To Test or Not To Test…
The Challenge for Phase

International ■ Telecom ■ Sync ■ Forum

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12 Months on…

Business Pressure Remain… Even growing…

Total Cost Of Ownership

New technology
New Services VoLTE
Phase ready sync
Capex v Opex
Resources
Churn
SLA
QoE
ARPU & Revenues
Cost of network transformation
Ownership of sync strategy

Our **customers are complaining about poor throughput** and dropped calls. We need to get these issues resolved right now!

Quality Coverage Capacity

We're experiencing lower throughput and **more dropped calls at a specific eNB.**

Some a**pplications are not performing** as expected. Our customers are complaining about YouTube lags and dropped Skype connections.

Future Proof Technology

We plan to **launch VoLTE and several new apps** soon, but they have to be verified in our live network first.

Ongoing demands for bandwidth

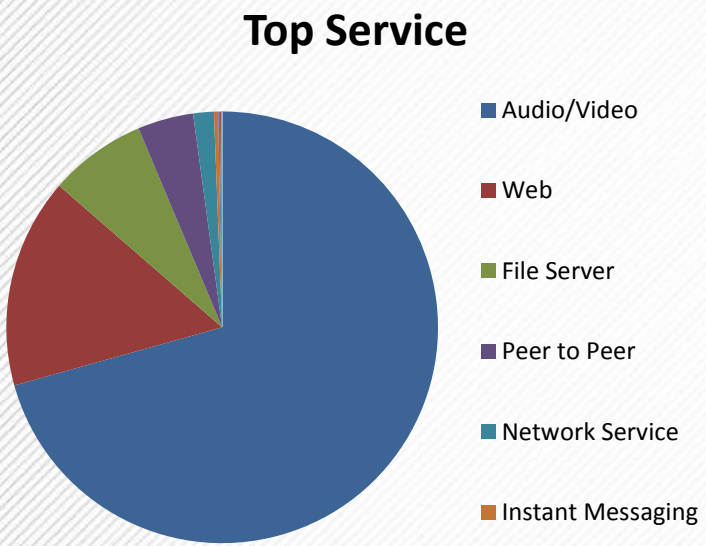
Smartphone penetration continues

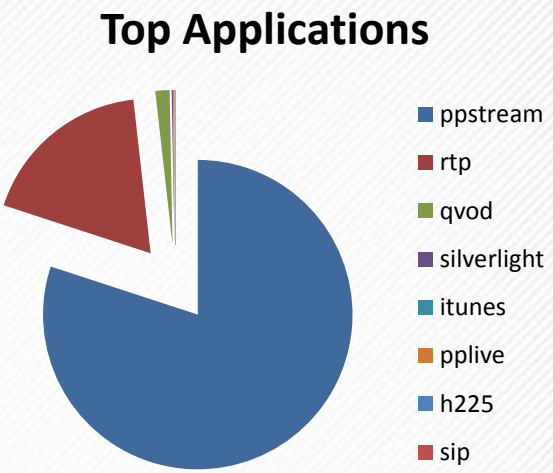
Global IP traffic will increase **4X** from 2009-2014.

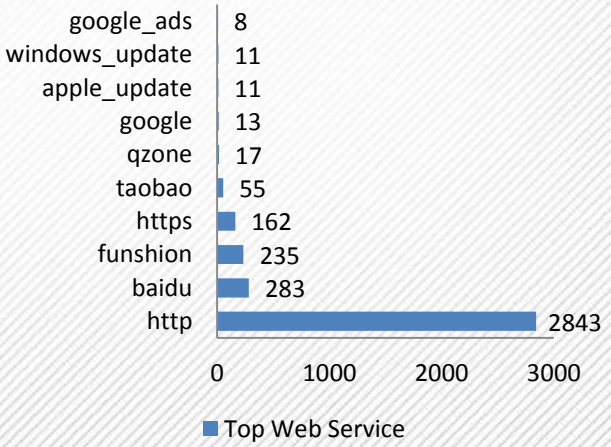
Mobile IP traffic will jump **39X.** (Cisco)

LTE network analysis – Application view

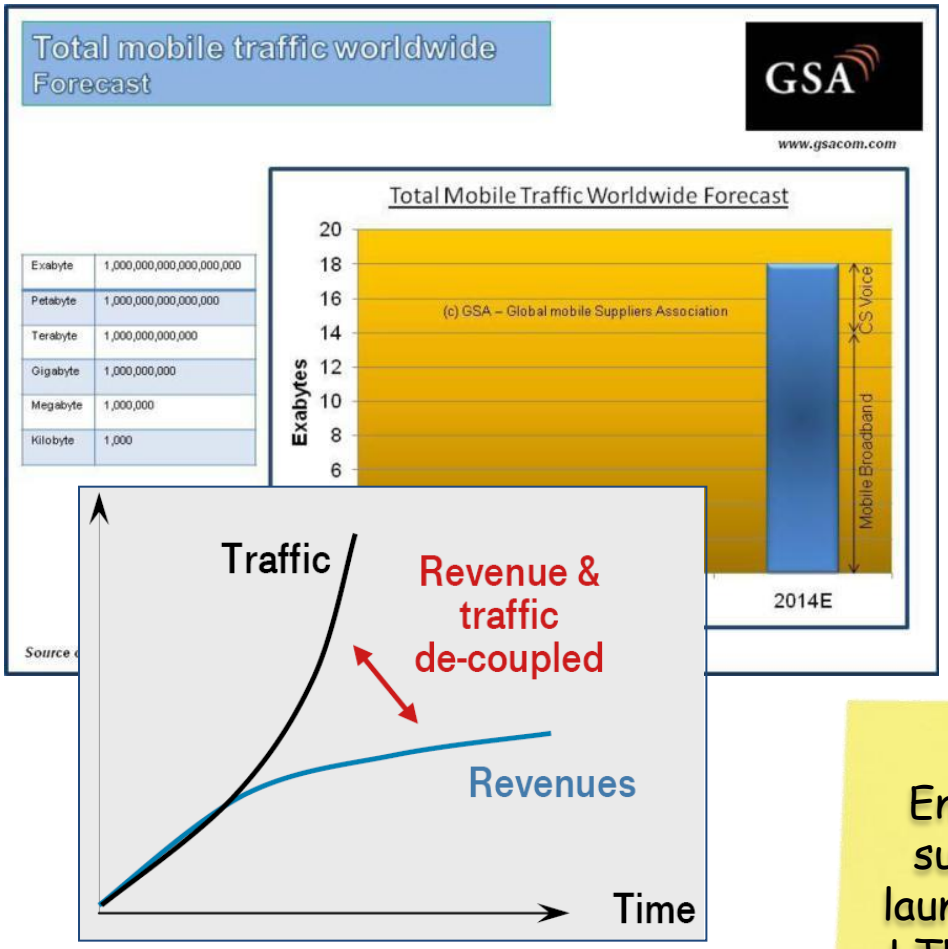
› Top application analysis







Mobile Broadband Explosion v. Revenue



- 3.5 Billion mobile broadband users globally by end 2015 (Ericsson)
- 2015 Data volume = 2010 vol x 30
- Operators NEED capital investments to increase capacity to meet demand. (Analysys Mason)

Ensure the successful launch of new LTE services

Make sure rollout is on track

Network Failures make News Headlines

'Gremlins in the system': Mobile network EE 'working hard' to fix massive signal outage

Kerry Mc

Mobile Ops Lose $15B Yearly to Network Outages

NEWS ANALYSIS
SARAH REEDY,
Senior Editor

11/14/2013

COMMENT (9)

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Mobile operators suffer from an average of five network outages or degradations that impact subscribers each year, costing them around $15 billion annually, according to new Heavy Reading research.

Put another way, that's about one outage every other month. More than 80 percent of those outages affect just one or a subset of networks or services. But given that operators are losing customers and spending an average of 1.5 percent of their annual revenues -- with some as high as 5 percent -- trying to rectify outages, the cause for concern is understandable. (See Outage Outrage.)

Heavy Reading 's new report, Mobile Network Outages & Service Degradations: A Heavy Reading Survey Analysis, looks at what causes outages, why they happen, and what can be done. These are issues that are becoming more pressing for operators as they roll out LTE networks for which expectations are high. (See LTE Brings Myriad Security Concerns and Can Mobile Networks Cope?)

FT Ora
repairs

July 11, 2012

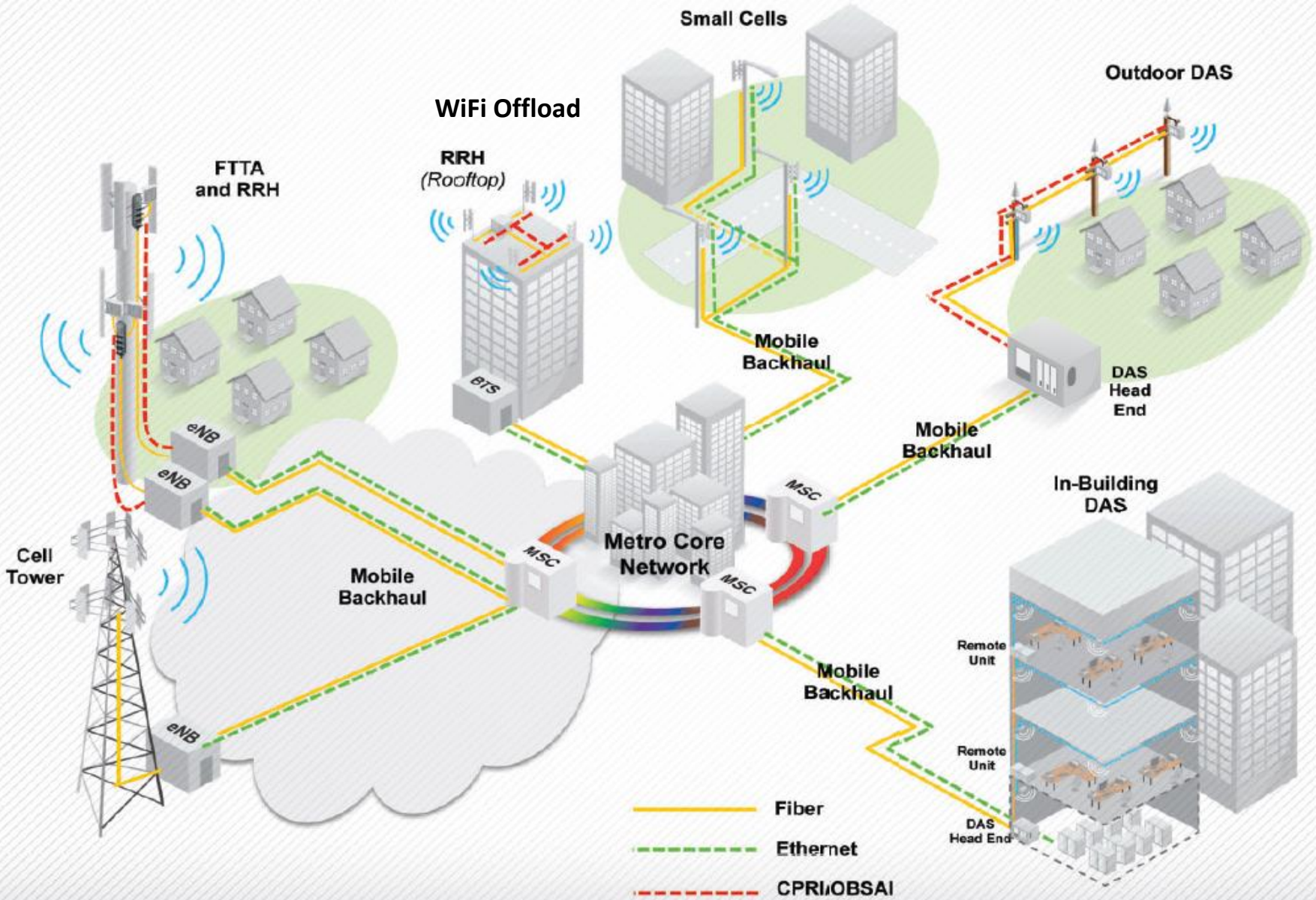
The French g
operator's ne

The countrywide failure, which stopped Orange customers from making calls or sending text messages, has prompted the French government to call for an audit of critical national infrastructure.

O2 UK COO Derek McManus wrote in a company blog post that the operator is "extremely disappointed to have let our customers down again" and said the network faults were "unsatisfactory."

se after

Networks Continue to Evolve



Where does testing fit in ??

What To Know During 3G/LTE/LTE-A Rollouts?

Issues in **deployed** or **operational** networks
are very expensive to fix!
Testing helps find issues before & during deployment and before they reach the end-user, saving time and money!!!

To know if it meets requirements

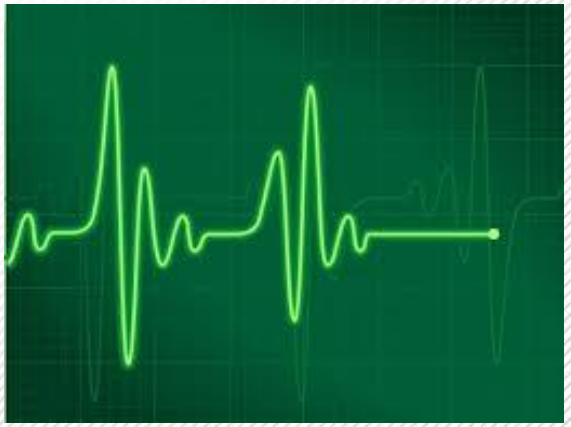
To know if it works with other stuff

No Question Synchronisation is required…

BUT…

Traditional frequency (Mbps/MHz/SyncE) sync "**just works**"

The anticipated 'problems' with 'digital' sync (i.e. SyncE & PTP 1588) simply NEVER MATERIALIZED in the real world



BUT Frequency alone for future is not enough

Sync Requirements for Mobile Services

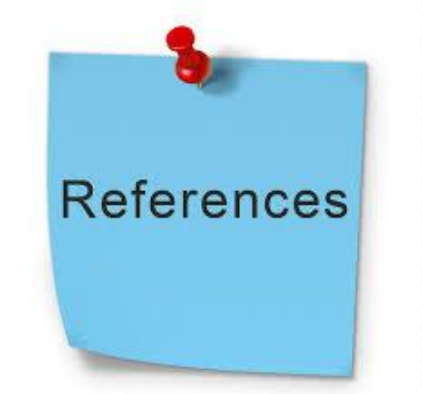
Mobility Air-Interface Stability Needs		
Mobility Standard	Frequency (ppb)	Phase
Billing, Alarms	---	(Time) 1 msec – 500 msec
CDMA2000	50	<3 to <10 µsec
GSM	50	Not needed
WCDMA (FDD)	50	Not needed
WCDMA (TDD)	50	2.5 µsec
LTE (FDD)	50	Not needed
LTE (TDD)	50	2.5-µsec inter-cell phase change
LTE MBMS	50	5-µsec inter-cell phase change
LTE-A CoMP	50	+/- 0.5-µsec
LTE (residential)	250	None
Backhaul	16	

MBSFN: Multimedia Broadcast Multicast Service (MBMS) over a single-frequency network
CoMP: Coordinated Multi-point Transmission/Reception

Synchronization is <u>essential</u> for Mobile networks

Sync Field Testing Challenges

1. Power (AC and/or DC)
   - test device/s
   - laptop

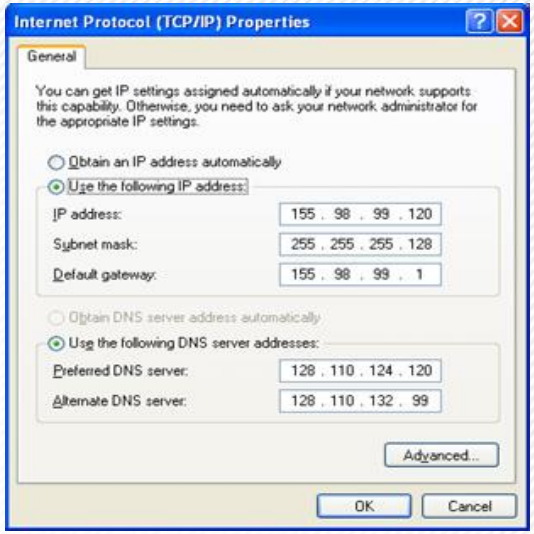


2. Test Reference Signal
   - GPS
   - PRC/SSU/SEC/Transport

3. Physical Connectivity
   - Reference signal
   - Test Signal (Freq)
   - Test Signal (PTP)

Sync Field Testing Challenges

4. Data Connectivity
    - IP address & subnet
    - Gateway
    - VLANS
    - GM details

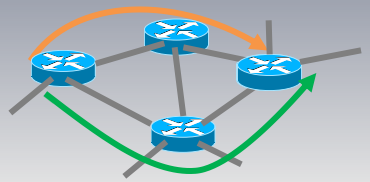


5. Knowledge & Understanding
    - Interpreting results
    - Pass v Fail
    - Troubleshooting

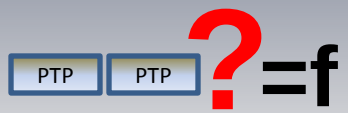
Possible causes of Sync Degradation…

Equipment failures

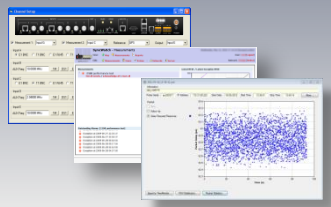
Path Reroutes

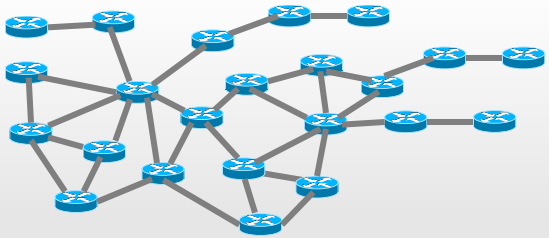


(1588_v2) PTP Client design

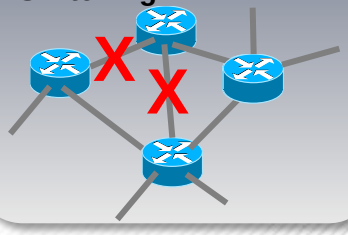


Implementation and Configuration

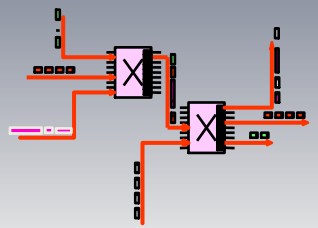




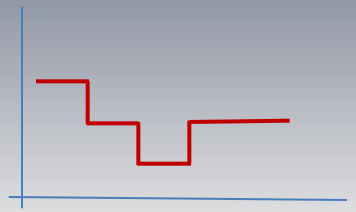
Outages & Protection Switching



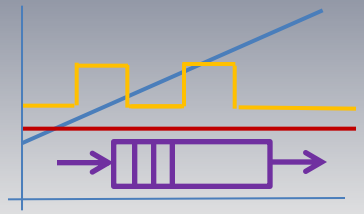
Queuing Delays



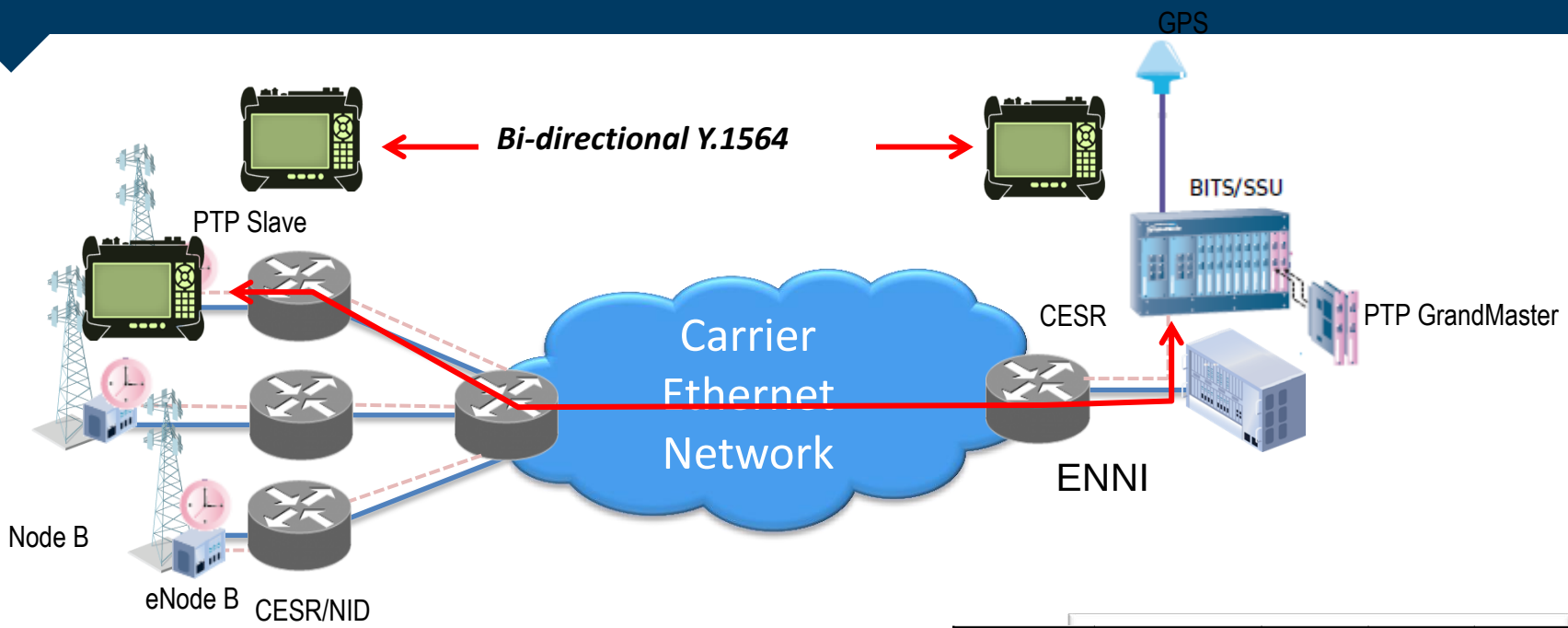
Bandwidth Variation



Changing Traffic



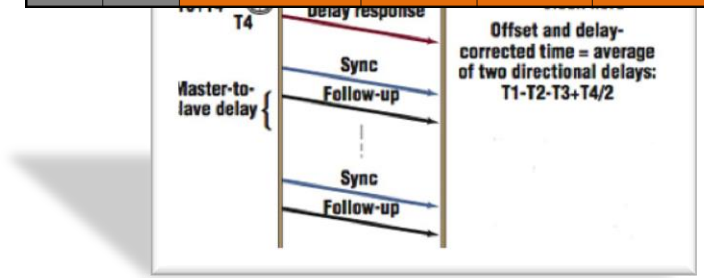
Recommended Field Test Applications…



Service Turn-up:

- Verify Ethernet Service SLA
  - Y.1564 EtherSAM test
    - Throughput, Latency (round trip), FDV/PDV, Frame Loss, VLAN, OOS, CoS/ToS, Priority;
  - Multi-stream recommended (up to 7)
  - 1 stream configured to emulate PTP
  - ? One-way Latency ??

LTE traffic		Transport Service Class	PCP	DSCP	LTE Interface
Synchronization		Synchronization	7	111xxx	Sync
Bearer OAM		Bearer OAM	4	100xxx	OAM
QCI Level	1/2	Voice/Live Video	6	110xxx	S1、X2
	3	Video on Demand	3	011xxx	S1、X2
	4	Real Time Gaming	5	101xxx	S1、X2
	5	Control/Management	7	111xxx	S1、X2
	6/7/8/9	Others	0,1, 2	000xxx~010xxx	S1、X2



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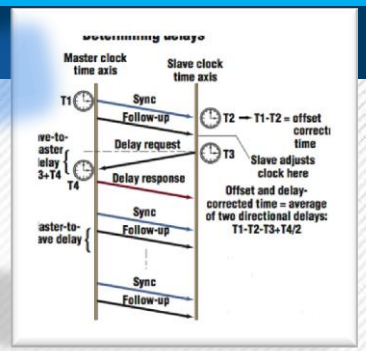
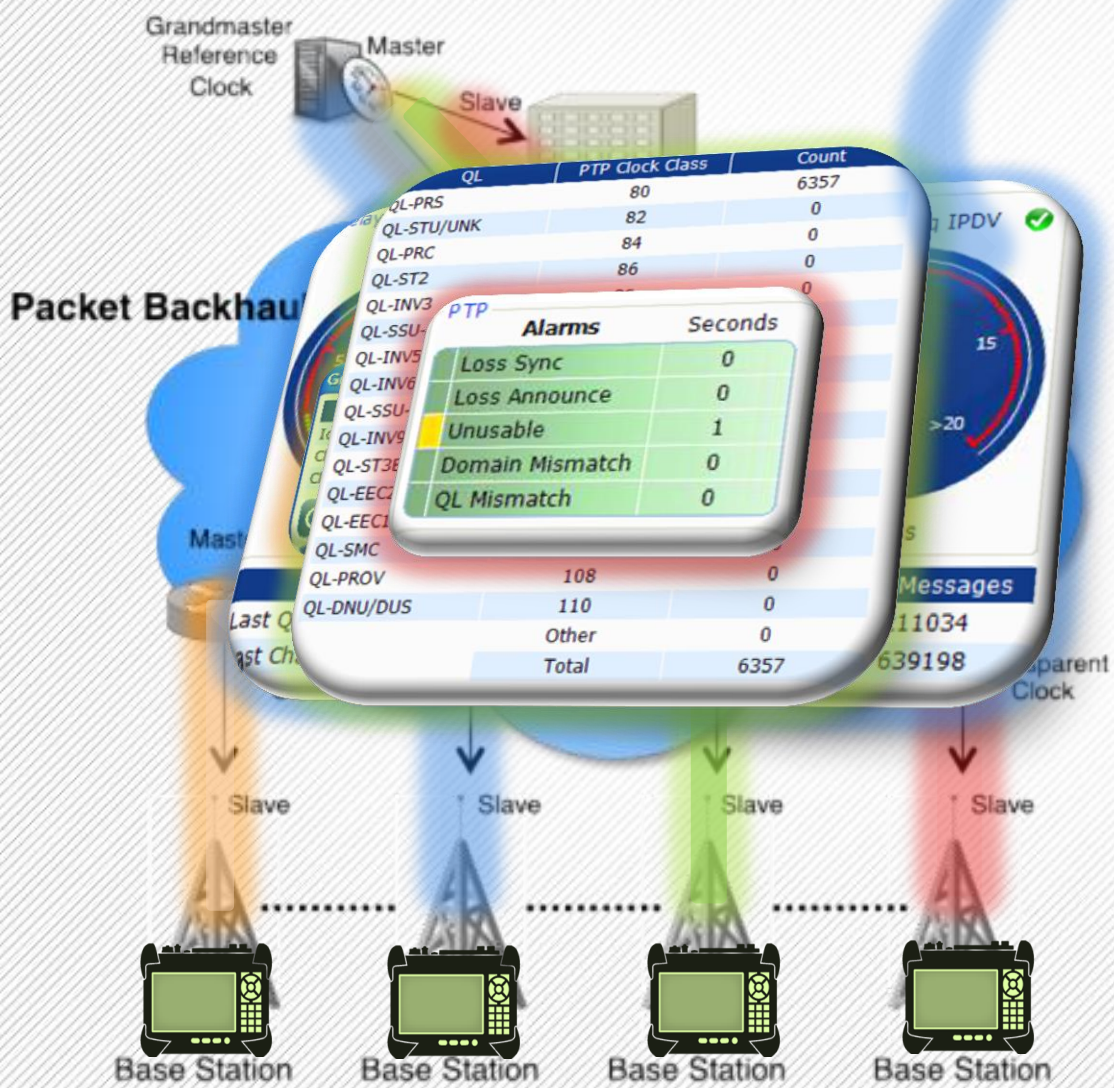




- Establish link with GM
- Measure K.P.M.
- Verify Clock quality levels
- Report PTP Alarms

PTP 1588 Challenges… Is testing required ?

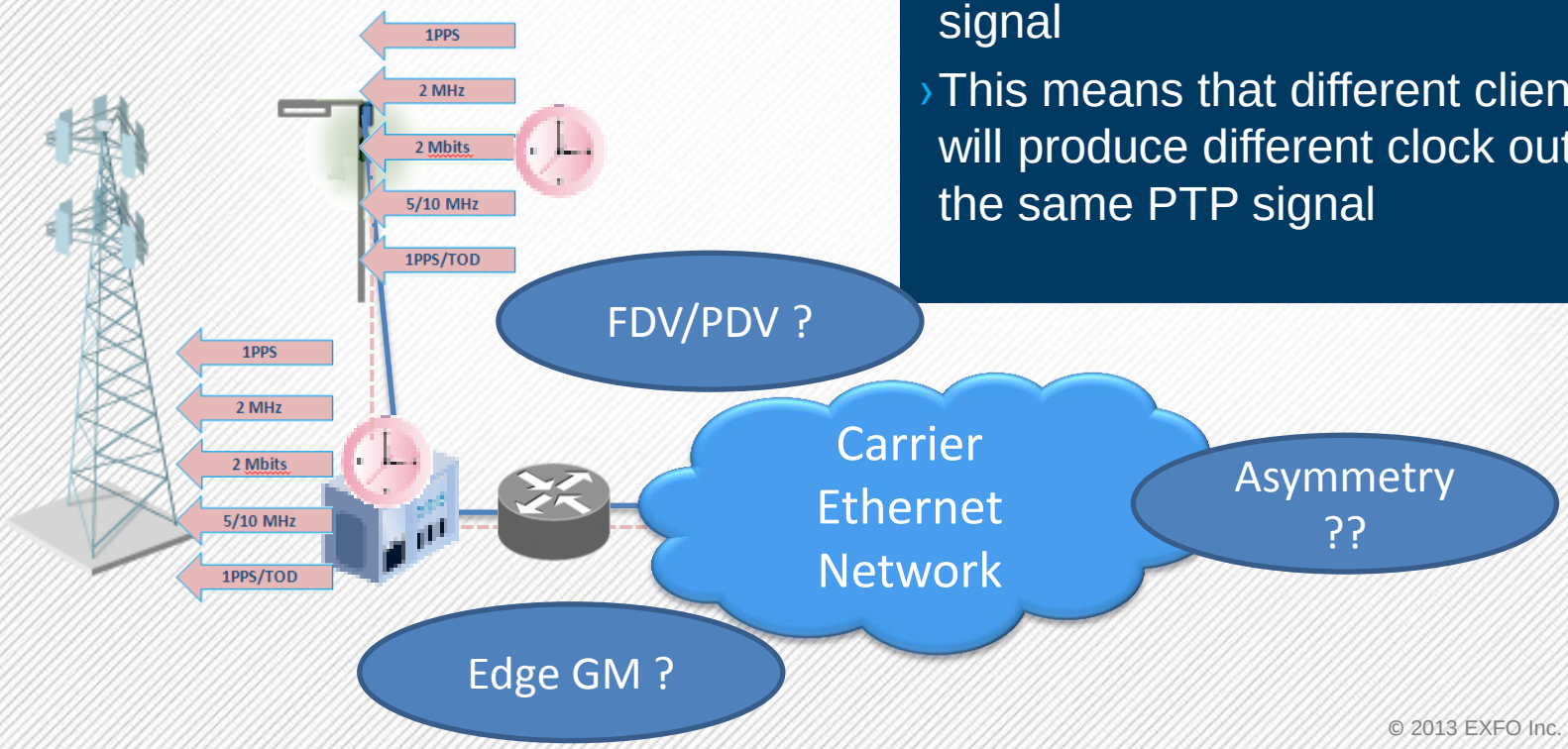
Frequency/Phase domain

› Objective of PTP network is to deliver Frequency and Phase to the tower…

› Based on its algorithm, the slave will output a clock signal.

› Each Vendor uses a different proprietary algorithm to process the signal

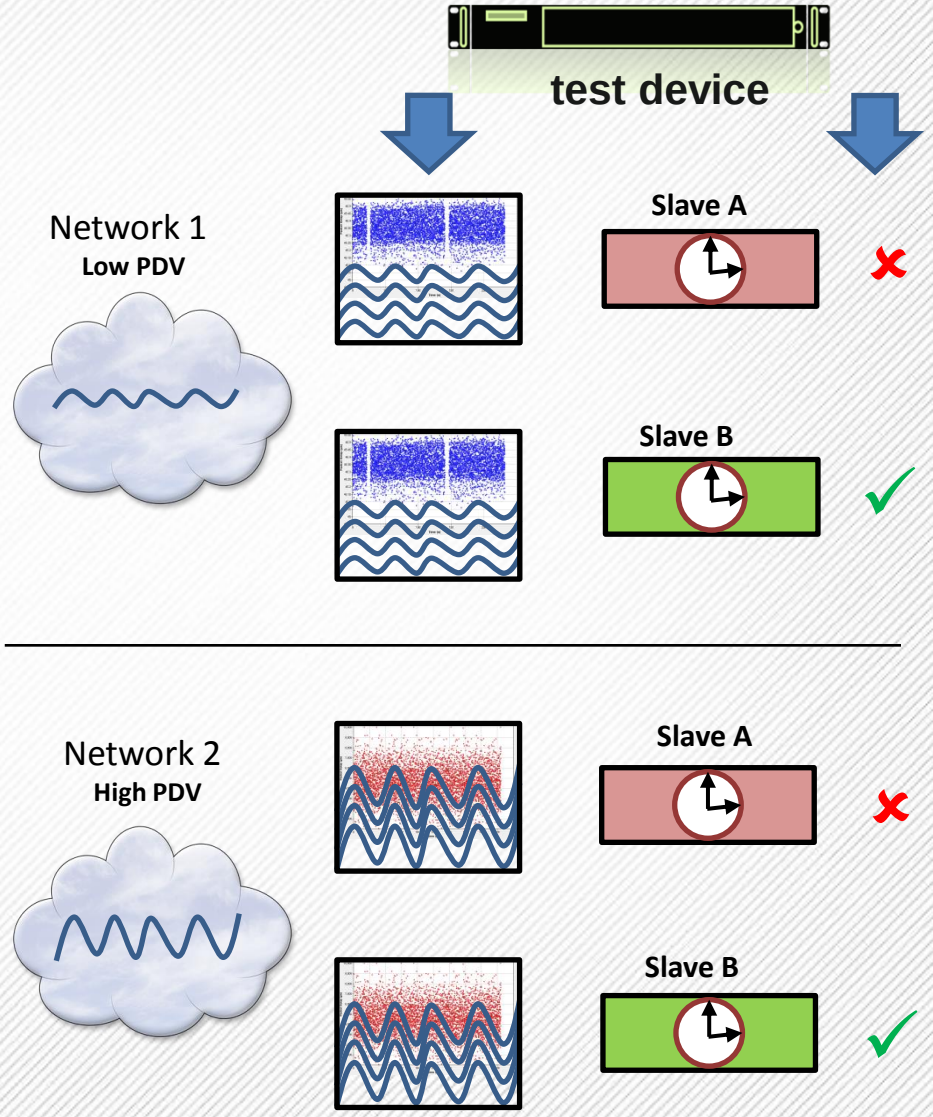
› This means that different clients/slaves will produce different clock output with the same PTP signal



PTP testing

Frequency/Phase domain

- Measuring PTPv2 delay and packet delay variation does not give any indication of slave clock quality
  - The slave clock output must be measured as a frequency or phase (TIE) measurement
- Clocks from different vendors will behave differently in identical PDV environments
- Measuring PDV is useful for qualifying/turn-up of the network for PTPv2 transport network and troubleshooting for network event correlation
- Measuring TIE will give visibility of slave clock performance



What about Phase ??

Customer Questions – Questions and More Questions !

- I still need my Frequency sync ☺ !
- BUT I guess I will need PHASE as well ☹
  - 6-12-18-24 months from now ??

- How do we deliver phase ?
  - GPS/1PPS is a really expensive option ?
  - Is PTP/1588 good enough on it's own ?

- How do we measure and validate phase ?
  - Not all my network elements have a clock out port…
  - Do they have a1PPS out port ?
- Is my GPS installation qualified and characterized ?
  - A 'green light' at the end of my GPS ref cable connection is not enough now
- Who is responsible ?
  - MNO ? NEM ? Contractor ? SI ? Managed Services Provider ?

- I think I want and need 1PPS at the network edge but how…

- What testing do I need to consider ?
  - Ethernet/packet testing ?
  - One way Latency ? (Doesn't that need a 1PPS reference as well?)

Customer Case Study: Sync delivery options ?

Network: E1/SDH and Ethernet combined	•Short term strategy based on usage of existing infrastructure and systems •Limited by BW, cost and LTE IF requirements for long term suitability •Delivers only frequency and not phase
GPS/GNSS receiver at every node	•Delivers frequency and time (up to 50ns), good performance •Cost, installation efforts and satellite reception to be considered
Network: SyncEthernet	•E2E solution using PHY clock from bit stream (similar to SDH), requiring uninterrupted SyncE path •Delivers only frequency and not phase • Independent from network load
Packet based: in band Adaptive Clock Recovery (e.g. ACR, RTP)	•The clock is recovered by using the (inter) arrival time of the packets • performance affected by network load conditions, not always on • Delivers only frequency and not phase
Packet based: out of band IEEE1588v2 (PTP)	•Clock information is transported via dedicated packets (master-slave) •Always on solution (even without traffic data) •Works over any transport technology, high rate of adoption •Can deliver frequency and time

Customer Case Study for LTE-A/TDD

- Large country with 3 mobile providers in APAC region…
- 4G/LTE -> Only FDD-LTE has been licensed & deployed today…
- Lab-Trial for TDD-LTE network being built now…

- 4G TDD-LTE network sync strategy…
  - Sync E delivers frequency synchronization
  - PTP (called In-band synchronizing) for phase + backup
  - 1PPS+ToD (called out-band synchronizing) are for time synchronizing.

- Field technician, they need the test instrument which at least supports PTP (Precision Time Offset measurement, one-way latency, one-way PDV, etc.), SyncE (TIE, MTIE, basically) and 1PPS+ToD (Precise Time of Day, frequency synchronization

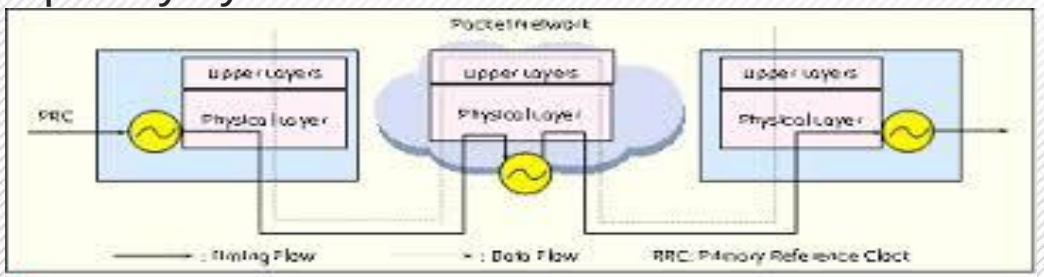


Figure 1. Physical–layer synchronization in PTN

Customer Case Study for LTE-A/TDD Sync

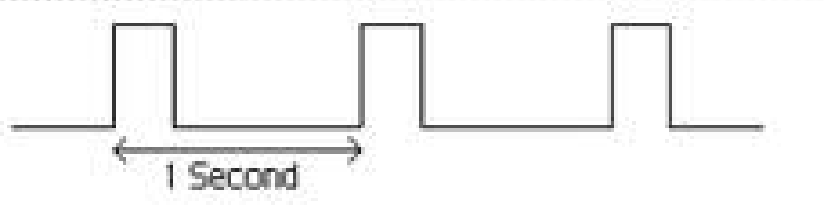
- Plan A …
- GPS module to be deployed in each eNB,
- Delivering Freq Sync and 1PPS/ToD

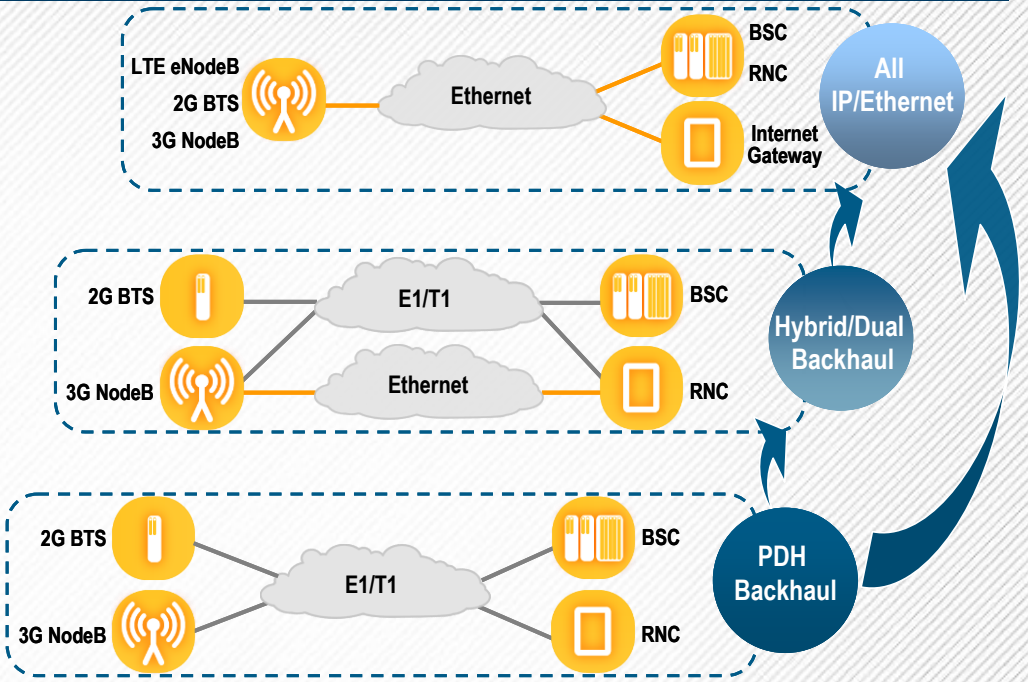
  - BUT…
  - Decided NOT cost effective nor viable nor scalable nationwide

  - BECAUSE
    - HIGH cost,
    - HARD to be maintain,
    - HIGH fault rate
    - High security risk.

Customer Case Study for LTE-A/TDD Sync

- Plan B
- SyncE and PTP
  - Delivered via MBH network
  - Supported by 1PPS+ToD
    - eNB <-> MBH.





- P-OTN is hot topic under heavy discussion
  - i.e. PTN+OTN delivering PTP & SyncE
  - Successful within the trial network thus far…

- Additionally Compass is also under consideration as a synchronization signal resource.

Customer Case Study: Sync Challenges

- No technical challenge with deploying SyncE across PTN network (yet ?)

- PTP challenge is addressing the asymmetry of network transmission (GM to slave + slave to GM)

- Field challenges are:
  - Clock reference resource for test equipment,
  - Selection of (and availability of) test signal & test point,
  - Duration of test

- Phase testing challenges in the field…
- FEW LTE or LTE-A deployed eNB have clock out or Sync interface…
  - So where to get the 'sync signal under test' ??

- FDD v TDD
  - Pay close attention to PTP (timing) test.
  - To obtain sub 1.5us between BS , pure Packet statistics are necessary yet less important, because it reflects the performance of underlying transmission network.
  - PDV -> With PTN networks, PTP is transmitted in BC mode (every network node act as master and slave), so PDV is less important.

Conclusions

- Phase synchronization is coming and will be essential.
- Sub 1 us synchronization requirement hard to achieve.
- Challenges with SyncE and PTP for Freq did not happen

Conclusions

- Traditional Freq “Reference” will not be enough for test & measurement
- 1PPS “Reference” required at the edge of the network
- To test or not to test… The Challenge for Phase…

Thank You

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Questions