

Challenges and Tested Solutions in Diverse Clock Distribution Media

European Advanced Networking Test Center

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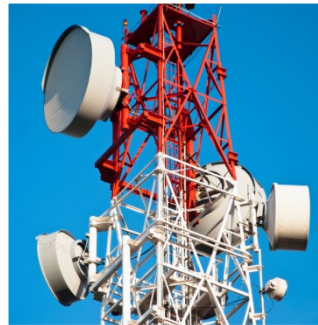
Clock Distribution over Diverse Media



Last Mile

Transparent Ethernet access service - effect of underlying technology?

Microwave



Variable bandwidth according to external conditions



40G/100G Ethernet

Parallel transmission lanes and skew

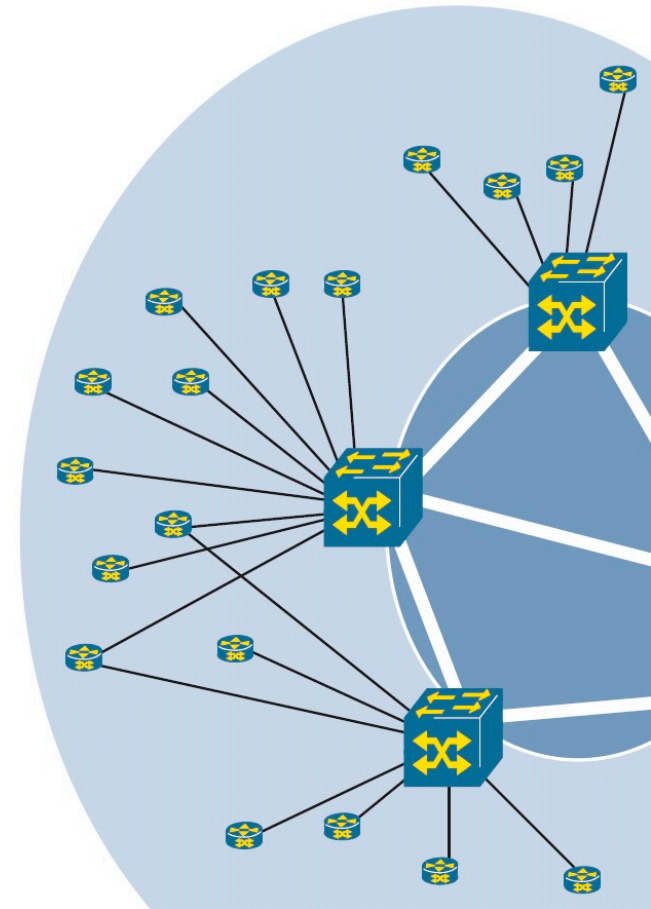
Last Mile Ethernet Access Service

- Not a specific medium
 - Generally, no physical layer synchronization available to customer
- Physical medium is not a part of the SLA in general
 - May change after initial activation
 - No guarantee for timing-friendly PDV



Use Case: Carrier Ethernet in the Last Mile Customer Introduction

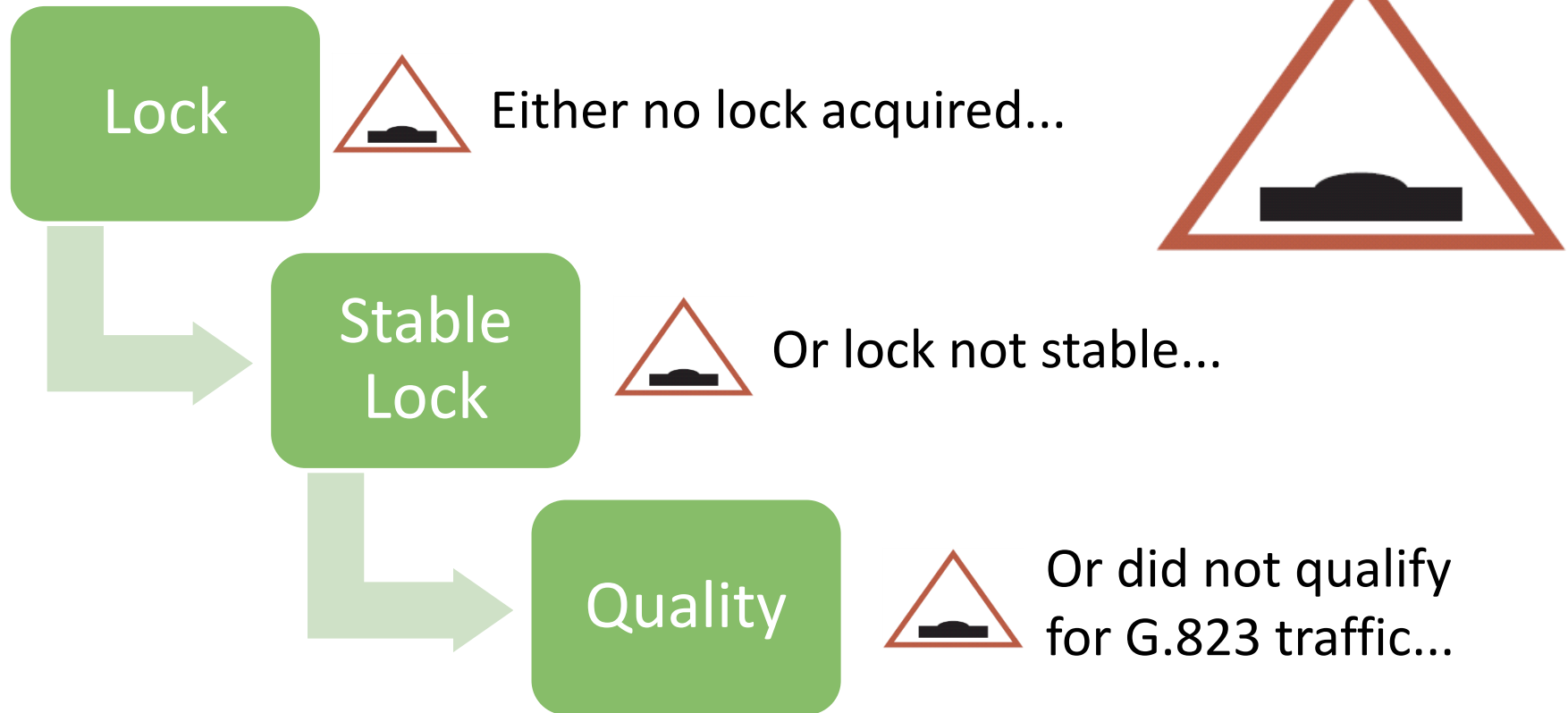
- Frequency for 100+ sites (G.823 SEC)
- Green-field roll-out
 - State of the art Carrier Ethernet design
 - SyncE support
...except for the last mile.
- Last mile connectivity from various operators
- Proposed solution: deploy PTP in the last mile



Use Case: Carrier Ethernet in the Last Mile

Road Bumps

Results varied from site to site



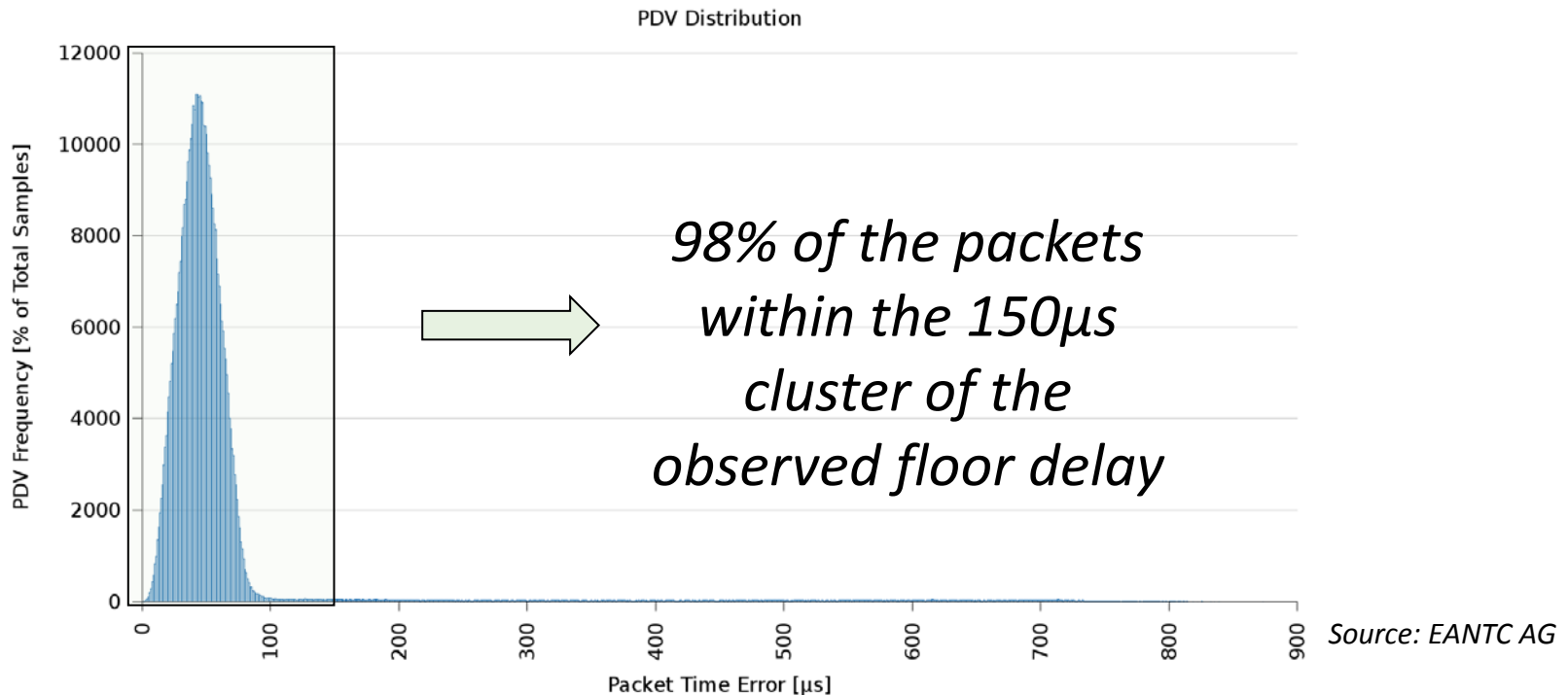
Workaround

Keep TDM leased lines just for synchronization, evaluate a new solution in later stage

Use Case: Carrier Ethernet in the Last Mile

Field Measurement Phase (Circuit 1)

Field recording of PDV complies with network limit described in ITU-T G.8261.1, clause 8.

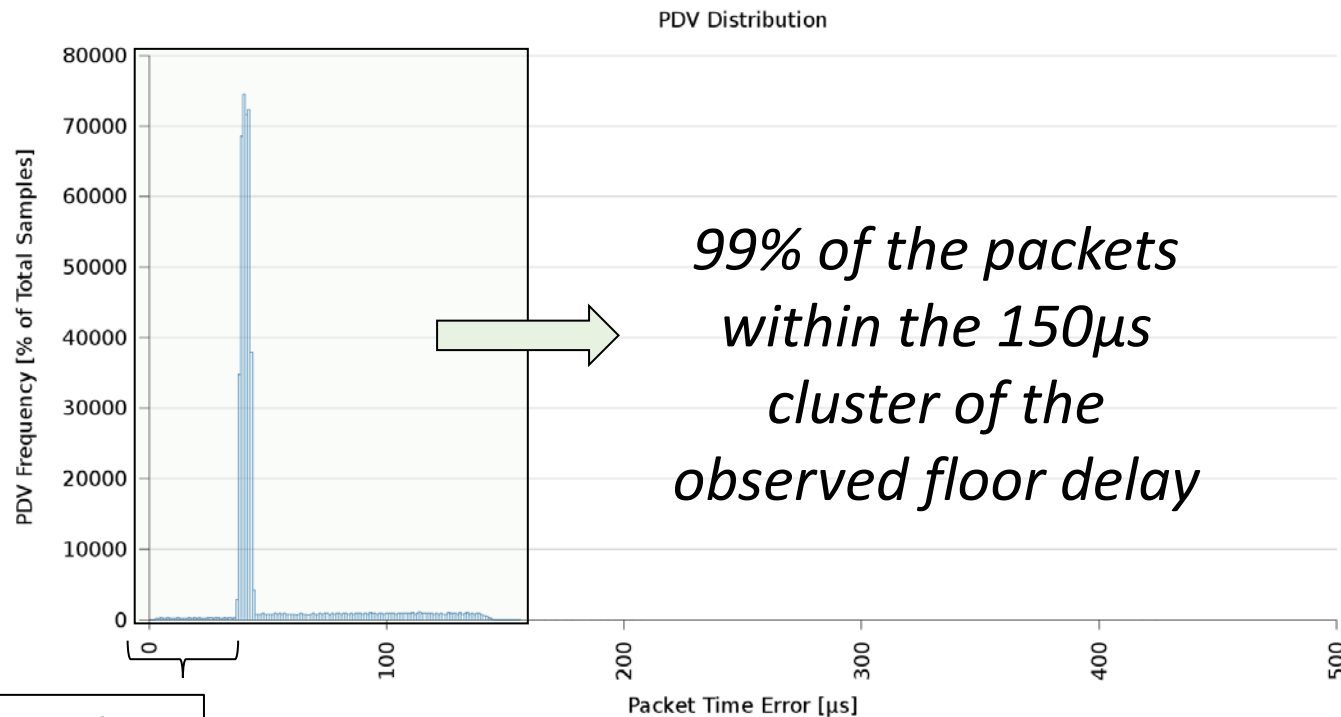


Data normalized to floor delay of 1 hour measurement period

Use Case: Carrier Ethernet in the Last Mile

Field Measurement Phase (Circuit 2)

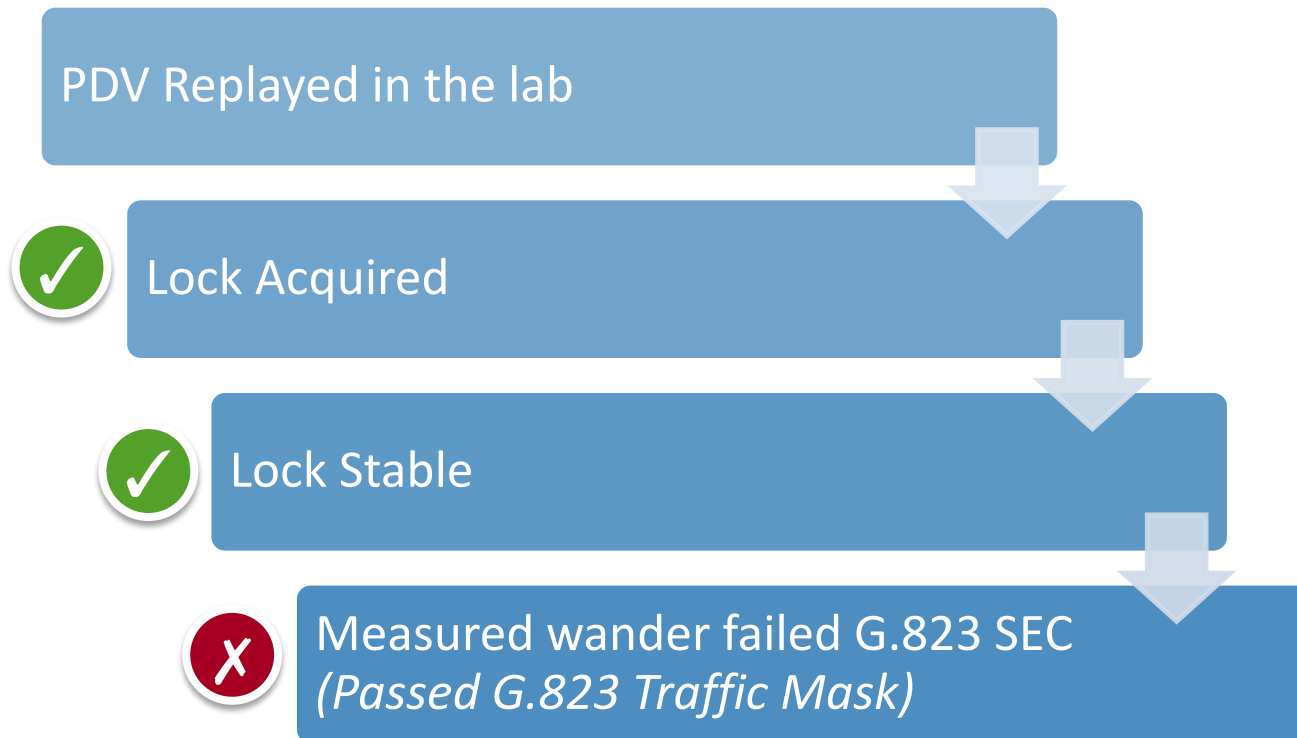
Measurement of second circuit yielded a different distribution, also compliant with FPP



Data normalized to floor delay of 1 hour measurement period

Use Case: Carrier Ethernet Last Mile

Test Results

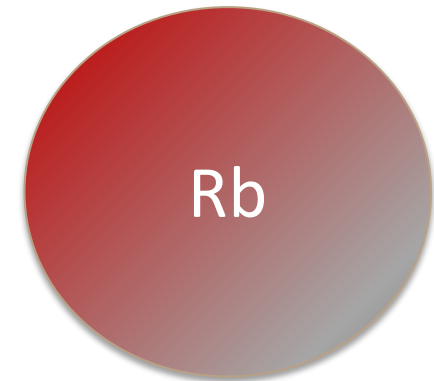
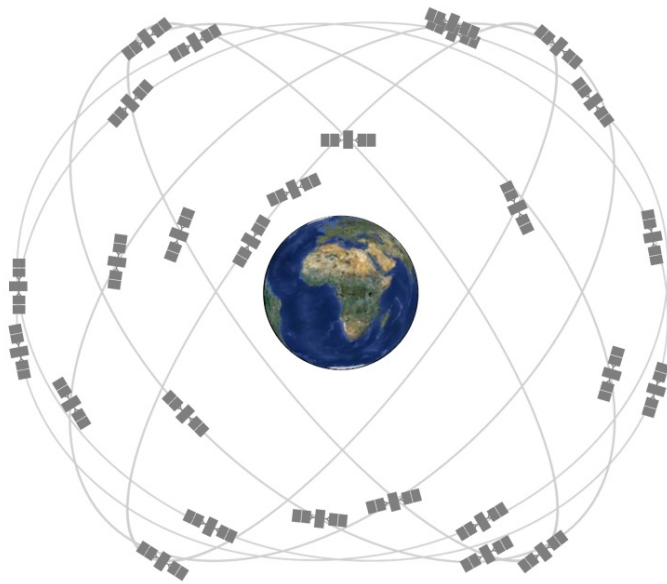


Service provider implementation: EoSDH



Use Case: Carrier Ethernet Last Mile Deployed Solution

Solution?



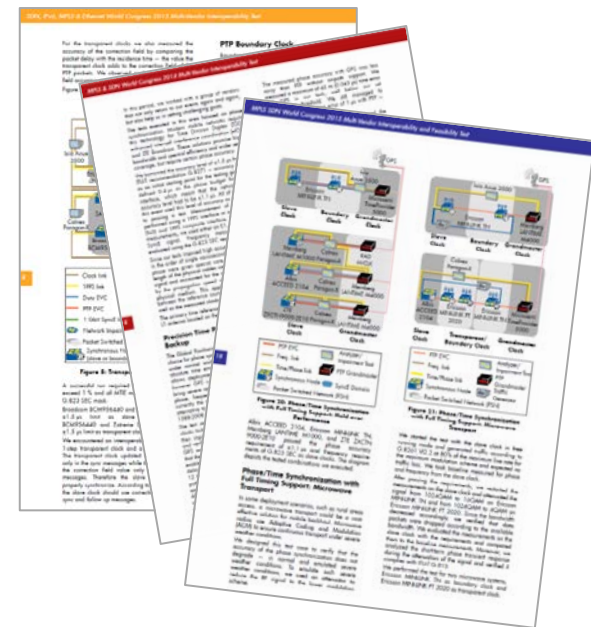
Microwave



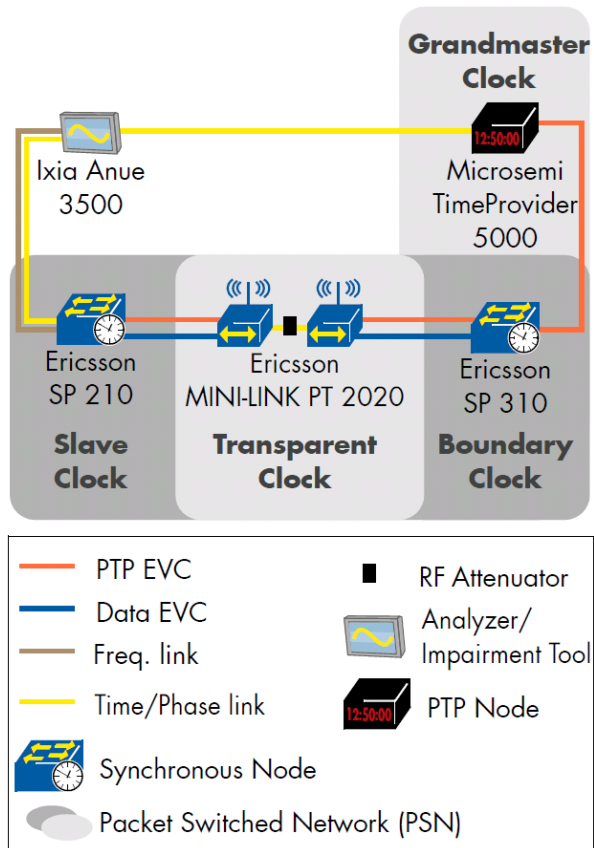
- Last mile access to sparsely populated locations
- Mobile backhaul and small cells
- Power utility market

- Tested clock synchronization with MW systems in EANTC multi-vendor interoperability events
- 2014 and 2015: tested microwave adaptive modulation

Report available for download at www.eantc.de



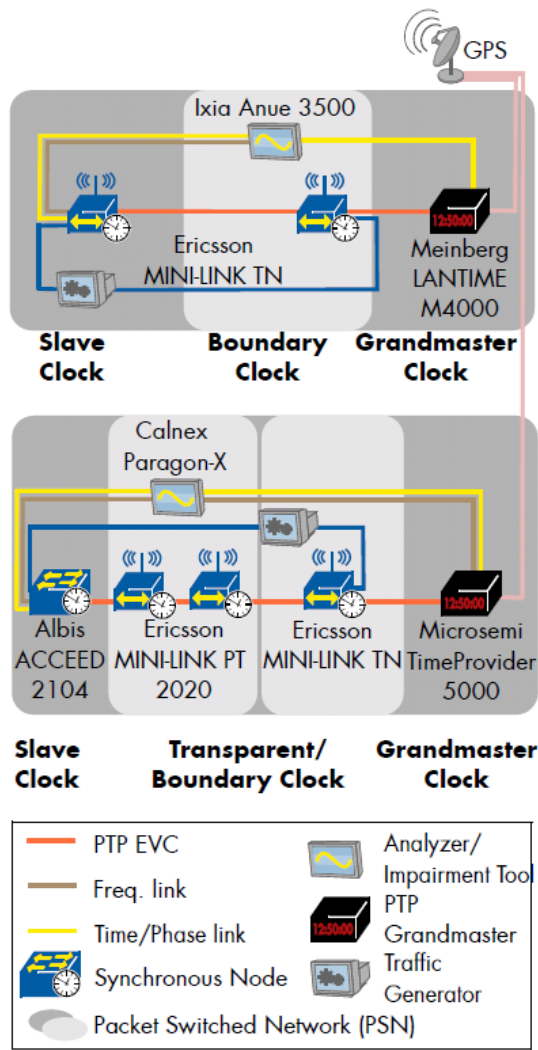
Microwave Adaptive Modulation (1/2)



- Phase synchronization
- Traffic pattern: static load G.8261, VI2.2
- RF signal attenuated
 - Initial modulation: 512QAM
 - Under attenuation: 4QAM
 - Partial background traffic loss due to reduced bandwidth

Source: MPLS & SDN World Congress 2014
Multi-Vendor Interoperability White Paper, EANTC

Microwave Adaptive Modulation (2/2)

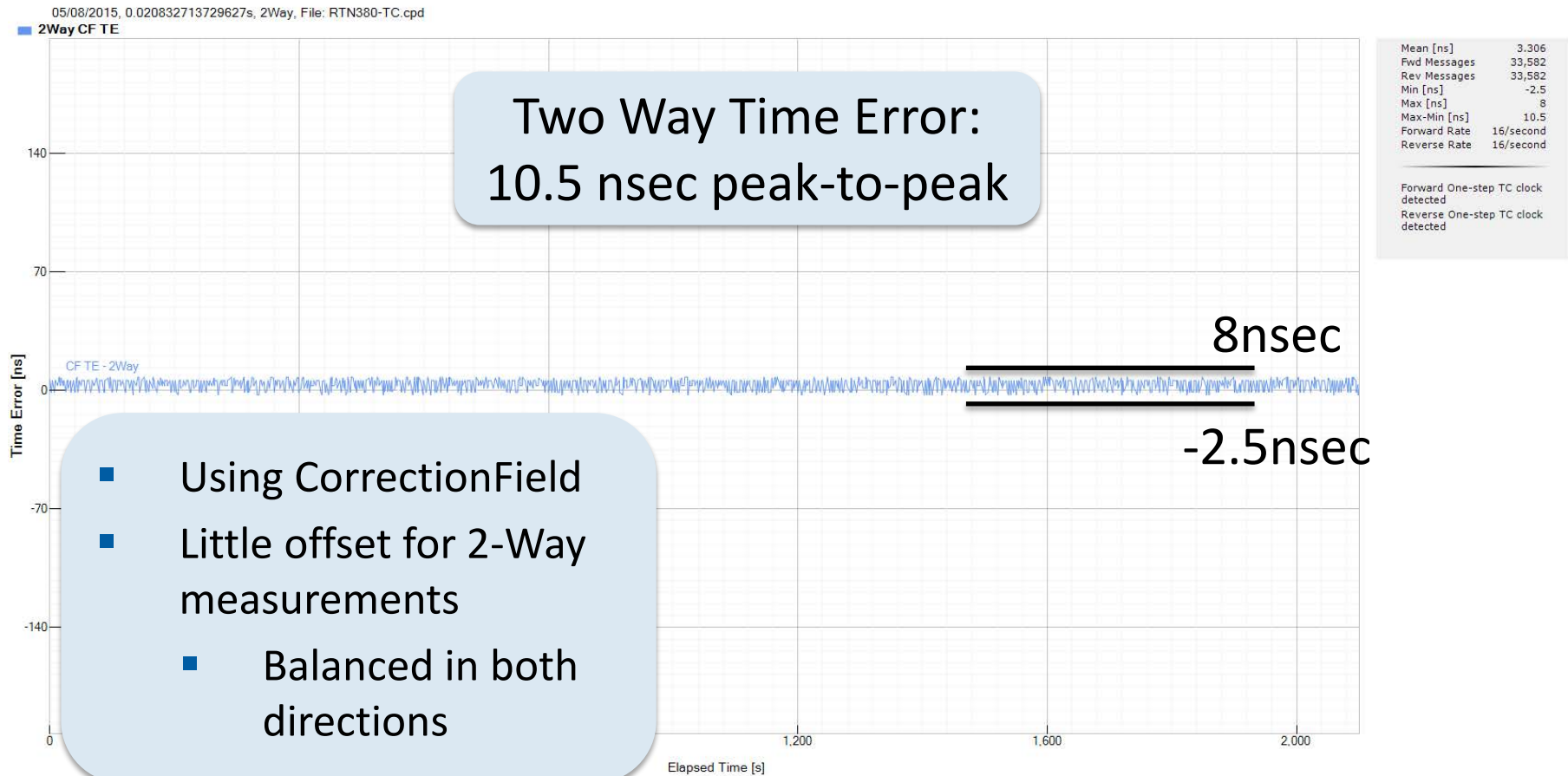


- Phase synchronization
- Traffic pattern: static load G.8261, VI2.2
- RF signal attenuated
 - Initial modulation: 1024QAM
 - Under attenuation: 16QAM (top)/ 4QAM (bottom)
- Partial background traffic loss due to reduced bandwidth

Source: MPLS & SDN World Congress 2015
Multi-Vendor Interoperability White Paper, EANTC

Microwave System Utilizing T-TC Mode

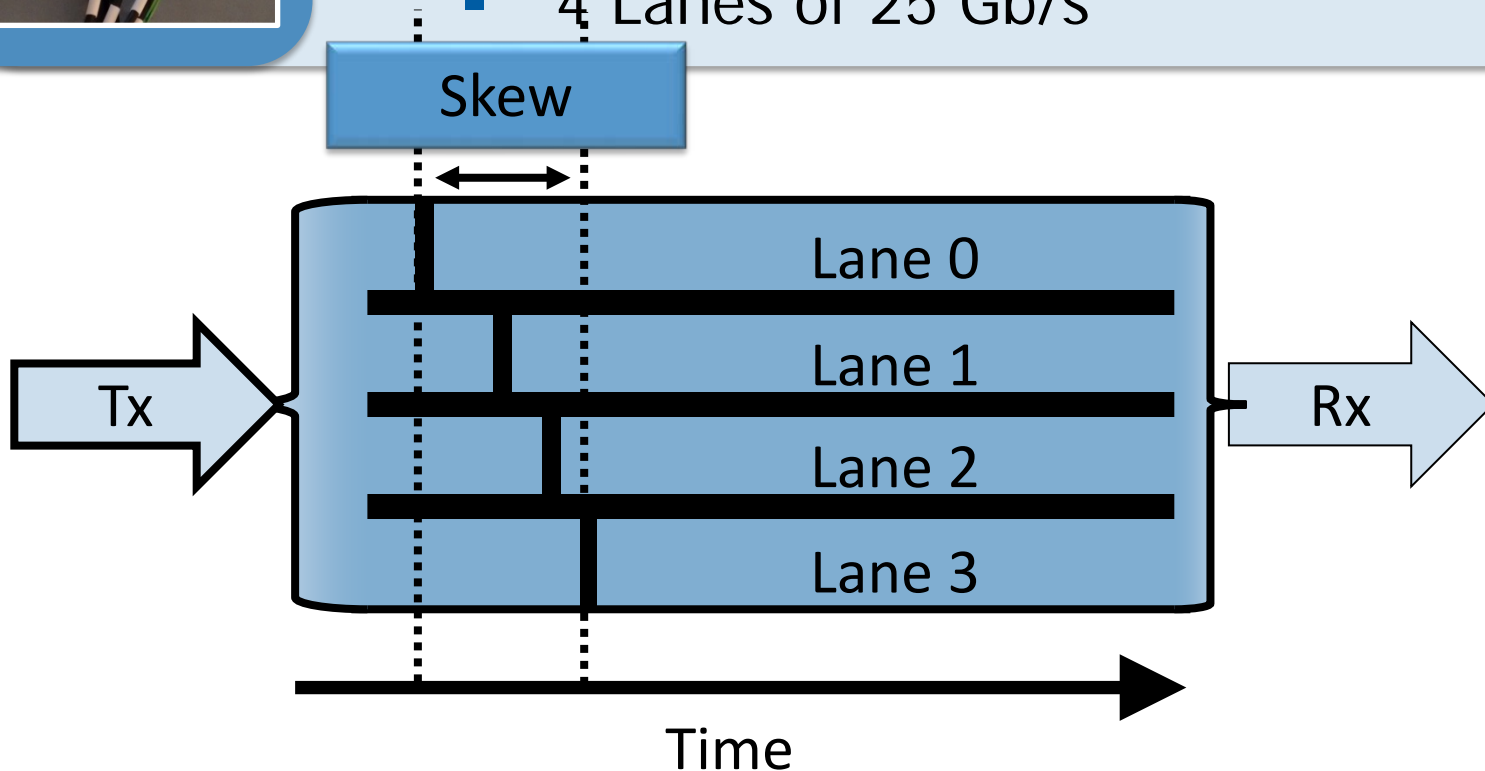
Slide courtesy of **Calnex**



40G and 100G Ethernet



- 40G Ethernet: 4 Lanes of 10 Gb/s
- 100G Ethernet:
 - 10 Lanes of 10 Gb/s
 - 4 Lanes of 25 Gb/s



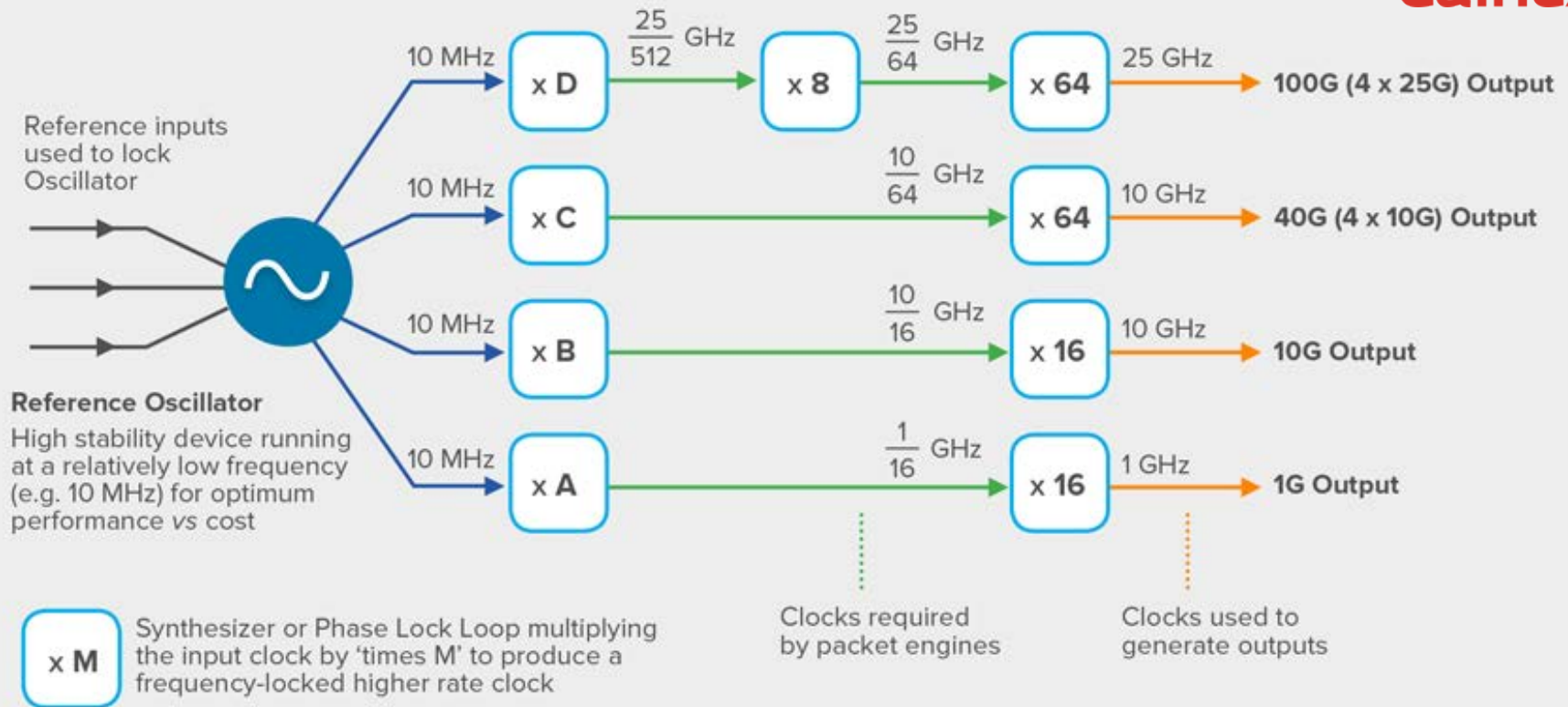
Skew and Skew Variation

Skew points	Maximum Skew (ns) ^a		Skew points	Maximum Skew Variation (ns)	
SP0	29	Transmit	SP0	0.2	CAUI-4
SP1	29		SP1	0.2	XLAUI, CAUI-10, CAUI-4
SP2	43		SP2	0.4	
SP3	54		SP3	0.6	
SP4	134	Receive	SP4	3.4	
SP5	145		SP5	3.6	
SP6	160		SP6	3.8	
SP7	29		SP7	0.2	CAUI-4

Source: IEEE Std 802.3bm-2015, Table 80-4 and Table 80-5

Conceptual Example of the Clock Generation Inside a Switch or Router

Slide courtesy of **Calnex**



Central Oscillator

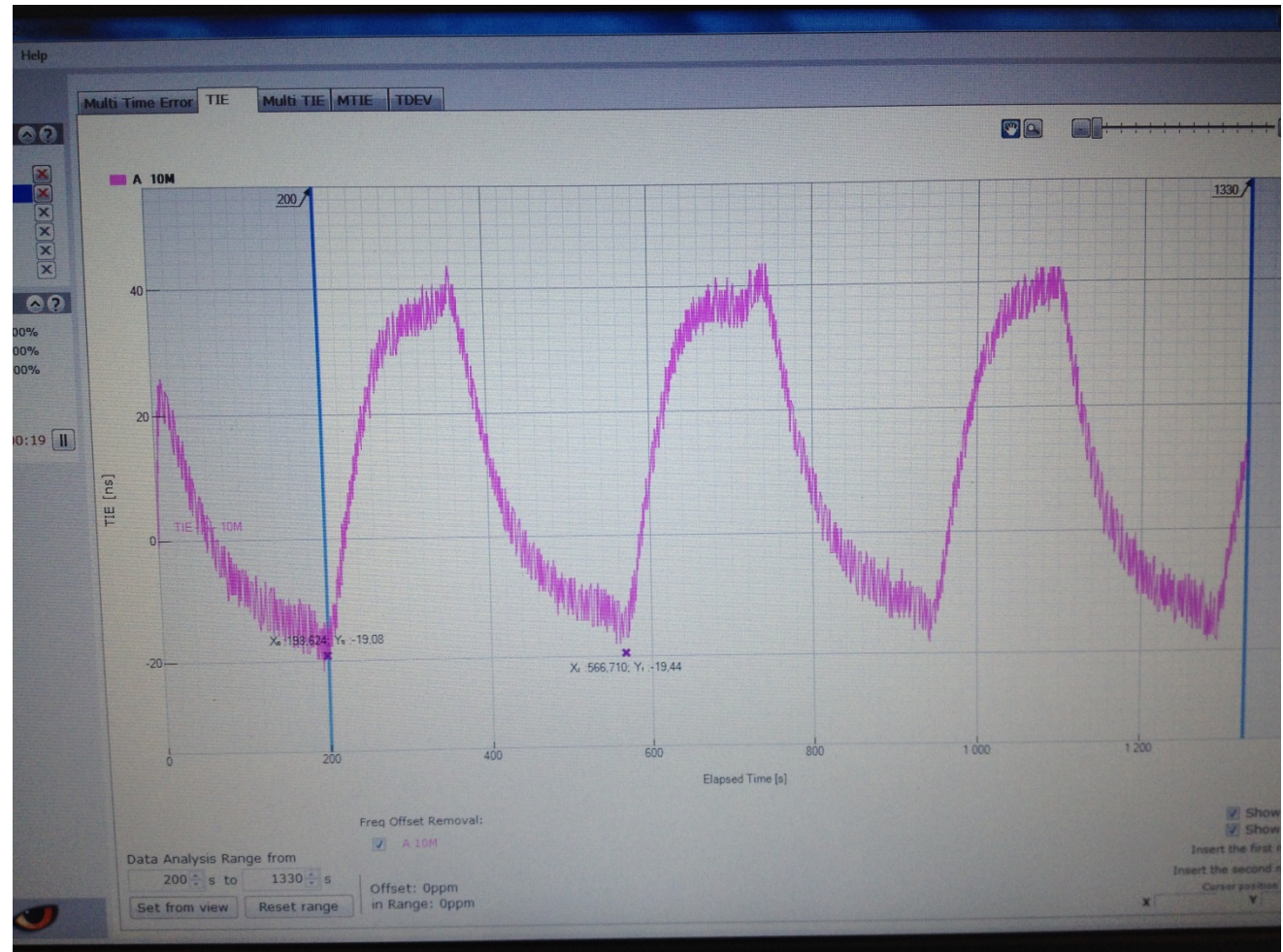
Unique
Synthesizers/PLLs

Unique wander
characteristics on
output interfaces

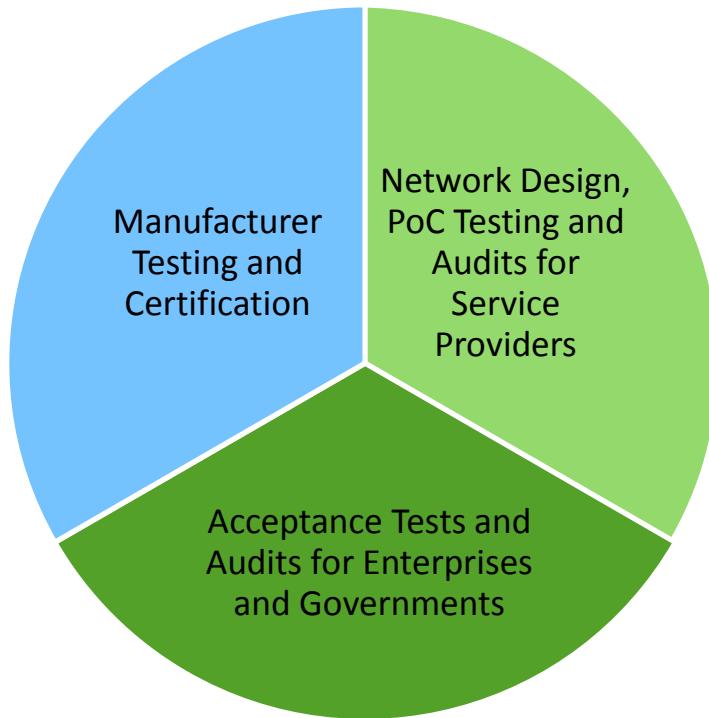
Standards Compliance Can Only Be Guaranteed by Testing Every Interface

Slide courtesy of **Calnex**

Example:
Wander on
100G interface
that was not
visible on the
other
interfaces



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- Highest quality standards



Thank you for your interest!

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