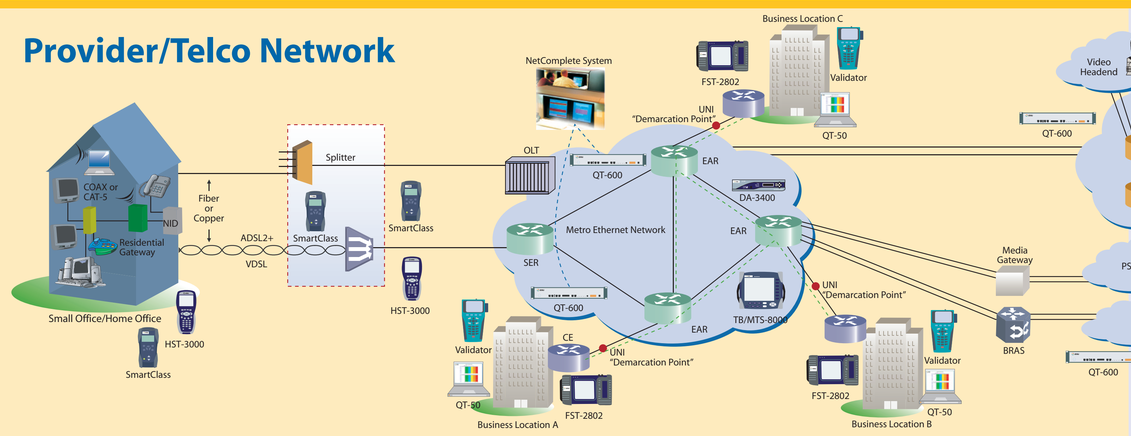
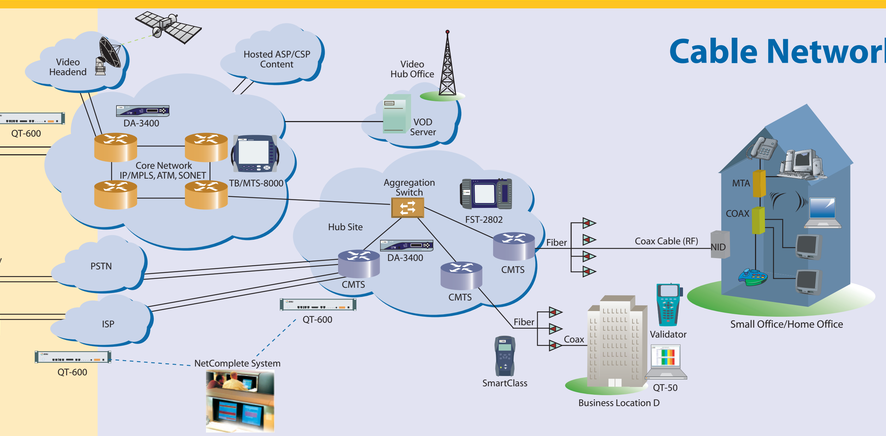
# Carrier Ethernet Service Testing

METRO Ethernet Forum MEMBER

## Provider/Telco Network




## Cable Network




## Ethernet Portfolio
### Network Element Testing & Production

### The ONT Family

The ONT product line provides lab and field optical test solutions for network equipment manufacturers and service providers. Applications include service and feature testing to support development, verification, and manufacturing. In addition, the platform generates and analyzes jitter to support testing traditional transport technologies from 1.5 up to 43G. Options are available to test Ethernet technologies from 10 Mb/s up to 10 Gb/s including Ethernet over OTN.

**Development/Production**
Component development and verification
Network element and production testing
Interoperability and QoS sustainability testing

## Ethernet Portfolio
### Service Deployment Testing

### Validator-NT™ Ethernet System

The Validator-NT is an all-in-one Ethernet System Certifier that delivers network test and configuration functionality. It uses Active Network Tests to identify network devices and verify Internet connectivity by pinging up to seven different IP addresses simultaneously. The Validator-NT certifies (per IEEE 802.3 data speed carrying specifications) that cabling will perform as rated for speeds up to 1 Gb/s; measures cable length and distance to opens and shorts; and tests for continuity, proper termination, and polarity.

### SmartClass™ Ethernet

A cost-effective and rugged portable test instrument designed for field technicians who are responsible for installing Ethernet and IP services. The SmartClass Ethernet's test capabilities, which range from cable diagnostics to RFC 2544 testing, enable service providers to successfully verify Metro Ethernet SLAs at installation.

### HST-3000 Ethernet Module

The HST-3000 Handheld Services Tester is a modular, portable, and rugged instrument that tests multiple technologies (xDSL, Copper, T1/E1, fiber, Ethernet, etc.) on both Metro and Access networks. The Ethernet module supports physical layer testing (cable diagnostics), service quality verification (RFC 2544 and CoS), and application performance analysis (VoIP and IP Video). This unique blend of features in a single module makes the HST-3000 the premier field tool for next generation Ethernet services rollout.

### FST-2802 TestPad™

A portable field test instrument targeted for the installation and maintenance of Metro Ethernet services, featuring a variety of technologies on a widely accepted test platform. Test capabilities include traffic generation, bit error rate testing (BERT), and verifying frame loss and round trip delay (RTD) as per Metro Ethernet service level agreements (SLAs). Advanced features, such as multiple streams or VLAN discovery, allow for the testing of true customer traffic conditions in the network.

### T-BERD®/MTS-8000 Transport Module

A next-generation, modular, and cost-effective platform solution, featuring an innovative design that combines traditional SONET/SDH testing and Ethernet/IP testing – all in a single test module. The Transport Module supports 10 Mb/s to 10 Gb/s Ethernet testing, ensuring that proven test methodologies for Ethernet services remain the same regardless of the rate. The Transport Module offers a blend of BERT and Ethernet/IP/VPLS/MPLS (with multiple streams) test capabilities in a superior, portable design.

### DA-3400 Data/IP Analyzer

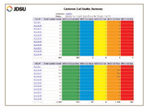
A portable protocol analyzer designed for service support engineers tasked with troubleshooting problems at the IP layer and above. The DA-3400 is a multi-technology, 7-layer, hardware-based IP analyzer built to identify root cause impairments by providing expert analysis for pinpointing and solving complex IP, VoIP, and application problems.

### NetComplete™ Service Assurance System with the QT-600

A service assurance solution that provides service turn-up verification, problem segmentation, and troubleshooting test capabilities. NetComplete provides automated, centralized remote testing complete with drill down IP and data analysis functionality, allowing service providers to quickly and efficiently identify and resolve service degradations in their networks.

### QT-50 Software Agent

QT-50 offers providers the flexibility to monitor and rapidly troubleshoot VoIP issues as experienced by the end customer. Easy to implement, the Agent may be technician installed on the premises or customer installed. QT-50 also may be installed permanently at the customer premises on a dedicated 1u high PC.



## Service Lifecycle Verification

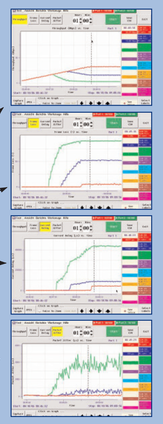
### Installation Use Case

**Perform End-to-End Connectivity Testing**
- Verify physical layer with fiber characterization tools
- Perform physical layer BERT

**Perform RFC2544 Automated Testing**

OR

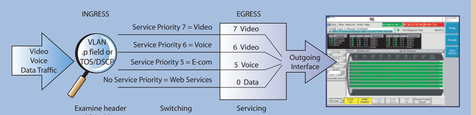
**Perform Traffic Emulation and CoS Testing**
- Verify:
  - Throughput
  - Frame Loss
  - Latency
  - Packet Jitter
- Ensure SLAs are met



***Class of Service (CoS) Verification***

Next Generation networks carrying triple-play services require CoS traffic prioritization based on the application type.

Verification Requirements
- Are streams prioritized per their CoS profiles?
- Are bandwidth, frame loss, delay, and packet jitter correct per CoS profiles?




### Bandwidth Consumption Use Case

Customer reports slow network on: VLAN 10, 20, 30

Service Provider launches test with the DA-3400 to mirror traffic over for SP VLAN 50. VLAN 50 contains VLAN 10, 20, 30 (ie. stacked)

Analysis Steps/Observations

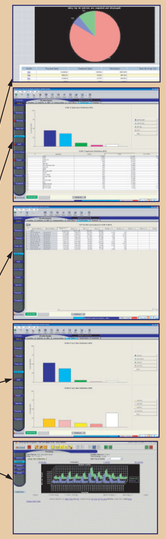
Display Utilization Graph
Sort by customer VLANs

Check individual customer VLANs
Notice VLAN 10 consuming the most bandwidth

Filter on VLAN 10 and sort by Top Applications. Shows offending application

Drill down into application on VLAN 10 and sort by top IP address.
Shows one IP address on VLAN 10 generating all the traffic

Compare filtered traffic utilization to total link utilization. Proves single user consuming all the bandwidth



### Application Performance Use Case

User complains of slow application response

Monitor the user's traffic with the DA-3400

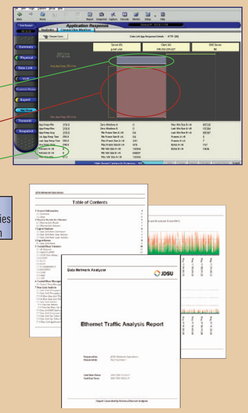
Display the application response screen and identify the following

Network Latency is acceptable

Server response time is excessively high

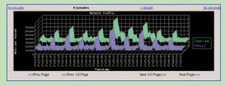
TCP retransmission rate is low

Generate a report for the customer that shows the problem and identifies the source as the server/application

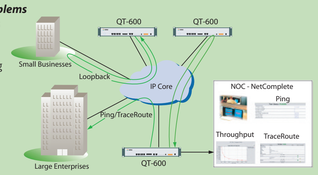



### Service Assurance Use Case

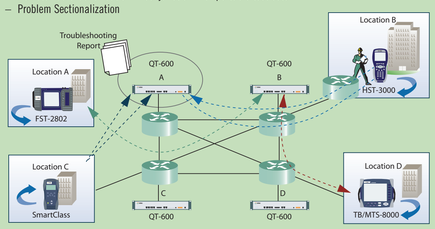
***Identifying the Source of Problems***
- Mis-configured customer equipment
- Congestion in the Core Network
- Bandwidth network traffic



***Sectionalizing the Problems***
- Ping destination targets
- Perform trace routes on known paths
- Perform loopback testing




***Monitor the Network with NetComplete™***
- Systems-based Centralized Monitoring
- Remote Fault Identification in conjunction with portable test sets
- Problem Sectionalization




**Turn Up & Installation**
Fiber and copper characterization, loss measurements
Physical layer BER testing
Class of Service (CoS) testing

**Troubleshooting & Maintenance**
Root cause IP troubleshooting
Ethernet/IP service layer testing
IP packet inspection

**Service Assurance**
Proactive fault isolation
Trouble sectionalization
Scalable, distributed systems

## Technology

### Ethernet Frame

Ethernet frame (per IEEE 802.3) is defined as DIX (or Ethernet II) and 802.3 types. Allowed frame sizes are between 64 bytes and 1518 bytes.


### VLAN Overview



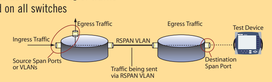

Paths are provisioned through the network based on VLAN ID

Customers can order multiple VLANs to
- Segment applications (VoIP, Data, etc.)
- Segment traffic destinations (ISP, Data Center, customer locations, etc.)
- Connect to multiple sites (Site A, Site B, HQ, etc.)

### Monitoring Test Access

***SPAN: Switched Port Analyzer***
- Monitored ports that are located on the same switch
- Also referred to as Mirrored Port
- Automatically sets up the SPAN based on port, VLAN IDs, both TX/RX


***RSPAN: Remote Switched Port Analyzer***
- Monitored ports, VLANs are not located on the same switch
- Special VLAN required to carry traffic being monitored by the SPAN feature between switches back to test equipment
- Depending on amount of traffic, can introduce performance issues
- Lose any details with respect to timing in monitored traffic
- Also referred to as back-hauling of traffic
- Not supported on all switches

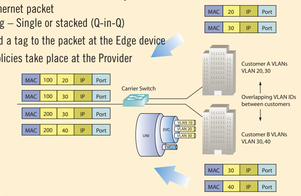



### VLAN Tagging/Stacking (Q-in-Q)

Ethernet packet can enter the network two ways
- Untagged Ethernet packet
- With VLAN tag – Single or stacked (Q-in-Q)

Provider will add a tag to the packet at the Edge device

Rate limiting policies take place at the Provider Edge router




***VLAN Tagging***

VLAN tag (per IEEE 802.1Q) adds 4 bytes to the Ethernet frame, including the Tag ID and a Priority (802.1p). The maximum size of the modified frame is 1522 bytes.

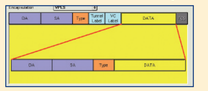

***VLAN Stacking***

Double VLAN tag (IEEE 802.1ad) adds 8 bytes to the Ethernet frame, including the Service Provider tag and a Customer tag. This allows for 'stacking' of several VLAN tags for tunneling applications.
Maximum frame size is 1526 bytes.


### VPLS/MPLS

***VPLS Frame***

Virtual Private LAN Service (VPLS) offers Layer 2 MPLS-based VPN service with multipoint connectivity. VPLS Frame consists of an Ethernet frame with MPLS tags inserted for proper information tunneling across the network. Customer frame information is stored in the Data portion of the VPLS frame. VPLS technology is an IETF standard, currently in Internet Draft status.




***MPLS Frame***

Multi-Protocol Label Switching (MPLS) utilizes label switching/tunneling in conjunction with network layer routing in applications such as MPLS-based VPNs. MPLS can be implemented over Layer 2 technologies, which may include Frame Relay, ATM, and Ethernet. It is defined in numerous IETF standards.


## Standards

### IEEE Standards

IEEE 802.3i (1990) – 10BASE-T
IEEE 802.3u (1995) – 100BASE-T
IEEE 802.3z (1998) – Gigabit Ethernet
IEEE 802.3ab (1999) – 10000BASE-T
IEEE 802.3ad (2000) – Link Aggregation
IEEE 802.3ae (2002) – 10 Gigabit Ethernet
IEEE 802.3ah (2004) – Ethernet in the First Mile
IEEE 802.3an (2006) – 10GBASE-T

IEEE P802.3ap – Backplane Ethernet Task Force
IEEE P802.3as – Frame Expansion Task Force

IEEE 802.1Q – Virtual LANs
IEEE 802.1p – Traffic Class Expediting and Dynamic Multicast Filtering
IEEE 802.1ad – Provider Bridges
IEEE 802.1ah – Provider Backbone Bridges

IEEE adds a "P" notation to the beginning of the standard name to indicate a non-ratified standard

### IETF RFCs

RFC 791 – Internet Protocol
RFC 793 – Transmission Control Protocol
RFC 768 – User Datagram Protocol
RFC 1889 – RTP: A Transport Protocol for Real-Time Applications
RFC 2544 – Benchmarking Methodology for Network Interconnect Devices
RFC 2475 – An Architecture for Differentiated Services
RFC 2547 – BGP/MPLS VPNs
RFC 3031 – Multiprotocol Label Switching Architecture
RFC 3032 – MPLS Label Stack Encoding

### MEF Recommendations

MEF 2 – Requirements and Framework for Ethernet Service Protection
MEF 3 – Circuit Emulation Service Definitions, Framework and Requirements
MEF 4 – Metro Ethernet Network Architecture Framework – Generic Framework
MEF 6 – Metro Ethernet Service Definitions Phase I
MEF 7 – EMS-NMS Information Model
MEF 8 – PDH Emulation over Metro Ethernet Networks
MEF 9 – Abstract Test Suite for Ethernet Services at the UNI
MEF 10.1 – Ethernet Services Attributes Phase 2
MEF 11 – User Network Interface (UNI) Requirements and Framework
MEF 12 – Metro Ethernet Network Architecture Framework – Ethernet Services Layer
MEF 13 – User Network Interface (UNI) Type 1 Implementation Agreement
MEF 14 – Abstract Test Suite for Traffic Management Phase 1
MEF 15 – Requirements for Management of Metro Ethernet Phase 1 Network Elements
MEF 16 – Ethernet Local Management Interface

JDSU