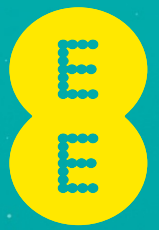
OTT Frequency Sync

Releasing PTP in to the wild



Terry Sullivan
Senior Designer - Mobile Backhaul
7th November 2017

Agenda

1. What is ‘the wild’?
2. Sharing the backhaul
3. Not just one solution
4. Solution considerations
5. Lab tests and trials
6. Deployment and performance

What is ‘the wild’?

Traditional backhaul transmission

- With Mobile Ethernet service you get…
  - Emulation services (TDM, ATM and L2 PWE3s)
  - QoS Profiles (end-to-end) with multiple VLAN support
  - Synchronisation as part of the service
  - All this with a price tag to match
- With Generic Ethernet service you get…
  - No service emulation
  - Pure Ethernet
  - Limited QoS (only 5% high priority guarantee) and only one VLAN
  - No synchronisation

Generic Ethernet pros and cons

Generic Ethernet service

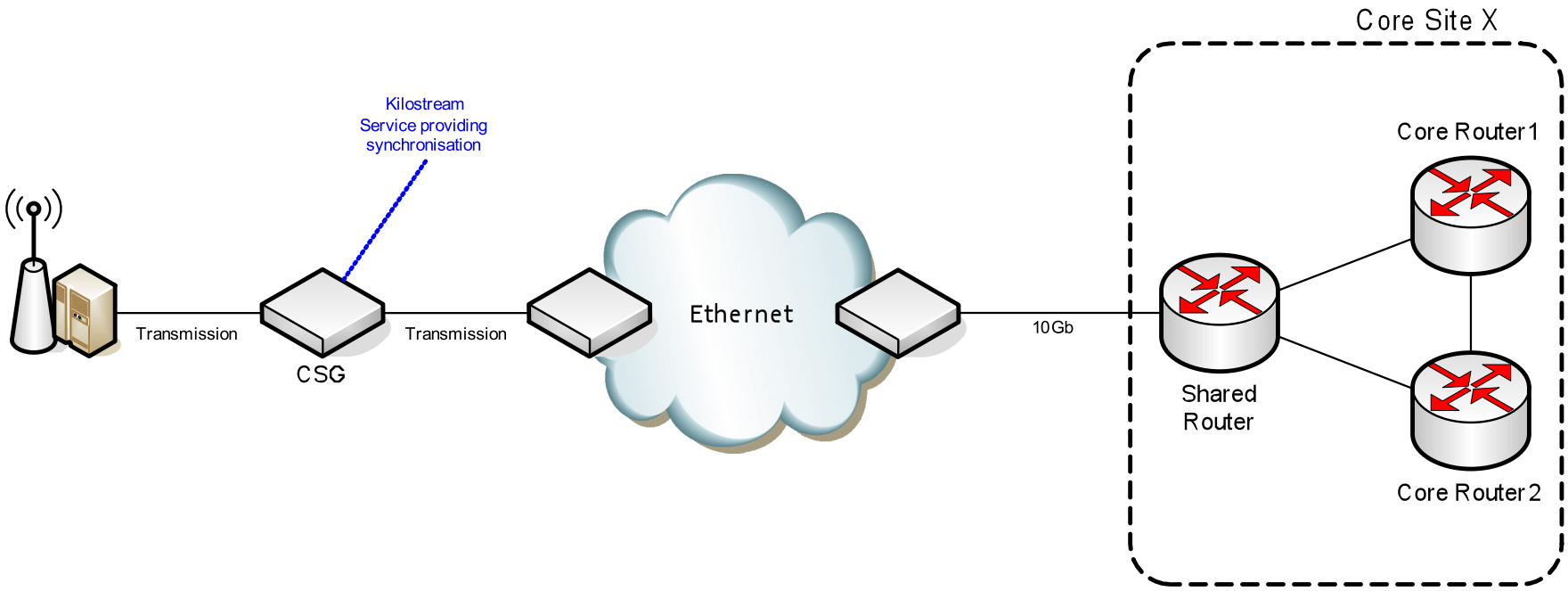
- Good for some services
  - General data transfer
  - Data backups
  - LAN services
  - Non time-critical services
  - Cost
- Bad for
  - Mobile networks
  - QoS
  - Synchronisation

Sharing the Backhaul with H3G

EE and H3G

- EE and H3G share RAN Backhaul
  - RAN sharing is limited to 3G infrastructure
  - Backhaul network managed and ran by MBNL
- MBNL
  - Jointly owned by EE and H3G
  - Manage the 3G network and Transport on behalf of EE and H3G
  - Act as a ‘middleman’ between EE and H3G
- MBNL Demarcation to EE
  - Shared core router

Existing solution

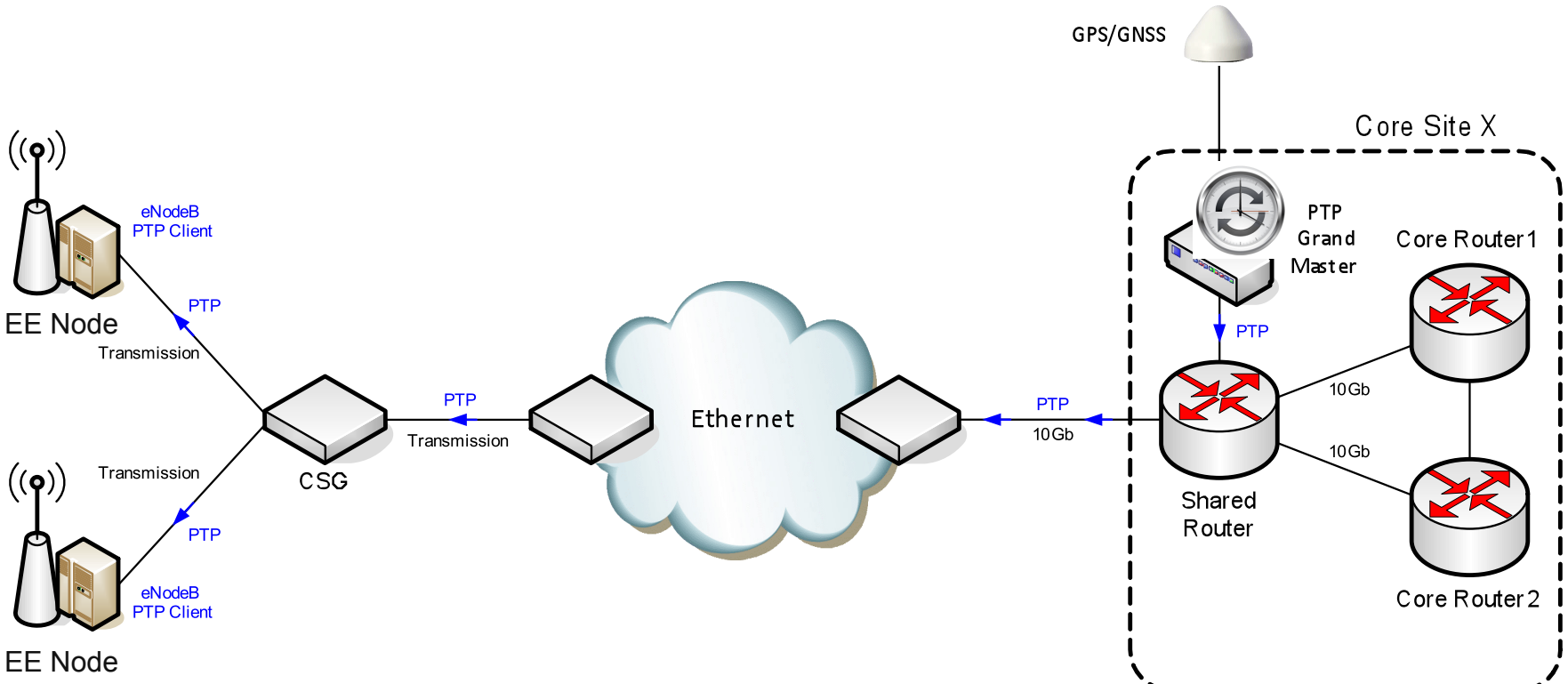


Not just one solution

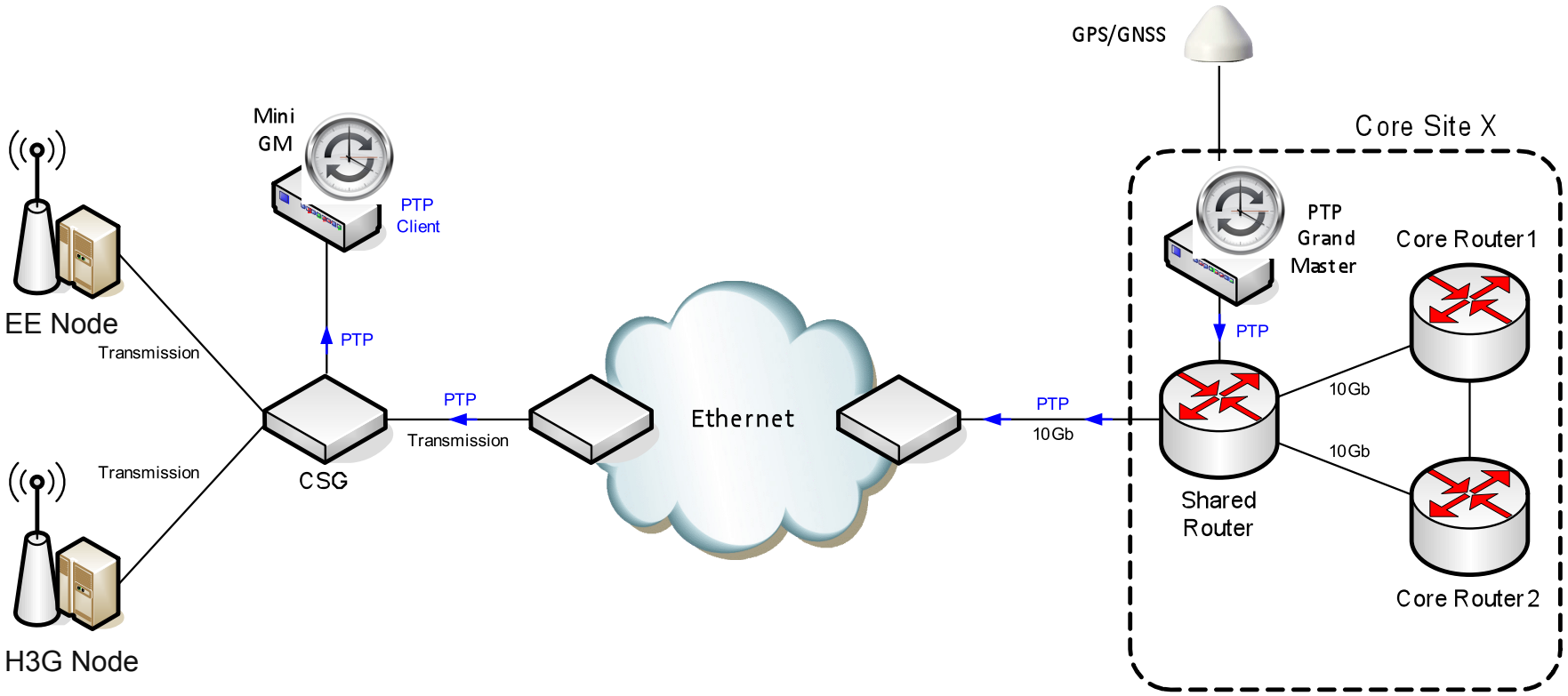
EE and H3G

- 2 Main solutions
  - EE Unilateral and Multi RAN sites
  - EE Shared sites (EE and H3G)
- Future considerations
  - Phase synchronisation
  - LTE-A
  - 5G

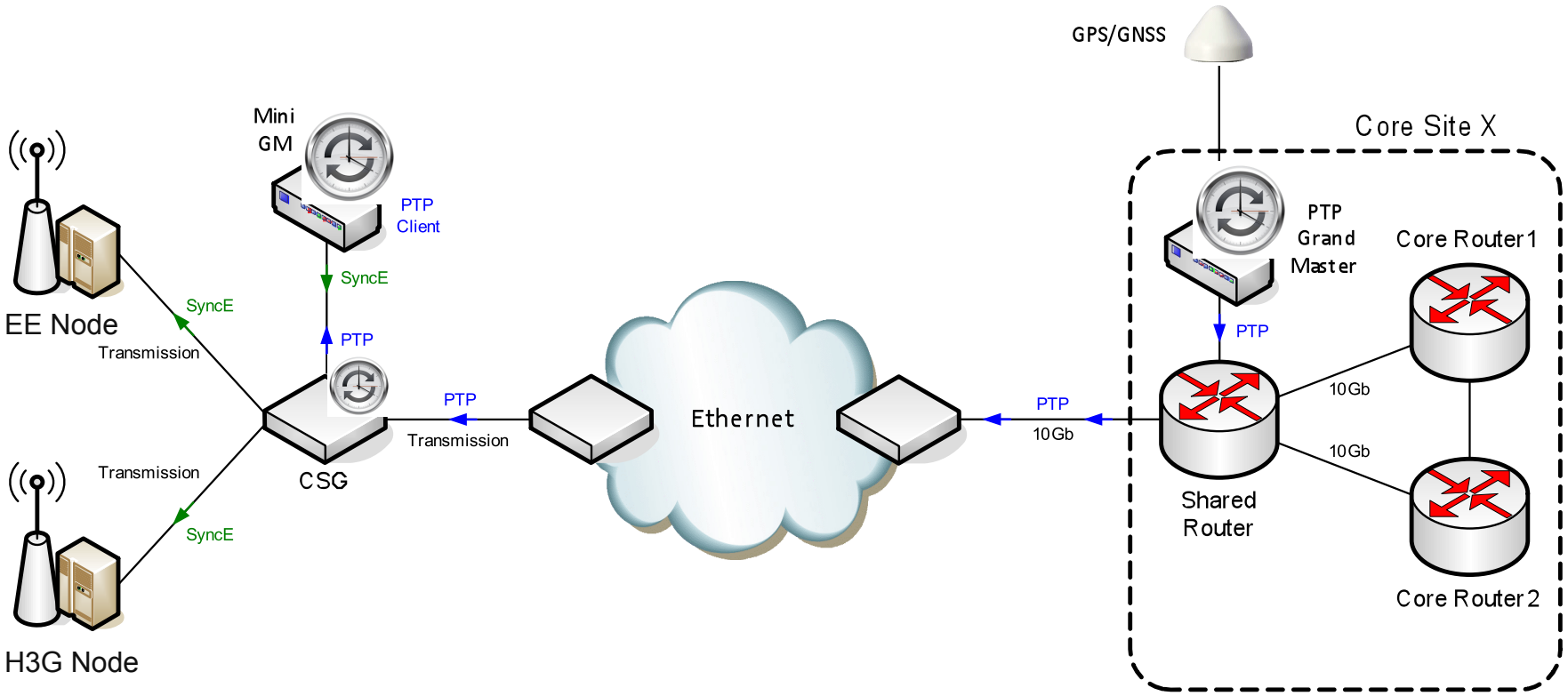
EE Unilateral sites – Multi RAN



Shared sites (EE and H3G)



Shared sites (EE and H3G)



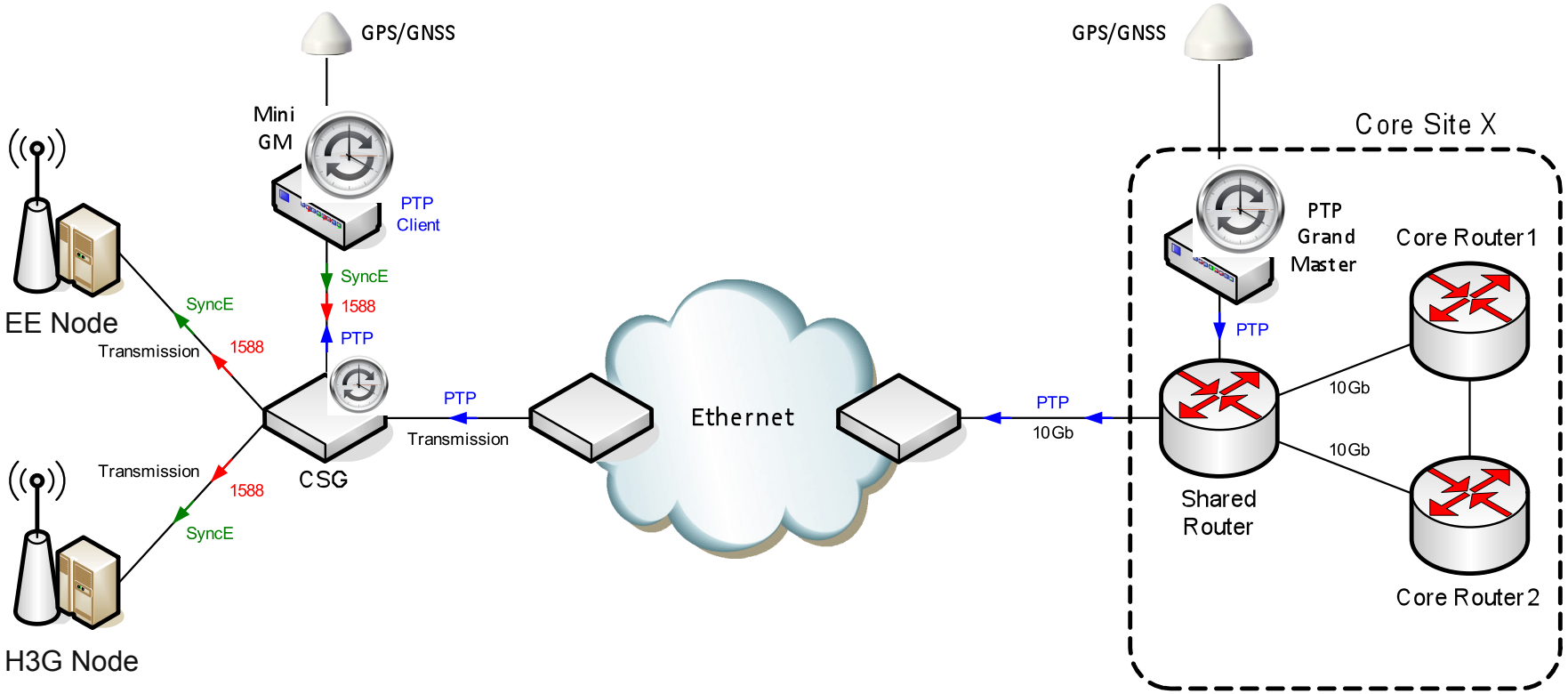
So why not GPS/GNSS at the cell site?

Reasons why it's not suitable

Reasons not to use GPS/GNSS

- Over reliance on GPS/GNSS
- Concerns about localised jamming
- RAN Cabinets often inside buildings
- No easy GPS/GNSS option for street cabinets
- No current Phase synchronisation requirement
- Per site hardware costs

Phase in the future



Core Grandmaster solution

Core Grandmaster locations

6 GMs around the country

- Tannochside
- Preston
- Solihull
- Cardiff
- Enfield
- Greenwich

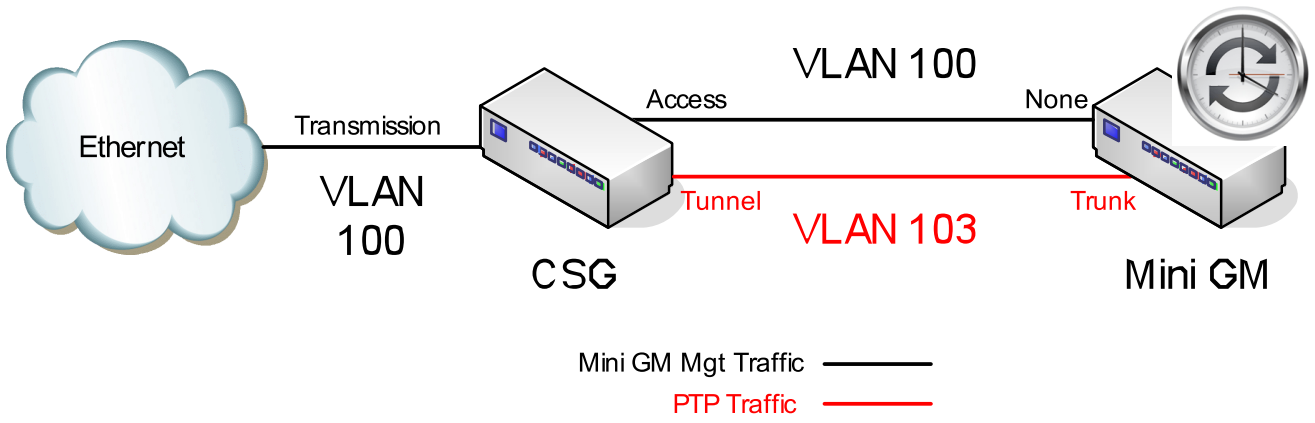
Cell site solution

Single VLAN problem solved

- Using QinQ (802.1q)

- PTP and inband management
  - Both use different VLANs

VLAN Title	VLAN Number	VLAN Tag
Cell Mgmt	Example 100	Outer
VLAN 3G	Example 101	Inner
VLAN Shared	Example 102	Inner
VLAN PTP	Example 103	Inner
VLAN Spare	Example 104	Inner



Solution considerations

QoS Profile, Shapers and Priority Queueing

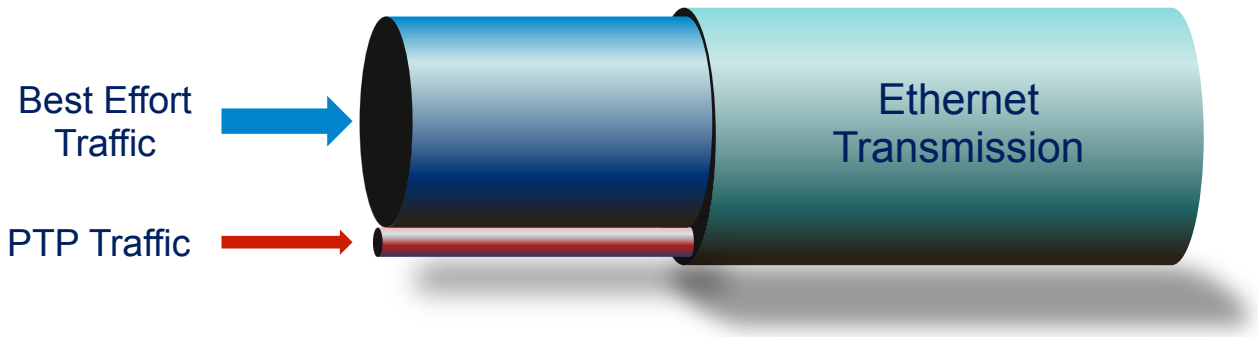
- QoS profile includes traffic shapers and priority queueing
- Traffic shapers on the shared router to limit congestion
- Shapers limit and guarantee traffic on the interface

- PTP priority queueing or best effort?
  - PTP in a high priority queue?
  - All the traffic in the same queue?
  - Is it better to delay all PTP packets or better to lose a few?

Priority queueing or best effort?

PTP in high priority queue

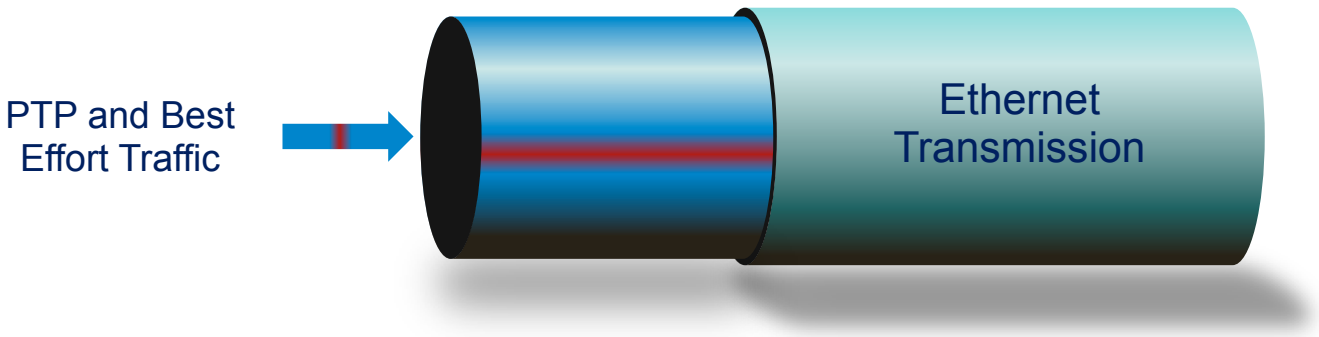
- PTP and control traffic used different Pbit values
  - High value Pbit marking for PTP traffic
  - Low value Pbit marking for all other traffic
  - PTP traffic in a separate queue from other traffic



Priority queueing or best effort?

All traffic in the same queue

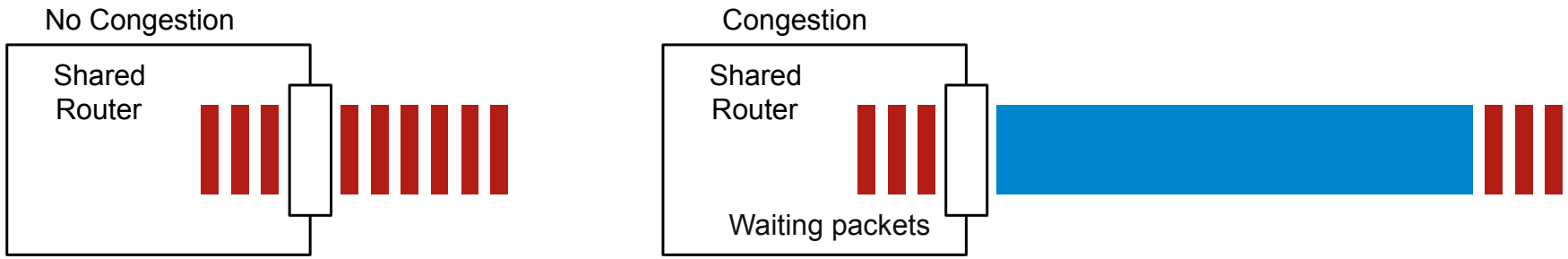
- All traffic marked with the same Pbit value
  - All traffic in the same queue
  - Similar delays in PTP packet transmission
  - Some packets are dropped under congestion



Always a queue…

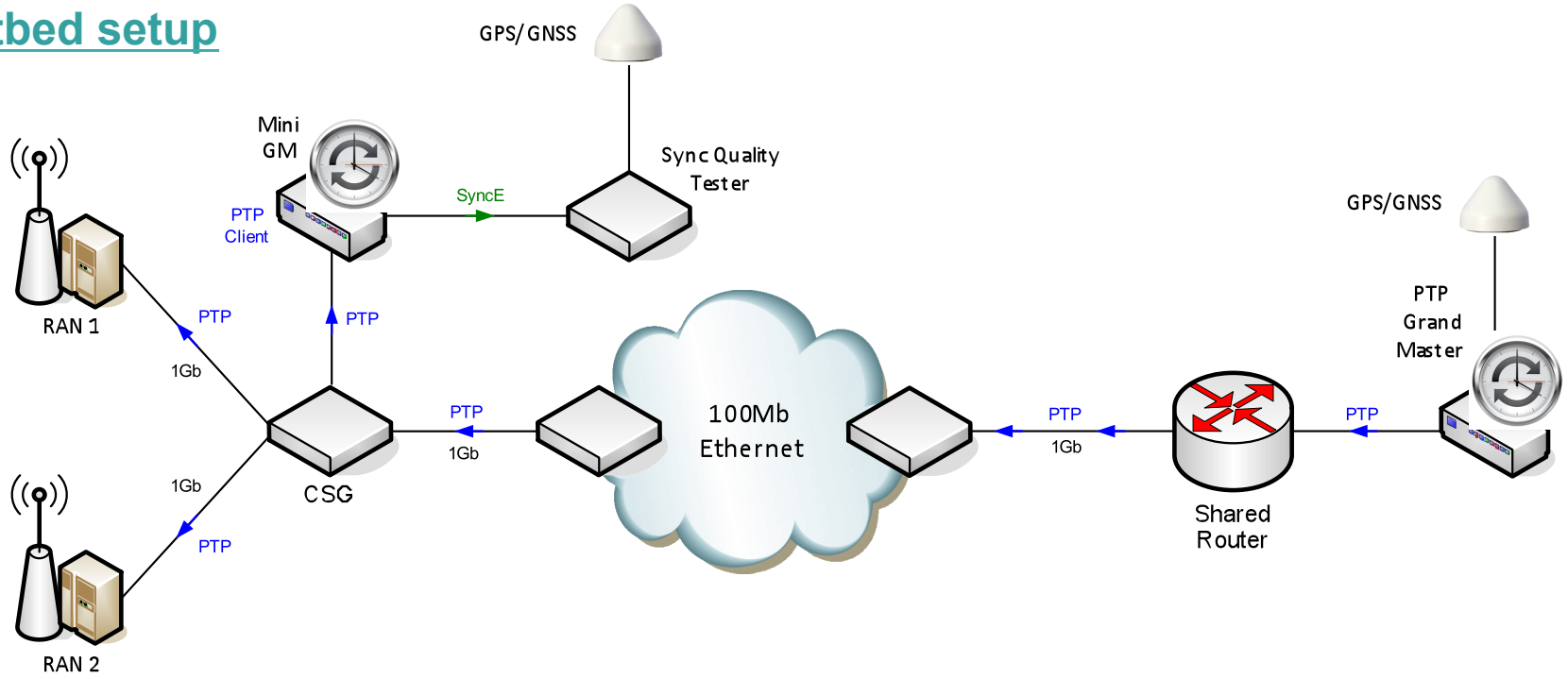
The large packet problem

- Do large packets get in the way?
  - Small PTP packets first in the queue
  - Do large packets (1500byte) block the way?
  - Especially a problem under congestion



Lab tests and trials

Testbed setup

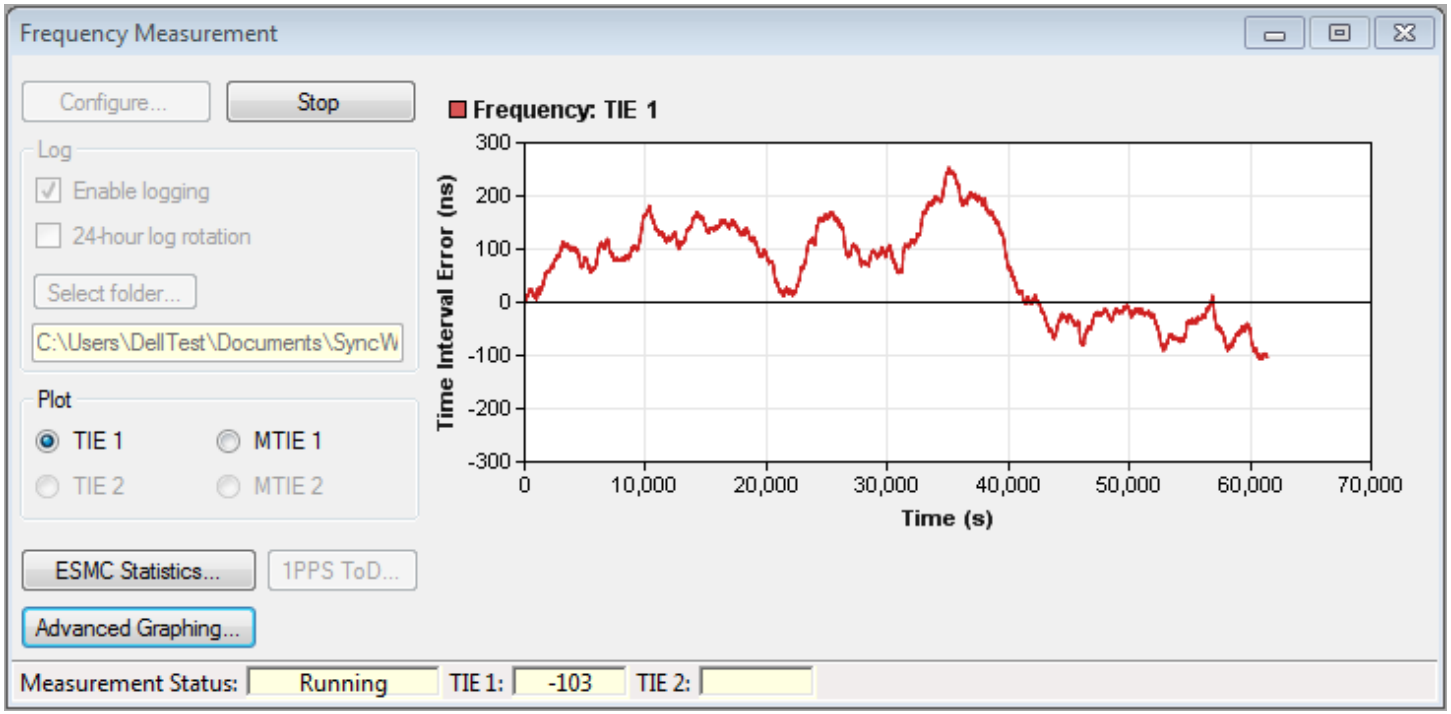


Testing parameters

Test parameters and test cases

- Testing to G.8261.1
  - G.8261.1 - Packet delay variation network limits applicable to packet-based methods (Frequency synchronization)
- Test Cases
  - PTP performance
  - PTP Holdover performance
  - PTP under congestion - high priority queue
  - PTP under congestion - low priority queue
  - Phase performance

Testing results – PTP performance over 16 hours



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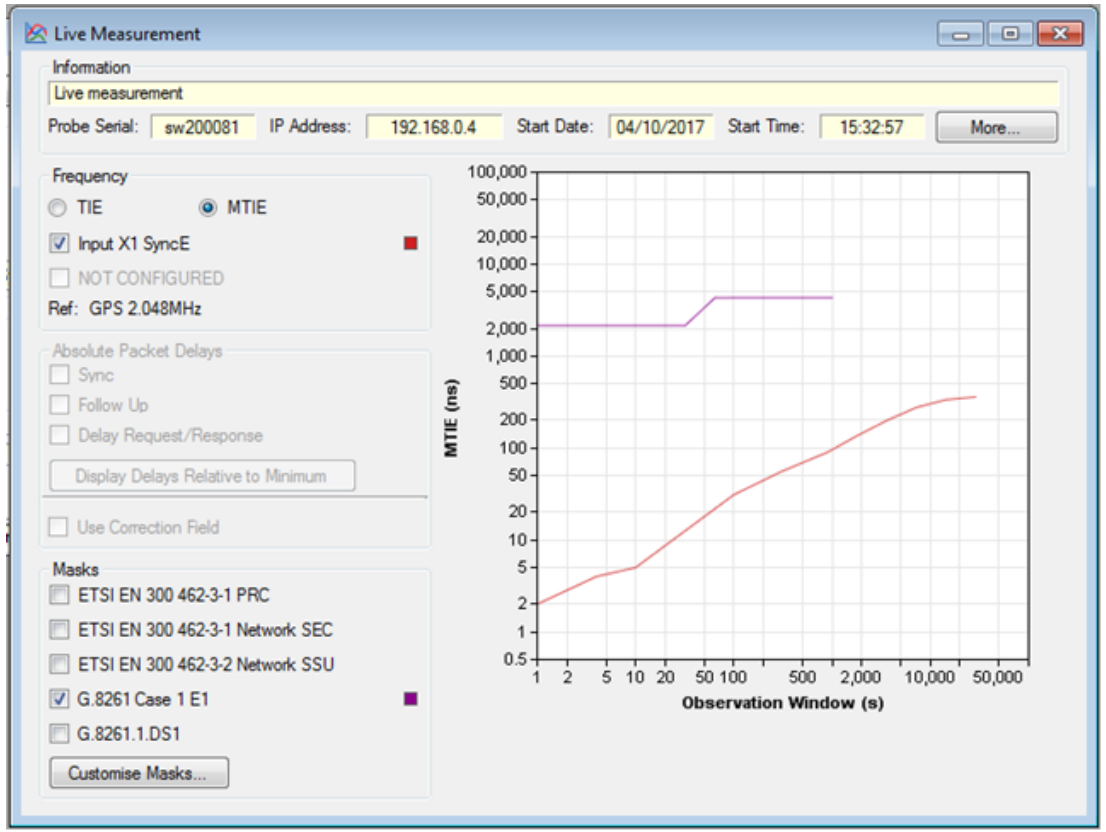
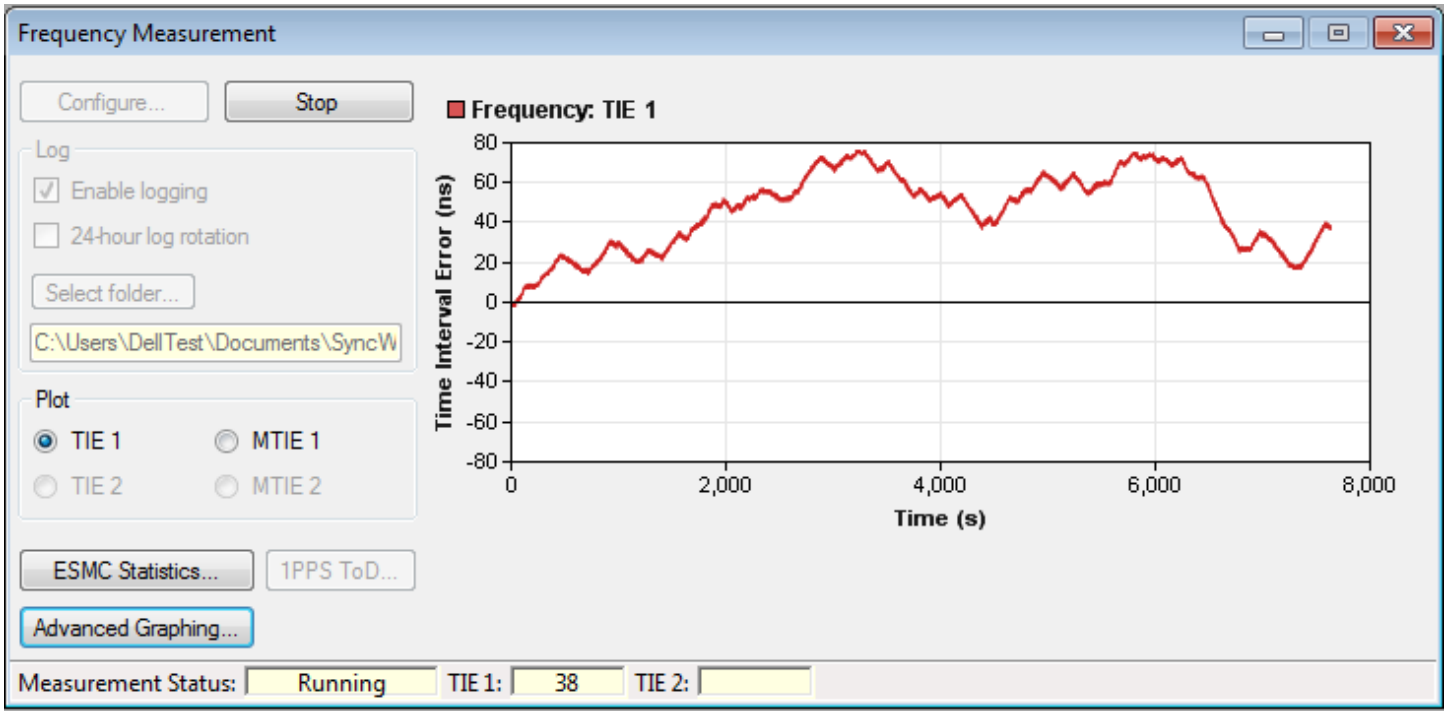


Testing results - PTP holdover performance over 2 hours



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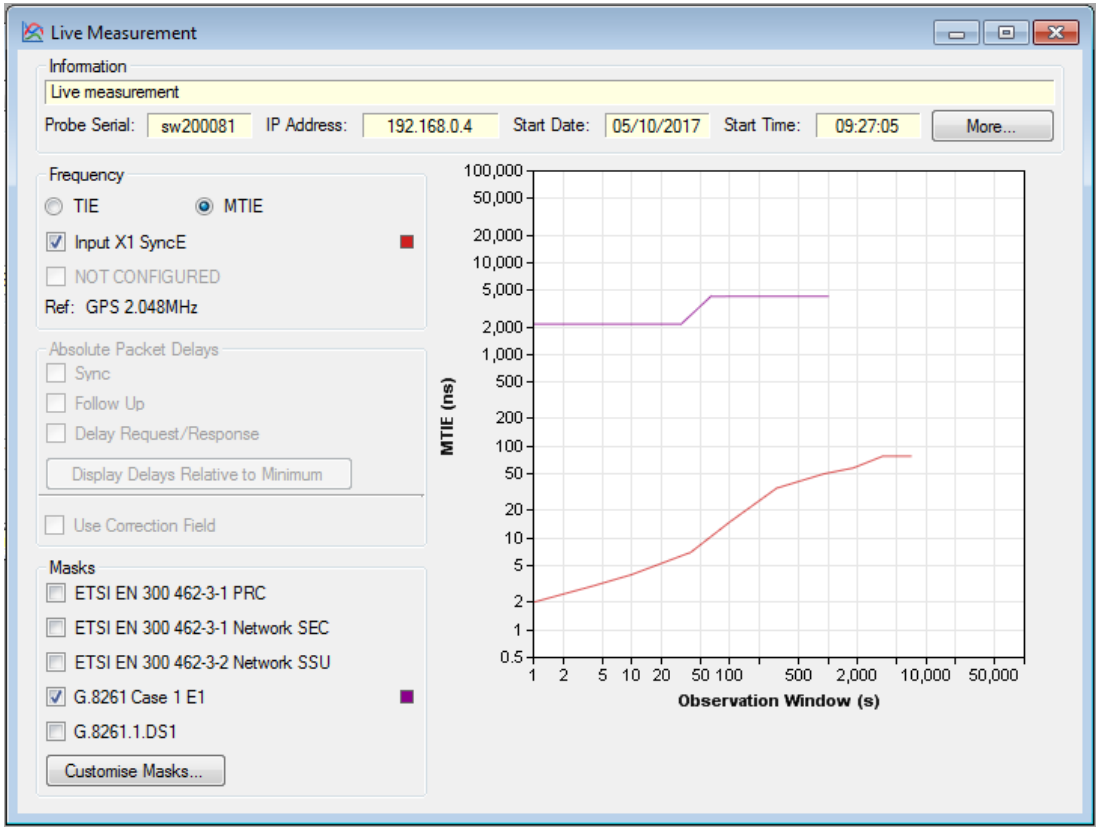
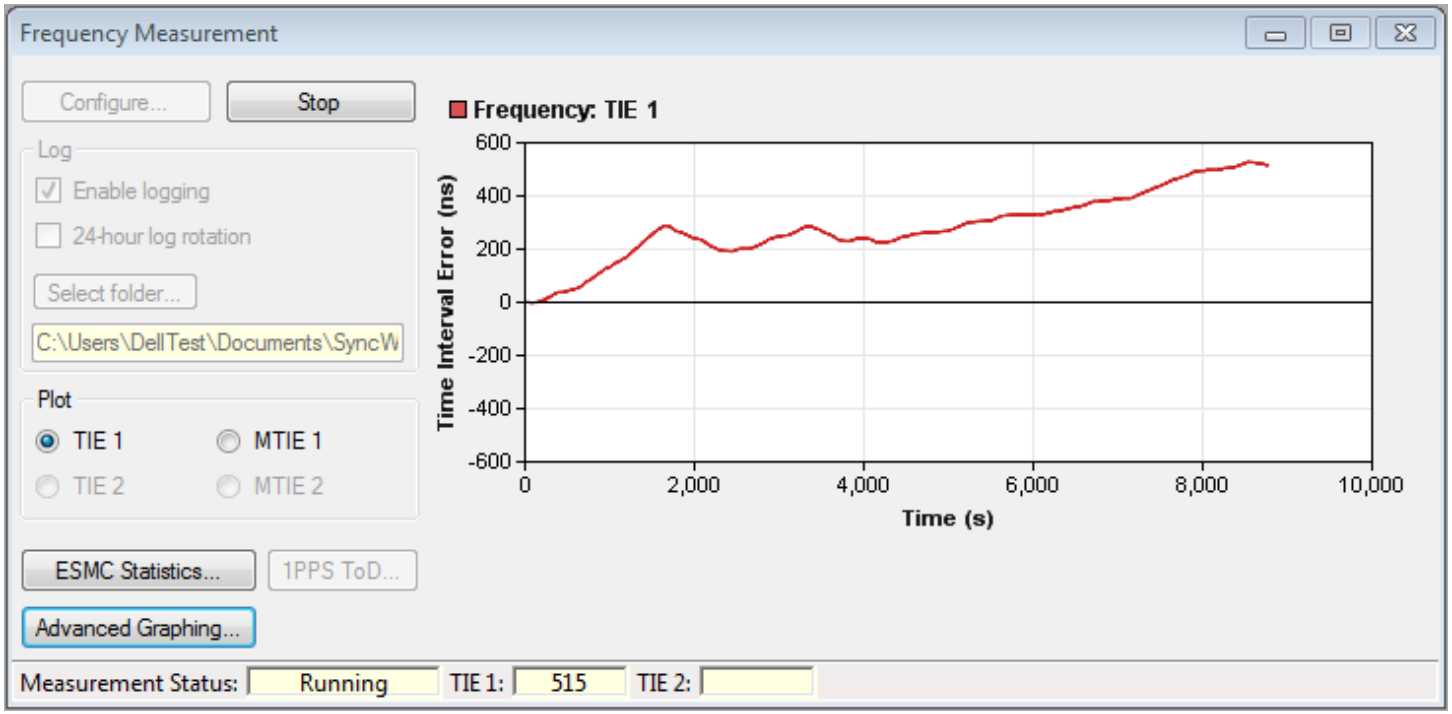


Testing results - PTP under congestion (high priority)



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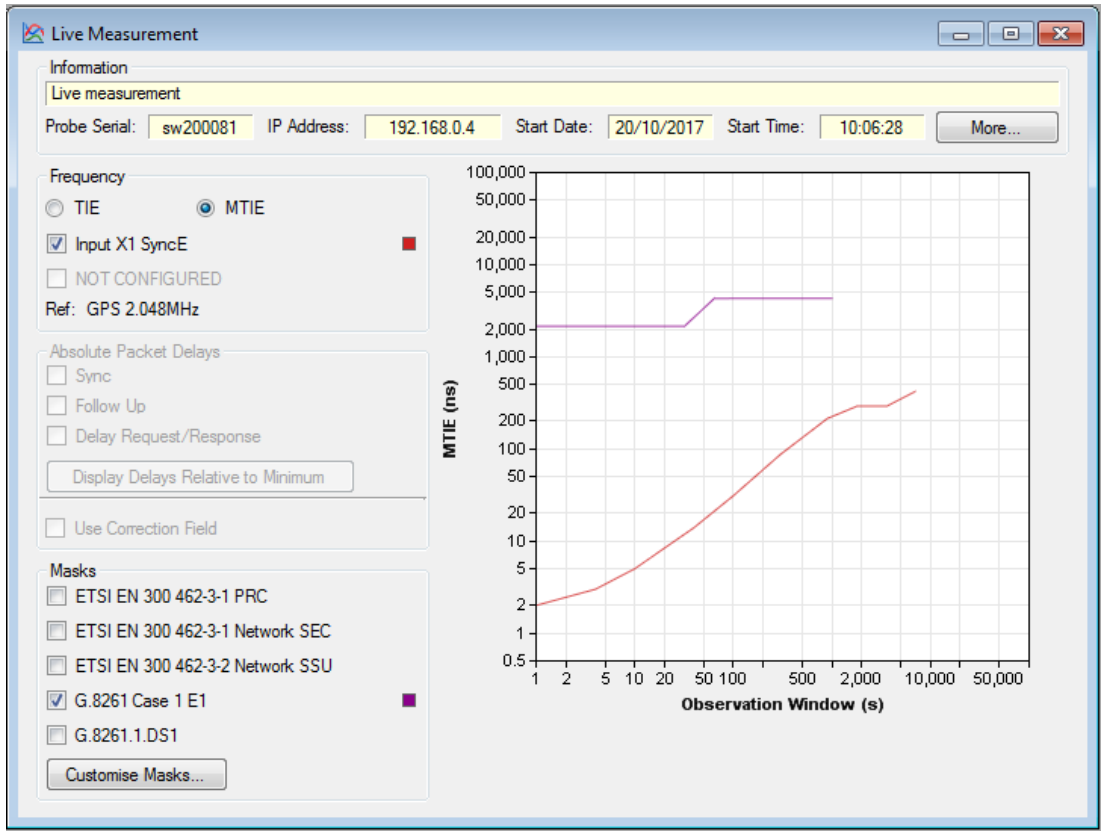
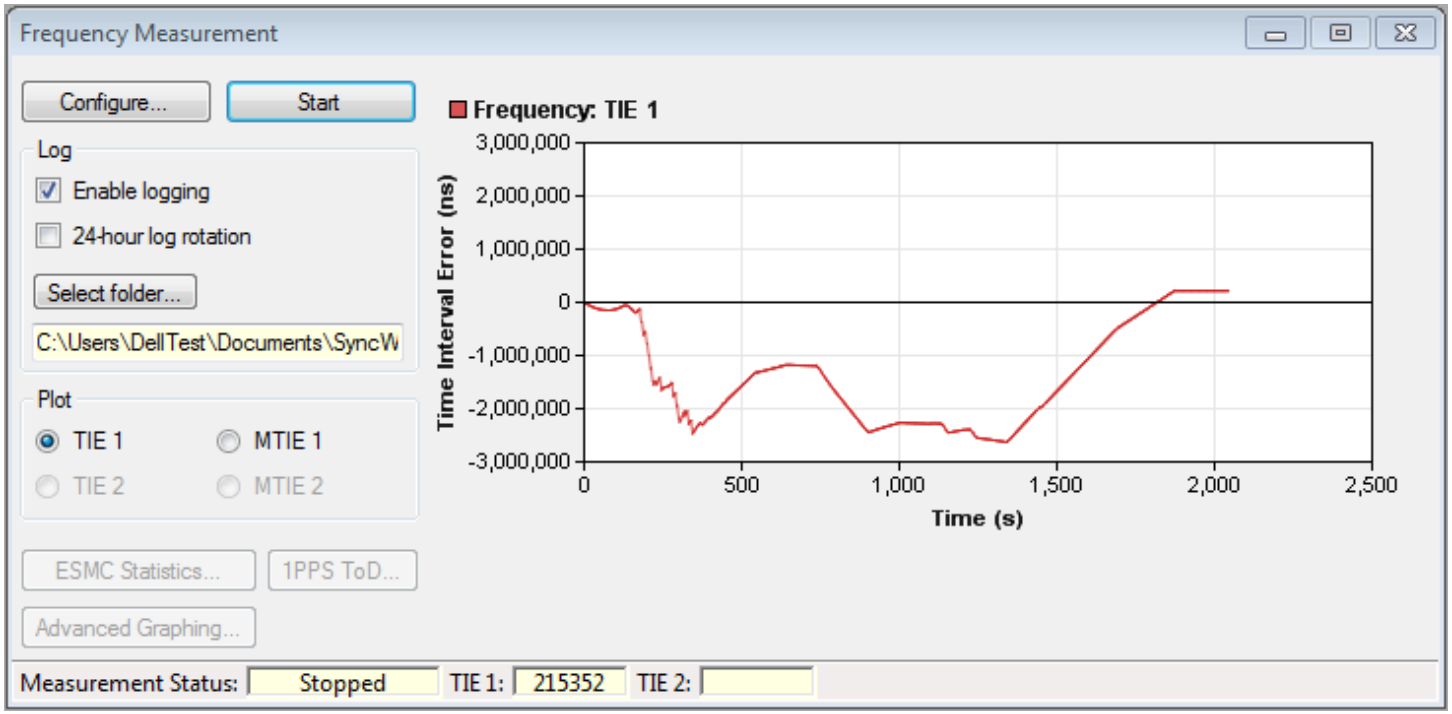
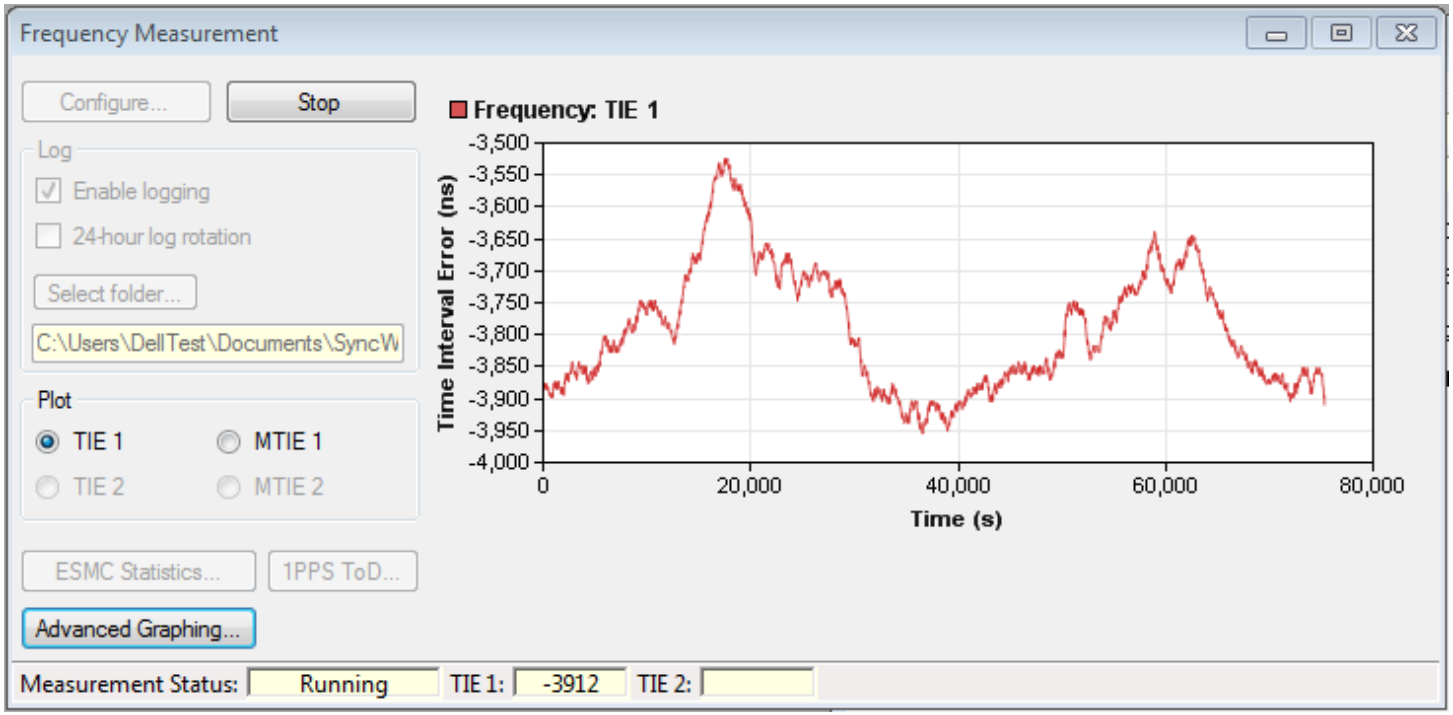


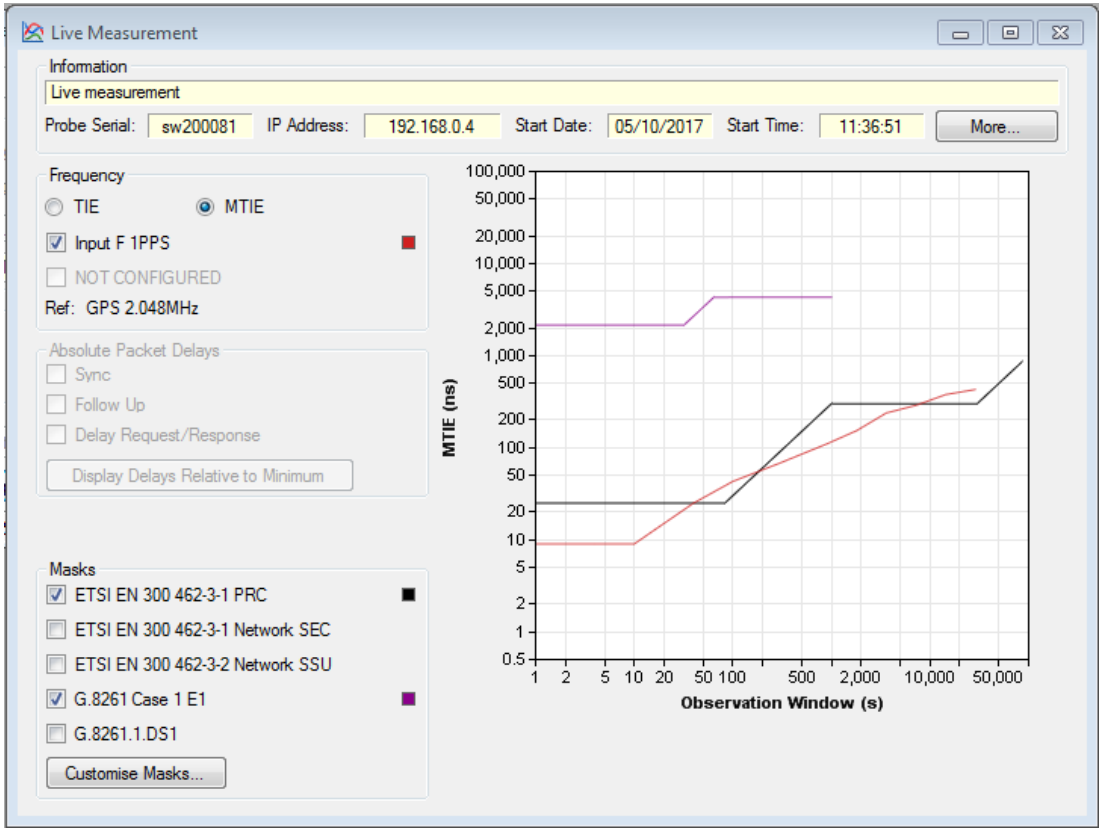
Testing results - PTP under congestion (low priority)



Testing results – Phase performance (Just to see)



Testing Results – Phase Performance



Testing Conclusion

Test Summary

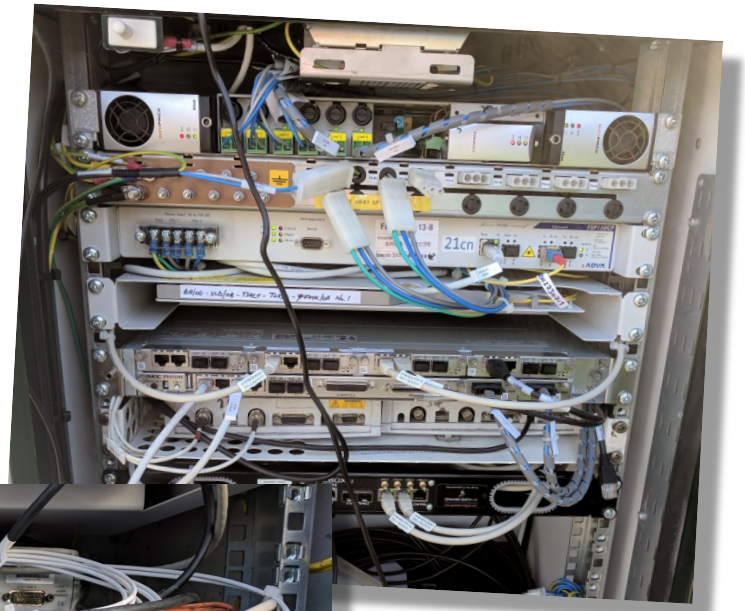
- Testing successes
  - PTP does work over a Wholesale Ethernet link
  - Holdover performance of the Mini GM was excellent
  - Both Mini GM and RAN as PTP clients worked well
- Observations
  - PTP packets in their own high priority queue perform better
  - Phase Sync performance was good, but not good enough for LTE-A or 5G without a cell site GPS/GNSS solution (but we guessed that anyway!)

Deployment and performance

Live Tests Ongoing

- Currently in limited live deployment
  - Live network testing going well
  - Both Unilateral and Shared sites deployed
- Next Steps
  - Continued monitoring of the live deployment sites
  - Planning for hundreds of additional Unilateral and Shared sites across the UK

Live deployment and performance in the wild!



THANK YOU

Questions?