DOCSIS provides access to last mile in Access Network

3
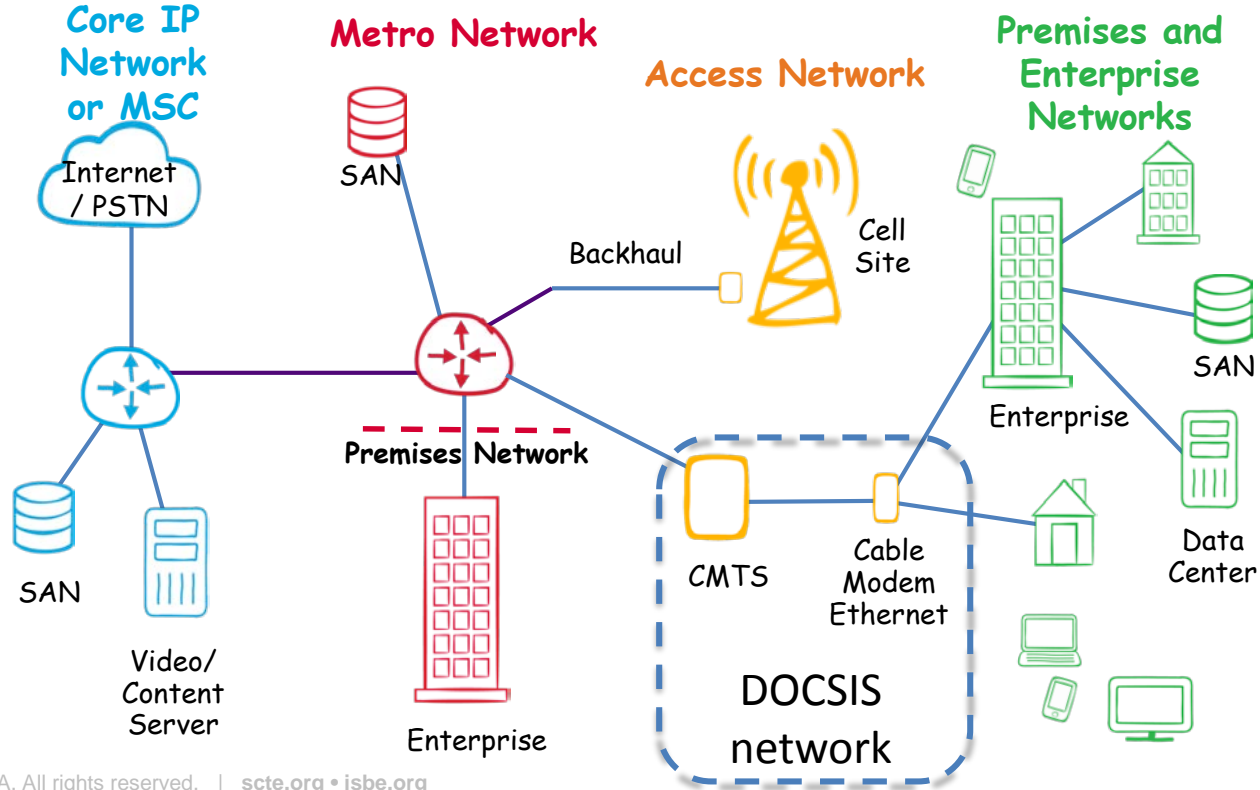
DOCSIS and Ethernet Testing

DOCSIS is a shared medium.

Multiple Ethernet Virtual Circuits (EVC's) can share the DOCSIS network

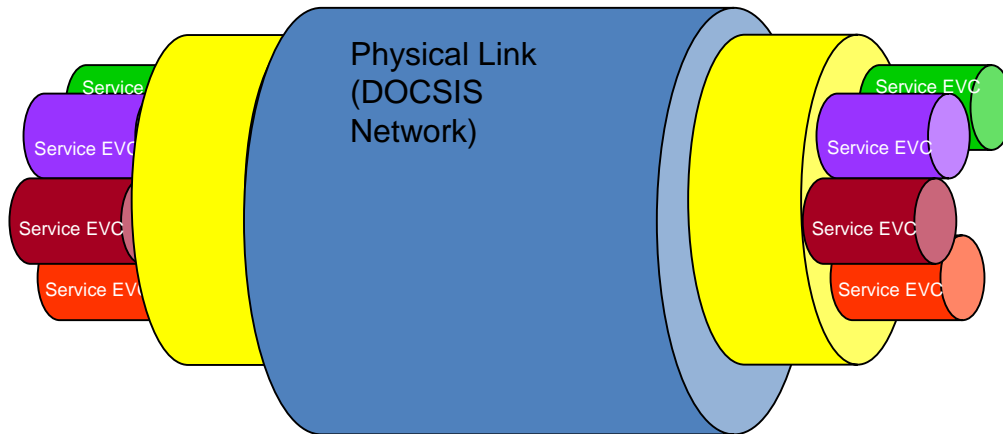Business class Ethernet services require tight timing requirements

Legacy DOCSIS asymmetry and jitter introduce error into any timing protocol that traverse the DOCSIS network

Ethernet Services over Legacy DOCSIS is possible the type of Ethernet services have been limited

Typical Metro Ethernet SLA vs. a Legacy DOCSIS SLA

KPI	Ethernet Services	Mobile Backhaul services
Frame Delay	typical 5 ms - best effort up to 30 ms	< 8 ms typical 5 ms
Frame Delay Variation	< 2 ms	
Frame Loss	6.25×10^{-6}	
Throughput	99.99%	
Availability	99.995%	
Mean-time to repair	2 hours (max 4 hours)	

KPI	DOCSIS Ethernet Services
Frame Delay	<60ms
Frame Delay Variation	< 12 ms
Frame Loss	< 0.1%
Throughput	95%
Availability	99.9%
Mean-time to repair	4 hours

For Ethernet Services in past 2-3 years:

A   Regularly deployed over DOCSIS

B   Avoided DOCSIS – used Fiber

C   Didn't deploy Ethernet Services

ABC

Service Activation Test	Description
Connectivity, Throughput and Auto-Negotiation	Verify basic connectivity Verify best effort throughput Validate auto negotiation settings to identify half/full duplex limitations
RFC-2544 – Single Stream Pipe test	Industry-standard service activation test for single-service Ethernet and IP (i.e. "pipe" test) Measures key performance indicators and bandwidth profile such as: CIR, EIR, FD, FDV, FLR, CBS (throughput, delay, jitter, packet loss)
Y.1564	The industry standard service activation test for multi-service Ethernet and IP ("Triple Play") Measures KPIs and bandwidth profile such as: • CIR, EIR, FD, FDV, FLR, CBS
Layer 2 Control Plane	Confirm transparent forwarding of Ethernet traffic through the providers network
RFC-6349	Automated and repeatable TCP-throughput test per IETF RFC 6349 standards, including key performance metrics of TCP efficiency and Buffer delay
Y.1731	Performance monitoring and PM protocol. Can be used for service testing including loopback, frame delay, frame delay variation, frame loss

What does DOCSIS 3.1 do differently

DOCSIS 3.1 added ability for the DOCSIS Timing Protocol (DTP)

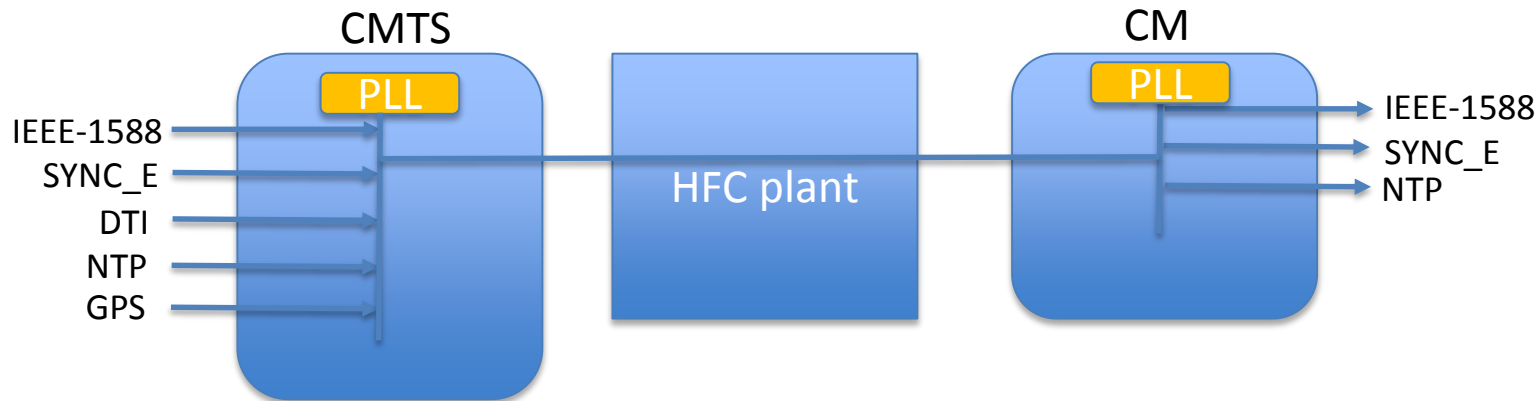DOCSIS 3.1 adds overall Downstream and Upstream Capacity

    2.5 Gbps on downstream (32 SC QAM's + 2x192 MHz OFDM)

    1 Gbps on Upstream (204 MHz return with 2x96 MHz OFDM)

DOCSIS 3.1 provides better timing offset calculation (TRO) True Ranging Offset

DTP – provides stable clock from input of CMTS to output of CM

CMTS

PLL

IEEE-1588
SYNC_E
DTI
NTP
GPS

HFC plant

CM

PLL

IEEE-1588
SYNC_E
NTP

Target accuracy is better than a few microseconds

Accuracy is dependent on the modeling of the CMTS, CM and HFC network

Source: cable labs specification
CM-SP-MULPIV3.1-I11-170510

The DOCSIS network looks like a boundary clock
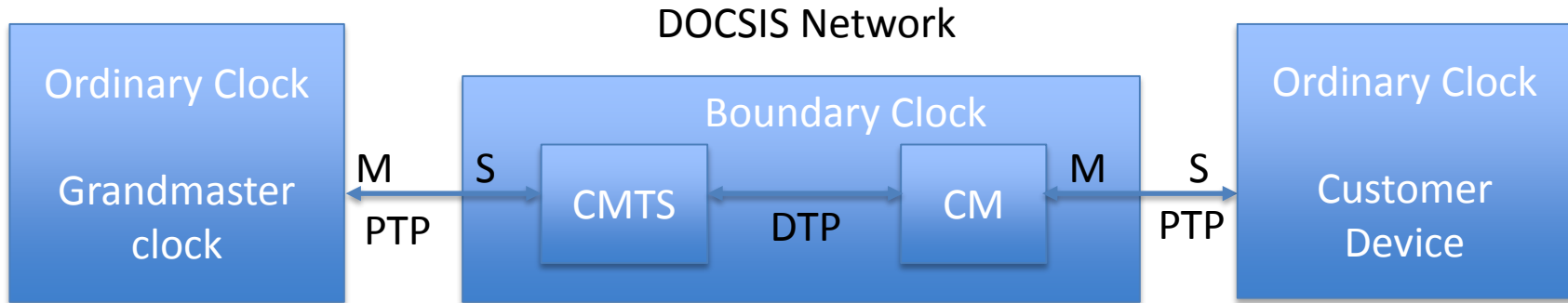
- A Boundary clock communicates with other clocks
- Boundary clocks can be used to bridge between different network transport technologies

Source: cable labs specification
CM-SP-MULPIV3.1-I11-170510

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DTP – Error budgets need to account for system SKEWs

Source: cable labs specification
CM-SP-MULPIV3.1-I11-170510
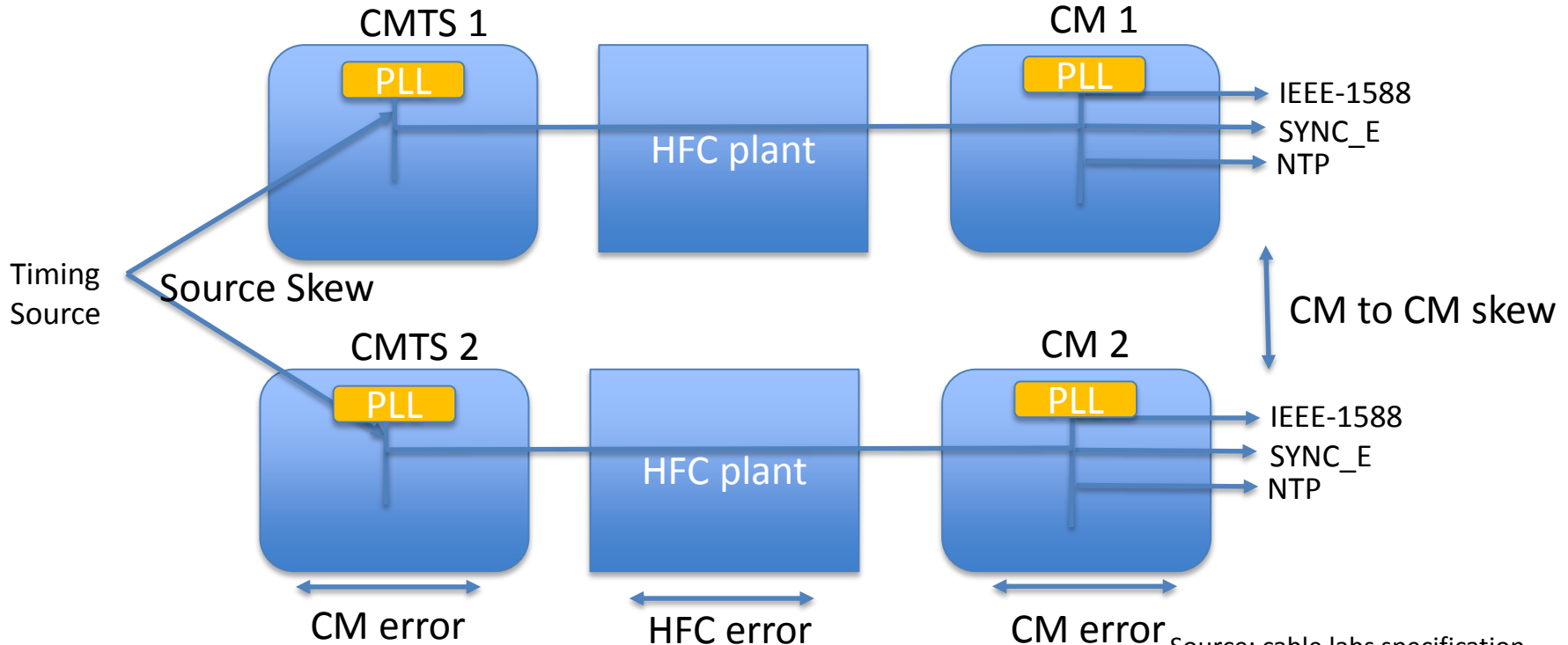
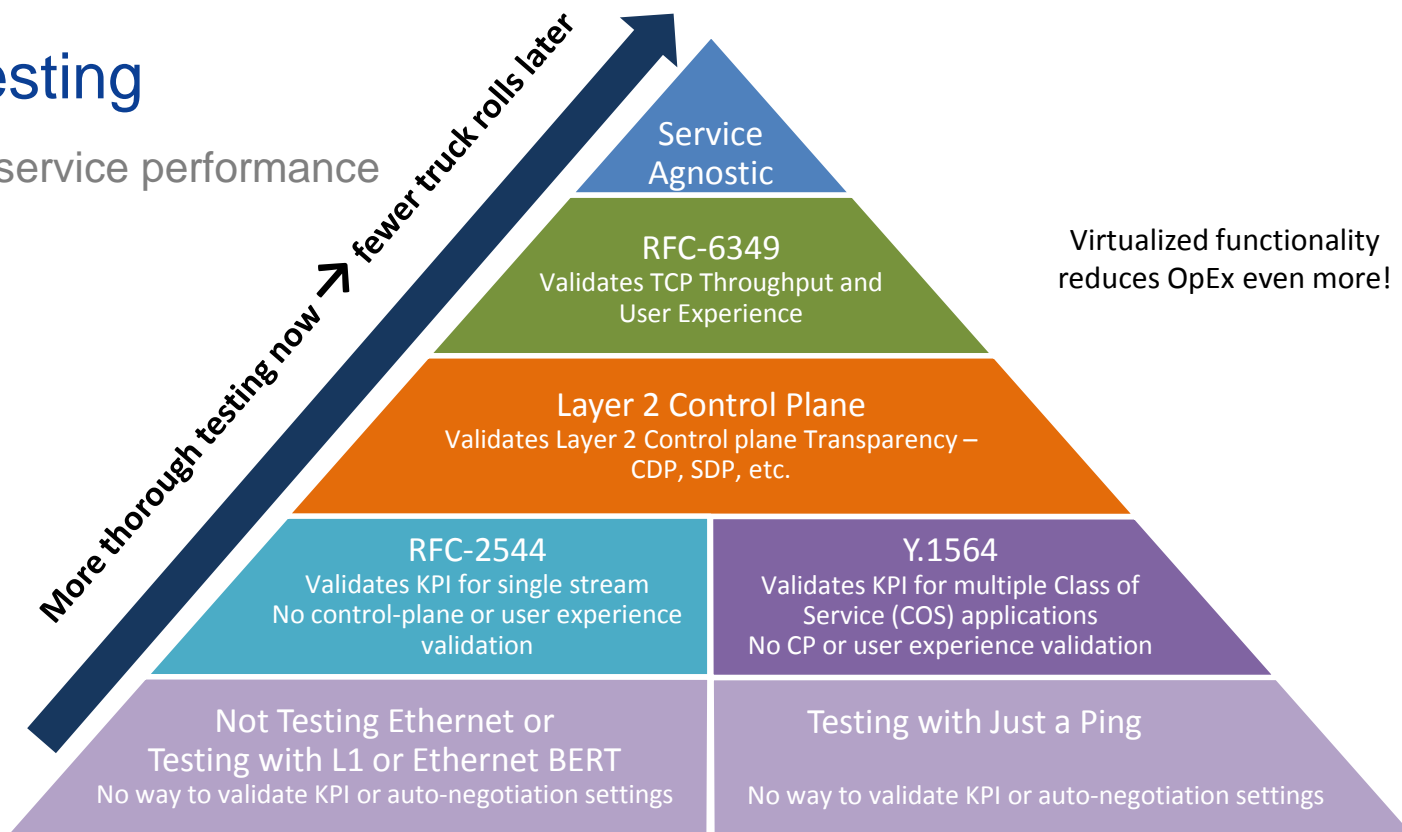# CableLabs Spec defines error budget for different services

Parameter	Level I System (GPS location requirements)	Level II System (Relaxed positioning)	Level III System (LTE Advanced Macro Cell + additional delay for CPE)	Level IV System (LTE Advanced macro cells and small cells)	Level V System – Current DOCSIS implementation
T-cmts-error	+/- 20 ns	+/- 40 ns	+/- 150 ns	+/- 200 ns	+/- 500 ns
T-cm-error	+/- 20 ns	+/- 40 ns	+/- 200 ns	+/- 300 ns	+/- 500 ns
T-docsis-error	+/- 40 ns	+/- 80 ns	+/- 350 ns	+/- 500 ns	+/- 1000 ns
T-source-skew	5 ns	10 ns	100 ns	200 ns	500 ns
T-hfc-error	+/- 7.5 ns	+/- 15 ns	+/- 50 ns	+/- 150 ns	+/- 250 ns
T-cm-cm-skew	100 ns	200 ns	900 ns	1500 ns	3000 ns

Source: cable labs specification
CM-SP-MULPIV3.1-I11-170510

We will be deploying DOCSIS 3.1:

A   Already doing it

B   Next 6-12 months

C   2-3 years out

D   No definite plans

ABCD

SLA Testing

Improves service performance

More thorough testing now → fewer truck rolls later

Virtualized functionality reduces OpEx even more!

Service Agnostic

RFC-6349
Validates TCP Throughput and User Experience

Layer 2 Control Plane
Validates Layer 2 Control plane Transparency – CDP, SDP, etc.

RFC-2544
Validates KPI for single stream
No control-plane or user experience validation

Y.1564
Validates KPI for multiple Class of Service (COS) applications
No CP or user experience validation

Not Testing Ethernet or Testing with L1 or Ethernet BERT
No way to validate KPI or auto-negotiation settings

Testing with Just a Ping

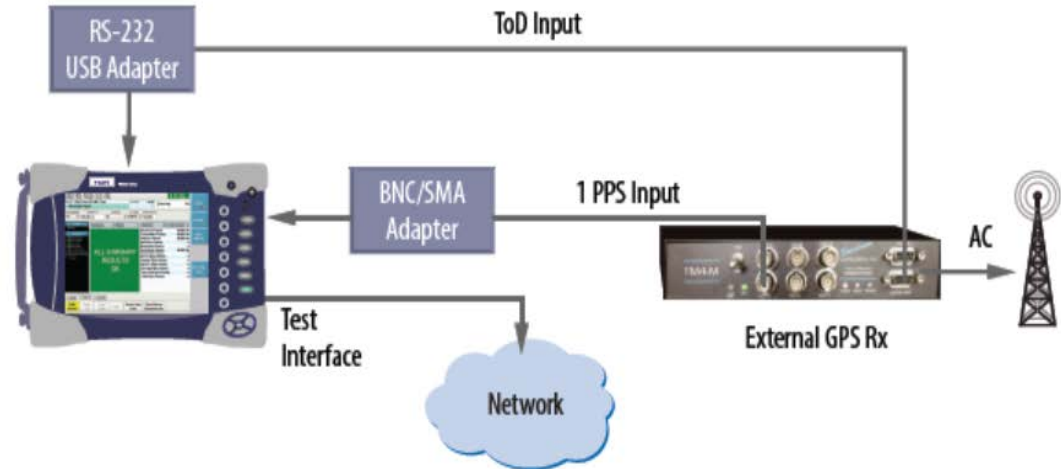No way to validate KPI or auto-negotiation settings
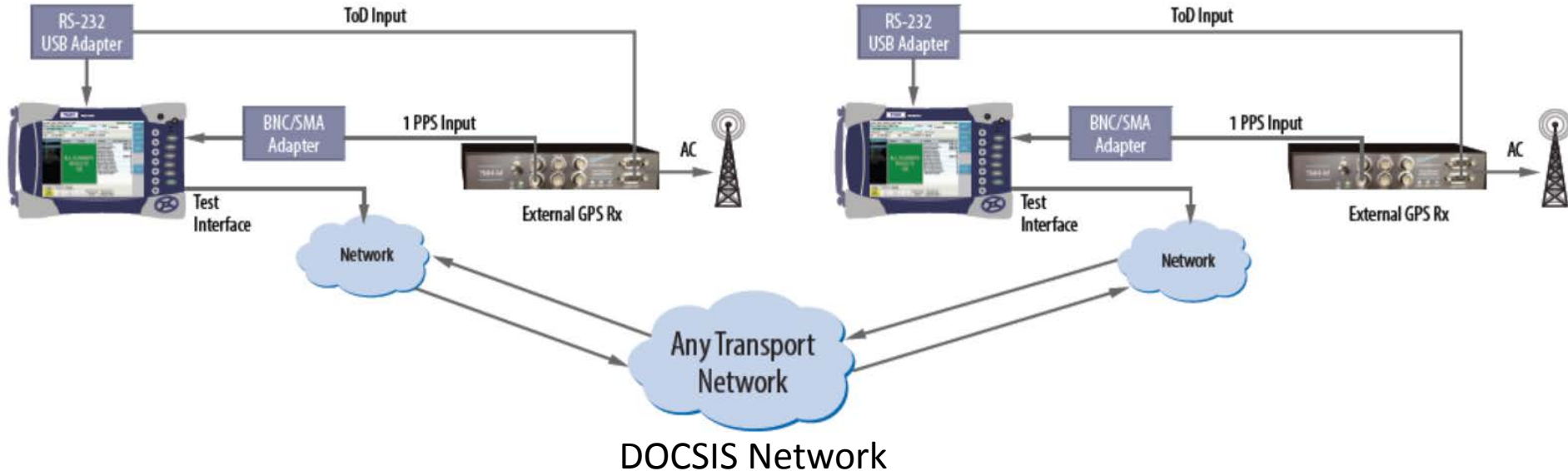
Testing PTP performance for SLA

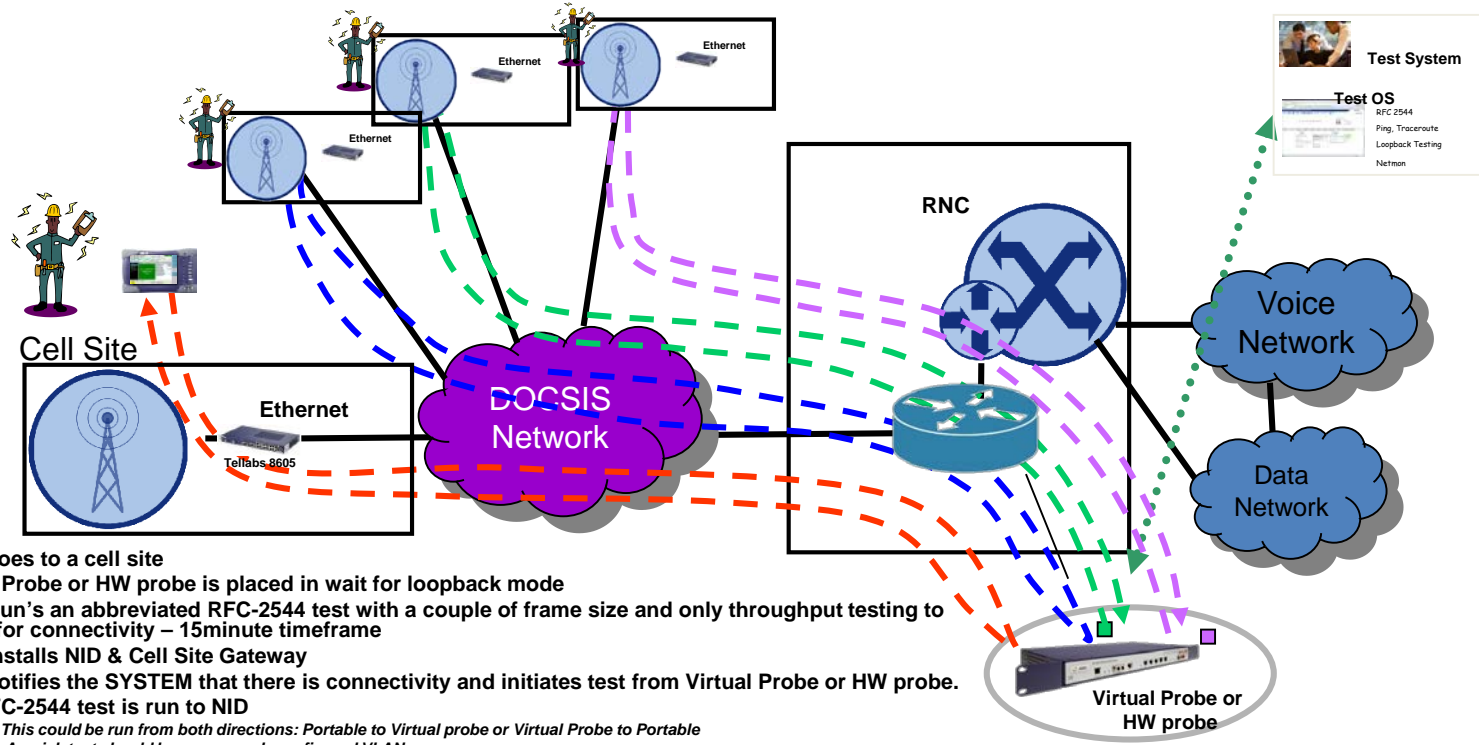Accurate testing of DTP/PTP timing performance can be enhanced by using external input from GPS and/or CDMA receiver

This provides 10 time better accuracy

One Way Delay (OWD) and asymmetric delay can cause performance problems

PTP/DTP One Way Delay testing

DOCSIS Network

Test System

Test OS
RFC 2544
Ping, Traceroute
Loopback Testing
Netmon

RNC

Voice Network

Data Network

Cell Site

Ethernet

Tellabs 8605

DOCSIS Network

Virtual Probe or HW probe

Typical Operations

- Tech goes to a cell site
- Virtual Probe or HW probe is placed in wait for loopback mode
- Tech Run's an abbreviated RFC-2544 test with a couple of frame size and only throughput testing to check for connectivity – 15minute timeframe
- Tech installs NID & Cell Site Gateway
- Tech notifies the SYSTEM that there is connectivity and initiates test from Virtual Probe or HW probe.
- Full RFC-2544 test is run to NID
- NOTE 1: *This could be run from both directions: Portable to Virtual probe or Virtual Probe to Portable*
- NOTE 2: *A quick test should be run on each configured VLAN*

Value

- Keeps Techs moving and working – Sites turned up faster
- Allows for full testing of EVC configuration (QOS, CIR, CBS, EIR, EBS, PIR, Frame Delay, Frame Delay Variation, and Frame Loss)

I have a better understanding of how DOCSIS 3.1 supports SLA based Ethernet Services