International Timing & Sync Forum 2021

#ITSF2021

Implementing and Monitoring Layer 2 and 3 PTP Networks
– *the learnings of a mobile operator*

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Agenda

1. Introduction
2. PTP network synchronization for 5G
   - Layer 2 PTP for NR 5G TDD
   - Layer 3 PTP for all NR 5G
3. Monitoring PTP networks
4. Future

Introduction

Who is TDC and TDC NET?

- TDC is a danish telecom provider covering TV, broadband, and mobile

- TDC emerged out of all danish telephone companies under state monopoly, the first of which was founded in 1882

- In 2019, TDC was split in two companies:
  - Nuuday: Service provider
  - TDC NET: Infrastructure provider

- Our goal in TDC NET is to provide the best wireless- and fixed connections in Denmark

- Tutela recently awarded us the global first price for the best mobile experience

tdc net

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Introduction

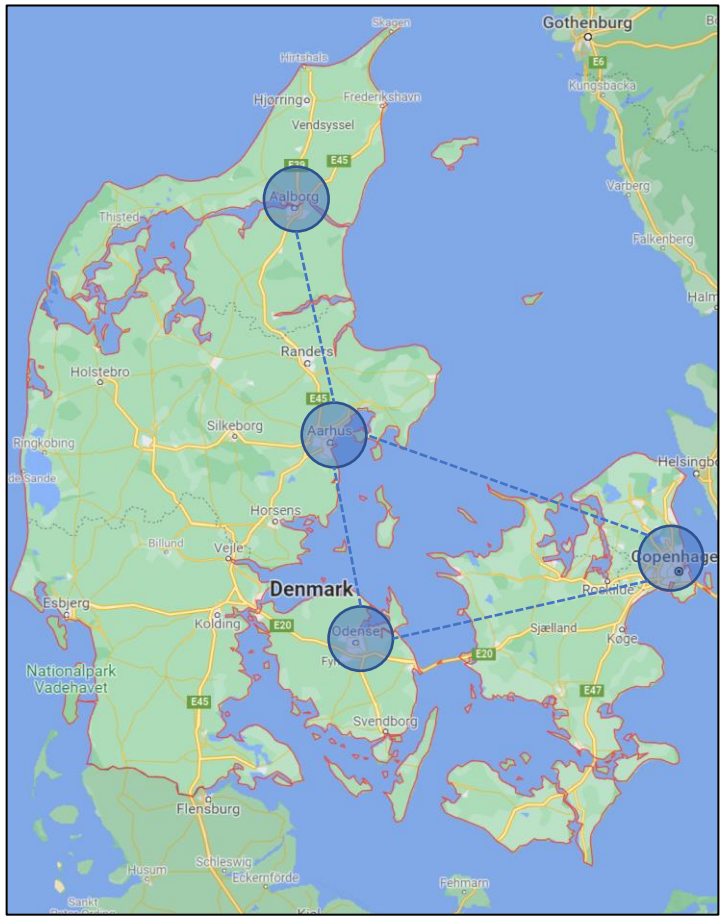
Who am I?

- My history is somewhat shorter as I'm a 31-years-old man living with my wife in Aarhus, Denmark
- I have a background in physics where I did a PhD in optical properties of rare-earth ions
- I joined TDC NET straight out of university in 2019 and soon found my niche in synchronization
- My hobbies are food & beverages, and to counterweight these fitness has proven necessary

Layer 2 PTP for NR 5G TDD

What did we design?

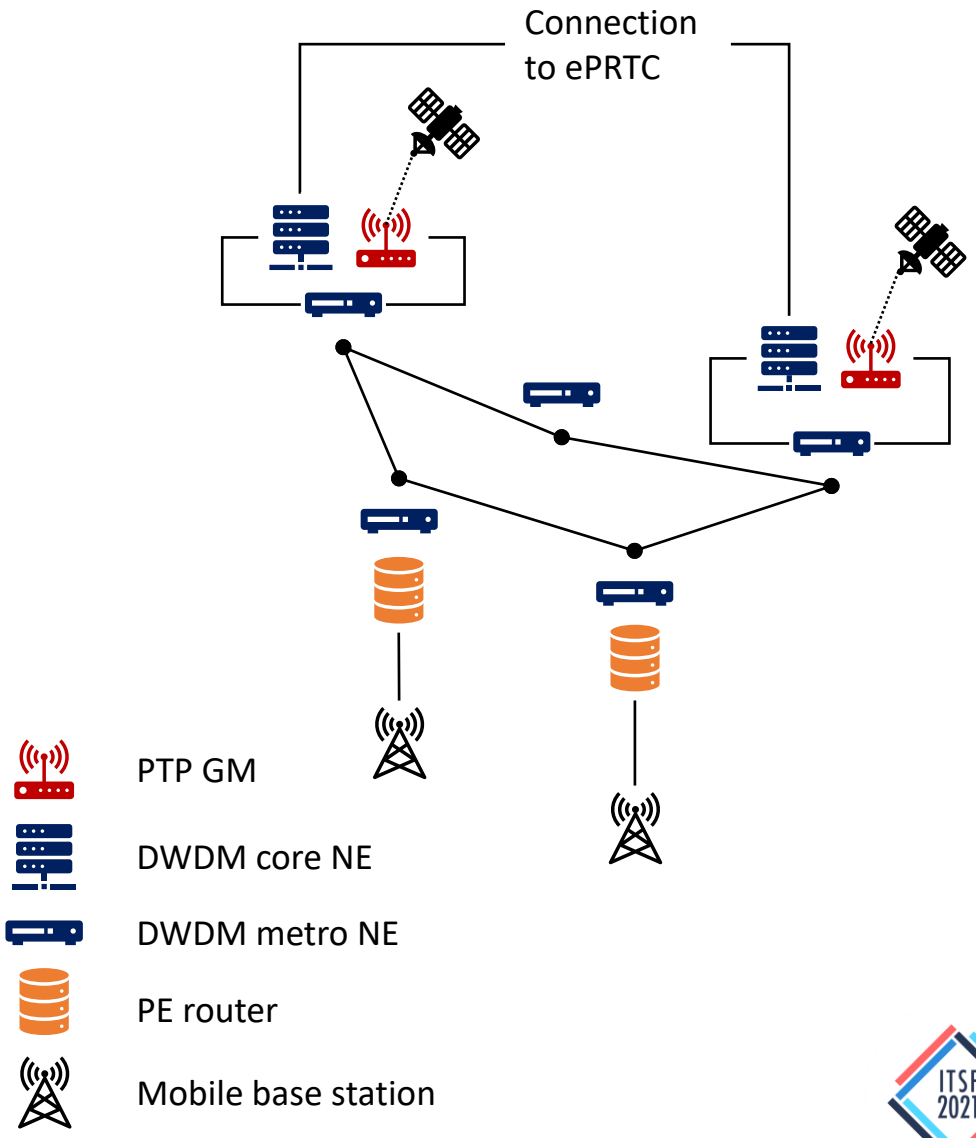
- An FTS/G.8275.1 sync network for NR 5G TDD BBUs in the four largest cities in Denmark
- The sync is distributed point-to-point in our DWDM networks
- Two ePRTCs are deployed geo-redundantly for extended holdover
- The sync must comply with a 1.5 microsecond max |TE| to prevent interference



Layer 2 PTP for NR 5G TDD

How did we implement the design?

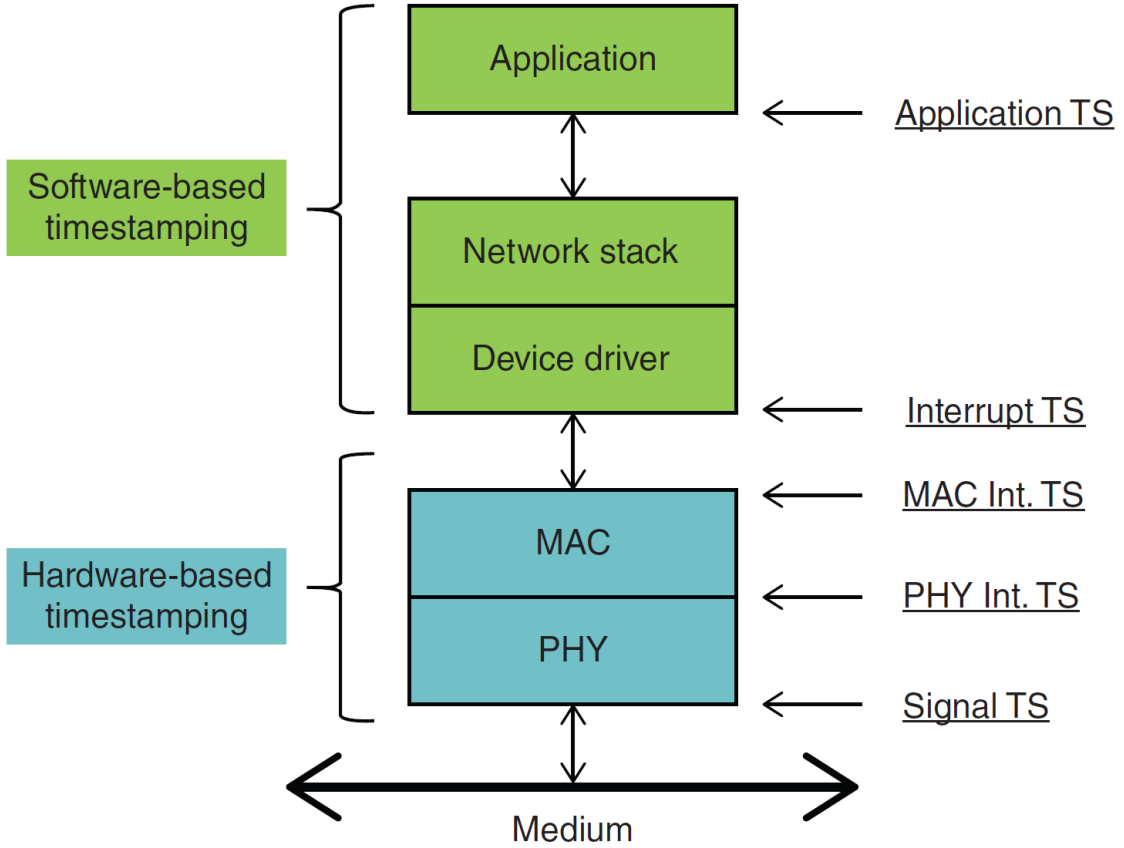
- Our IP/MPLS network is divided in 21 geographic layer 3 regions
- In each of the designated regions, we have placed two distributed GMs
- In these regions, we use DWDM metro networks to distribute sync on single fiber
- At each PoP, the DWDM node delivers sync to all mobile-circuit-terminating PE routers
- Our DWDM core network carries a backup signal from the ePRTCs to each of these regions



Layer 2 PTP for NR 5G TDD

What have we learnt?

- Standards are also up for interpretation
- Hardware timestamping isn't one single thing
- It is difficult to base a sync network on IP equipment alone



Rinaldi, Sisinni, and Ferrari, Network Synchronization: An introduction, DOI: 10.1002/047134608X.W8341

Layer 3 PTP for all NR 5G

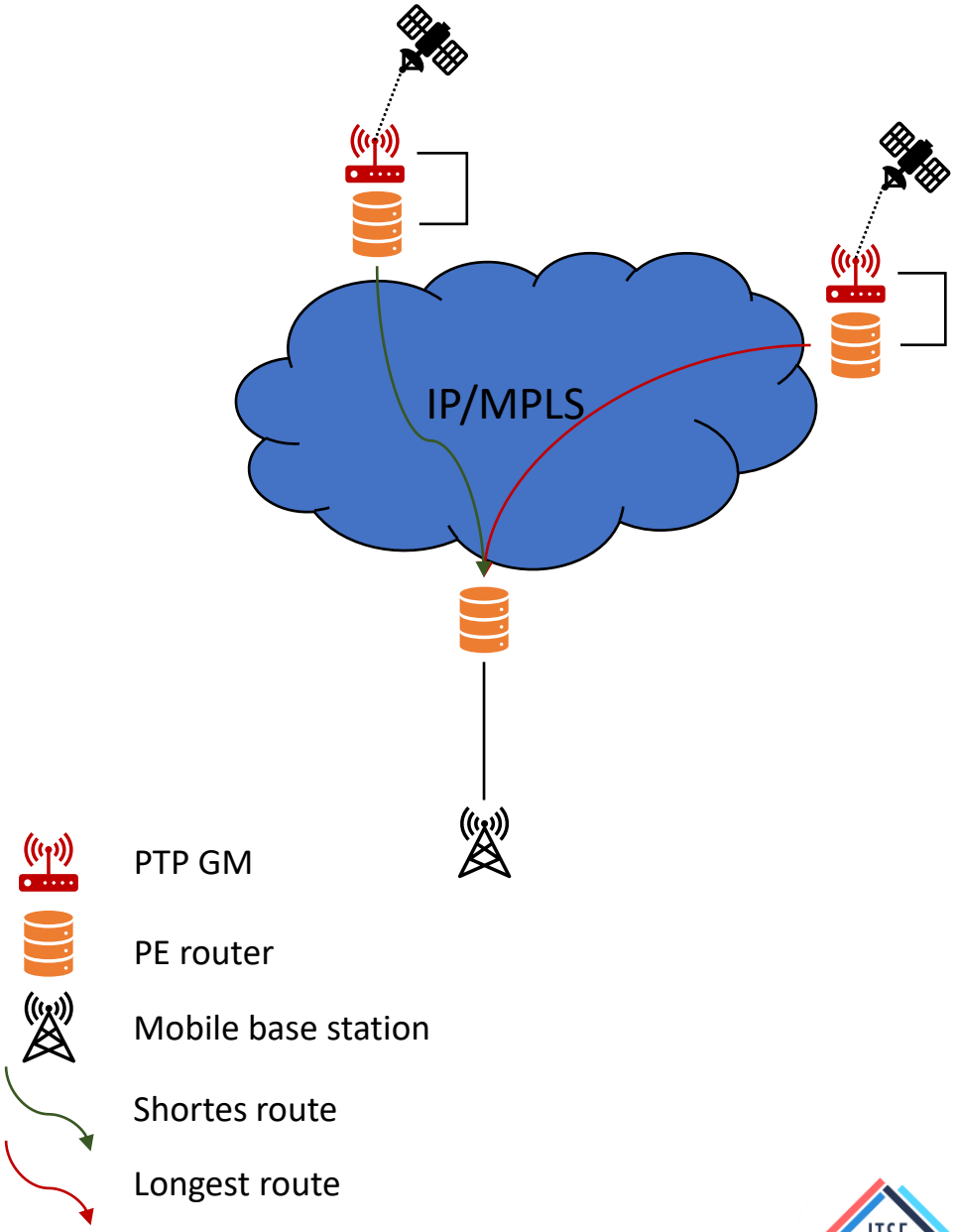
What did we design?

- A PTS/G.8275.2 sync network for the entire country for all NR 5G BBUs
- The sync is distributed transparently through our IP/MPLS network from our GMs
- We have chosen an IP anycast setup where the network ensures the BBUs are served by the “closest” GM
- The sync must comply with a 500-microsecond max |TE| for UE neighbor-cell measurements

Layer 3 PTP for all NR 5G

How did we implement the design?

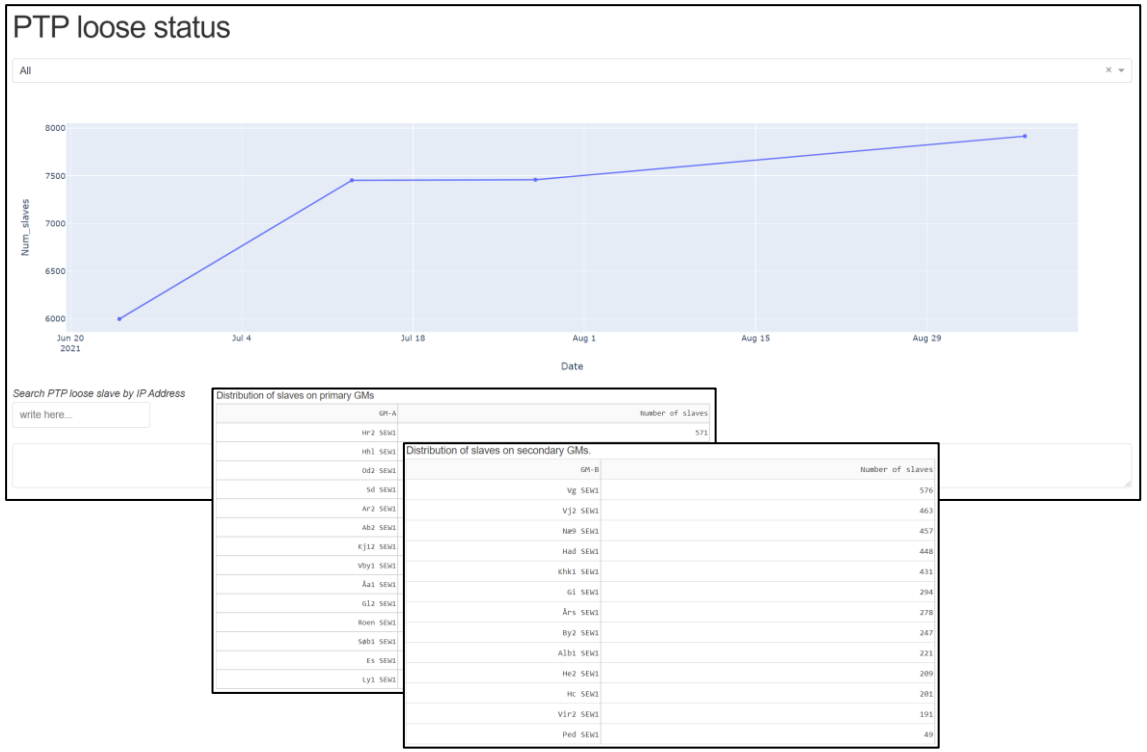
- All baseband receive two PTP references
- The GMs are categorized in primary and secondary references with each group sharing a single IP address
- The “shortest” path is computed from the routing metrices in our IP/MPLS network
- Note, the network will continue to route a client to the GM regardless of whether the GM is able to serve or not



Layer 3 PTP for NR 5G FDD

What have we learnt?

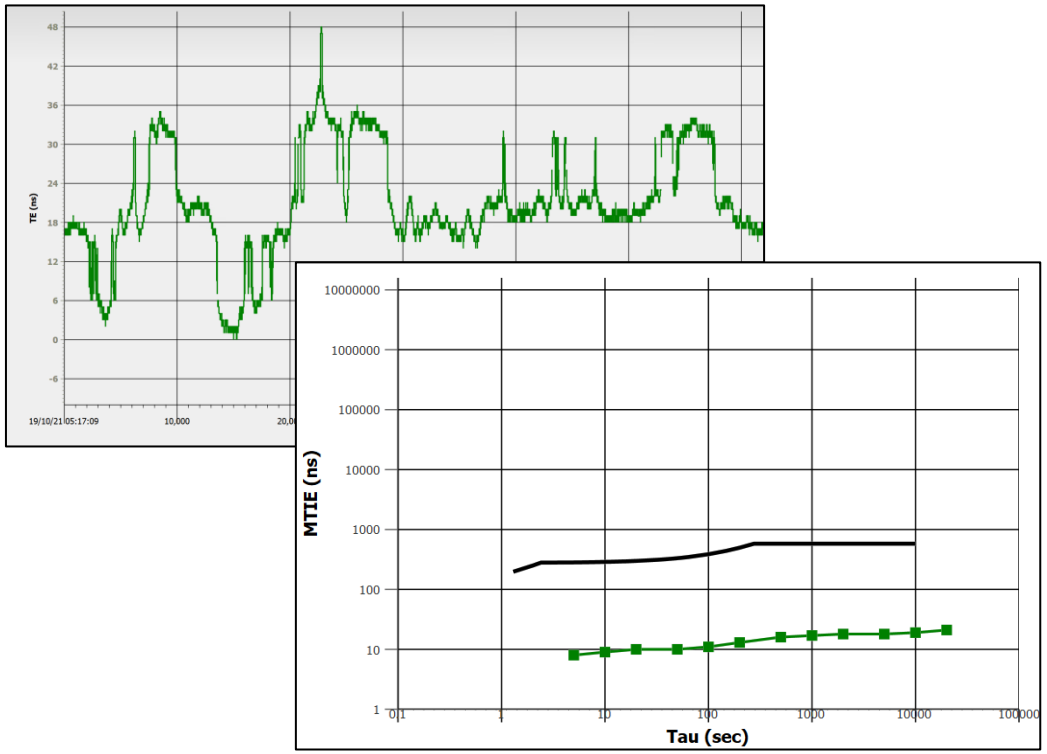
- The anycast setup makes it mandatory to know where the shortest paths are computed
- Anycast eases expansion- and to some extent planning tasks
- Anycast can be a nightmare in fault scenarios
- A DIY monitoring system might be necessary to get a log of which GMs serve the BBUs
- Legacy/low-speed microwave links have excessive PDV



Monitoring synchronization

Why do we need to monitor synchronization?

- Sync is vital for the underlying service
- The services needing sync are often critical
- We need to be able to mitigate issues before they become detrimental
- We have SLA obligations to honor



Monitoring Synchronization

How do we plan to monitor?

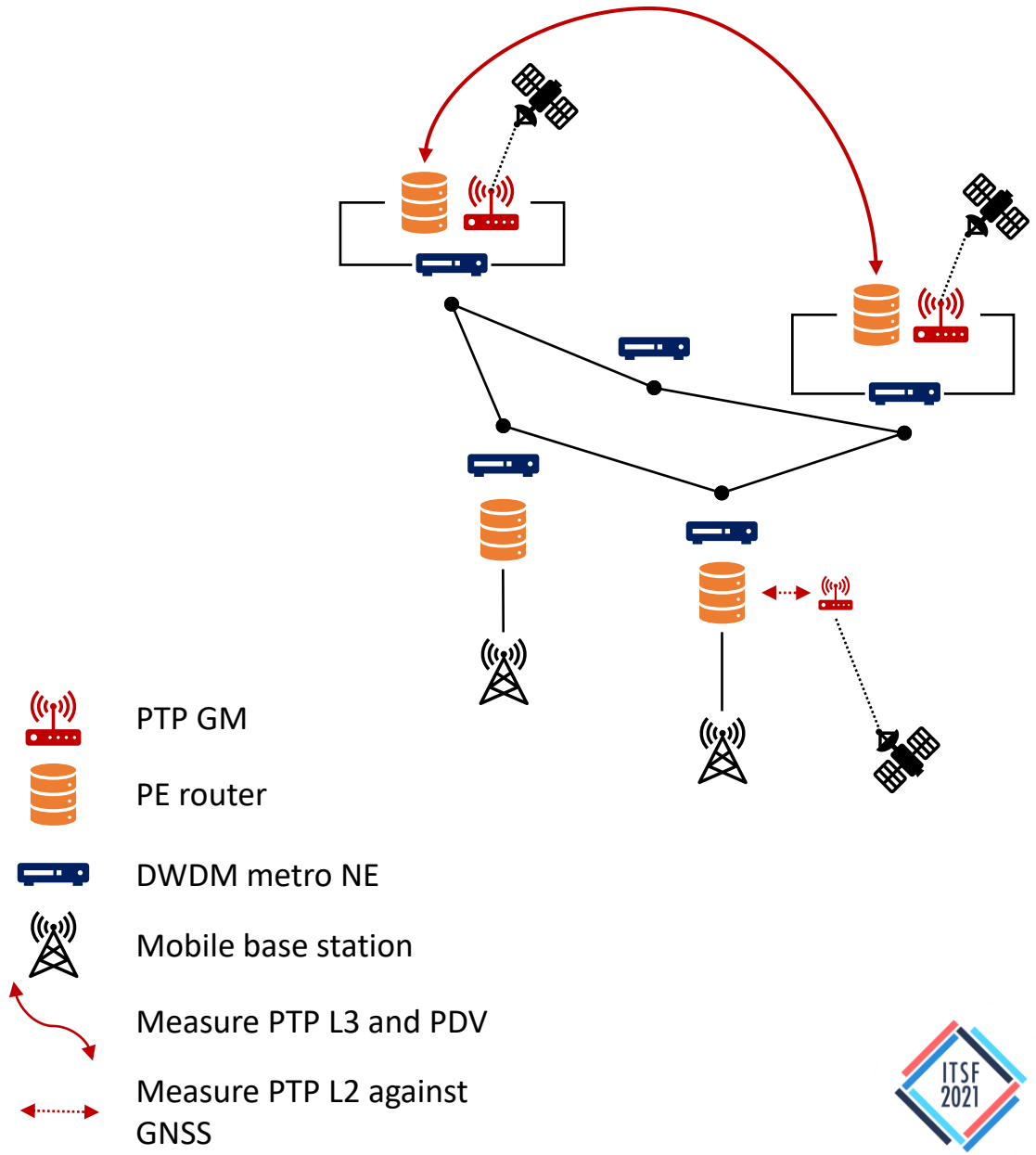
How to directly measure the quality of a sync signal without a reference?

- Well, you can't

What then?

1. You can measure indirectly like on the PDV?
   - We use our GMs to measure across our network

2. You can implement a remote reference
   - We are planning to implement micro-GMs with GNSS as measuring probes
   - Alternatively, you can always drive out to the site with sync-test equipment



Monitoring Synchronization

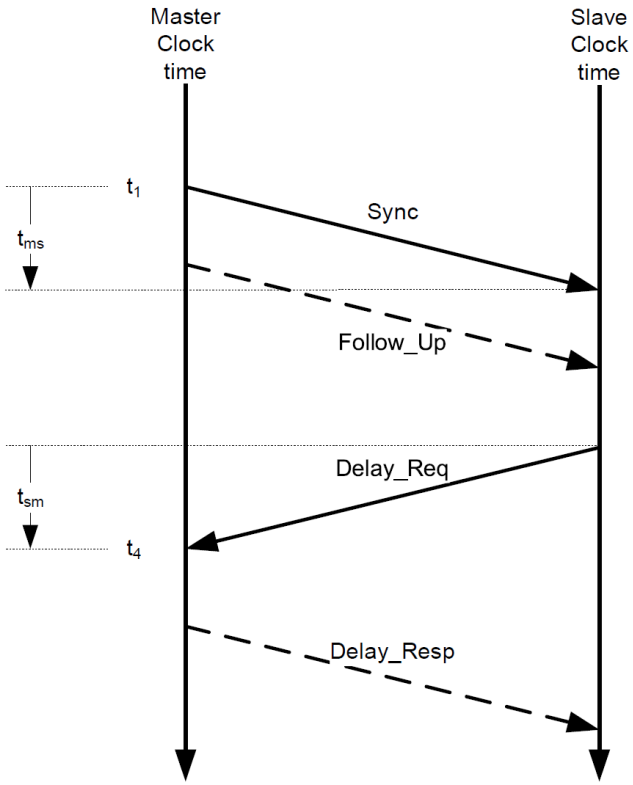
What have we learnt?

- Monitoring can aid in creating demarcation points which is necessary in managed service agreements

- It is problematic that Delay_Req messages are not necessarily time stamped since it hinders direct measurement

- We are still quite reliant on GNSS

And we are very much still learning



Adopted from IEEE 1588 2019

Plans

Which plans do we have for the future?

In the near future:

- Find a solution for our inadequate router line cards
- Implement the monitoring solutions discussed

A bit further ahead:

- Expand our FTS sync network
- Offer “Timing as a service”

But I’m here to be inspired

THANK YOU