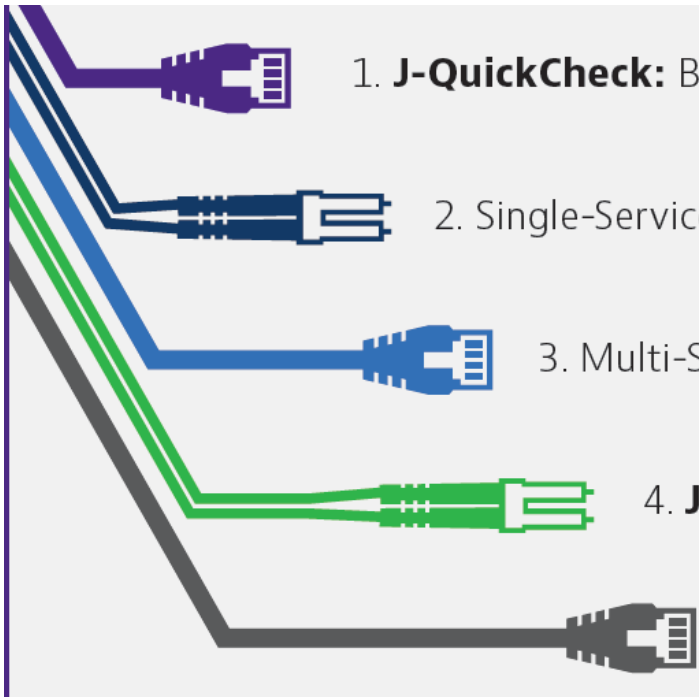
The Essentials of Ethernet Service Activation Series

Webinar #3

TrueSpeed: RFC6349 TCP Test

Ethernet Service Activation Webinar Series

3 Webinars covering five Ethernet tests:



1. **J-QuickCheck:** Basic Connectivity and Throughput Test
2. Single-Service: **Enhanced RFC 2544**
3. Multi-Service: **Y.1564 SAMComplete** For Ethernet KPI Verification
4. **J-Proof** Layer 2 Control Plane Transparency Test
5. **RFC 6349 TrueSpeed:** Layer 4 TCP Throughput

The Essentials of Ethernet Service Activation Series

JUNE
14
2:00 PM EST

Y.1564, RFC 2544, and QuickCheck

JUNE
28
2:00 PM EST

Layer 2 Control Plane J-Proof

JULY
12
2:00 PM EST

RFC 6349 TrueSpeed Testing

Agenda for Today's Webinar

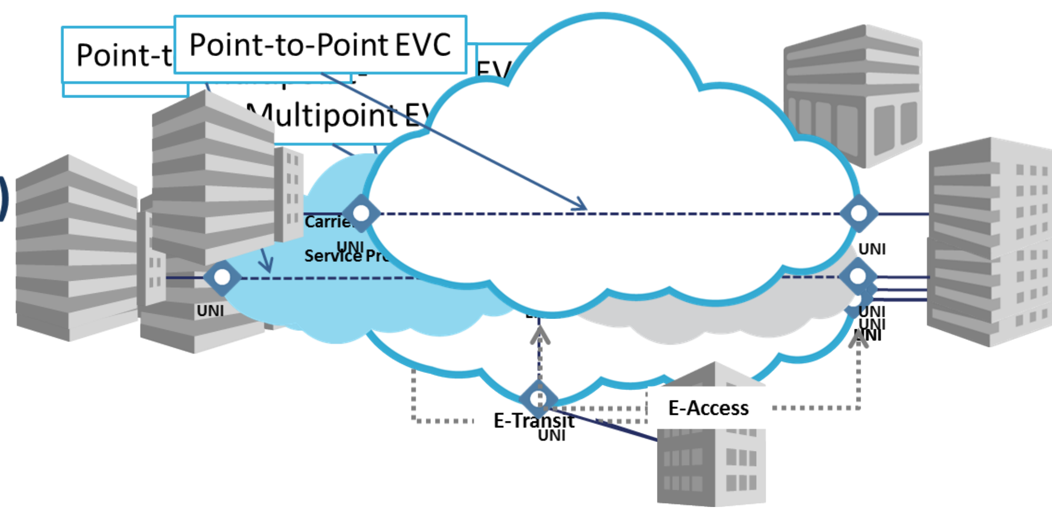
- TCP Testing for Business Class Ethernet Services
- Basic TCP Theory
- Overview of RFC 6349
- Testing Scenarios and 3 Demonstrations
- Additional Resources and Q & A

TCP Testing for Business Class Ethernet Services

Business Class Ethernet Services What they Are

The Metro Ethernet Forum defines 5 types of carrier Ethernet services

Retail Service Types	Wholesale Service Types
E-Line	E-Access
E-LAN	E-Transit
E-Tree	



Source: Metro Ethernet Forum

Which Applications use TCP?

How do end users experience the network?

Web Browsing	Business Applications	Streaming Web Video	Mobile Apps
Google	ORACLE	NETFLIX	Google Maps
facebook	IBM	YouTube	UBER
twitter	Microsoft	hulu	Instagram
YAHOO!	salesforce		PANDORA
	EVERNOTE		CLASH of CLANS

These are the applications driving increased network demand!

What is RFC 6349 TrueSpeed?

RFC 6349: Repeatable Standards Based TCP Test

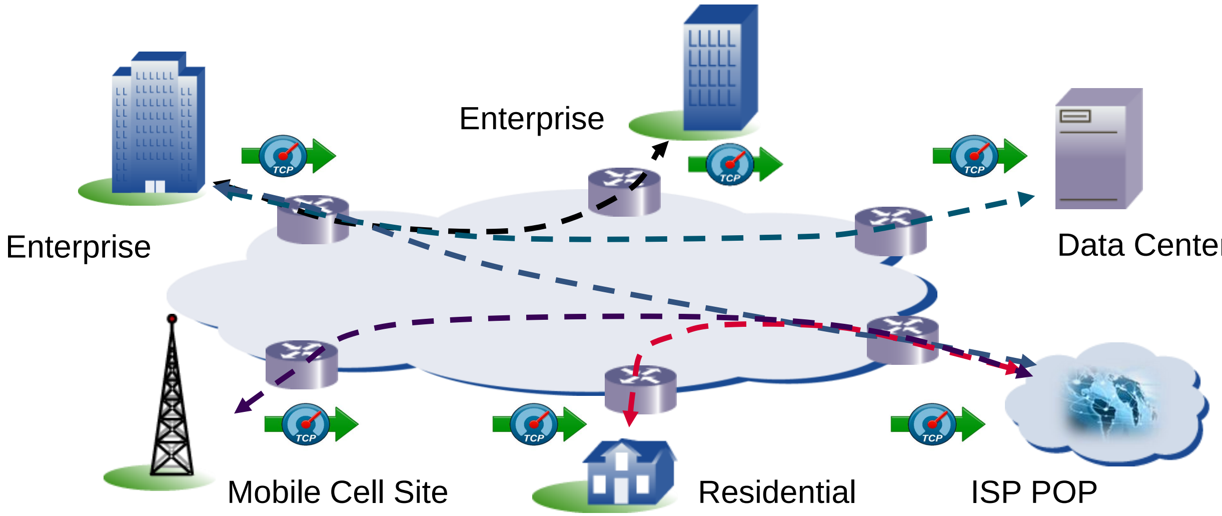
- TCP Applications: Web Browsing, File Transfer, Business Applications, etc.

Provides Network Operators, Managers, and Users

- Pass/Fail Results validate application quality of experience (QoE)
- TCP metrics and analytics expedite repair of network problems

Use Cases

1. **Business Services**
2. **Mobile Backhaul**
3. **Residential Broadband Services**



Characteristics of a Carrier Grade TCP Throughput Test

- Standards Based with Repeatable Results
- Easily Configurable and Customizable per Customer
- No Customer Configuration Required
- Common View of Pass/Fail Results with a Centralized Repository
- Built-in Intelligence: Detailed Diagnostics and Analytics on Failure

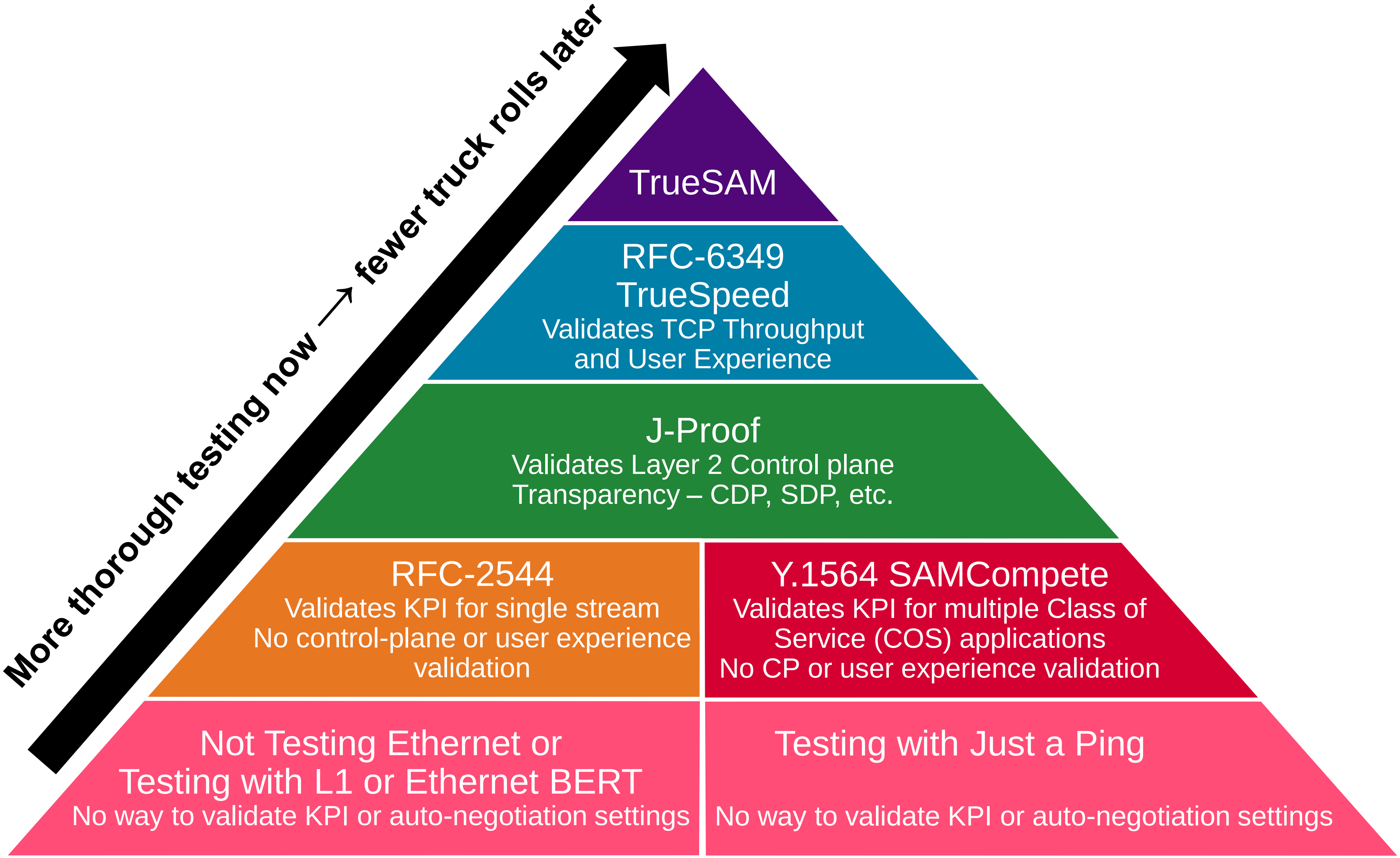
Quick Survey 1

- Is RFC 6349 testing part of your standard service activation procedure?
  - Yes
  - No

Quick Survey 2

- What percentage of time does a standard RFC 2544 / Y.1564 “pass” and yet your end customer complains the network is slow?
  - ~50%
  - ~25%
  - ~ 10%
  - Never

Reduce OpEx with Ethernet Service Activation Testing



TCP Theory and RFC 6349 Overview

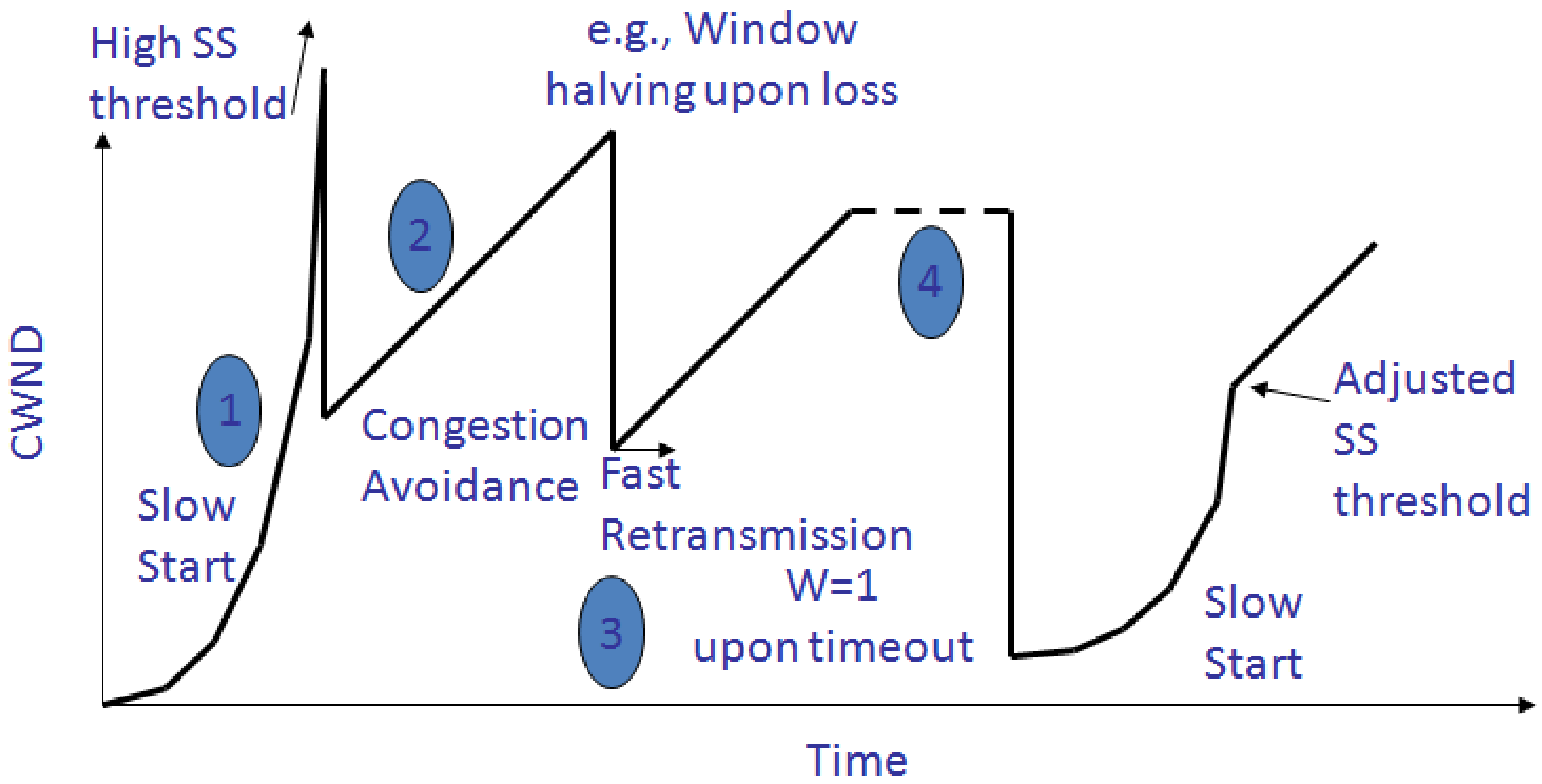
Transport Control Protocol (TCP)

- TCP's goal is to utilize the available bandwidth while avoiding congestion.
  - High throughput while maintaining stability

- TCP performance is influenced by its congestion control algorithms.
  - Packet loss and/or increased RTT lead to throughput reduction.

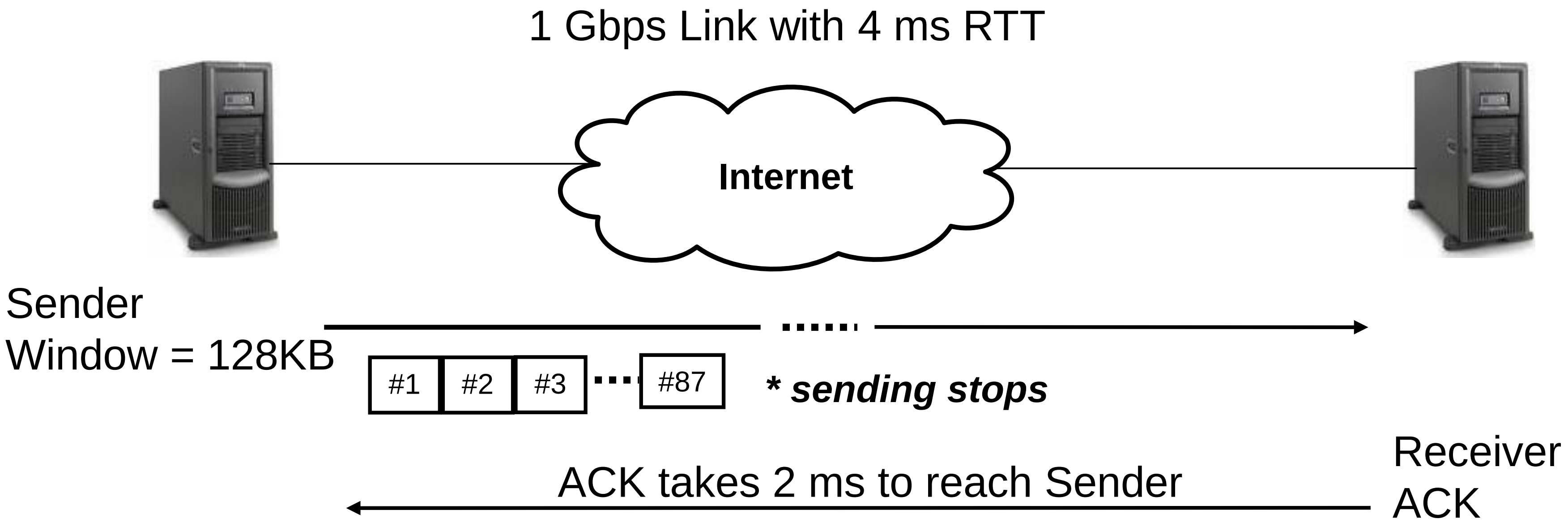
Congestion Window Phases

CWND = TCP estimation of available capacity.



Latency and TCP Window Size Relationship

- The TCP Window Size is the amount of data that a sender will place onto the network before an acknowledgment is required from the receiver.



- Window is “full” after ~ 1ms; no more data can be sent until the ACK is received
- ~87 consecutive “in flight” TCP segments = ~128KB between ACKs.
- Optimum Window is obviously much greater and this is called the Bandwidth Delay Product or the BDP

The Bandwidth Delay Product (BDP)

- Calculate the ideal TCP Window based on **Bandwidth Delay Product (BDP)** BDP = RTT * BW / 8
    - Using a 1 Gbps example with 4 ms RTT.
    - BDP = 4 ms * 1000 Mbps / 8 = 500 KB (Ideal TCP Window)
- With a TCP Window size of 128 KB
    - User would only achieve a maximum throughput of ~250 Mbps

RFC 6349 Summary of Test Steps

"0". **Run traditional RFC2544** to verify the integrity of the network at Layers 2 and 3 before conducting TCP testing.

1. **Path MTU Detection (per RFC4821)**
   - Verify network MTU with active TCP segment size testing to ensure payload does not get fragmented.

2. **Baseline Round-trip Delay and Bandwidth**
   - Predict optimal TCP Window size by calculating the Bandwidth Delay Product (BDP).

3. **Single and Multiple TCP Connection Throughput Tests**
   - Verify TCP Window size predictions to enable automated "full pipe" TCP testing.

RFC 6349 Metrics: TCP Efficiency

- TCP retransmissions are a normal behavior in network communications.
  - But what is the "efficiency" of a network transfer?
  - Time spent transmitting "good" payload versus retransmitting it.

- The TCP Efficiency metric is the percentage of bytes that did not have to be retransmitted and is defined as:

$$\frac{\text{Transmitted bytes - Retransmitted bytes}}{\text{Transmitted bytes}} \times 100$$

- As an example, if 100,000 bytes were sent and 1,000 had to be retransmitted, the TCP Efficiency would be calculated as:

$$\frac{101{,}000 - 1{,}000}{101{,}000} \times 100 = 99\%$$

RFC 6349 Metrics: Buffer Delay

- TCP throughput is also affected by increase in RTT, which can be caused by network congestion or buffer delay.
- The Buffer Delay Percentage is defined as:

$$\frac{\text{Average RTT during Transfer - Baseline RTT}}{\text{Baseline RTT}} \times 100$$

- Example: If the baseline RTT for a network path is 2 ms and the average RTT increases to 3 ms during the test. The Buffer Delay Percentage would be calculated as:

$$\frac{3 - 2}{2} \times 100 = 50\%$$

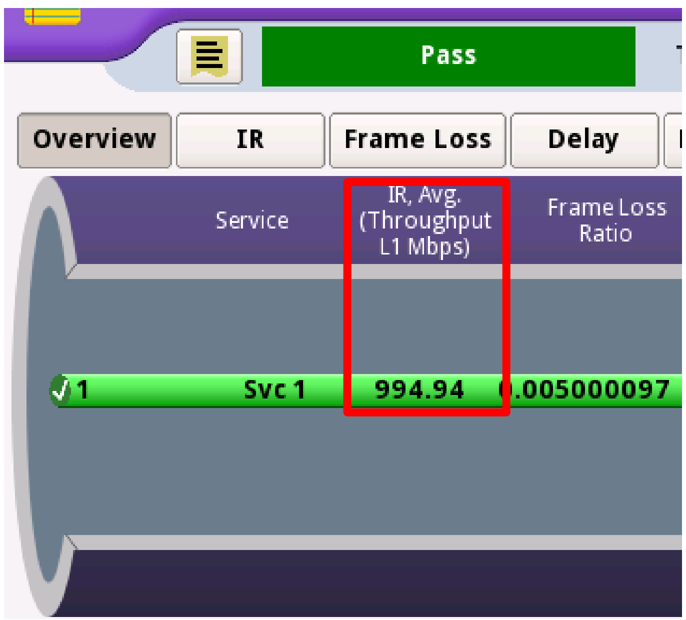
Y.1564 versus RFC 6349 with 0.25% Packet Loss

- In this example, a 1 Gbps service encounters 0.25% packet loss

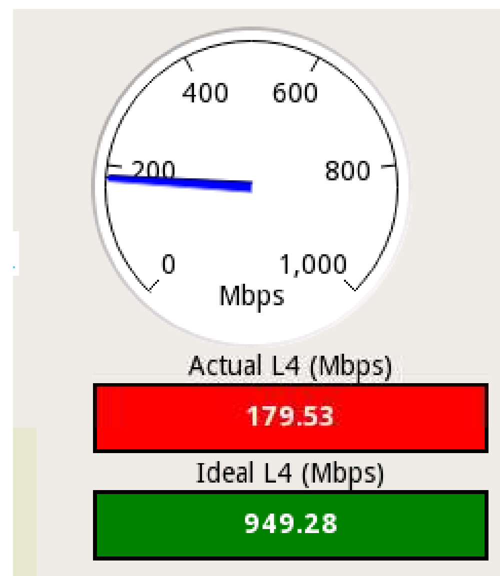
- Since Y.1564 is a packet transmission test, it simply drops 0.25% of the packets and the resulting throughput is 994.94 Mbps (Layer 1)

- But the RFC 6349 test is TCP, and the loss causes a lot of TCP Slow Starts and reduces TCP throughput dramatically

Y.1564 showed a "Pass"

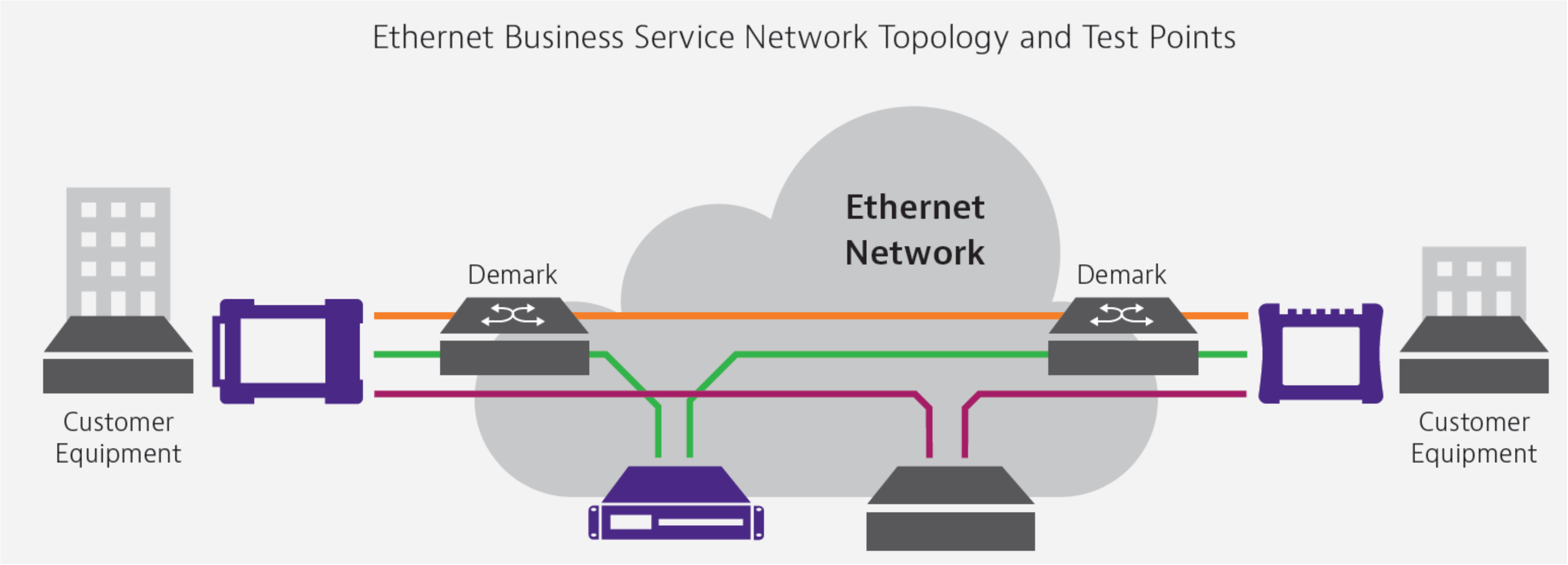


The TCP throughput result was quite different!

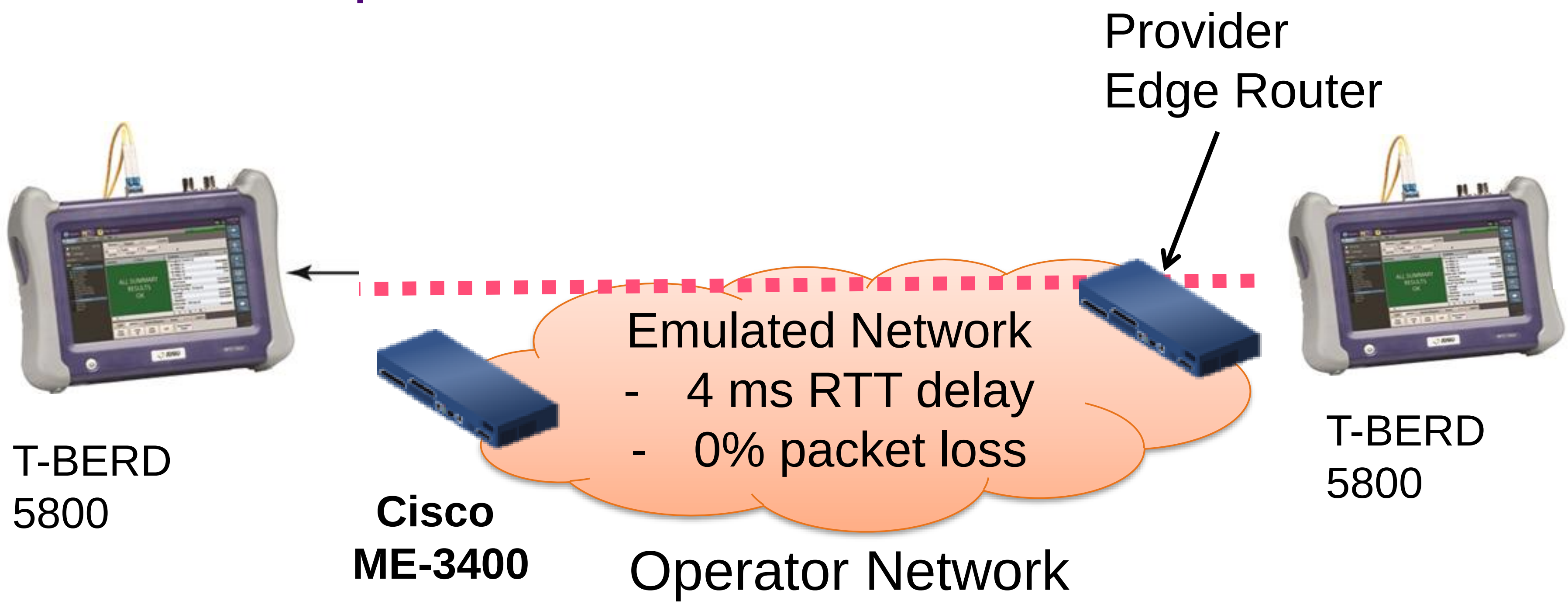


Testing Scenarios and Demos

Logical Ethernet Business Service Topology



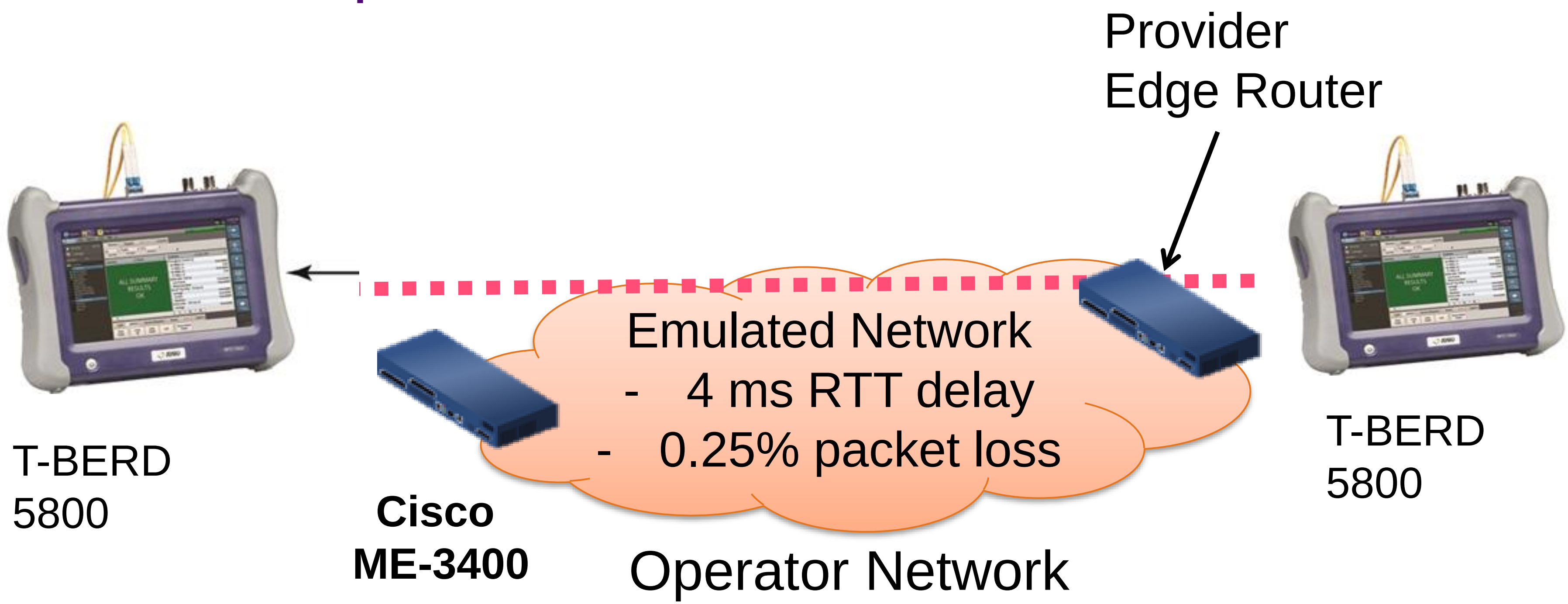
RFC 6349 TrueSpeed Demo #1



- Network is Gigabit end-end with Cisco ME-3400
- Walk the window test will show optimum TCP window size

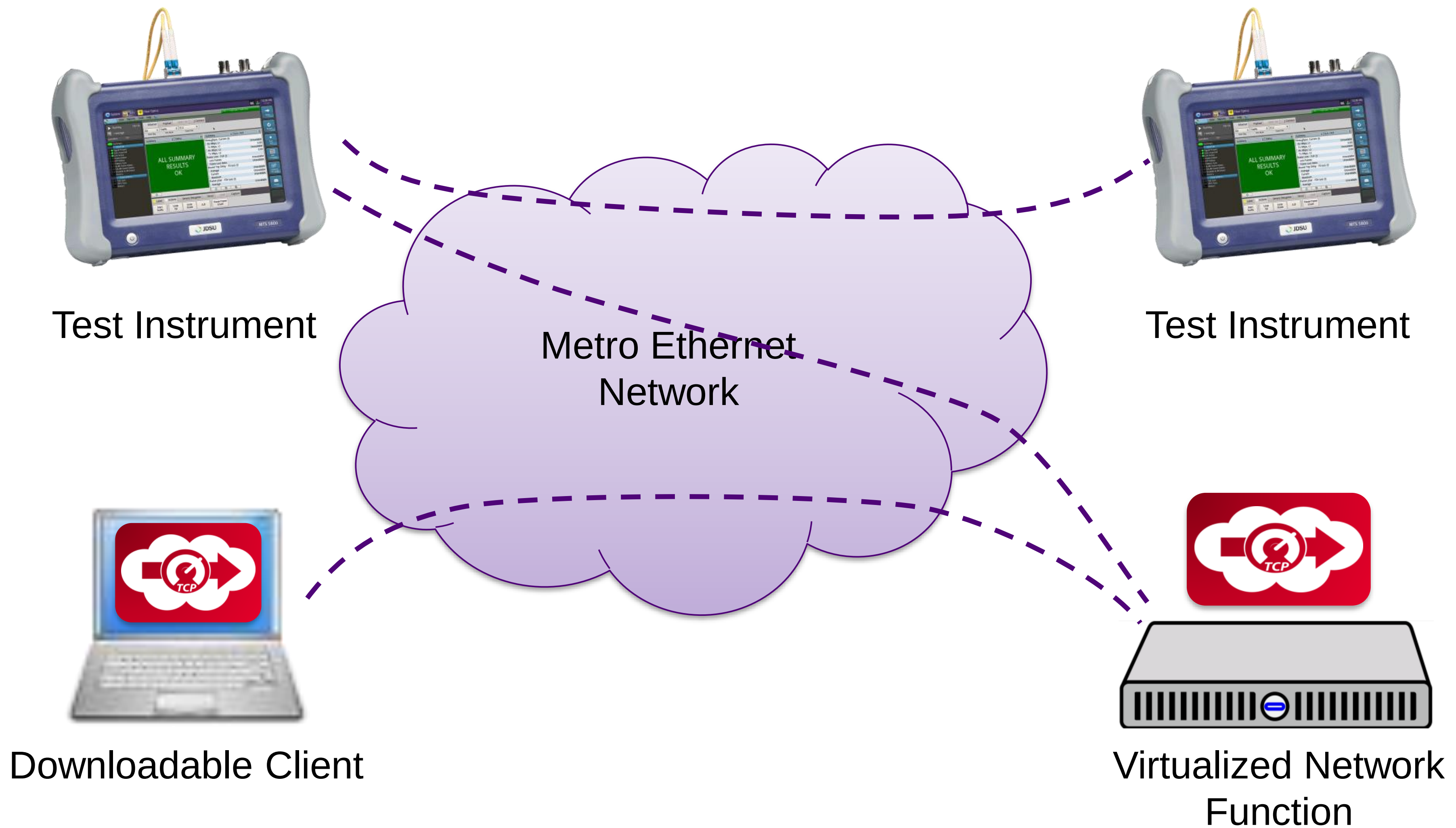
- BDP = 1 Gbps x 4 msec = 4 Mbits / 8 = 500 Kbytes
- The BDP can be a single or multiple TCP connections

RFC 6349 TrueSpeed Demo #2



- Network is Gigabit end-end with Cisco ME-3400
- Packet loss will be introduced in emulated network (0.25%)

Several options for executing RFC 6349 tests



Viavi Recommended Best Practice Workflows

J-QuickCheck
Basic Connectivity and Throughput Test

Single Service:
Enhanced RFC 2544
Multi-Service
Y.1564
SAMComplete

For Ethernet KPI Verification

J-Proof
Layer 2 Control Plane Transparency Test:

RFC 6349
TrueSpeed
Layer 4 TCP Throughput

Best Practice Workflow (Single and Multiple Services)

J-QuickCheck
Basic Connectivity Test

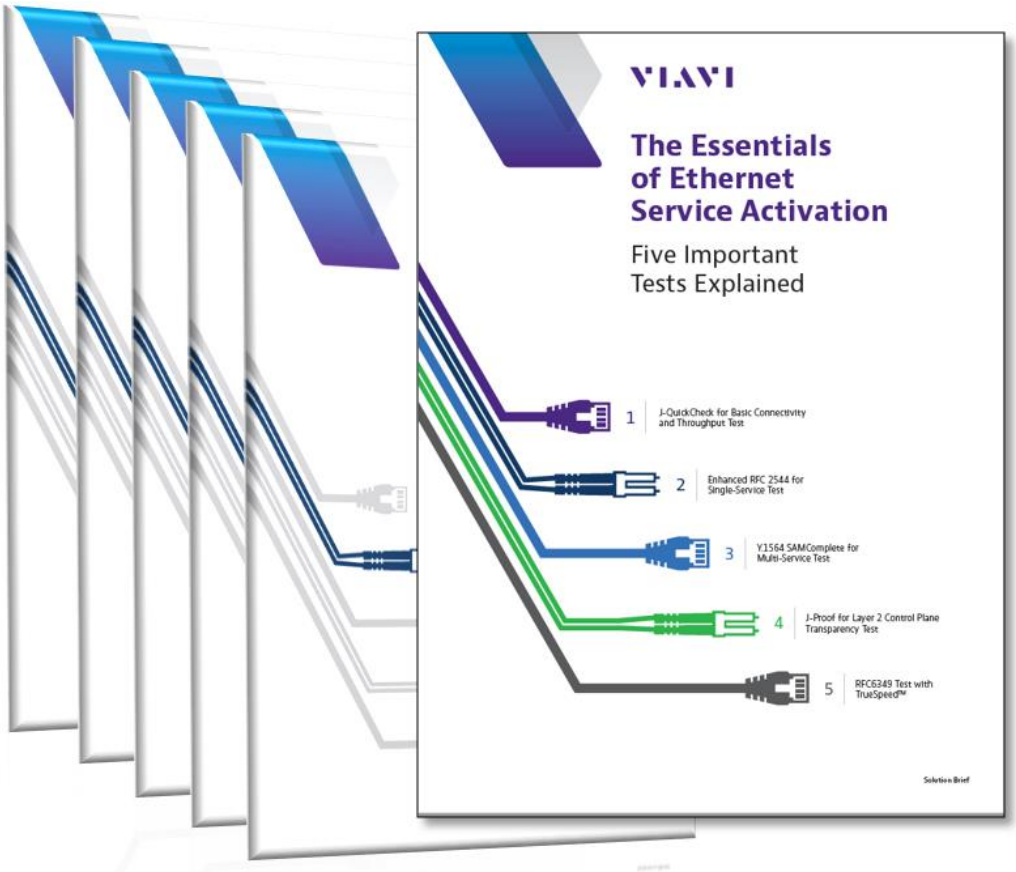
Y.1564
SAMComplete
Ethernet KPI Verification for Multiple Services

J-Proof
Layer 2 Control Plane Transparency Test:

RFC 6349
TrueSpeed
Layer 4 TCP Throughput

Multiple Class of Service (COS) Workflow

Wrap-up and Q&A



Stay tuned for a follow-up email with links to a whitepaper series with more details on the topics covered today

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