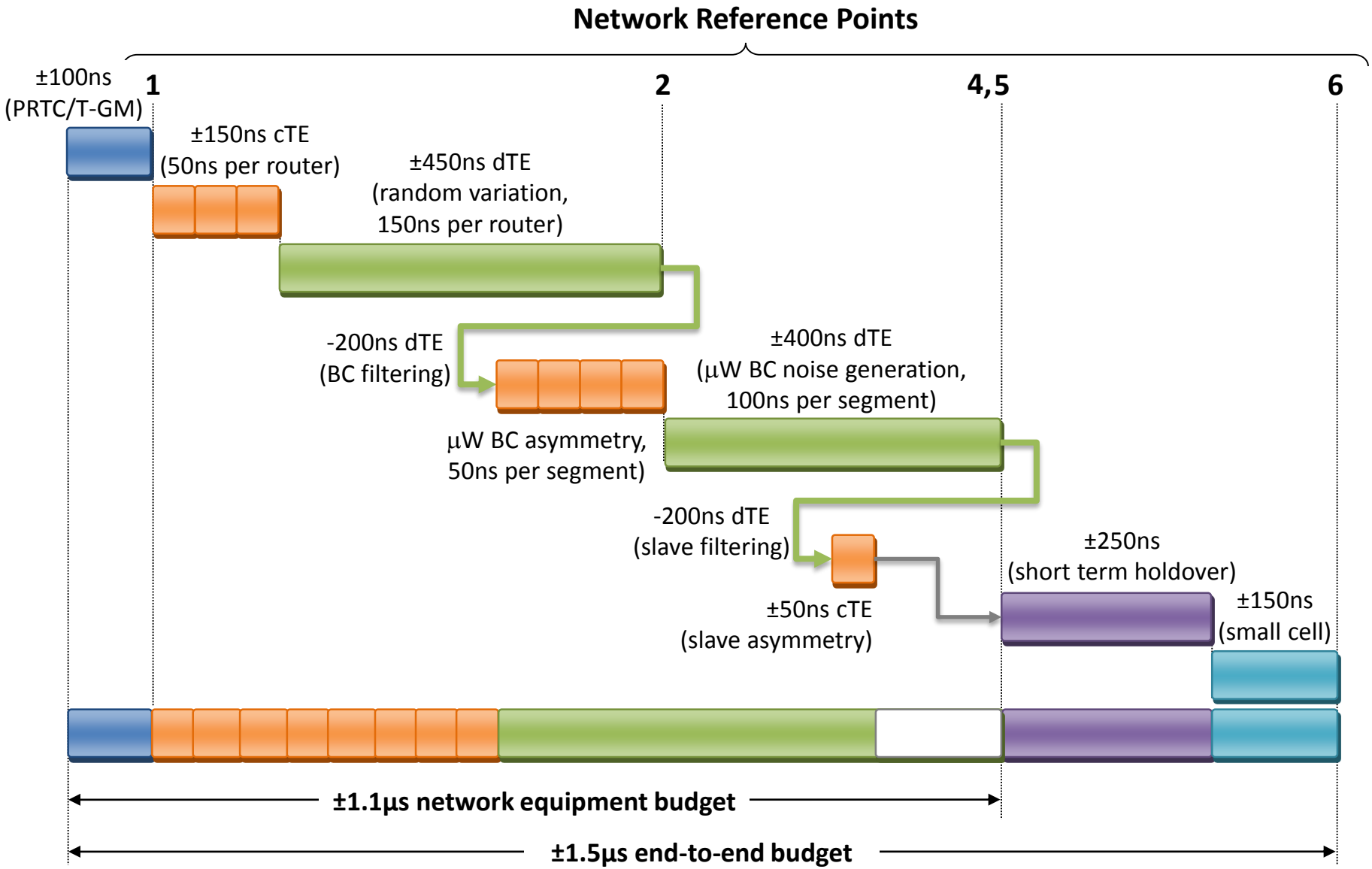
- What performance standards must the BC or TC function meet?

Hypothetical Reference Model

- Possible hypothetical reference model for outdoor deployment:
  - Assumes up to three PTP unaware aggregation routers
  - Up to four daisy-chained microwave segments with BC or TC capability



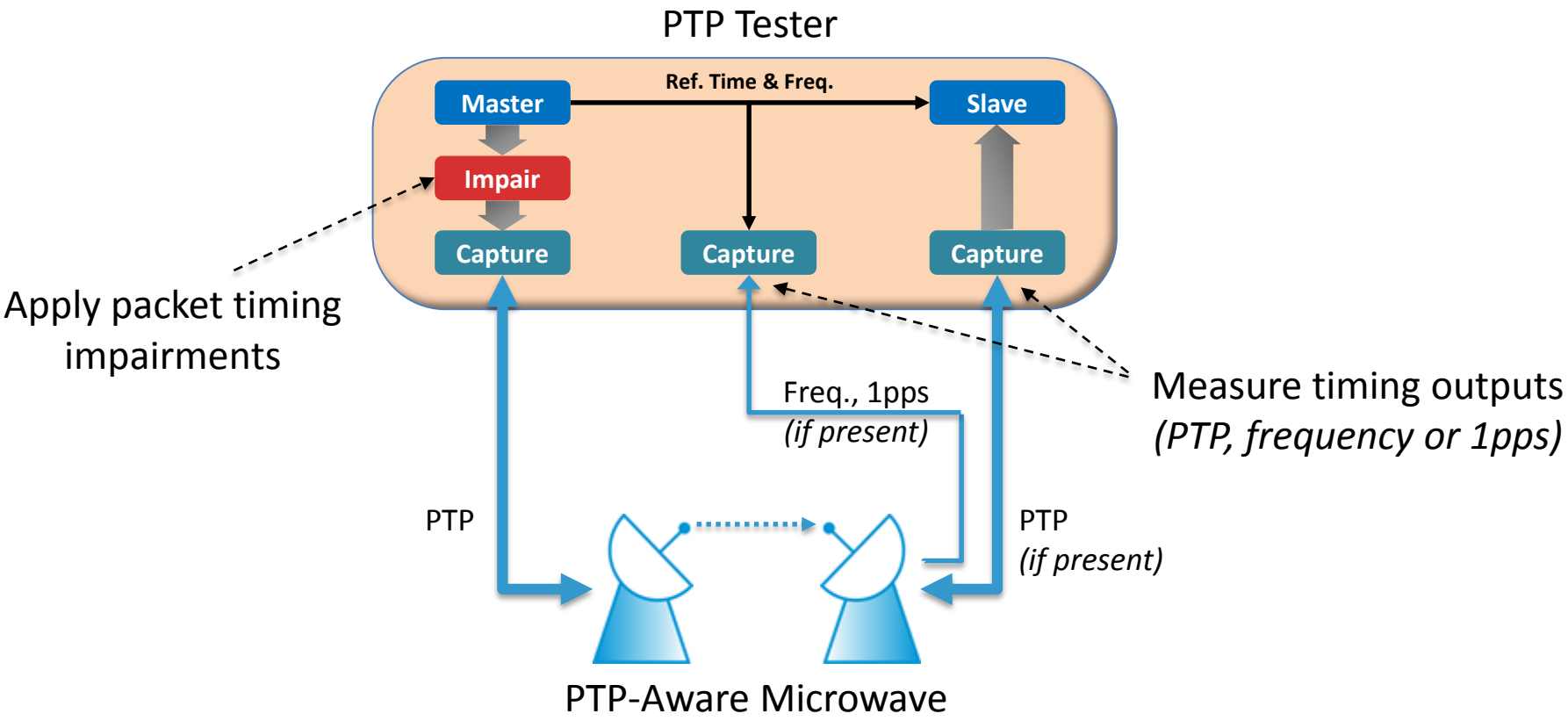
Possible Time Error Budget – Outdoor



Calnex

Measuring Small Cell Synchronisation

Microwave Test Configuration



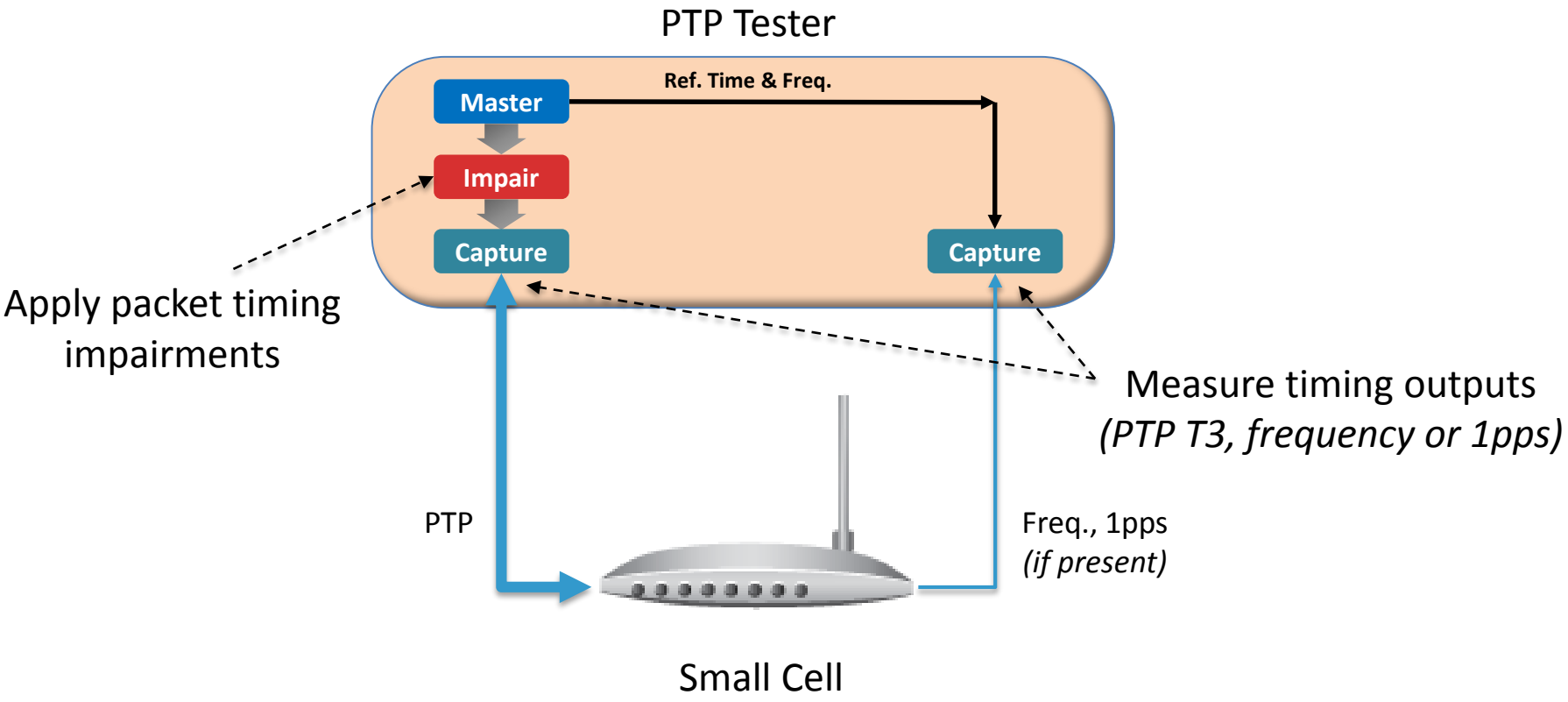
Tests to apply:

- Noise generation (±50ns cTE, ±100ns dTE proposed)
- Noise tolerance (from network limit, possibly 1.1µs max|TE|, 700ns dTE)

How to measure small cell sync

1. At the sync interface output
   - ***BUT*** most small cells don't have extra outputs such as sync interfaces
   - Possibly a test point is accessible in the lab, but not in a field environment
2. At the network interface
   - Probe PTP flow at network interface, then the originTimestamp in the Delay_Req message (T3) gives a direct readout of internal clock state
   - ***BUT*** PTP devices are not required to insert an accurate T3 value
     - IEEE1588-2008, Clause 11.3.2: ***"The originTimestamp shall be set to 0 or an estimate no worse than ±1 s of the egress time of the Delay_Req message."***
     - Requires on-the-fly hardware timestamp insertion, which is only mandated for one-step PTP master
3. At the air interface
   - Monitor the RF output signal, decode frames for frequency and alignment

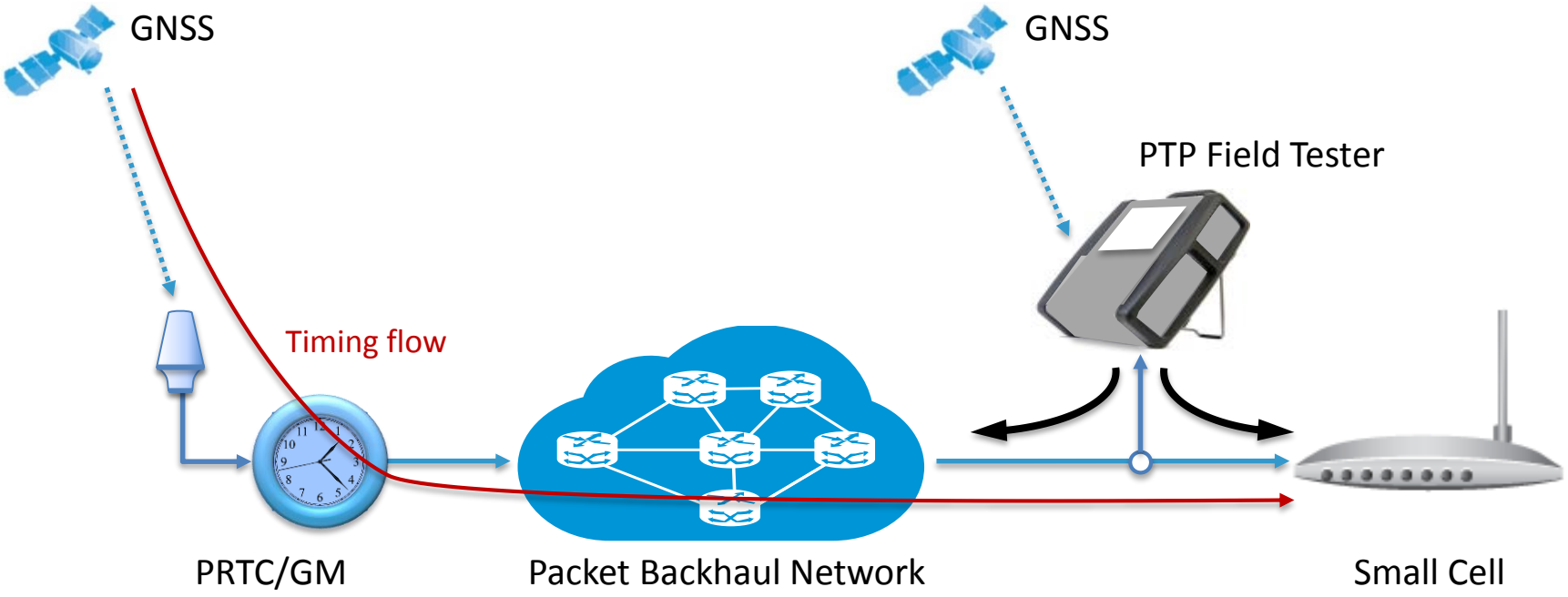
Lab Test Configuration



Tests to apply:

- Noise generation and tolerance for frequency (from G.8263)
- Noise generation and tolerance for time (to be determined)

Field Test Configuration



PTP Field Tester monitors:

- Quality of sync coming from PRTC/GM
- Accuracy of small cell sync (if accurate T3 available)

Recommendations for Small Cells

Calnex

Lab test units

- Provide a sync test output (e.g. 1pps and/or frequency o/p)
- Can be made available on an internal test point if necessary

Field units

- Sync test output not practical for cost reasons
- Make accurate T3 timestamp available to allow monitoring
- Needs to be mandated by carriers to force small cell vendors to make this available

INTEGRITY

TIME ERROR MEASUREMENTS REQUIRE TRUE PRECISION

Tim Frost
tim.frost@calnexsol.com
+44 (0) 1506-671-416