Field Measurement Methodologies for Synchronization in Mobile Networks

International ■ Telecom ■ Sync ■ Forum

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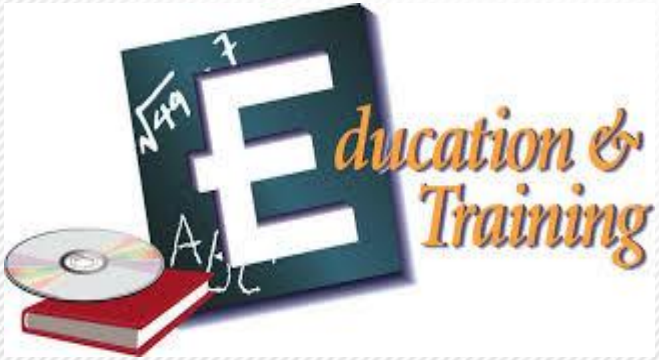
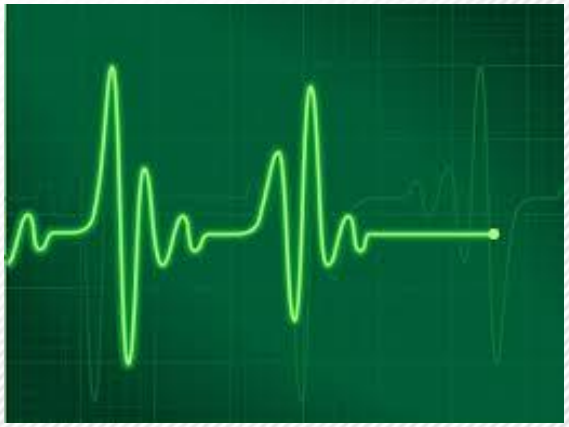
The Challenge…

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





BUT Frequency alone for future is not enough

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Four Major Business Pressures

Total Cost Of Ownership

Time to Market

Quality Coverage Capacity

Future Proof Technology

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Four Major Technology Transformations

VoLTE

LTE Deployment

Ethernet Backhaul

Converged IP Transport

2000 2005 2010 2015

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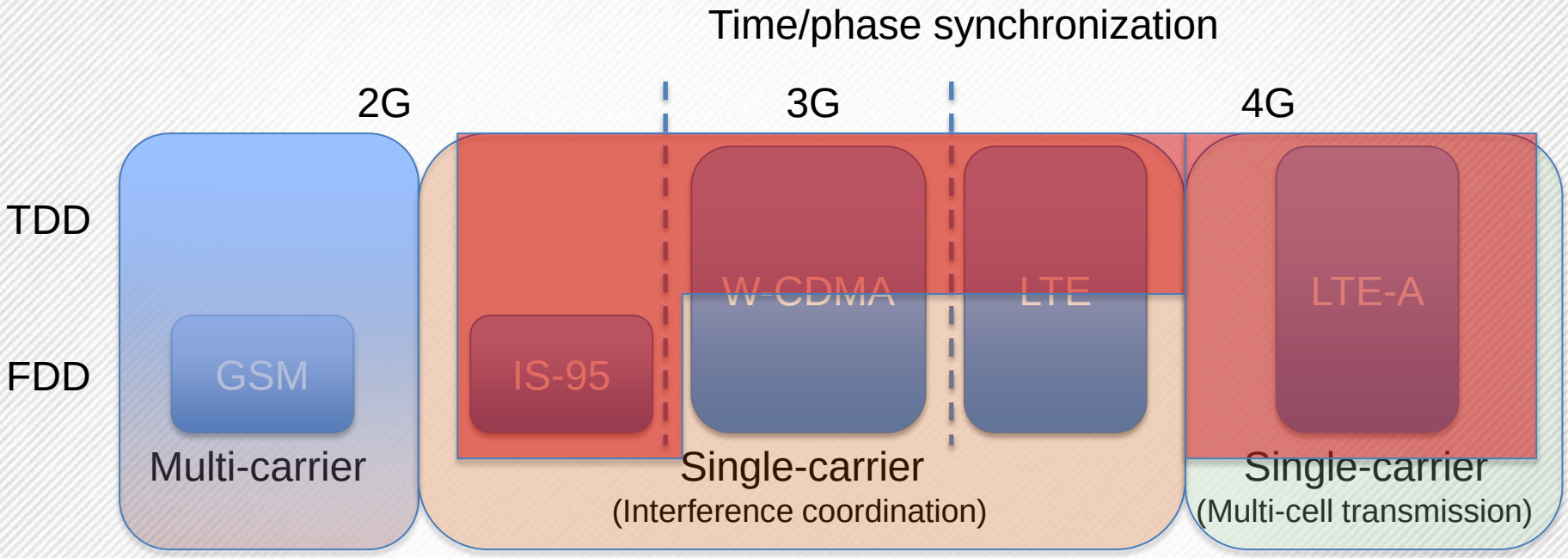
Mobile Network Technology Progression



- Higher peak throughput requirement -> wider band -> single frequency
- Multi-cell transmission to increase cell edge throughput
- Time/phase synchronization with tighter requirements

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Key Challenges

- Latency & Jitter (FDV/PDV) in the backhaul network
  - Transport Qos impacts Sync quality
  - Sync over PTP/1588v2

- Latency & Jitter (FDV/PDV) In the fronthaul
  - Sync transported over CPRI* and is impacted by latency and jitter
    - * CPRI = Common Public Radio Interface (2.4G/3.0G)

- Strict LTE Broadcast Sync requirements using MBSFN/E-MBMS*
  - Frequency, phase and content sync
    - * MBSFN = Multi-Broadcast Single Frequency Network
    - *E-MBMS = Enhanced-Multimedia Broadcast Multicast Services

- Small Cell rollout
  - Interference management schemes like eICIC* or CoMP * require very tight synchronization to ensure proper handoffs in an indoor environment
    - * eICIC = Enhanced InterCell Interference Coordination (freq & power management)
    - * CoMP = Coordinated MultiPoint (synchronized beam forming)

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Options to Deliver Time/Phase Synch

- GNSS (impediments to solve):
  - Interference vulnerability
  - Availability (in-doors, urban canyons, etc.)
  - Local oscillator quality
  - Need for absolute calibration
  - Impedance-matching antenna cables
  - Cost

- IEEE 1588v2 (impediments to solve):
  - **Focus of this presentation**

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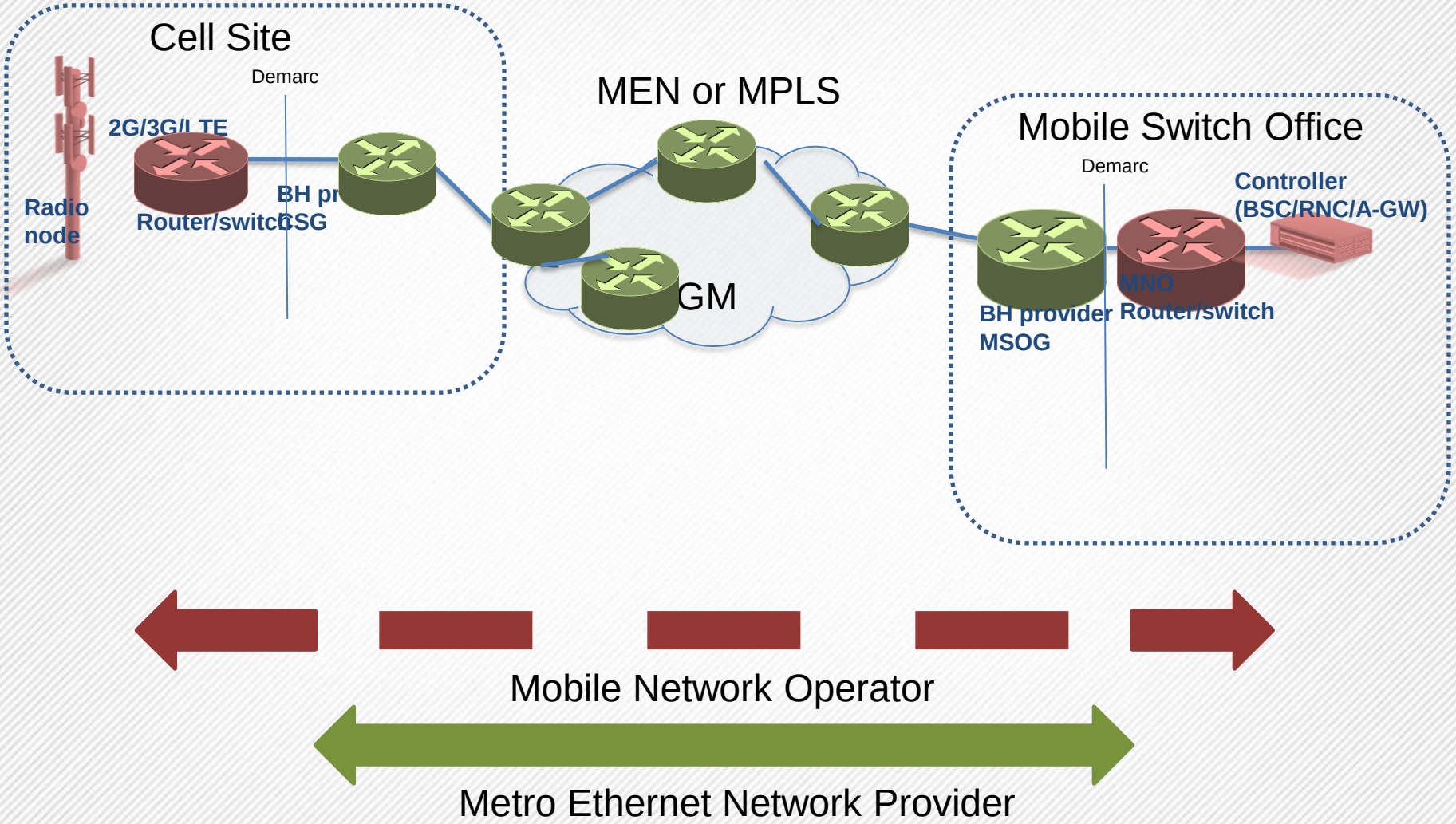
Typically More than One Organization



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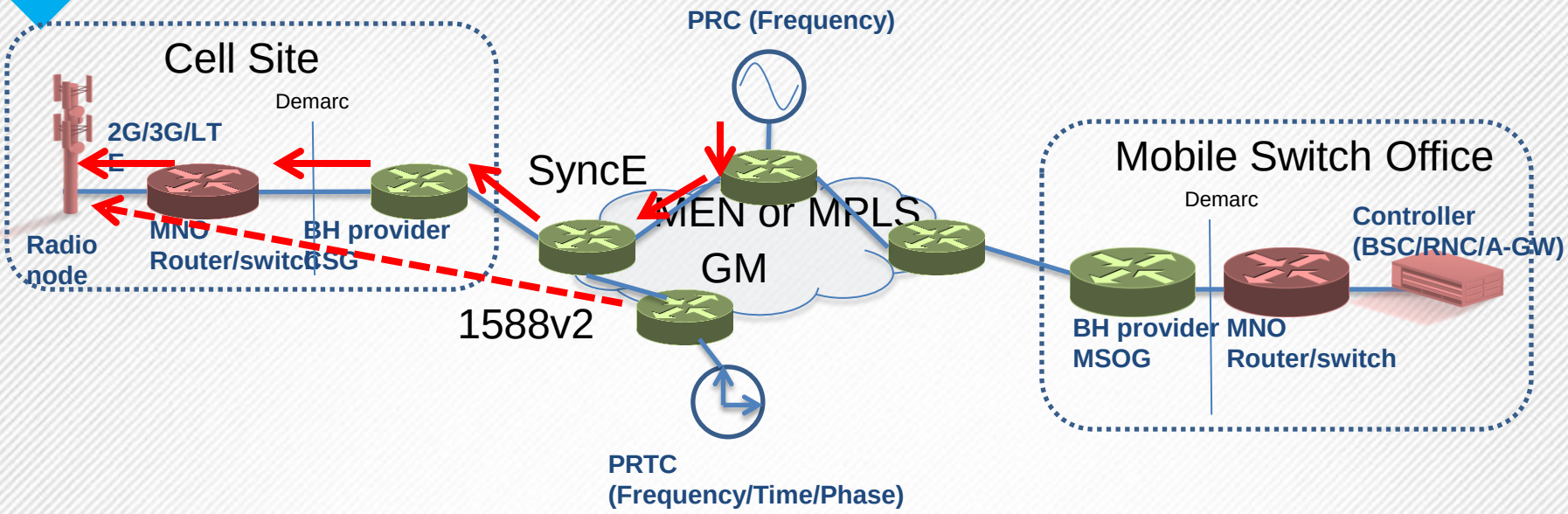
Mobile Network Transport and 1588v2



- Multi-class traffic over the access network
- Inter-mixing with other customer traffic over the MEN or MPLS carrier

- Result:
  - Impact of delay variation on synchronization quality

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Field Measurement Methodologies

- Service Activation
  - New site/equipment integration
  - New/additional synchronization

- Troubleshooting
  - Basic troubleshooting
  - Advanced troubleshooting

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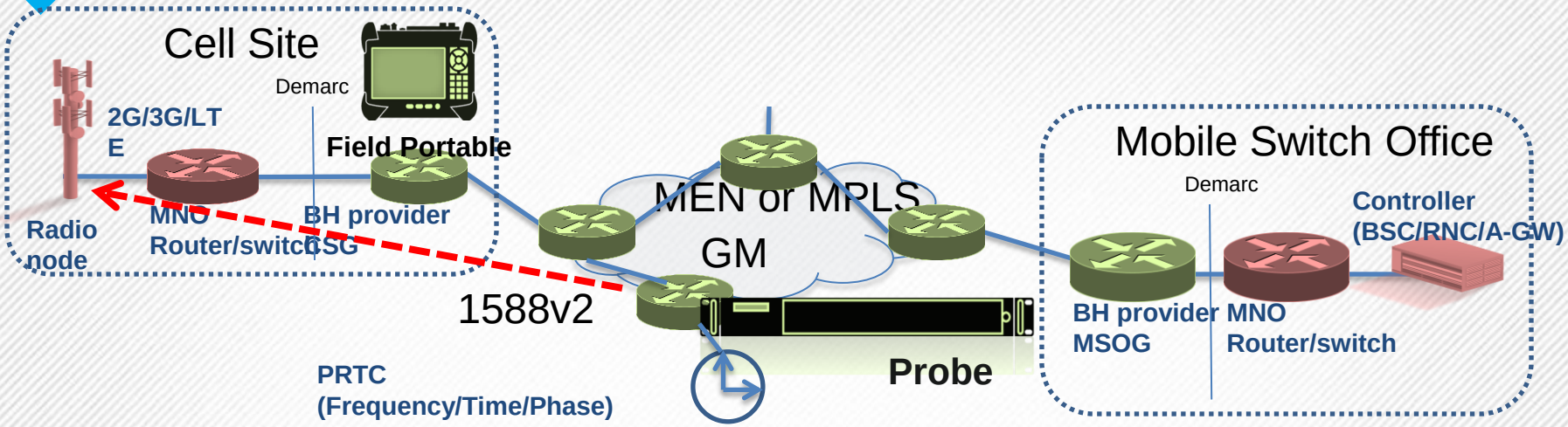
Y.1564 Testing for New Site



Phase 1: Service Configuration Test (Ramp Test)

Objective: Validate the network configuration of each defined service (rate limiting, traffic shaping and QoS)	**Methodology:** For each service, a ramp test is used to gradually reach and exceed the CIR. All KPIs are measured against a threshold.

Phase 2: Service Performance Test

Objective: Validate the QoS of each defined service and the conformity of the SLA.	**Methodology:** All services are generated at once to their CIR, and all KPIs are measured for all services.

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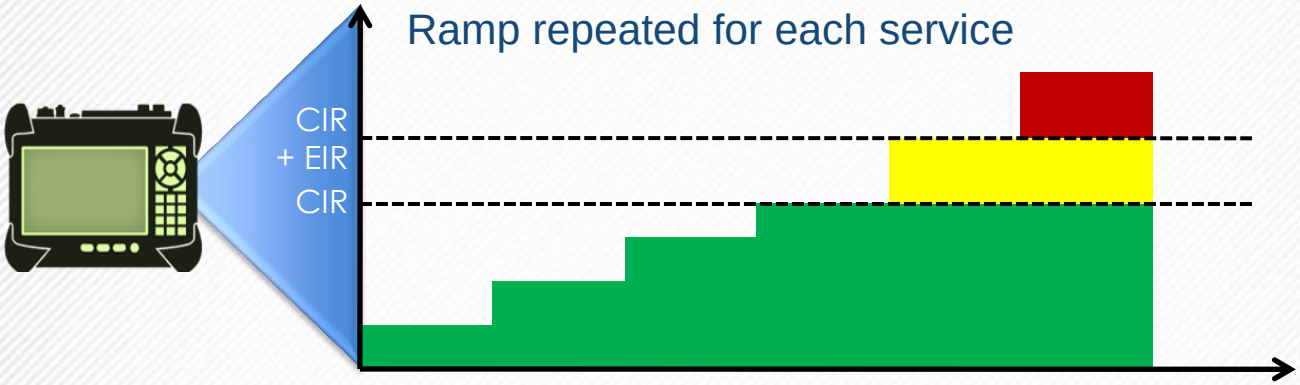
Y.1564 Phase 1 for PTP

Phase 1: **Service Configuration Test**	
Objective: Validate the network configuration of each defined services(rate limiting, traffic shaping and QoS).	**Methodology:** For each service, a ramp test is used to gradually reach and exceed the CIR. All KPIs are measured against a threshold.



Primarily to find configuration errors on network devices for PTP traffic treatment

~ 1 minute per service

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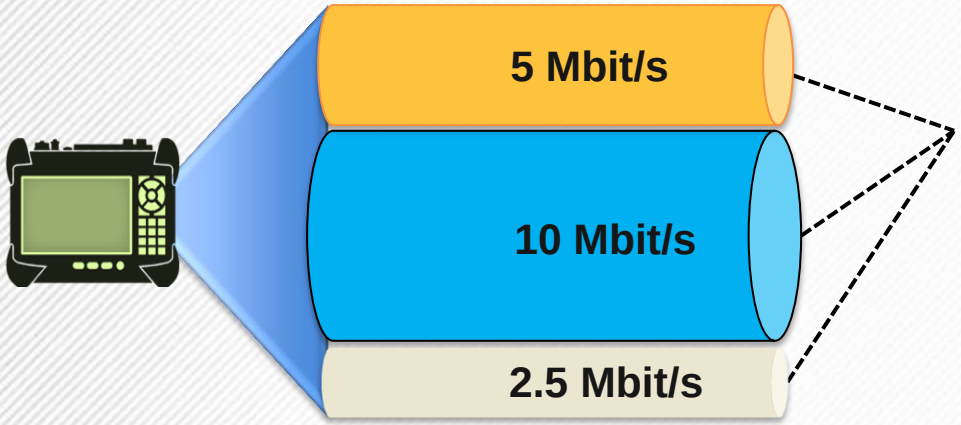
Y.1564 Phase 2 for PTP

Phase 2: **Service Performance Test**	
Objective: Validate the quality of service of each defined service and prove SLA conformance.	**Methodology:** All services are generated at once to their CIRs, and all KPIs are measured for all services.



Primarily used to identify any effects of peak traffic on PTP

From 30 sec, can be extended for long-term tests

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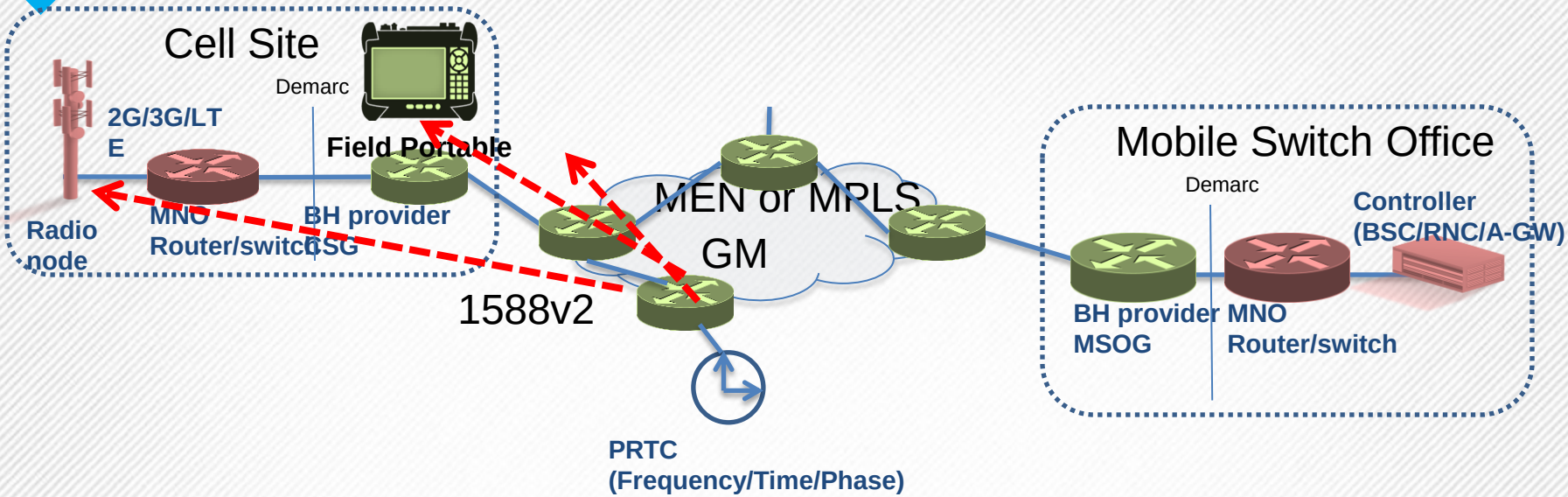
1588 Client Emulation

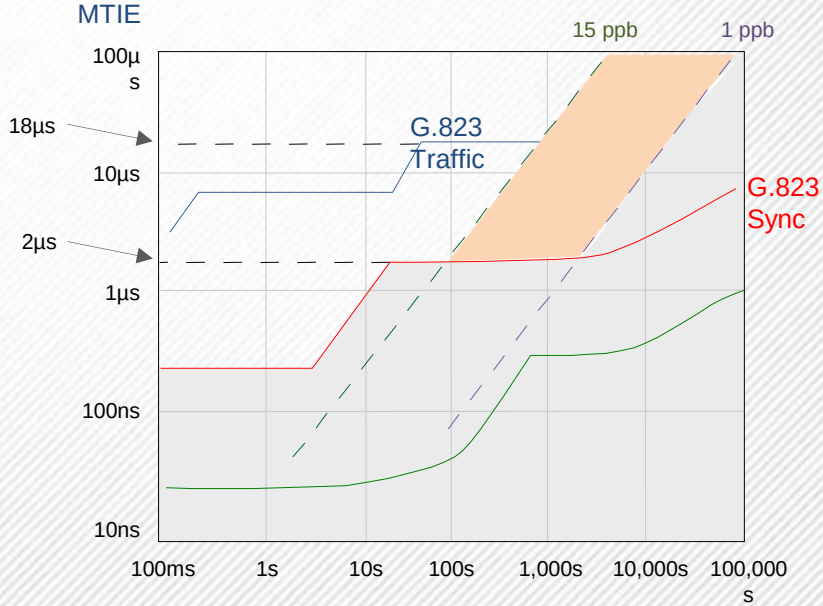


Frequency accuracy and stability produced by the client:

- Look at the frequency output signal of the client (2MHz, E1)

  "Traditional Analysis"

- Analyze TDEV to quantify stability of the output signal
- Analyze MTIE to identify frequency offset and/or frequency drift



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Troubleshooting

1588v2 client testing

- Ability to measure client performance along the path
- Measure TDEV
- Measure MTIE

Grand Master emulation

- Connectivity testing for PRTC
- Connectivity testing with test clients

Y.1564 testing between GM and (e)nodeB

- Bi-directional versus uni-directional
- PTP profile test with other traffic classes for performance testing

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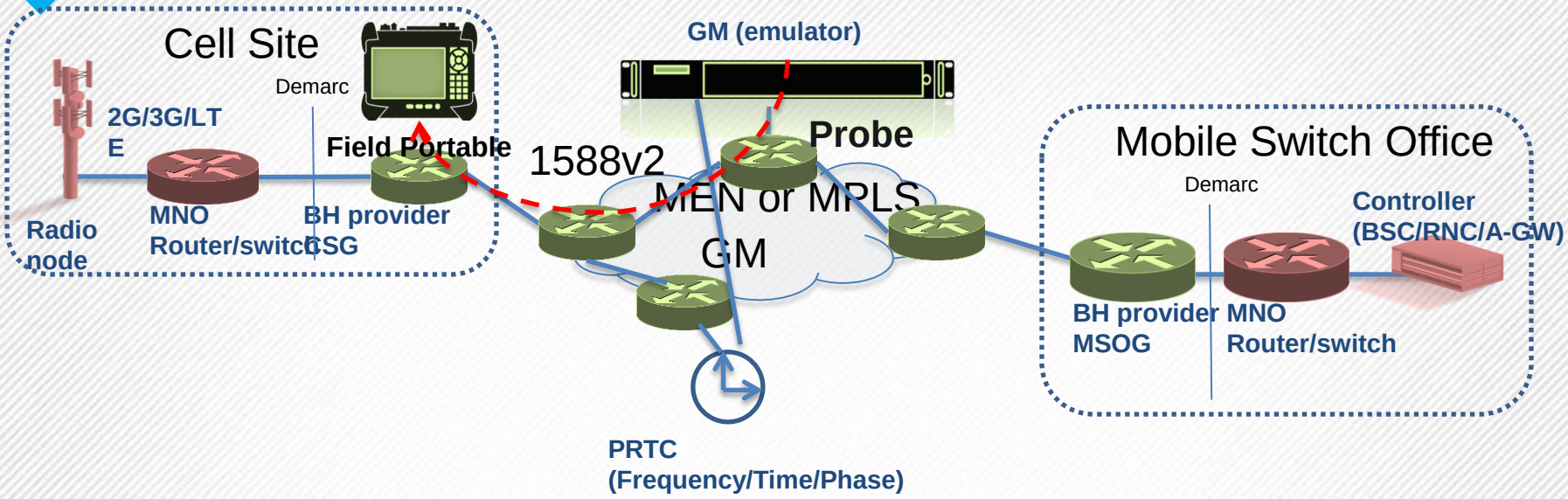
Grand Master Emulation



From emulated GM:

- **Validate PRTC connectivity**
- **Validate cell site client connectivity**

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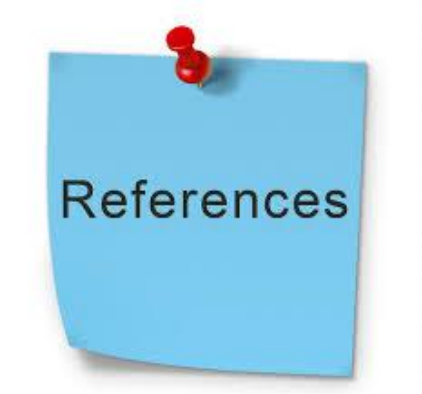
Practical Field Testing Challenges

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)

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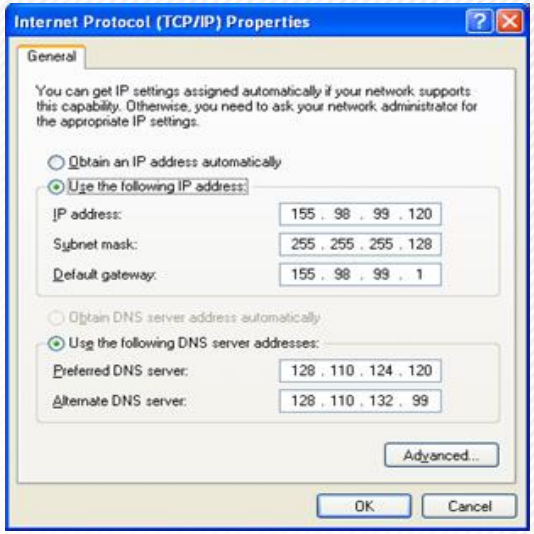
Field Testing Challenges

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



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

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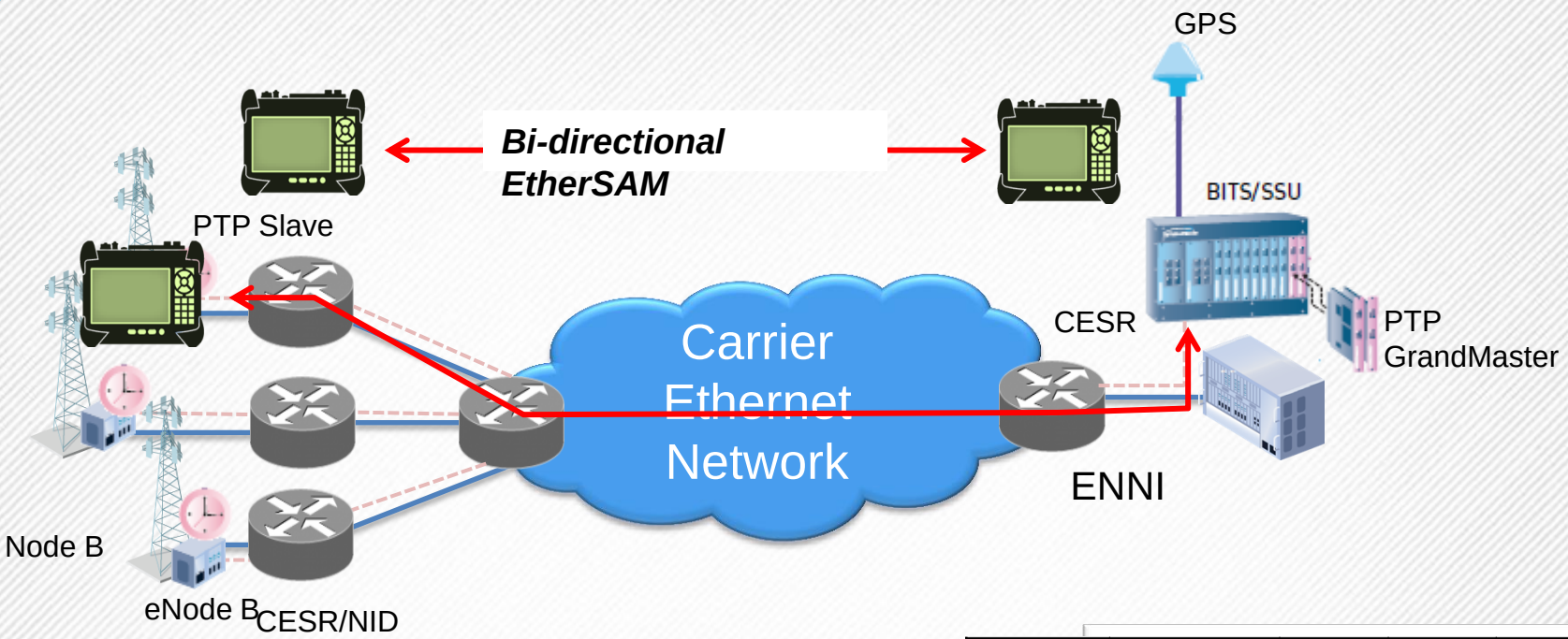
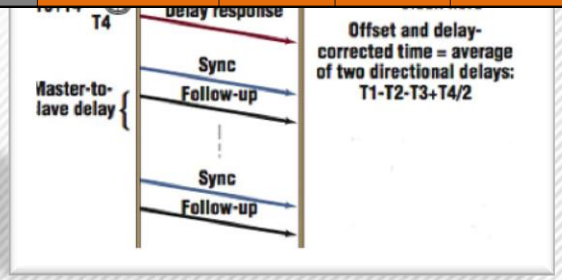
1588/PTP Turn-up Applications



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



Service Turn-up:

1. Verify Ethernet Service SLA
   1. EtherSAM test (can have 1 stream configured to emulate PTP stream)
2. Turn-up PTP client (slave)
   1. Verify connectivity to GM
   2. Verify CQL
   3. Verify key performance indicators and alarms

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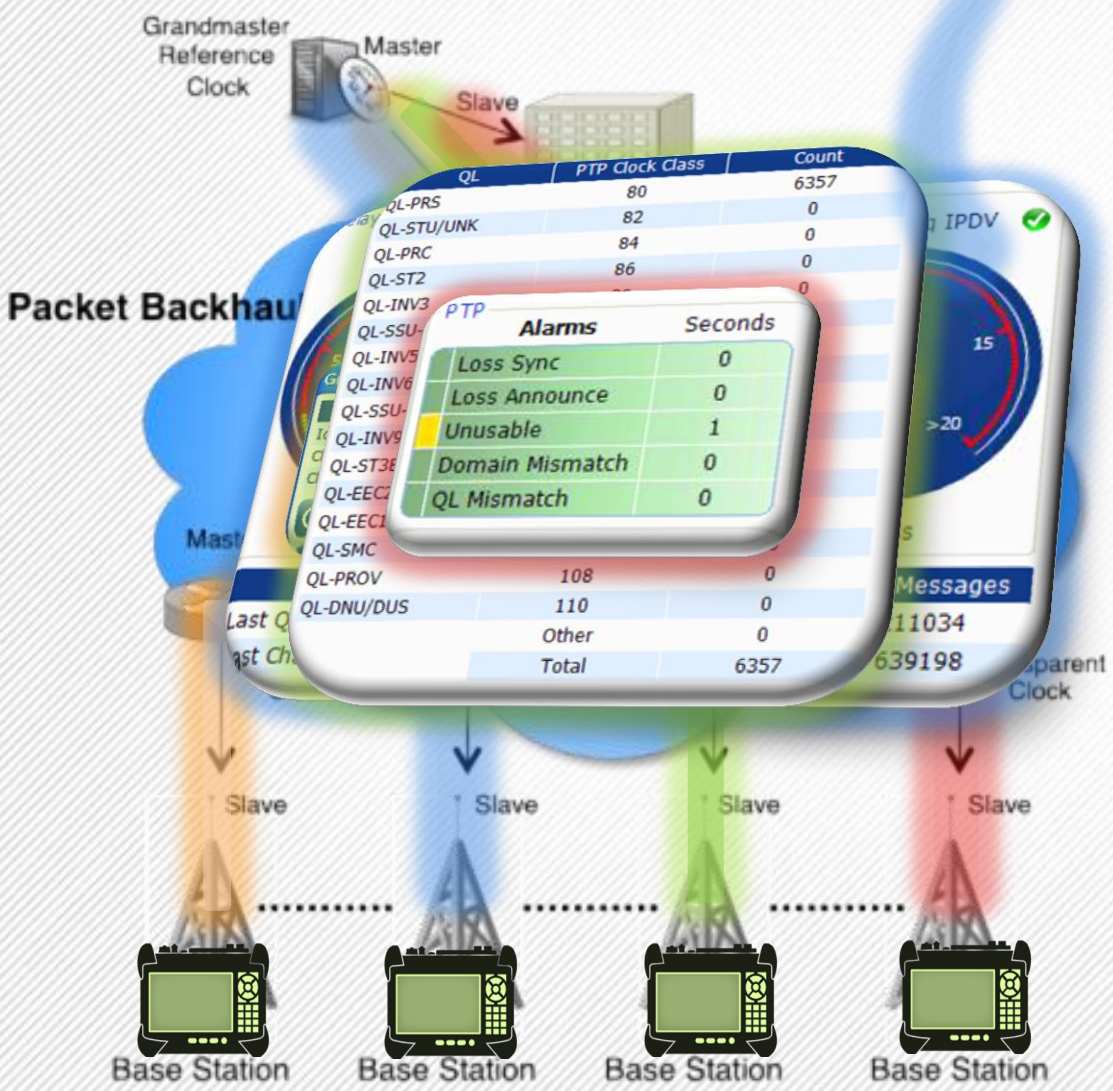
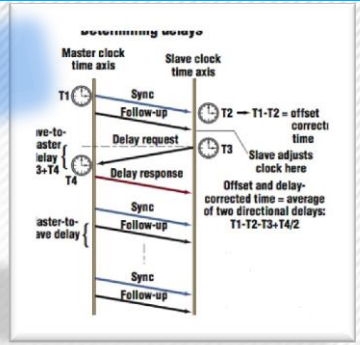
Field Test Applications





Establish link with GM

Measure K.P.M.

Verify Clock quality levels

Report PTP Alarms

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Conclusions

- Time/phase synchronization via packet networks is essential.
- Sub 1 us synchronization requirement hard to achieve.
- Initial radio network OAM capabilities will be limited.
- Field portable tools are essential to accelerate deployment and troubleshooting.

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Thank You

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Questions

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