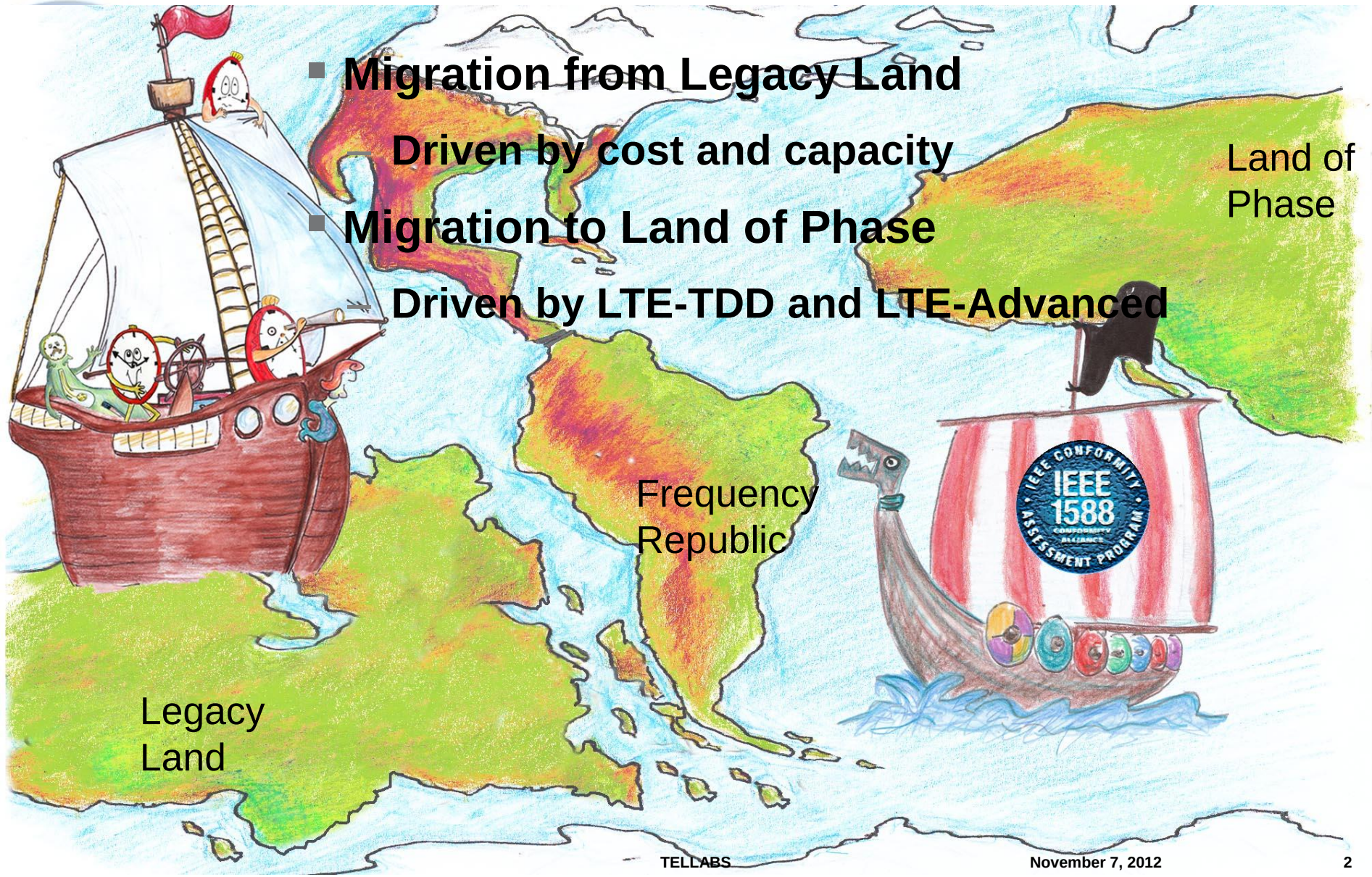
Planning for time - deploying Telecoms Boundary Clocks

ITSF 2012

Ken Hann

Artwork: Tanja Hann

Review of the Sync landscape



Time across a transport network ...

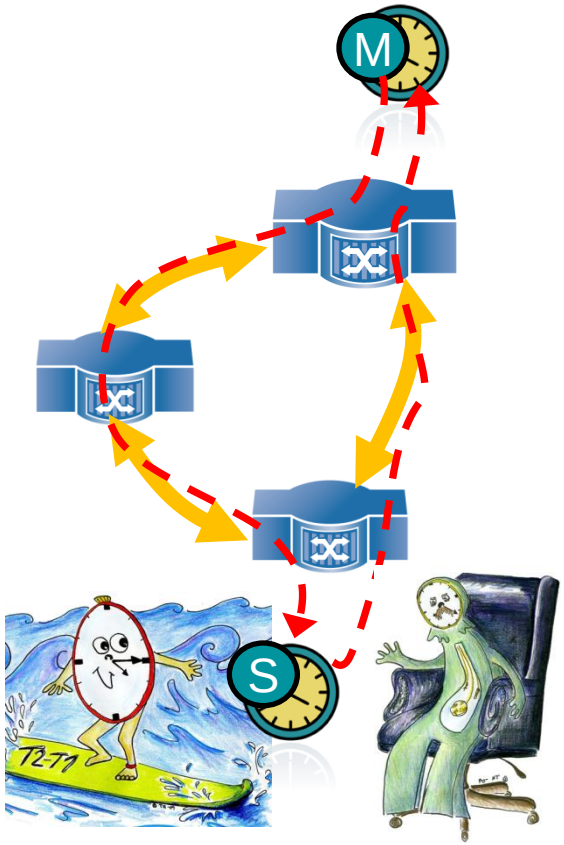
1. One big challenge is **Asymmetry**:
   - of forward and reverse paths
   - in physical media i.e. optical cables
   - due to different lambdas on single fibre
   - of forwarding within transport nodes
2. Time migration
   - Time starts at the Primary Reference Time Clock

   (but where is the PRTC)?
   - What about migration from G.8265.1?
3. Conclusions

Path asymmetry

M = master

S = slave

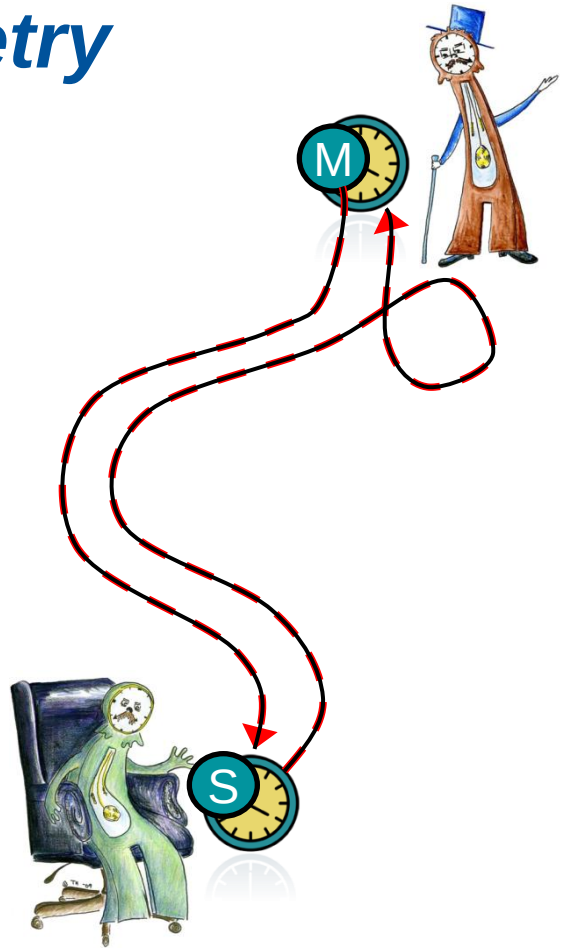


Problem	L3 addressing	
Mitigation 1	Use constrained routing	~ok
Mitigation 2	Use L2 link-local addressing	best

Fibre asymmetry

M = master

S = slave

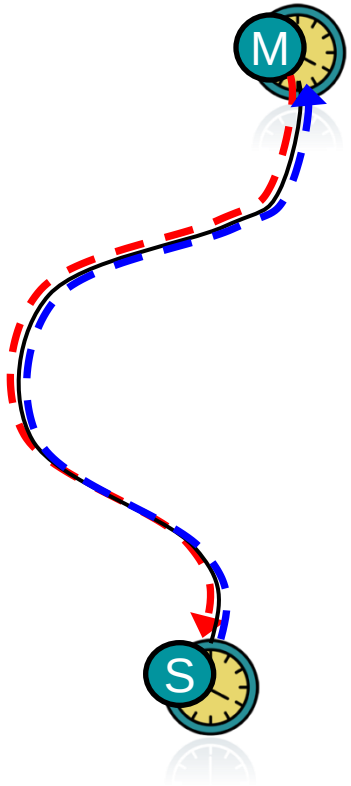


Problem	Different fibre lengths	
Mitigation 1	Measure fibres and compensate	~ok
Mitigation 2	Use single, bi-directional fibre	best

Lambda asymmetry

M = master

S = slave



Problem	Different delays per lambda	
Mitigation 1	Calculate delta and compensate	ok
Mitigation 2	Absorb delta in overal budget	best

Delay Measurements of fibre using two lambdas (wavelengths)

Cable Type	Lambda 1 (nm)	Lambda 2 (nm)	Length (km)	Delay difference (ns)	Delta (ns/km)
G.652	1310	1550	37.0	76.1	2.05
G.652	1310	1550	25.6	53.1	2.07
SMF-28	1310	1490	20.0	17*	0.85

(*Time Synchronization over Ethernet Passive Optical Networks
IEEE Communications Magazine • October 2012)

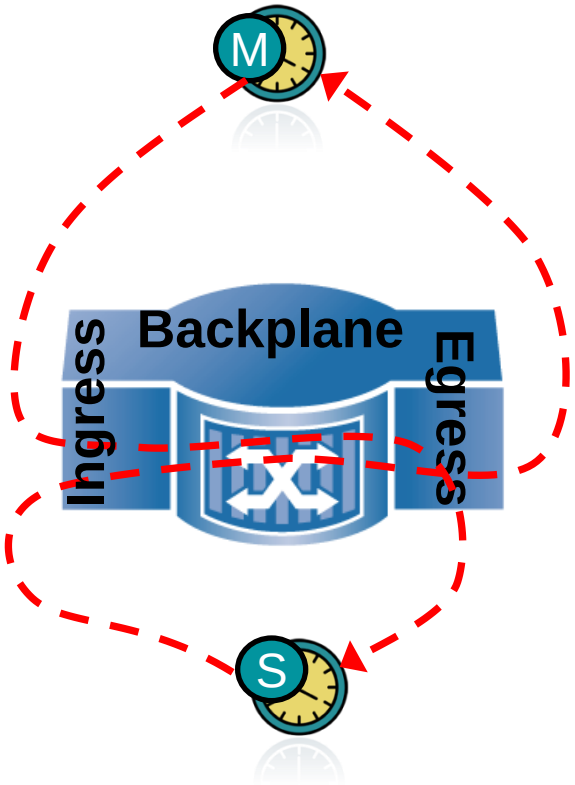
Frequency asymmetry can be 1-2ns/km
Depending on wavelengths and fibre

Lambda asymmetry compensation not usually needed!

Forwarding asymmetry

M = master

S = slave



Problem	Varying forwarding delay	
Mitigation 1	Measure delay variation	?
Mitigation 2	Add BC or TC	best

Forwarding asymmetry and the 1us budget

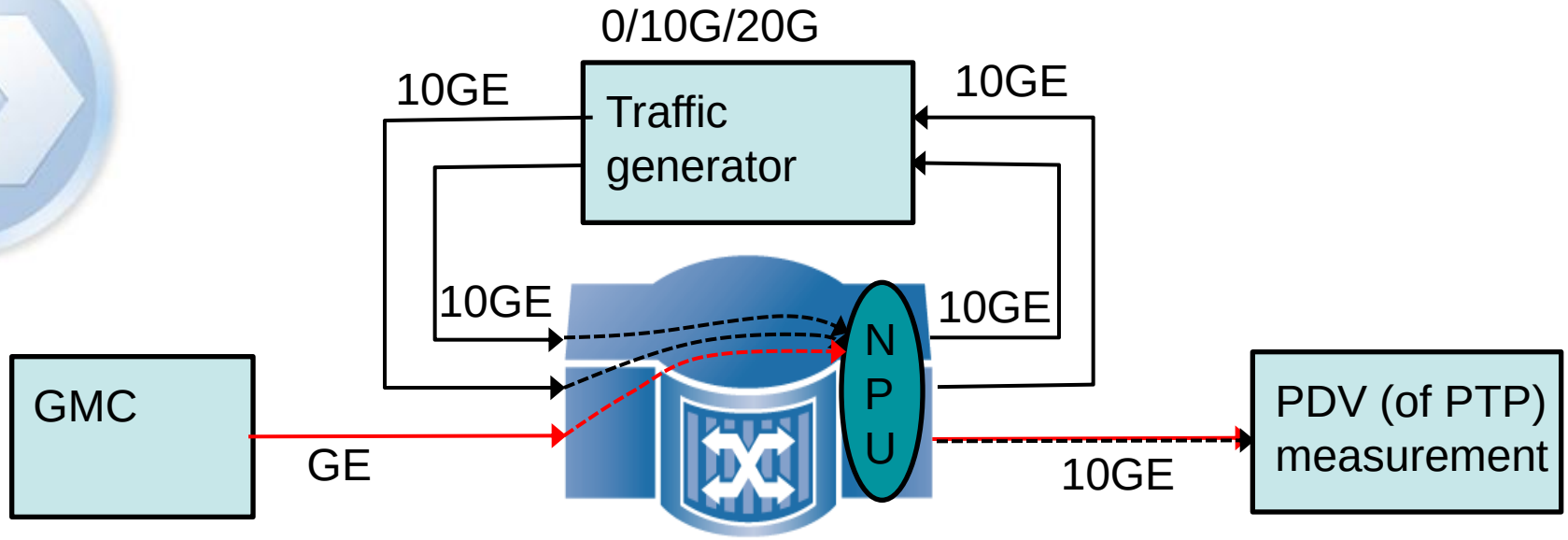
- Forwarding asymmetry measurements on

”**A typical network processor**”

- Next slides measurement result slides
  - Test setup description
  - Well behaving cases first
  - Then not so well behaving ones

Forwarding asymmetry can kill!

Measurement of Forwarding asymmetry



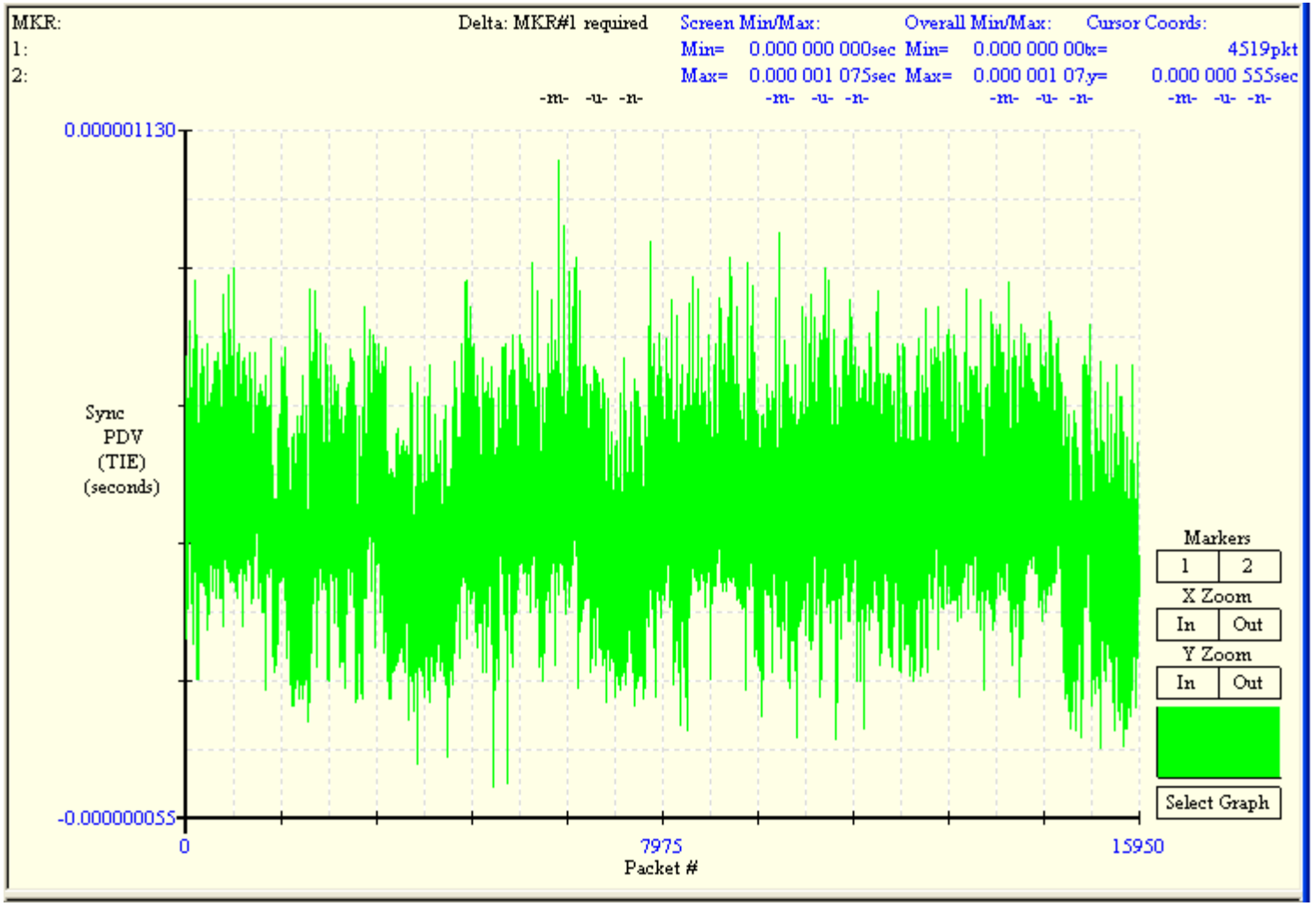
NPU - Network Processing Unit

Following diagrams show <u>some</u> effects of:

1. ***Background loading of NPU***
2. ***Heavy loading of PTP port***

Packet delay variation no load

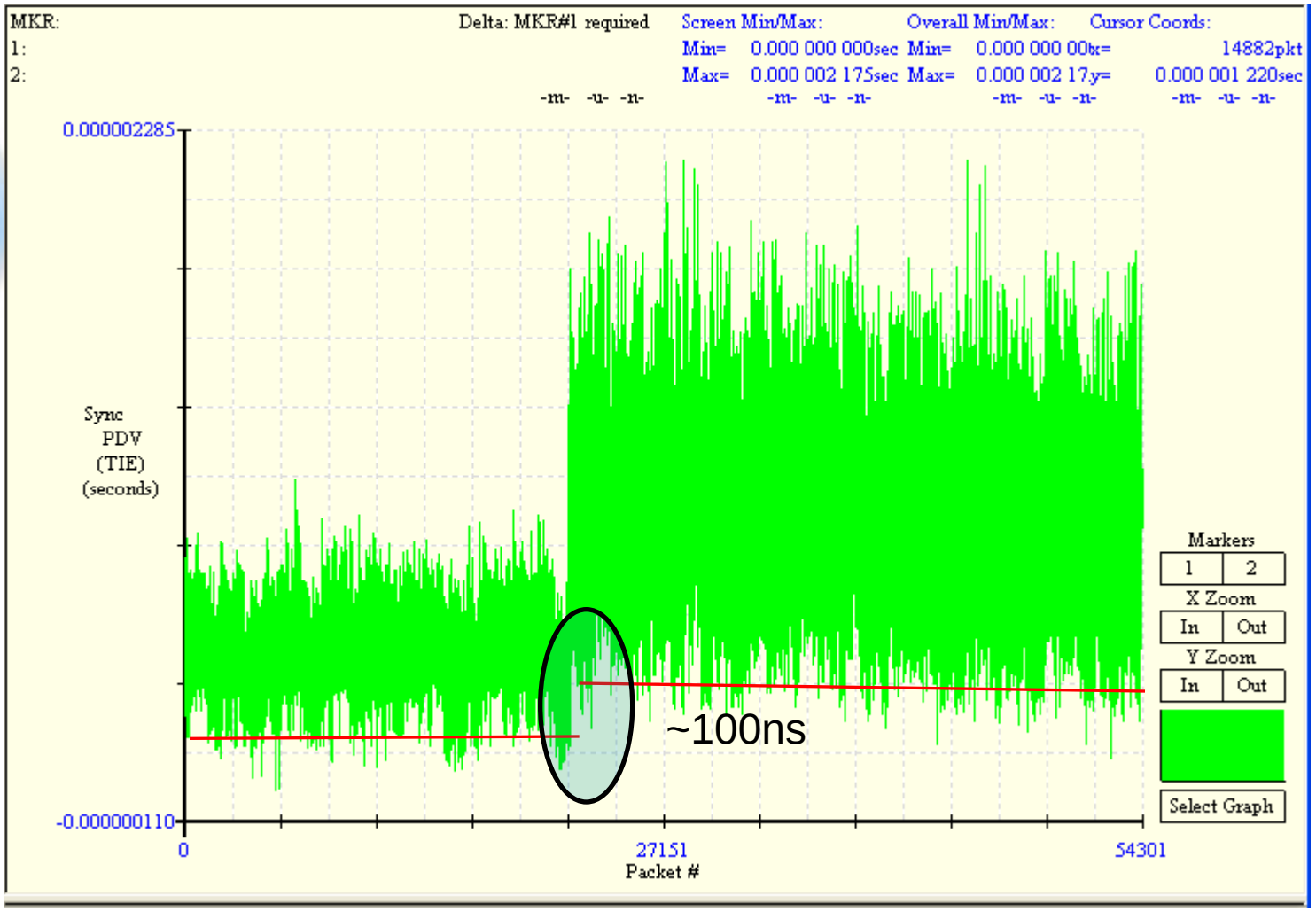
0.1us /div



Suitable filtering can reduce to below 50ns

10G background traffic on NPU

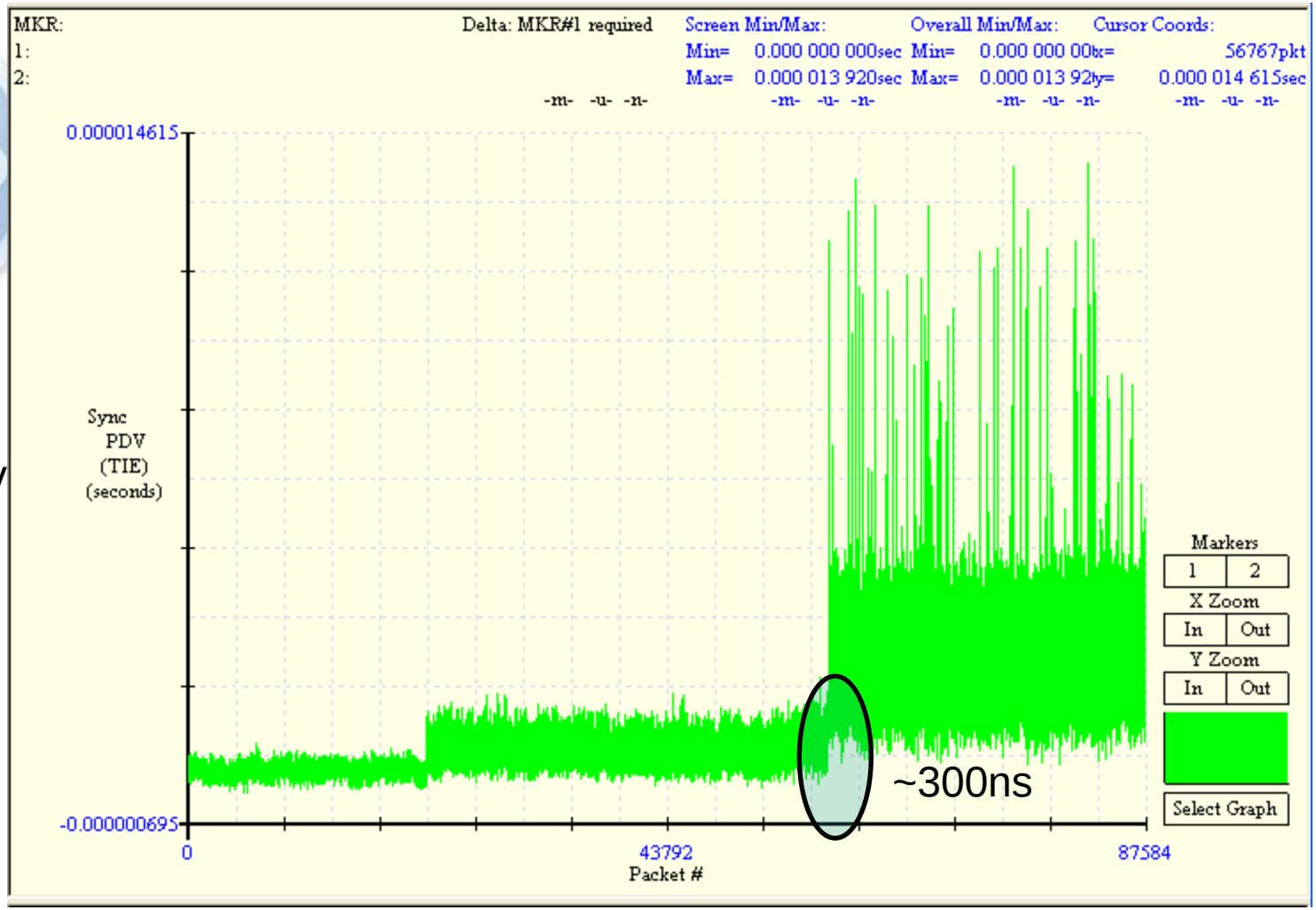
0.2us /div



After filtering results in 100ns error

0/10G/20G background traffic on NPU

1.4us /div



After filtering results in 300ns error

PTP in CS7 Heavily loaded egress port

4us /div

Loading change in one direction

Interpretation of Forwarding PDV results

Forwarding asymmetry of One port of a router exceeds 1us

Router forwarding planes do not support constant latency applications

Latency characteristics of simpler ”bit-pipes” may be better (e.g. Ethernet switches, Microwave radios)

Conclusion:
IEEE1588 support is needed in every router

Asymmetry mitigation - Conclusions

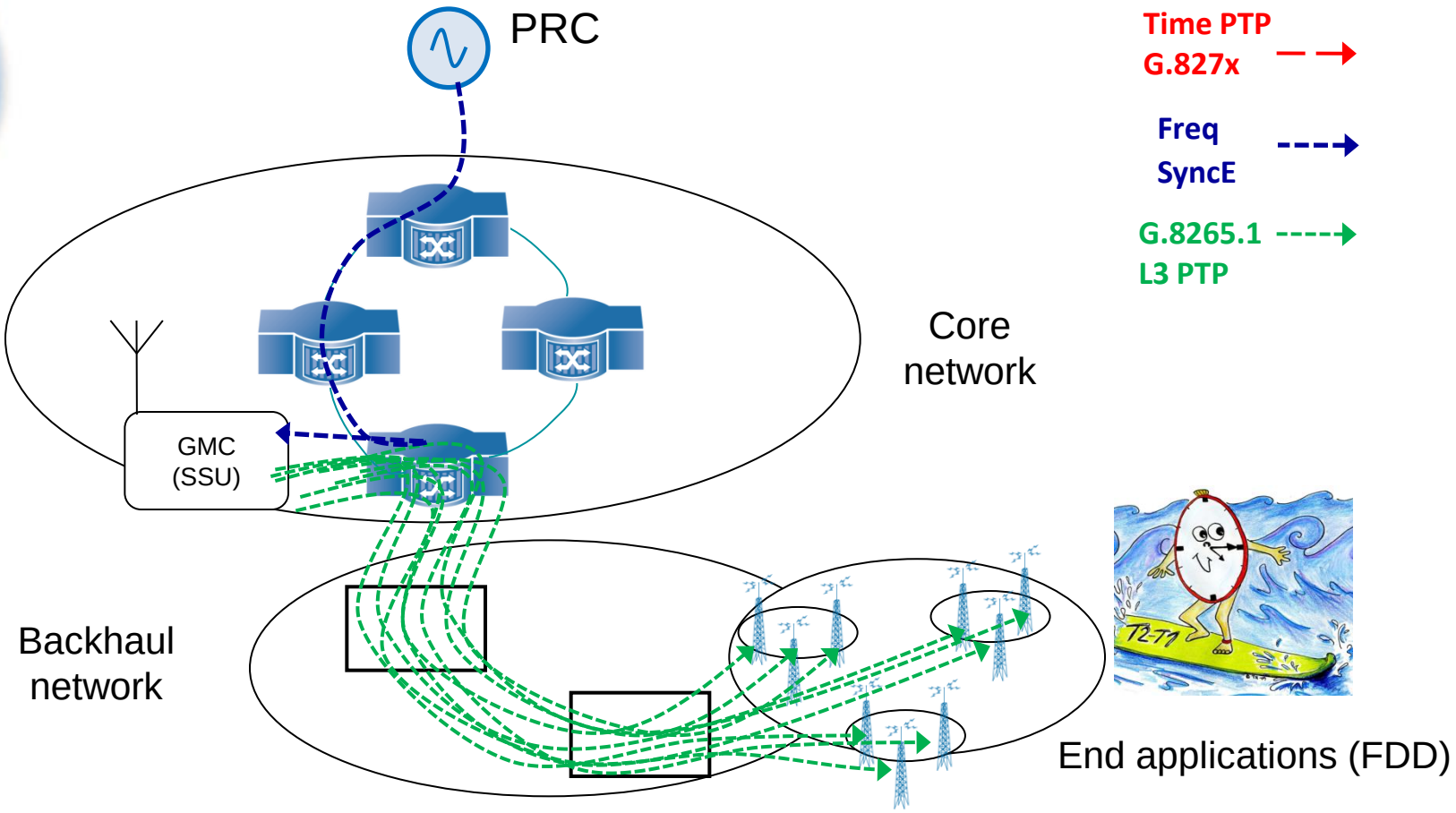
Asymmetry	Best Solution	Comments
1) Path	L2 link local addressing	Enforces hop-by-hop model
2) Fibre	Bi-directional	Dual fibres need measurement or trust.
3) Lambda	” ”	No compensation for metro
4) Forwarding	1588 processing in every node	

1 + 4 = T-BC

Conclusion:
Each routing node contains a T-BC
i.e. IEEE1588 Boundary clock using Layer-2 encapsulation

2) Time migration – adding time

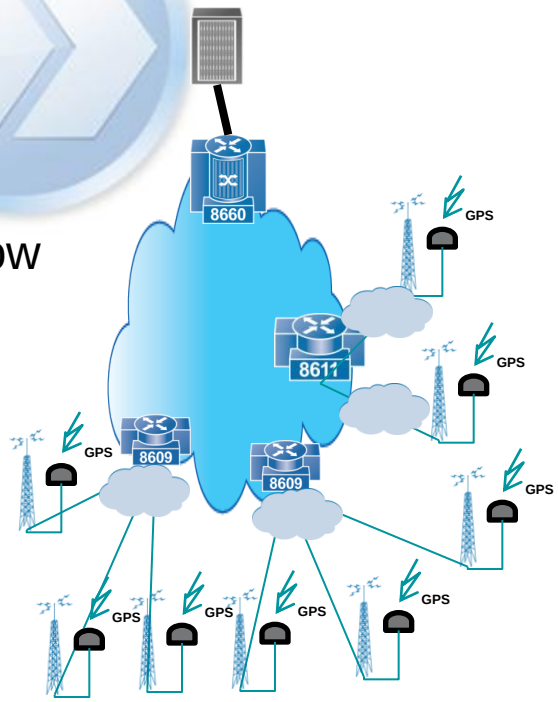
Migration from existing deployment I.e. Limited SyncE + G.8265.1



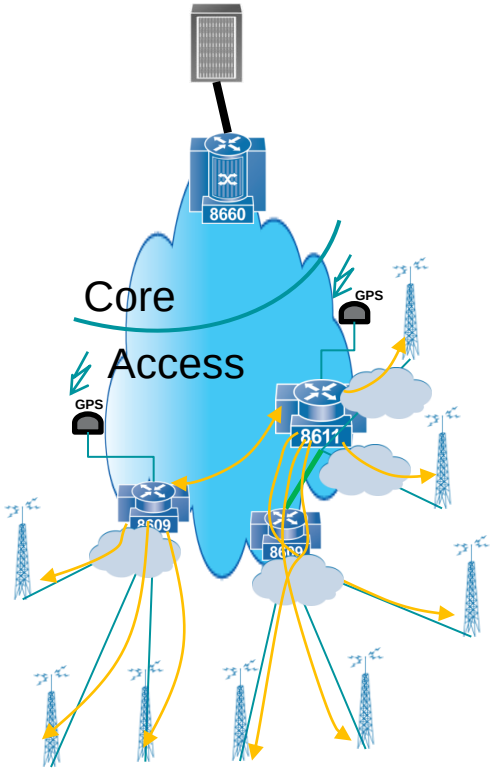
How to support Time (e.g. For TDD applications) ?

Where is the Primary Reference Time Clock?

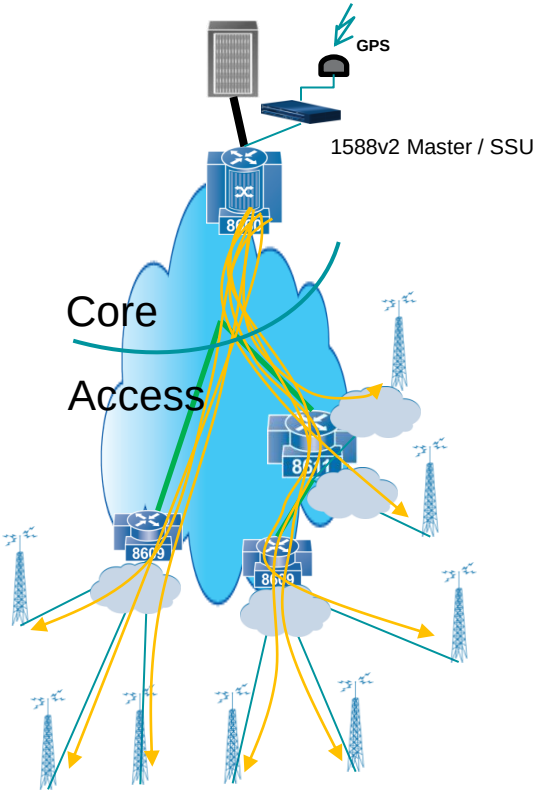
Now



PRTC at cell site



PRTC in aggregation sites



PRTC in Core sites

Phase Synchronization... develops from the edge

SyncE (frequency) ... starts at the core

The trade-off...

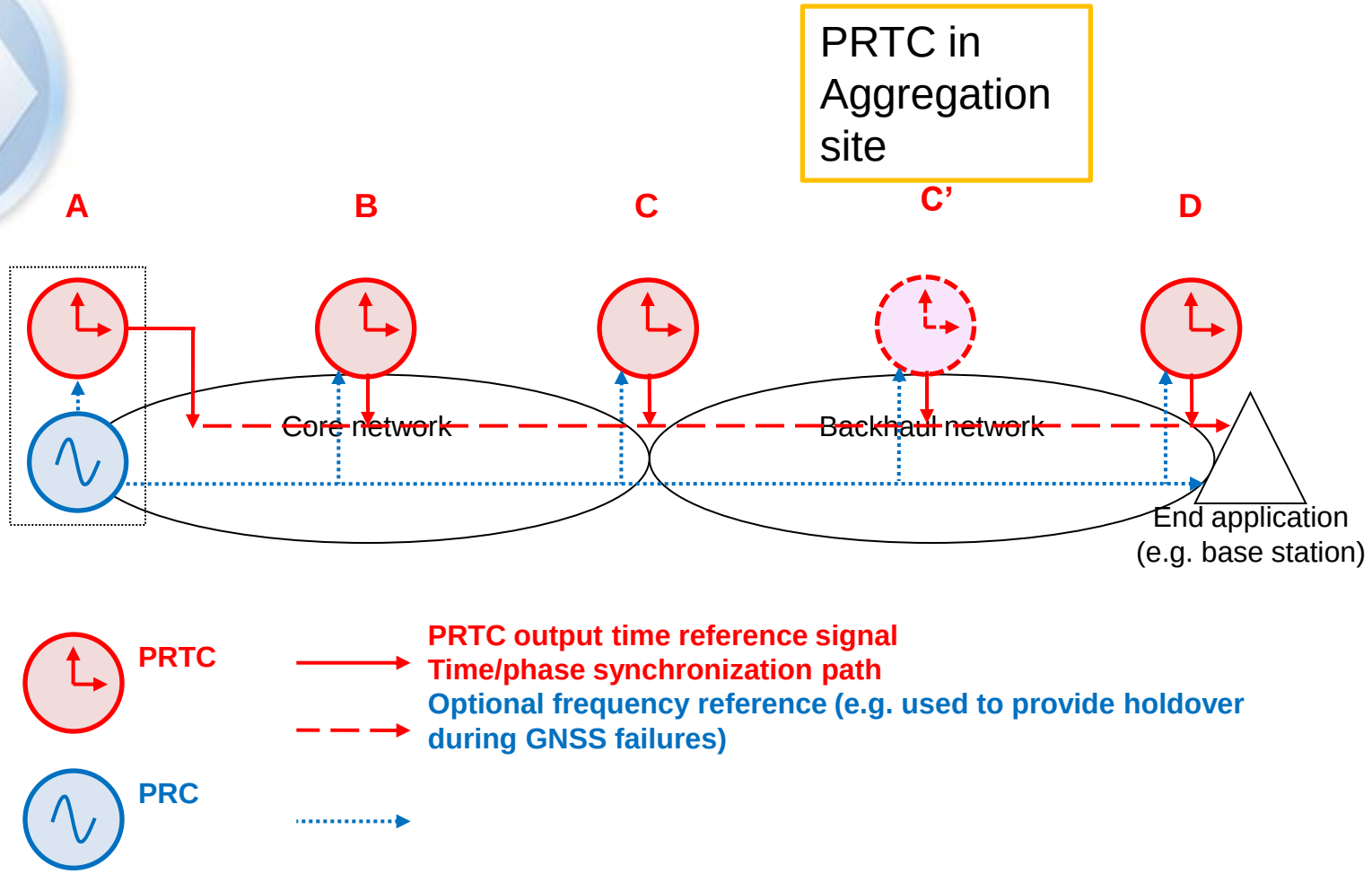
- GNSS is the source for time (UTC)
- Network support for IEEE1588 is limited

IEEE1588 capability of his network (also SyncE)
versus
The number of Local GNSS

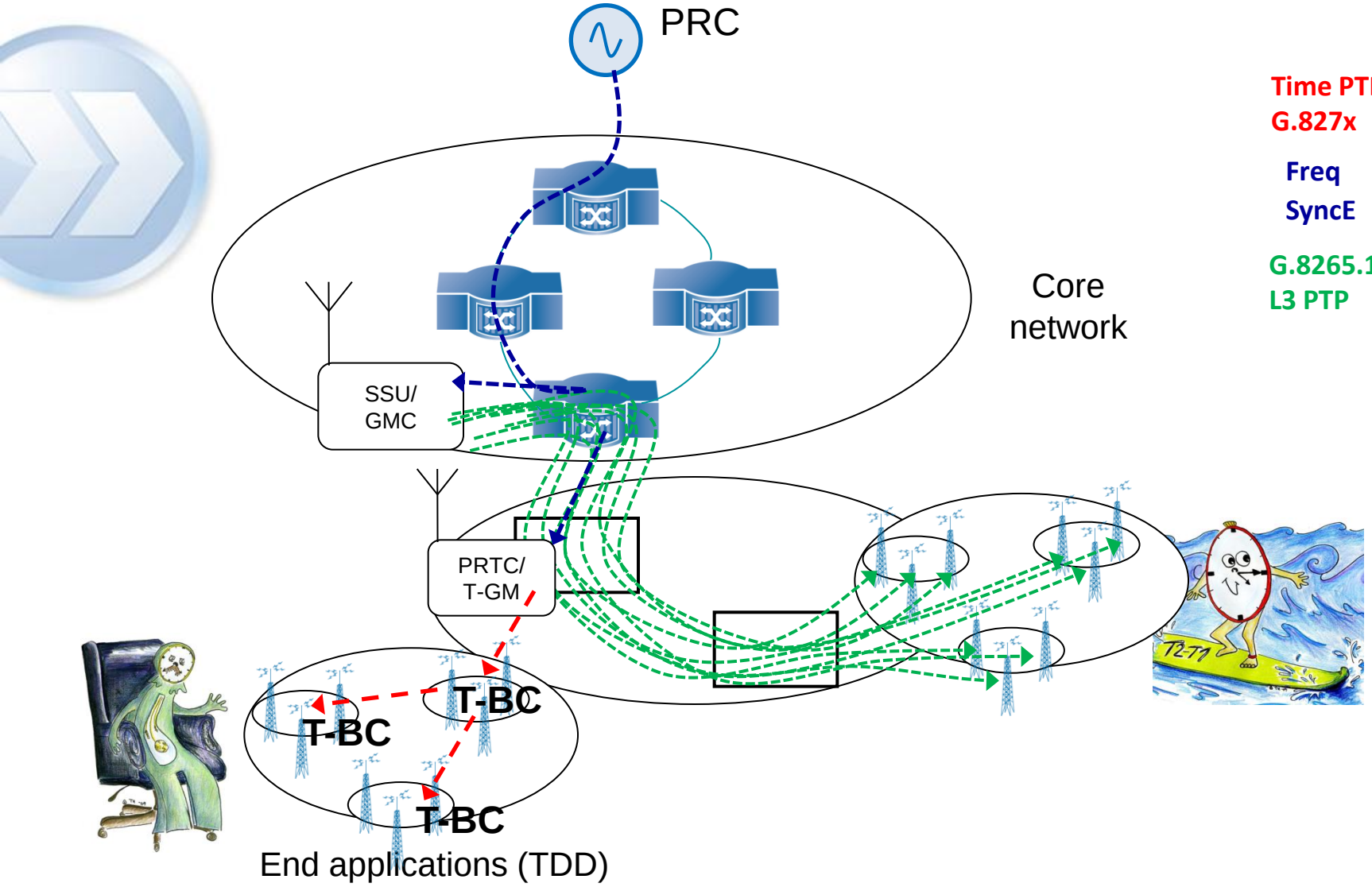
GNSS will often be needed low in the network

(SyncE reference useful for time holdover)

PRTC can be anywhere in network (from G.8272)



PRTC at an aggregation site

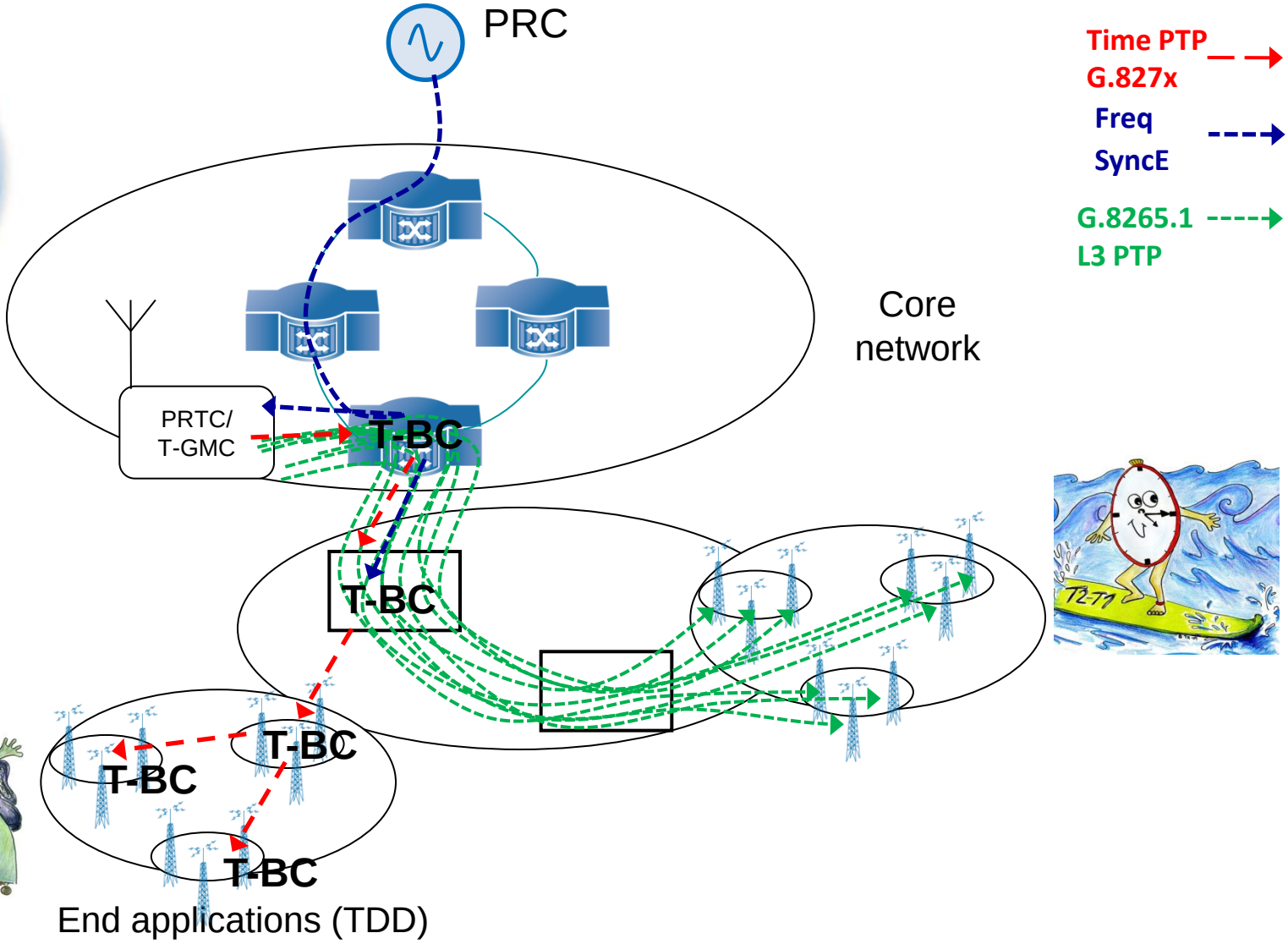


Multiple small ”Time Islands”

Assisting migration to IEEE1588

1. Deploy T-BC capability to core/backhaul nodes
   - Ideally retrofit to existing nodes
2. Deploy PRTC (1588 masters) low in network
   - E.g. Aggregation sites
3. Add PTP L2 support to 1588 masters (L3 + L2)
   - Ideally retrofit to existing masters

PRTC at core site



Same site provides both G.8265.1 and G.827x service.

Migration path combining Freq and time service

1. Difficult for a BC to do L3 L2 conversion

(no guarantee of service – just another L3 client)

2. Easiest to do support L3 and L2 from the GMC

Message type	L3 Message rate	L2 Message rate
Signalling	10/sec	0
Announce	500/sec	1/sec
Sync	32000/sec	16/sec
Delay Response	32000/sec	16/sec

Assuming 250 IPv4 PTP Clients as per G.8265.1

L2 support technically trivial compared with L3

3) Conclusions

- Phase (distribution across legacy core...)
  - Not possible due to asymmetries (forwarding asymmetry)
  - **L2 BC needed in each router**
  - ”Bit-pipes” e.g. Microwave Radios are considered in other talks.
- IEEE1588 Phase synchronization will develop from the edge... to the core...
  - **PRTC in Aggregation sites**
- SyncE will develop from the core to the edge
  - Supports both PRTC and T-BC

Thank you!
Questions?