

Packet Transport:

EPL/EVPL over PBB-TE Transport Technologies

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Multi-Layer Dynamic Transport Networks Enabling Rich Bandwidth

ECOC 2009, Vienna, Austria, 20th September 2009

Ethernet Services

Early days of a new network investment cycle

\$68B

service provider investment
PDH
digitizing voice

1986

Source: ITU historical report estimate.

\$81B

\$47B ('96-'00)
\$34B ('01-'06)

service provider investment
SONET/SDH
scaling capacity

1996

Source: Dell'Oro SONET/SDH
historical revenue reports.

\$70-\$90B

service provider investment
ETHERNET
service convergence

2006

Source: Infonetics CE switches, Ethernet over
SONET/SDH, Ethernet over WDM, Ethernet
access forecasts, Ciena Marketing.

2016

OIF Interoperability work on Ethernet Services is timely and speeds deployment of interoperable solutions

Ciena Participation

... at the OIF 2009 Interoperability Demo

Locations

→ Verizon, Deutsche Telekom, France Telecom/Orange and KDDI

Functional Testing

→ Control Plane Interoperability Using OIF E-NNI IAs

→ Ethernet E-Line Services (EPL/EVPL) over multiple technologies

→ **Ethernet Private Line (EPL) = Single EVC* per UNI**

→ **Ethernet Virtual Private Line (EVPL) = Multiple EVCs* per UNI**

*EVC = Ethernet Virtual Connection

Products

→ Optical Service Delivery

→ Carrier Ethernet Service Delivery

Ciena's Functional Roles

... at the OIF 2009 Interoperability Demo

EPL/EVPL over SONET/SDH

- Dynamic SONET/SDH Connection supporting EPL/EVPL
- Control Plane Interoperability based on OIF E-NNI IAs
- Multi-layer control plane for SONET over OTN

ELP/EVPL over OTN

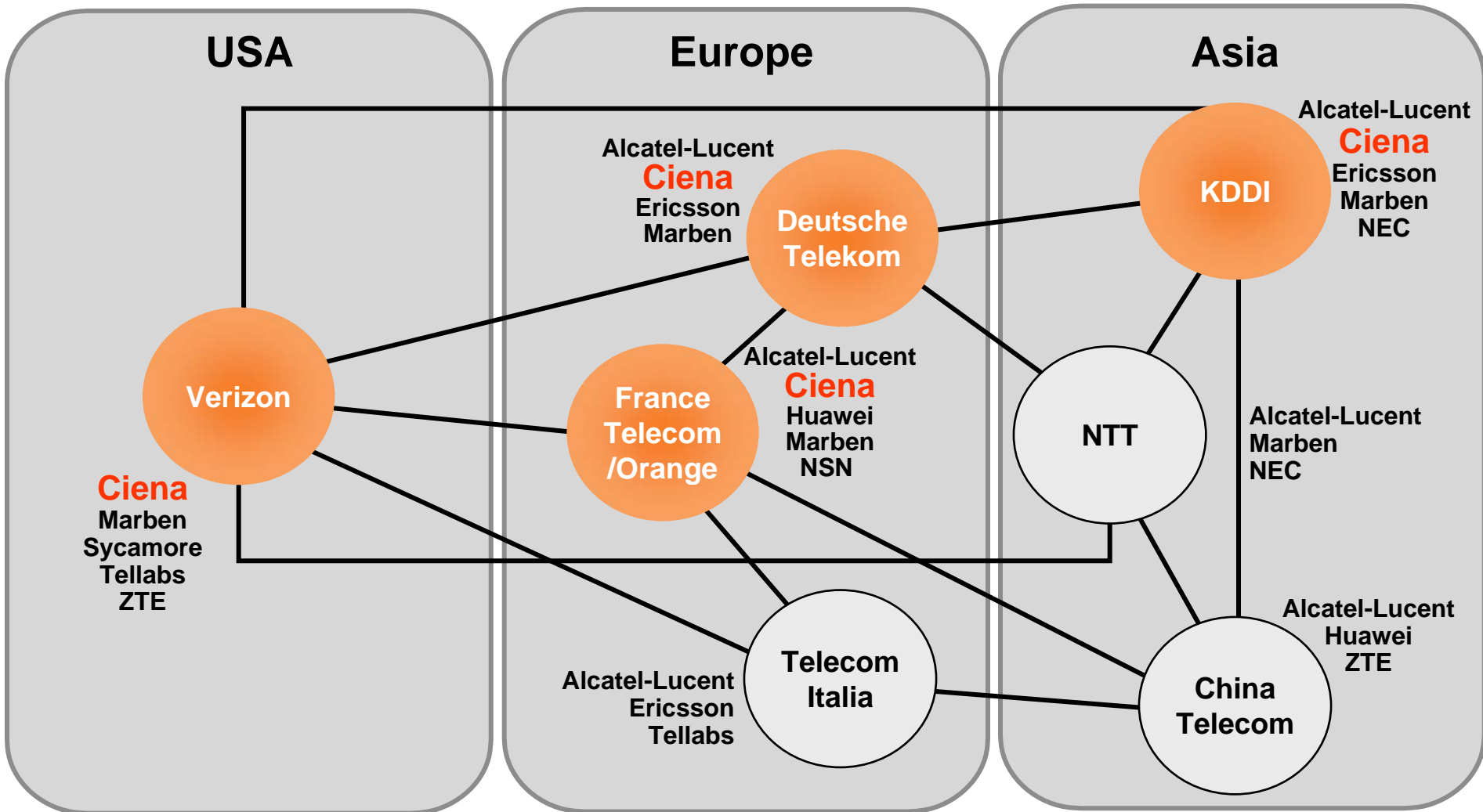
- Ethernet EPL/EVPL Service
- Ethernet Adaptation to OTN
- OTN Data Plane Interoperability

EPL/EVPL over Packet Transport

- EPL/EVPL Services Using PBB-TE Carrier Packet Transport
- PBB-TE Data Plane Interoperability
- PBB-TE Operations Functionality

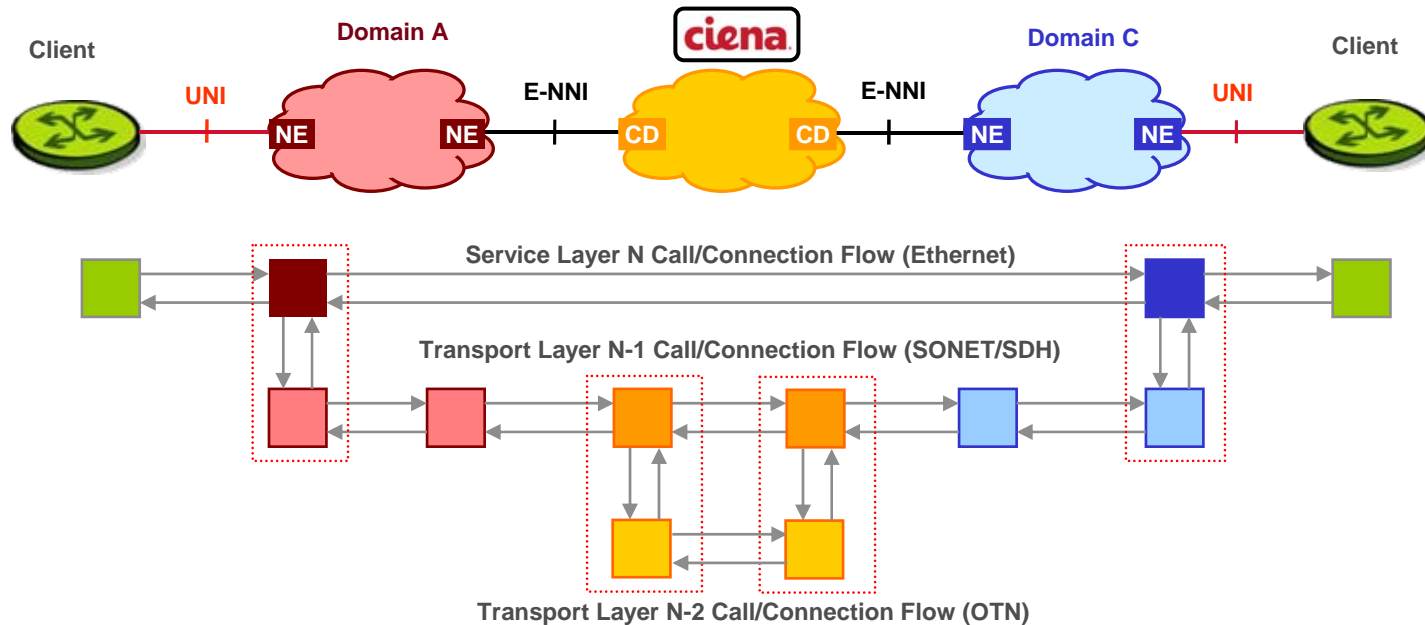
Ciena Locations

... at the OIF 2009 Interoperability Demo



Ciena's Multi-layer Control Plane

Supporting EPL/EVPL over SONET/SDH & OTN



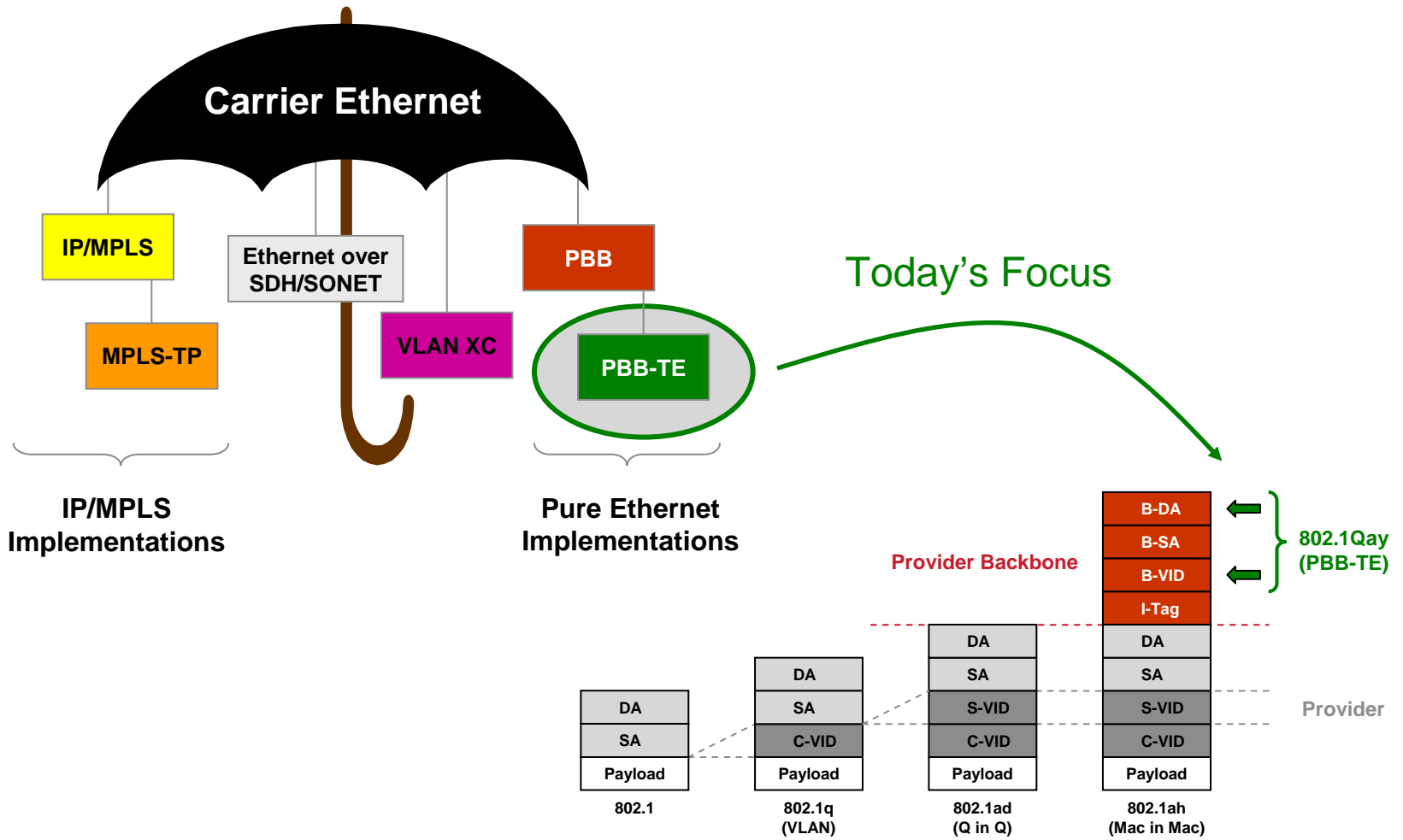
- OTN control plane supports automated discovery, provisioning and restoration at the OTN layer
- SONET/SDH control plane supports automated discovery, provisioning and restoration at the SONET/SDH layer (including embedded SONET/SDH links)
- SONET/SDH E-NNI supports interoperability with other vendor domains

PBB-TE Overview

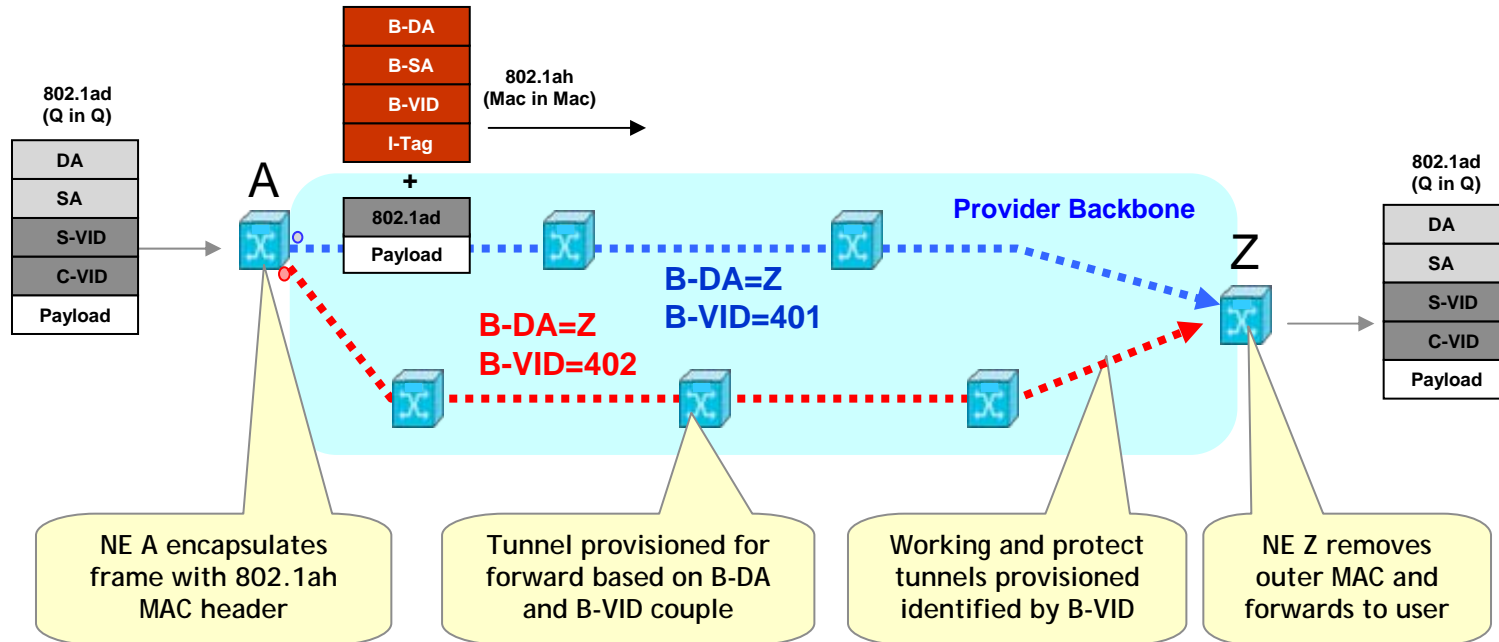
What is it?	A new version of Ethernet that replicates many of the carrier-friendly attributes associated with SONET/SDH, in terms of service transport and scale, for metro/backhaul applications.
Why it was invented?	To give Ethernet the same predictability and resiliency of traditional circuit-switched networks. Provides alternative to MPLS VPLS-based Ethernet transport.
Why was it standardized?	IEEE 802.1Qay was standardized to promote interoperability, innovation, competition, and avoid proprietary nature of its precursor (PBT).
Promising applications?	Packet-based 3G/4G mobile backhaul applications.

Technology Choices for Carrier Ethernet

There's more than one implementation approach



EPL/EVPL over PBB-TE Transport



NE A encapsulates frame with 802.1ah MAC header

Tunnel provisioned for forward based on B-DA and B-VID couple

Working and protect tunnels provisioned identified by B-VID

NE Z removes outer MAC and forwards to user



LE-311v
Service Delivery Switch

Carrier Ethernet Solutions:

- Scalable
- Interoperable
- Secure
- Multi-protocol



CN 5305
Service Aggregation Switch

EPL/EVPL over Packet Transport

Functions Tested

Forwarding Plane

IEEE 802.3, 802.1ah, 802.1Qay

→ PBB-TE over GbE PHY

Service Support

MEF 10.1

→ PBB-TE E-Line Service

QoS Capabilities

IEEE 802.1d/q/ad

→ CIR, PIR and Priority per VLAN ID

→ E-Tunnel/ESP

OAM Capabilities

IEEE 802.1ag, ITU-T Y.1731

→ CFM/CCM Messages

→ LBM/LTM Loopback & Link Trace

→ DMM Test Sequence for delay/jitter

→ LMM Test Sequence for loss

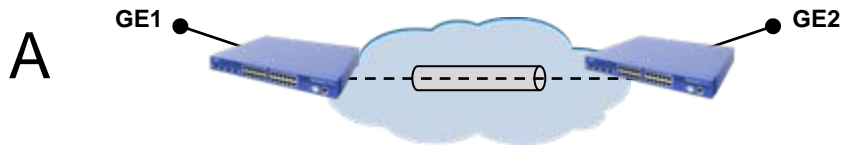
Protection

IEEE 802.1Qay

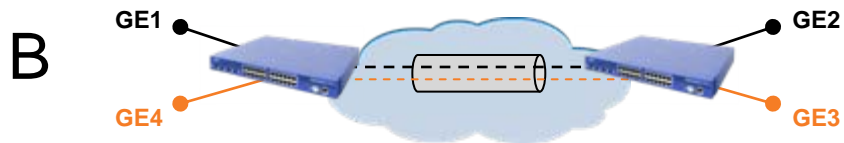
→ 1:1 Tunnel/ESP Protection

EPL/EVPL over Packet Transport

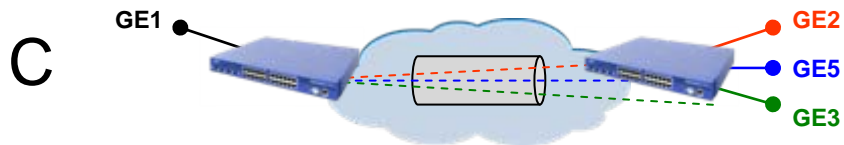
Configurations Tested



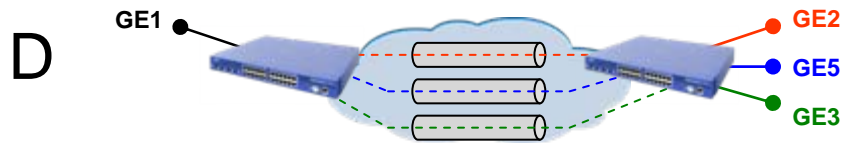
EPL: Single P2P EVC over single PBB-TE tunnel



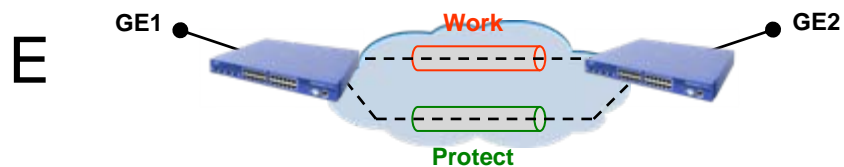
EPL: Two P2P EVCs over single PBB-TE tunnel



EVPL: Three P2P EVCs with different VLAN groups over single PBB-TE tunnel



EVPL: Three P2P EVCs with different VLAN groups over three PBB-TE tunnels



EPL: Single protected EVC over two PBB-TE tunnels (Work & Protect)

Example Application

4G Wireless Backhaul with Microwave Radios



Base station

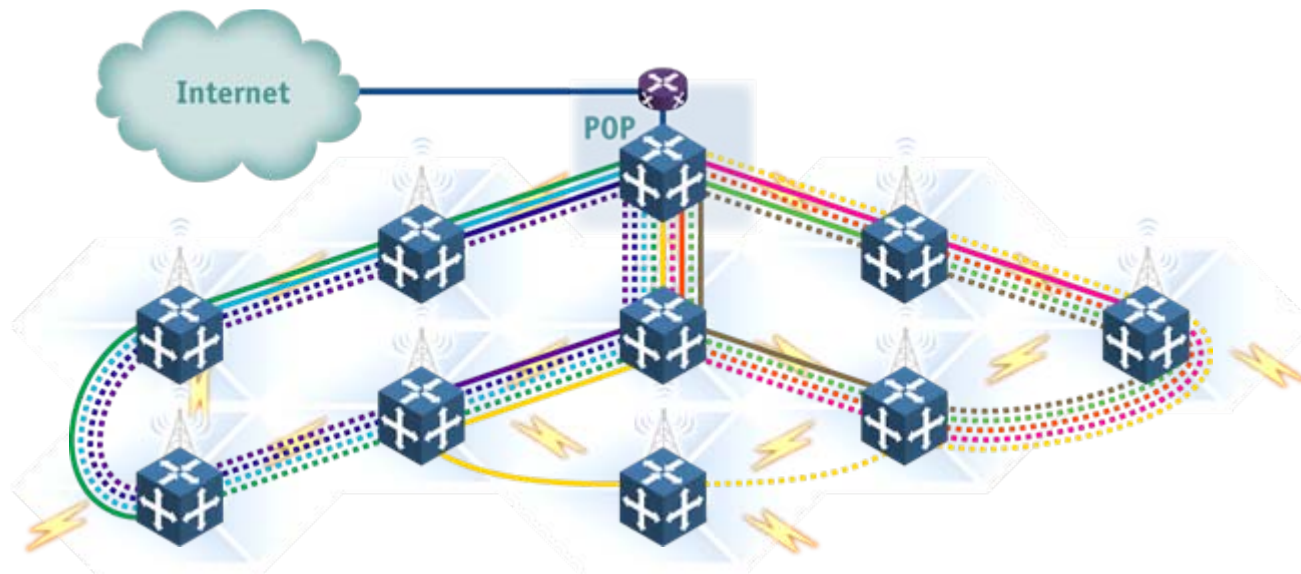
- IEEE 802.16 WiMAX
- (3) 120° radios per tower
- (1) Tower Ethernet Switch per tower
- Microwave links between towers

POP

- POP Ethernet Switch at POP
- Terminates tunnels
- PBB-TE tunnels over Ethernet over microwave

Example Application

Topology View



Topological view

- Diverse (ring) connections constructed to provide diverse paths to POP
- Tower Ethernet Switch originates/terminates a tunnel pair per tower
- Tower Ethernet Switches also serve as transit nodes

Scalability

- Each Tower Ethernet Switch learns Customer MACs for local base station
- Each Tower Ethernet Switch tunnels C-MACs for transiting tunnels
- POP Ethernet Switch learns all C-MACs at POP

Example Application

Logical Tunnel View



Logical view

- Each base station has primary and backup PBB-TE tunnel pair for resiliency
- POP Ethernet Switch terminates tunnels and hands off to service router

Benefits

- Improved resiliency
- Predictable failover
- Connection-oriented traffic engineering, provisioning
- Increased MAC scalability

Standards Summary



- 802.1ad Provider Bridges (2006)
 - **Defines basic Q-in-Q service provider VLAN capability**
- 802.1ag Connectivity Fault Management (2007)
 - **Defines Connectivity Fault Management for Bridged Networks**
- 802.1ah Provider Backbone Bridging (2008)
 - **Defines Mac-in-Mac for added scalability and separation**
- 802.1Qay PBB – Traffic Engineering (ratified 18-6-2009)
 - **Defines TE extensions for PBB**



- ITU-T Recommendation Y.1731 (2008)
 - **OAM functions and mechanisms for Ethernet based networks**



- draft-ietf-ccamp-gmpls-pbb-te-02.txt
 - **GMPLS Extensions for PBB-TE (Work in Progress - Completed WG Last Call)**



- MEF 10.1 Ethernet Services Attributes (2006)
 - **Defines characteristics of Ethernet service types**



Opportunities Enabled by OIF Interoperability Testing

Ciena testing supports deployment of Carrier Ethernet Services over the latest Carrier Transport Technologies

- Allows the use of cost effective and innovative network elements, including L0/L1/L2 transport

Ciena testing supports deployment of Carrier Services using interoperable control plane provisioning and restoration

- Reduces carrier operations overhead and simplifies provisioning of new services

Speeds the deployment of new and innovative technology

Thank you

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