

Hands-On

# Metro Ethernet Design and Engineering for CO



Designing Carrier Networks that Deliver Metro Ethernet Services

## 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 signaling and routing costs of MPLS and layer 3 solutions have still been significant, which has led 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 carrier network designers with the understanding and tools needed to design and build carrier class solutions that deliver Metro Ethernet Services. It will identify how to put together loading and sizing data and then select the correct technologies to match the requirements for delivering customer services.

## Students Will Learn

- Describe in detail Metro Ethernet Services and Functions
- Identify how specify requirements and size solutions
- Design and build carrier networks to deliver Metro Ethernet Solutions
- Compare operational alternatives for service delivery, Metro and Core Architecture
- Size and Engineer networks that can meet Service Level Agreements
- Deploy protections options to match reliability needs.
- And More...

## Target Audience

This course is designed for strategic or telecom managers, Datacom managers with responsibility for telecom, designers, engineers, consultants, communications professionals, software engineers, system engineers, network professionals, implementers, Network integrators, Product and service developers, Industry analysts, marketing and sales professional, IT professionals, and anyone who plans on using, evaluating or working with MetroE, applications and services as well as wholesale markets carriers and CLECs/ICPs/ISPs

## 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: Principles of Design

- Appreciating What The Technology Can Do
- Identifying the User Requirements
- Documenting and Agreeing the User Specification
- Translating into Technical Requirements
- Specifying Key Network Parameters
- Producing a Service Specification
- Proving the Design Meets the Specification
- Installing, Testing and Troubleshooting Procedures
- Delivering Documentation of the Service

### Module II: Next Generation Service Requirements

- What services carriers need from their infrastructure
- Services to be delivered
- Quality and Protection Demands
- Access and Core divisions
- User Network Interface (UNI)
- User interface requirements
- Private networking needs: at layer 2 and/or Layer 3
- Security and isolation
- Service Management
- Automatic capability discovery

### Module III: Customer Private Service Solutions

- Virtual Network Services

- 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 IV: Carrier Ethernet Technology**

- Ethernet Speed Evolution to 10Gbit/s and beyond
- Ethernet switching
- Ethernet Addressing
- Address characteristics
- Routability of address structures
- Problems with MAC address Tables and their solutions
- 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
- Overcoming the VLAN limit
- Provider Layer 2 VPN Solutions Options

#### **Module V: Delivering Quality of Service in Carrier Environments**

- QoS 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
- Aggregation and Protection
- Understanding Reliability and Availability
- MTTF and MTTR
- Calculating Availability
- Impact of Redundancy
- Independence of Services
- Mechanisms for Improving Reliability

#### **Module VI: Sizing The Service**

- Cross Site Traffic Loading
- Access Loading
- Defining Peak Day Loading Profiles
- Identifying Core Loading
- Selecting Protection Services

#### **Module VII: Core Network Alternatives**

- Delivering High Performance Core Services
  - The Key Core Objectives
  - Scaling the problems of routing
  - Routing vs switching in the core
  - Cache Sizes
  - MPLS 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
- Carrier Backbone Bridge Transport Solutions
  - Traffic Engineered Bridged Transport Solutions
  - Switched Ethernet Solutions for Small Systems

## **Module VIII: Configuring Metro Ethernet Service Solutions**

- Service Signalling concepts
  - Virtual Private Wire Services
  - Requirements for Pseudo-Wire Emulation Edge-to-Edge (PWE3)
  - Carrying TDM Legacy Traffic
  - RFC 4197 Emulation of TDM over PWE3
  - RFC 4553 Structure-Agnostic Time Division Multiplexing (TDM)
- over Packet (SAToP)
    - Hierarchical Services
    - Routing Issues for Carrier Deployment
    - Control Plane and Auto Discovery
    - 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 IX: Designing Service Management**

- Scaling Issues
- Service Level Agreements
- Testing and Service Verification
- Operations, Administration and Management
- IEEE 802.1ag and ITU Y.1731 Management solutions
- Operational Service Monitoring

## **Delivery Method**

Instructor-Led with numerous case-studies and exercises.

## **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