Hands-On
Metro Ethernet
Carrier Class Networks

BTS
Real-World Experience

Course Description

Carriers have offered connectivity services based on traditional TDM, Frame Relay and ATM for many years. However customers now use Ethernet as the interface of choice for virtually all services and applications. The cost of operating separate networks to provide each service, as well as the need to sell higher bandwidth services than can be offered with traditional networks, is forcing carriers to move to newer, more cost effective technologies, namely Ethernet, Backbone Bridging, IP and MPLS.

Ethernet and IP have allowed networks to deliver high bandwidth and new services with greater flexibility, while MPLS has allowed these new services to become more "carrier-class", offering the connection-oriented behaviour, quality of service, and reliability normally associated with traditional technologies. However the signalling and routing costs of MPLS and layer 3 solutions have still been significant, which has lead to the development of other layer 2 Provider Backbone Transports (PBT) and Provider Backbone Bridging (PBB) solutions for small to medium scale carrier metro services.

The Metro Ethernet Forum has evolved a set of standard service definitions for the kinds of Ethernet services customers now require. These can deliver services between sites that look to customers like end to end Ethernet. For carriers they can emulate other traditional TDM services over the same infrastructure and deliver all services over a common unified network by adding Pseudo Wire Emulation edge to edge (PWE3).

This course provides an in-depth look at carrier Ethernet technologies, the Metro Ethernet Forum specifications for services and how these can be delivered over carrier core networks along with other services deployed over PWE3.

Students Will Learn

- **Identify How To Build Networks To Deliver Metro Ethernet Services**
- **Relate The Importance Of Metro Ethernet Switching To Service-Provider Markets**
- **Describe How Ethernet Services Can Be Delivered Over MPLS And Provider Backbone Transports**
- **Describe, Configure, And Troubleshoot Metro Ethernet Deployment Solutions**
- **Compare Operational Alternatives For Service Delivery, Metro And Core Architecture**
- **Examine Options For Delivery Of Next Generation Services Over Metro Ethernet**
- **Identify The Equipment And Solutions That Would Best Fit In Given Customer Scenarios**
- **Identify How Qos And Security Can Be Guaranteed**
- **Provision Metro Ethernet Switching Equipment With The Circuits Required To Support Various**
- **Service Models Across The Classroom**
- **Test And Troubleshoot Configurations**

Target Audience

Individuals who design Metro Ethernet Switching solutions for service providers, who implement end-to-end Metro Ethernet Switching services, who deploy networks using Metro Ethernet Switching services and anyone interested in Metro Ethernet.

Prerequisites

Attendees should have a good understanding of IP and WAN principles. They should also understand the basics of Next Generation Networks.

Course Outline

Module I: Next Generation Carrier Network Requirements

What services carriers need from their infrastructure
Bandwidth for services
Customer Interfaces
Carrier Network Interfaces
QoS and Protection for Service Level Agreements
Evolution mechanisms for service development
Services to be delivered
Migration of existing TDM using emulation
Business Ethernet LAN services
Customer VLAN
VoIP, IPTV and Triple Play
Quality and Protection Demands
Mechanisms for protection
Aggregation
Ring switching
Access and Core divisions
Requirements for the access
Requirements for the core
Aggregation network
User Network Interface (UNI)
User interface requirements
Private networking needs: at layer 2 and/or Layer 3
Security and isolation
Service models
Management
Mechanisms for Management
Management protocols and services
Automatic capability discovery

Module II: Customer Private Service Needs

Virtual Network Services
What are virtualised services?
Why are they required?
Topology needs
Topology reliability
Designing for Service Levels
Point to point services using Pseudo Wires
IETF Pseudowire Emulation Edge to Edge (PWE3)
Key RFCs
Metro Ethernet Forum Service Definitions
MEF standards
What are the MEF Standards?
MEF 6.1
MEF 10.1 and 10.2
Ethernet Service Attributes
Virtual LANs
Emulated LAN using multipoint services
E-Line Services for Point to Point
E-LAN MultiPoint to MultiPoint
Physical Interfaces
Traffic Parameters
Classes of Service
Models for carrier services
Control Plane vs Data plane
Requirements for requested QoS and Protection

Module III: Carrier Ethernet Primer

Ethernet Speed Evolution to 10Gbit/s and beyond
How Ethernet Evolved
Evolution from 10 Mbit/s LAN to Gigabit Ethernet
Impact of Optical transmission
Removing the distance limitations
Ethernet switching
Bridging functions
Learning Bridges
Removing Loops
802.1d Spanning Tree and Rapid Spanning Tree
Ethernet Addressing
Address characteristics
Routability of address structures
Problems with MAC address Tables
How MAC addresses are used
ARP and IP
Limiting MAC address table sizes
Mac-in-Mac solutions
Multicasting
IGMP
Multicasting over Ethernet
Mechanisms for signalling Ethernet characteristics

GARP and GMRP
Tag Headers
IEEE802.1Q VLANs
GVRP
Overcoming the VLAN limit
Using VLANs within customer environments
VLANs in Carrier Environments
Service Separation
Impacts on Security
What limits the number of VLANs
Scaling Services
Q-in-Q solutions
Provider Layer 2 VPN Solutions Options
Provider Backbone Bridging
IEEE 802.1ad
Delivering Provider Backbone Transport
IEEE 802.1ah

Module IV: Delivering Quality of Service in Carrier EnvironmentsQoS Motivations

Analysing What Identifies QoS
Bandwidth
Delay
Delay variation
Availability
Access to Service Features
Delivering Bandwidth and Delay
Understanding Queues
Impact of queuing on Jitter and packet loss
Traffic Shaping Mechanisms to control queues
Sizing for Service quality
QoS Signalling
Exploiting Tag Headers for QoS
Mapping QoS across the Transport network
IEEE802.1P/Q
Layer 2 vs Layer 3 QoS
Differentiated Services

Module V: Aggregation and Protection Understanding Reliability and Availability MTTF and MTTR

Calculating Availability
Impact of Redundancy
Independence of Services
Mechanisms for Improving Reliability
Topology considerations
Mesh
Ring
Trees
Ethernet Rapid Packet Ring (RPR)
Ring Resilience protocol (RRP)
Comparing Layers 1, 2 and 3 protection
Physical switching

Layer 2 switching
Layer 3 rerouting
Ethernet Aggregation
802.3ad Aggregation and Bridging
Aggregation groups
Aggregation for bandwidth improvement
Protection using Aggregated Services
Example aggregation network applications
IPTV service protection
Aggregation for bandwidth increase
Ethernet Rings
Delivering reliability for Service Level Agreements

Module VI: MPLS Primer

Delivering High Performance Core Services
The Key Core Objectives
Scaling the problems of routing
Routing vs switching in the core
Cache Sizes
Label switching concepts
What is a label?
Normal hop-by-hop routing
Creation of Labels
Distribution of Labels
Function of Label switching
Forward Equivalence Class (FEC)
Label Edge Switches
Label Distribution Protocol
Explicit routed Label Switched Paths
Constraint routed Label Switched Paths
Traffic Engineering
Fast Rerouting

Module VII: Metro Ethernet Service Solutions

Service Signalling concepts
Virtual Private Wire Services
Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3)
RFC 3916
Carrying TDM Legacy Traffic
RFC 4197 Emulation of TDM over PWE3
RFC 4553Structure-Agnostic Time Division Multiplexing (TDM)
over Packet (SAToP)
MEF Service Control Word Signalling
MAC address Learning
Hierarchical Services
Deployment over LDP
Generalized PWid FEC
Learning Actions
MAC address withdrawal
Scalability
Routing Issues for Carrier Deployment

Control Plane and Auto Discovery
Delivering QoS
Ingress Bandwidth Profiling
Egress Bandwidth Profiling
Deploying DiffServ and CE-VLAN CoS using 802.1p
CE-VLAN Services
Service Attributes and Parameters
Securing the Service
Multicasting over VPLS
IGMP
IGMP snooping
Triple-Play Solutions

Module VIII: Deploying Services in Existing Networks

Scaling Issues
Service Level Agreements
MTU issues
Operations, Administration and Management
IEEE 802.1ag and ITU Y.1731 Management solutions
Ethernet Service Definitions

Evaluation and Review

Delivery Method

Hands-On Instructor-Led with numerous Labs and activities.

Equipment Requirements
(This apply's to our hands-on courses only)

BTS always provides equipment to have a very successful Hands-On course. BTS also encourages all attendees to bring their own equipment to the course. This will provide attendees the opportunity to incorporate their own gear into the labs and gain valuable training using their specific equipment.

Course Length

4 Days