PBB-TE Testing to Ensure Success

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Michael Haugh -Biography

- Over 11 years in networking
- Network Engineer at IBM Global Service
- Test Engineer at IBM Global Service
- Senior Test Engineer at AT&T Labs
- Cisco CCNA, CCNP, CCIE #4334
- Senior Systems Engineer (Test equipment manufacture)
- Five years in Product Management
- Currently Sr. Product Manager at Ixia
- Originally from Chicago, now reside in Los Angeles

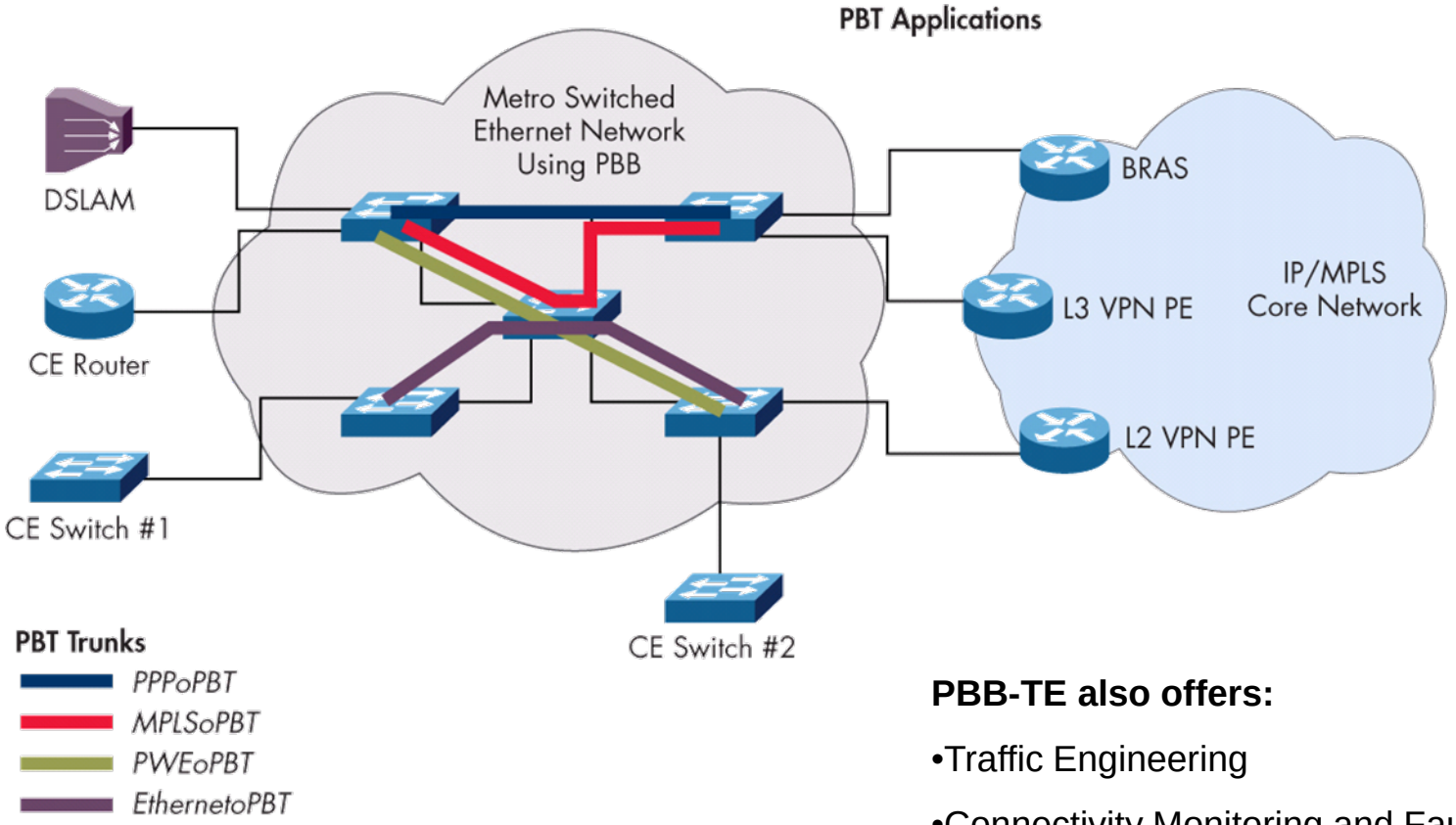
PBB-TE (Formerly PBT) – Overview

- **Provider Backbone Transport (PBT)**
  - Based on Nortel pre-standard implementation
  - More than nine vendors have implemented this flavor driven by BT
  - PBB-TE is a competing technology to MPLS in Ethernet Metro networks and is similar to MPLS Pseudowires (PWE3) but with no signaling protocol
  - It is now moving forward in the IEEE as a standard called Provider Backbone Bridges – Traffic Engineering (PBB-TE) under IEEE 802.1Qay (draft 2)
- **PBB-TE uses Ethernet forwarding (PBB aka MAC-in-MAC) without the traditional control plane and uses CFM for fault management/protection switching**
  - It is a feature added to a PBB Network to support point-to-point trunks
  - Traditional Ethernet broadcasting (flooding)/learning is “turned off”
  - Spanning Tree Protocols are not needed and disabled on PBB-TE ports
- **PBB-TE uses direct configuration of Ethernet forwarding tables**
  - Tables are configured manually or via a provisioning tool typically using SNMP SET to configure the paths

PBB-TE – Overview Cont'd

- PBB-TE provides a scalable Point-to-Point connectivity service
  - Pinned and engineered routes are supported
  - Protection switching is supported for resiliency
    - 50ms recovery can be achieved
  - Ethernet Service OAM (CFM) can be used for millisecond-level fault notification. CCI intervals can be from 3.33ms to 10min. 3.33ms or 10ms are required for sub 50ms recovery
- PBB-TE is "service agnostic", applications include:
  - E-Line services in the metro network
  - Broadband Access backhaul from DSLAM to BRAS
  - Extension of a VPN service over a switched metro network
  - Pseudo-wire support to tunnel legacy services

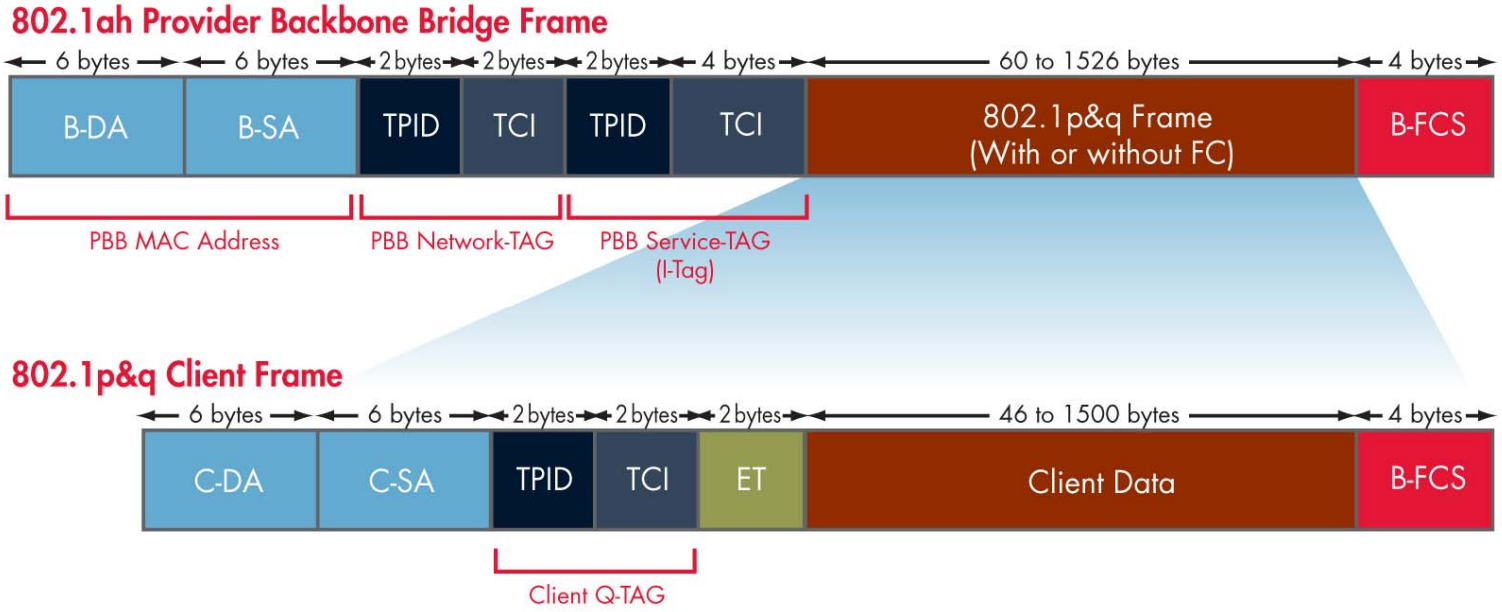
Examples of PBB-TE Applications



PBB-TE also offers:

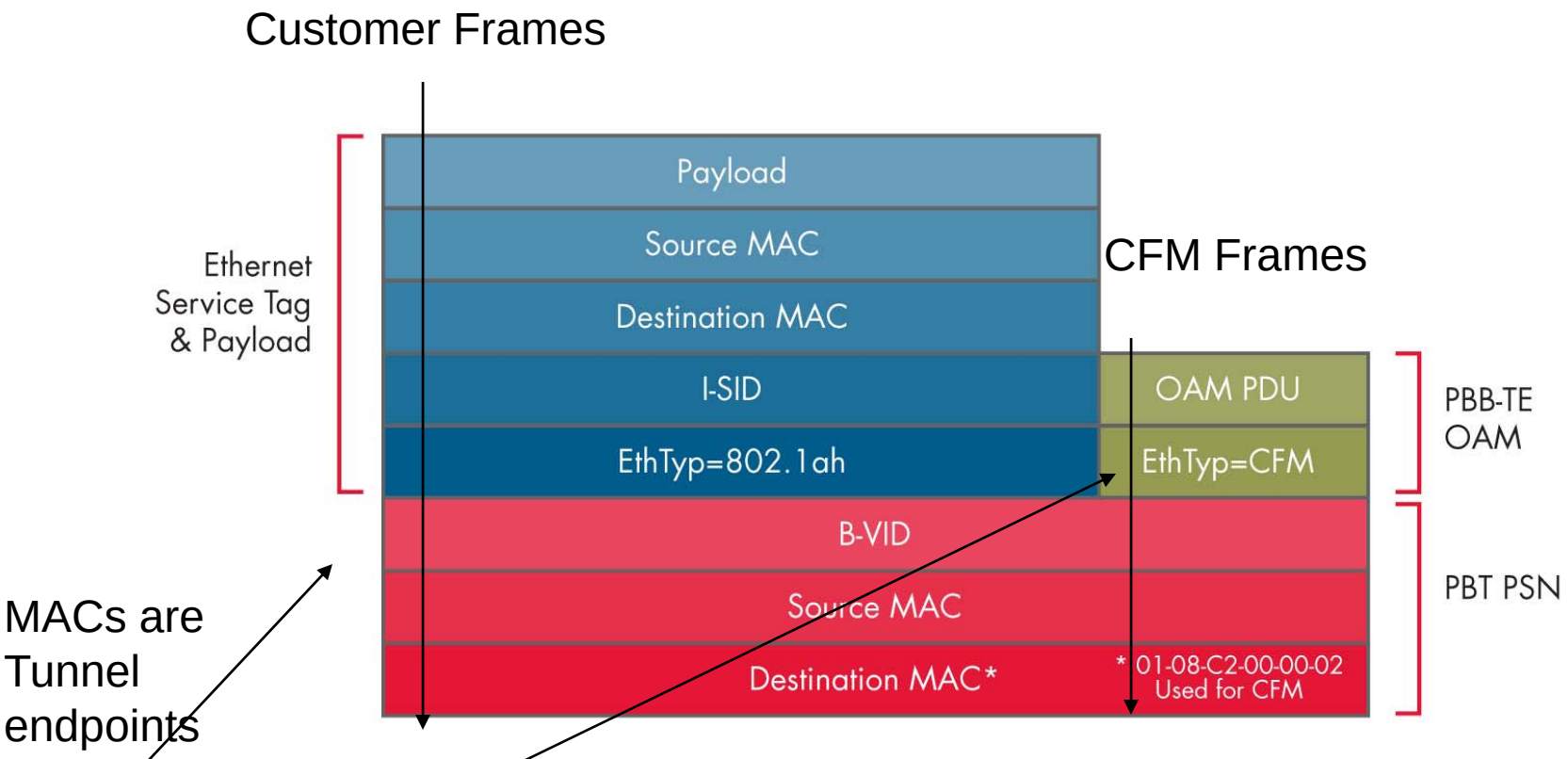
- Traffic Engineering
- Connectivity Monitoring and Fault Management leveraging EOAM (CFM)
- Leverages pure Ethernet switched Network

PBB-TE Customer Traffic



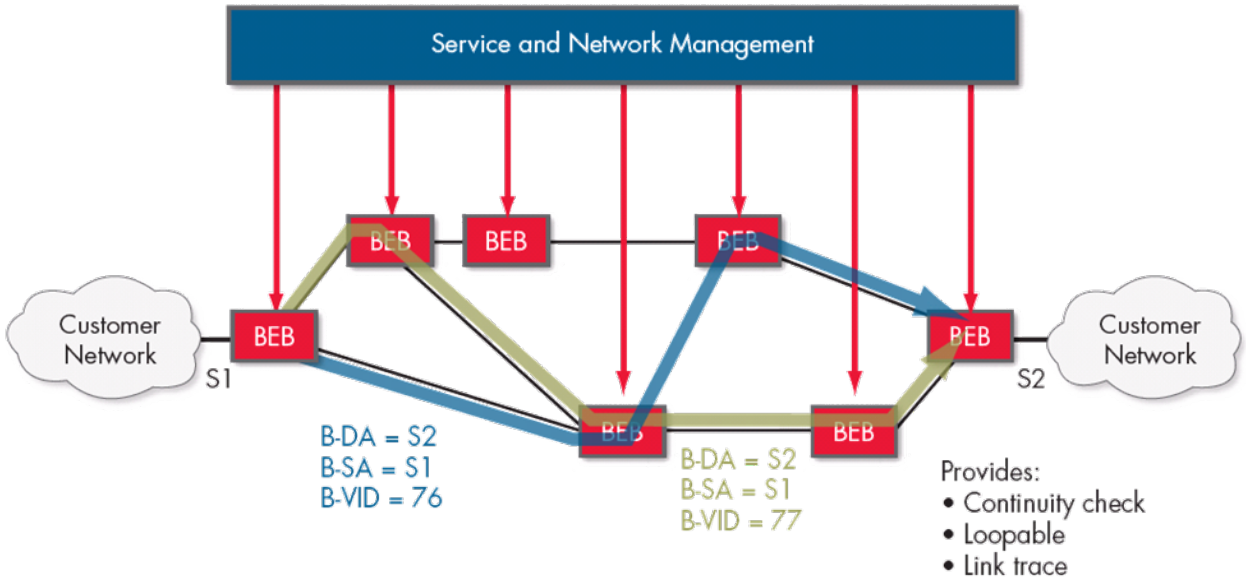
- Customer Traffic is encapsulated in PBB (MAC-in-MAC)
- PBB MAC SA/DA are trunk end-points, Network TAG (B-VID) identifies trunk

PBB-TE Frame Formats



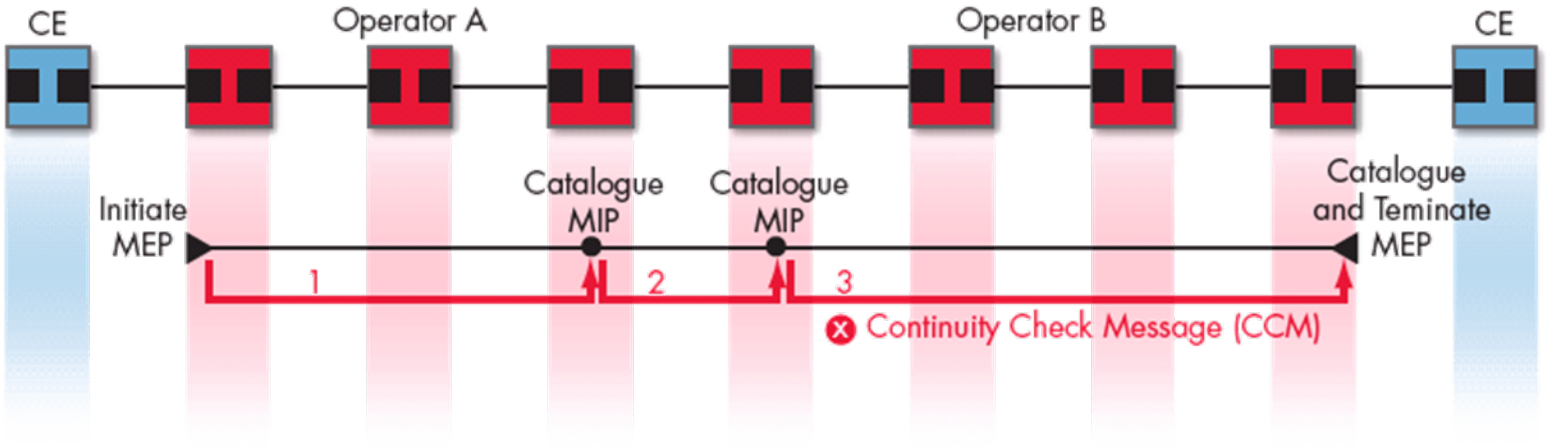
- Customer Traffic and CFM is encapsulated in PBB, 802.1ah Ethertype (TPID) for B-VLAN is 0x88A8
- CFM Ethertype is 0x8902, CFM CCI sent over tunnel in each direction to keep state “up”

PBB-TE Trunks (ESPs)



- Uses 802.1ah PBB frame format, builds an Ethernet Switch Path (ESP)
- Provides Point-to-Point Service (PtoMP emerging for multicast)
  - E-LINE or tunneling services
- Resiliency achieved by providing 1:1 backup
  - Uses IEEE 802.1ag CFM continuity check message, can also use ITU-T Y.1731
- MAC Forwarding tables are hard coded, learning/STP disabled
- Theoretical high scalability – SA/DA MAC + BVID , 24-bit space for service

PBB/PBB-TE (PBB-TE)



- 802.1ag/Y.1731 **CFM Continuity Check Protocol** is used over each tunnel
- **Maintenance End Points (MEPs)** send and terminate continuity messages
- **Maintenance Intermediate Points (MIPs)** catalogue MEPs at the same **Maintenance Domain (MD)** level
- **802.1ag Linktrace and Looback** can also be used for fault isolation and verification, Note PBT implementation does not include Linktrace

PBB/PBB-TE (PBT) Testing Challenges

- Functional
  - Basic service and interoperability testing
    - Test static MAC table entries
    - Validate forwarding of various protocols over PBB-TE (XoPBB-TE)
- Performance/Scale testing
  - QoS Testing (Using 802.1q priority and 802.1ah PCP and DE bits)
  - Mixed applications and service levels (Using unique I-SIDs)
  - Scalability of the tunnels and services (Unique SA/DA, MA)
- Resiliency
  - Test protection switching
  - Test integration of E-CFM for fault detection
- Management
  - Provisioning services without interruption
  - Service level reporting
  - Connectivity detection and fault management

Functional Testing PBB-TE

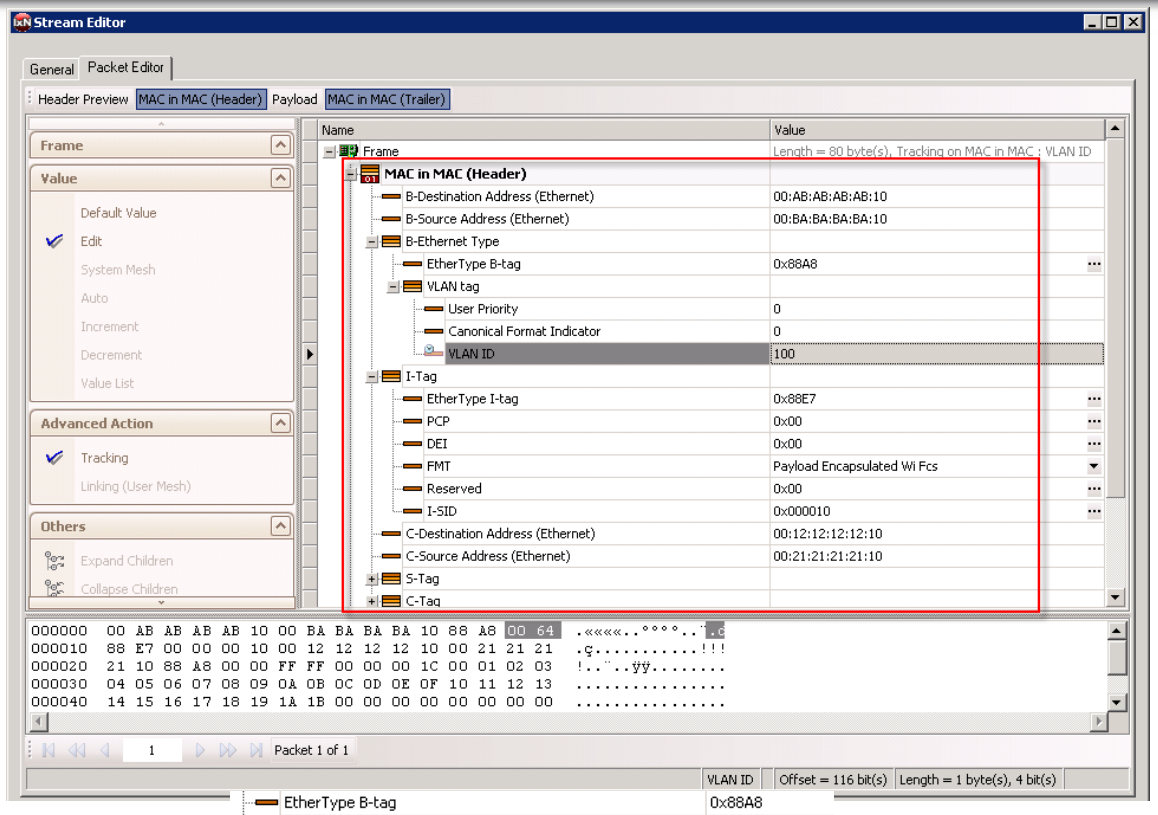
- Functional Testing Elements in PBB-TE Network:
  - Backbone Edge Bridge (BEB)
    - Initiates and terminates PBB-TE Trunks (ESPs)
    - Test Variables Control-Plane (CFM):
      - Source/Destination MAC address (Trunk endpoints), number of unique trunks
      - MA Format and Name
      - MD Format, Name and Level, number of MDs, number of levels configured
      - Test using standard Ether-types (TPID) – B-VLAN 0x88A8 is standard, 0x8100 is also common
      - Test using different B-VLAN priority
      - CCI (3.33ms to 10min), typically 100ms is used, tunnels with different CCIs
      - CFM loopback verification (initiate and respond to loopback)

Functional Testing PBB-TE

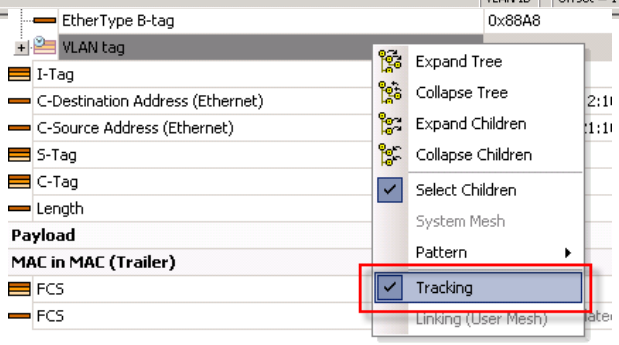
- Functional Testing Elements in PBB-TE Network
  - DUT as Backbone Edge Bridge (BEB)
    - Test Variables Data-plane (PBB a.k.a MAC-in-MAC):
      - DUT as Ingress (customer traffic is encapsulated in MAC-in-MAC)
        - » Customer traffic with different encap Ethernet, 802.1Q, 802.1ad
        - » Valid address mapped to trunk, invalid address handling (MAC table)
        - » Broadcast/Multicast traffic handling
        - » Traffic with different QoS using 802.1Q bits
      - DUT as Egress (Traffic is MAC-in-MAC, encap is removed)
  - DUT as Backbone Core Bridge (BCB)
    - Test Variables Data-plane (PBB a.k.a MAC-in-MAC):
      - Build/provision trunks so the forwarding table is populated correctly
      - Configure as MIP, test CFM loopback/linktrace

Data-Plane Testing

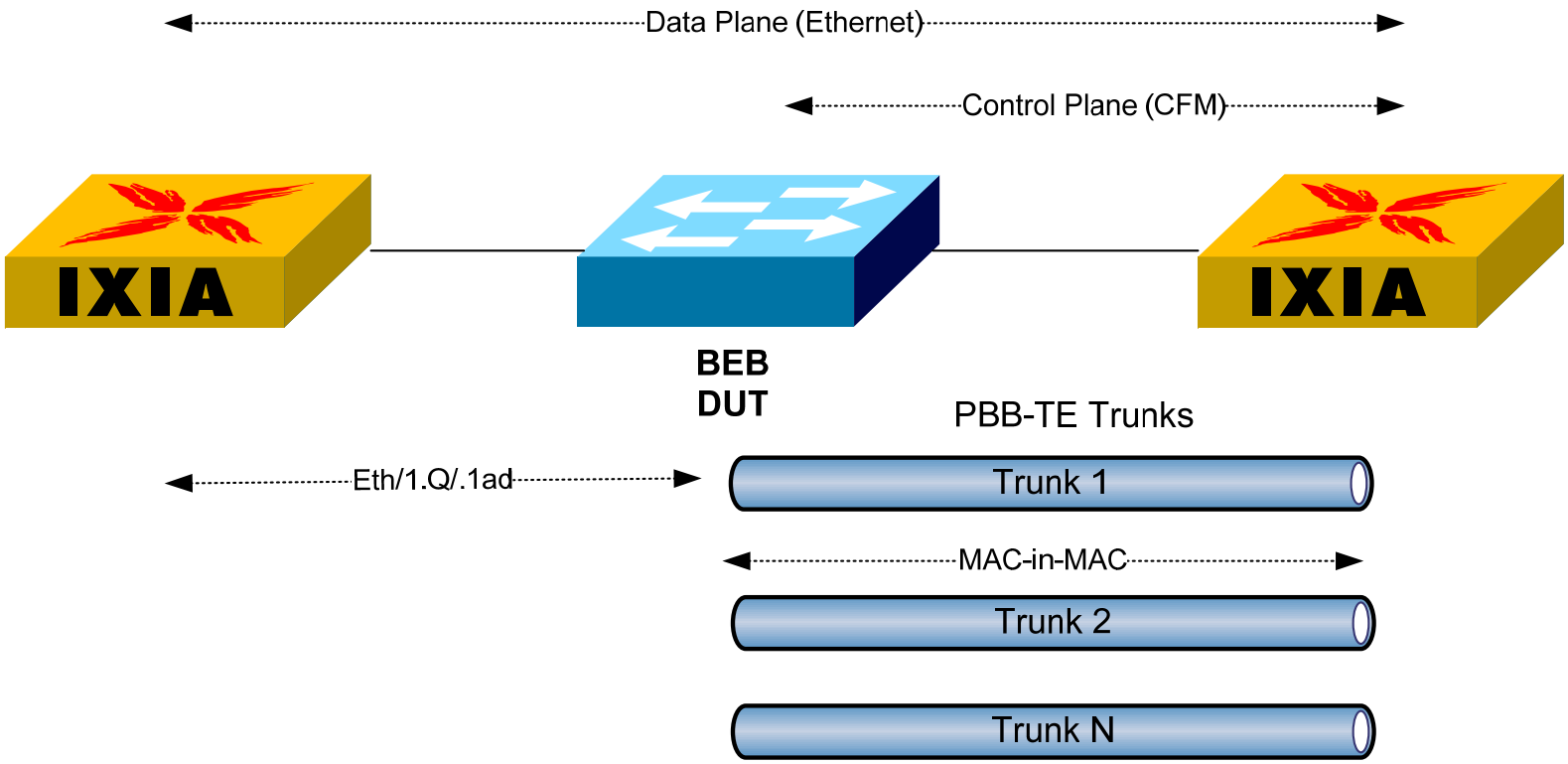
- Build MAC-in-MAC traffic, every field is configurable
- Easily step values to create lots of unique streams



- Easily enable tracking on a field using the right-click option

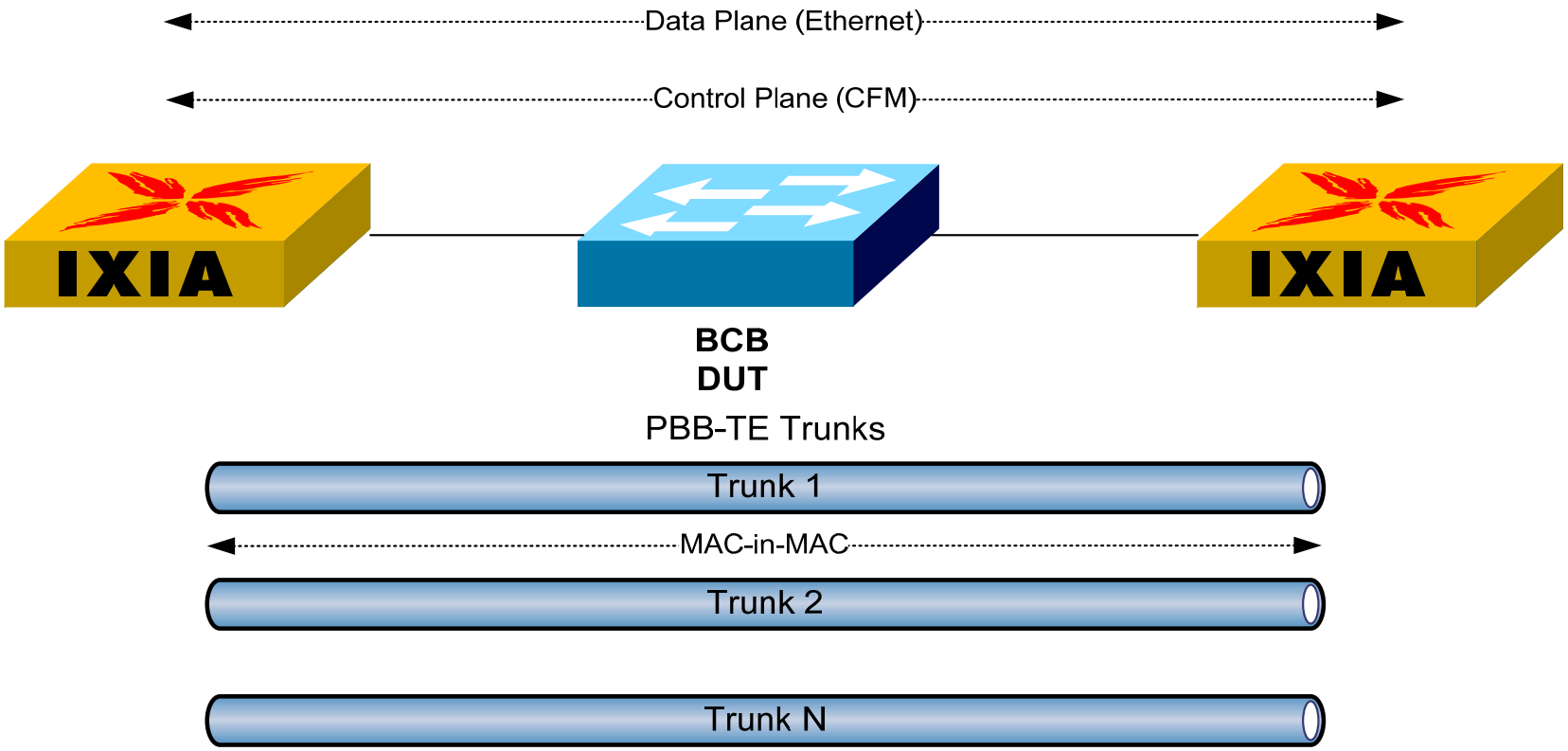


DUT as Backbone Edge Bridge



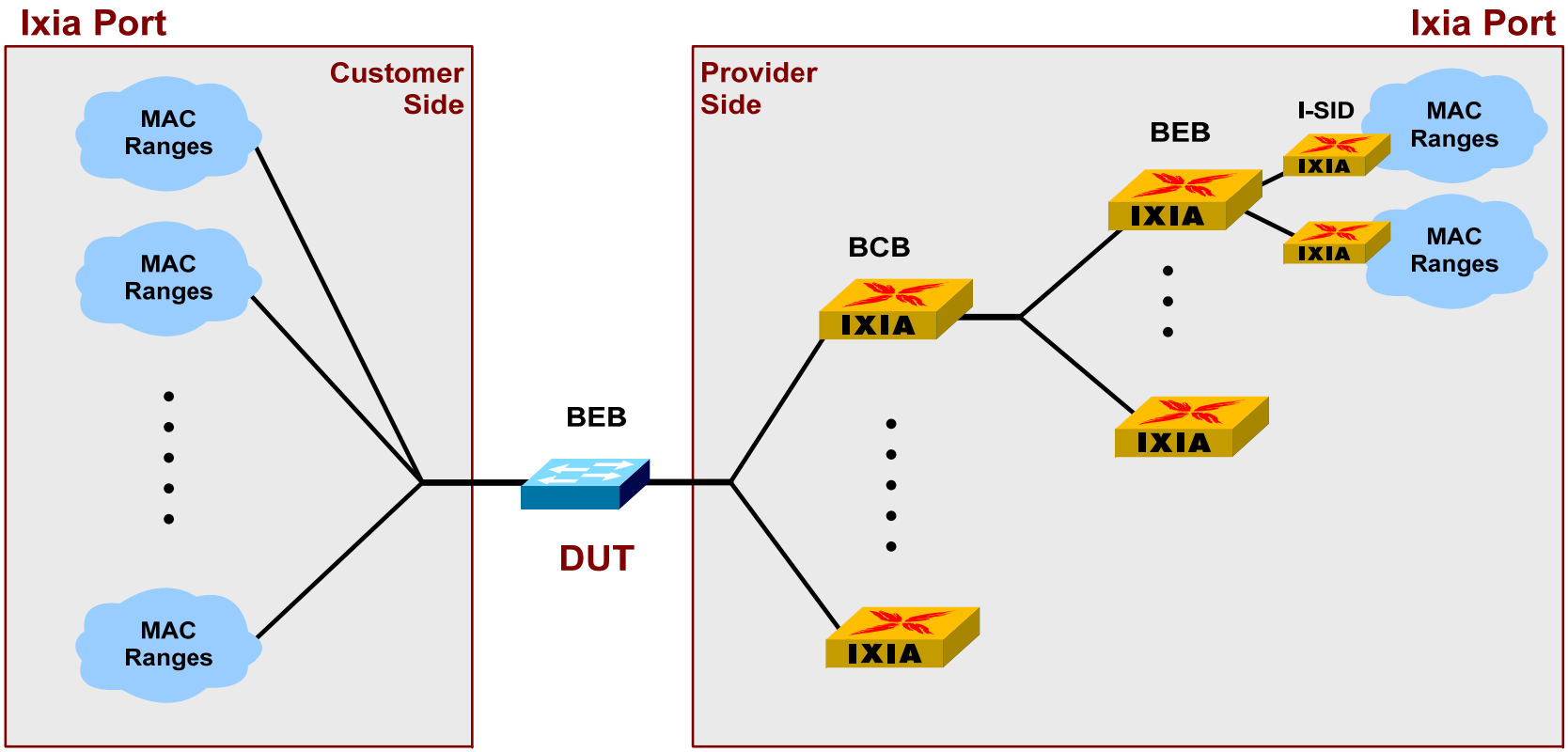
- Test Scenario: DUT as BEB (PBB-TE trunk Endpoint)
- DUT must maintain Trunk State (CFM), initiate and reply to loopback
- DUT must properly map traffic to tunnel

DUT as Backbone Core Bridge



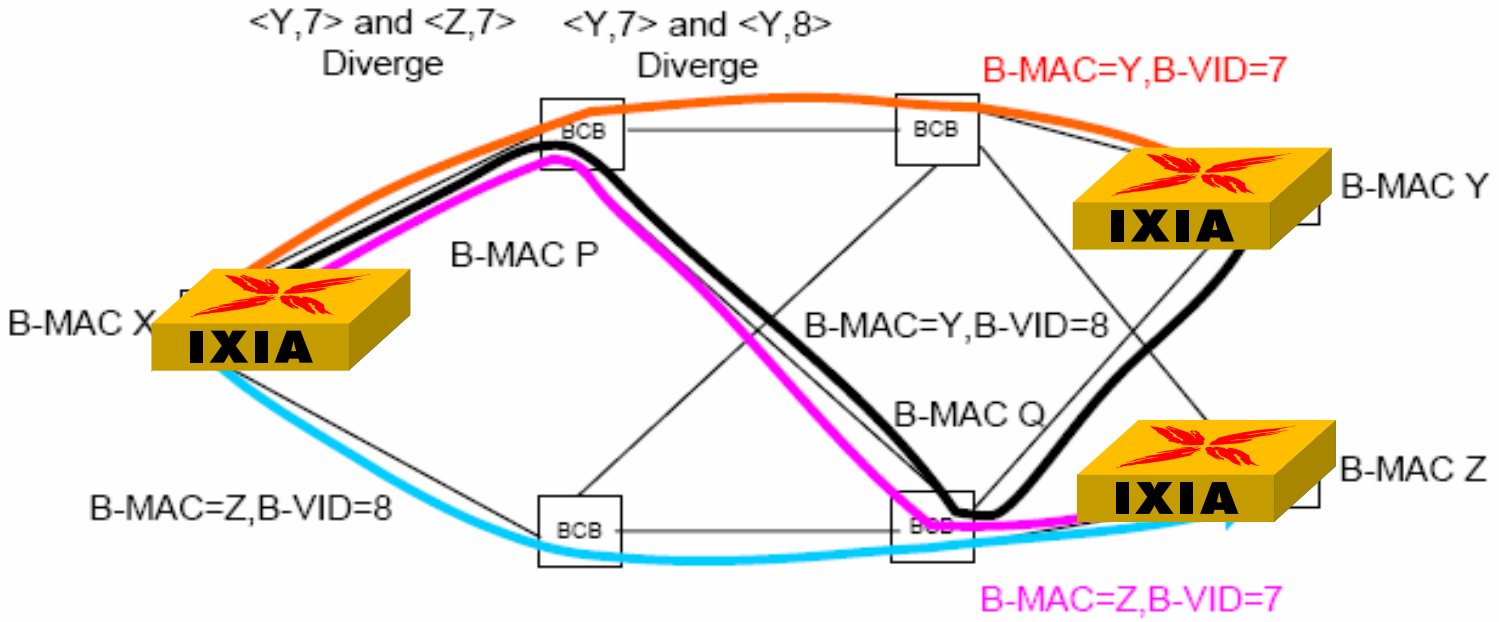
- Test Scenario: DUT as BCB
- DUT does not participate in control-plane (CFM), unless configured as MIP
- DUT must properly forward traffic on configured PBB-TE trunk

Emulate Large Topologies



- Extend the testing to emulate large topologies
- DUT can be BEB or BCB depending on test requirements for PBB-TE

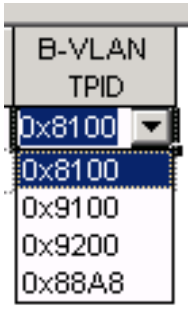
PBB-TE System Under Test



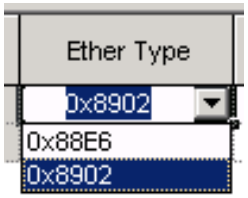
- Example System Under Test
- Test trunk failure/resiliency

Testing PBB-TE Today

- PBB-TE trunk interoperability
  - 4 B-VLAN Ethertypes (proprietary & standard)
  - Standard is 0x88A8, 0x8100 is common



  - 2 PBB-TE CFM Ethertypes (pre & standard)
  - Standard is now 0X8902



- PBB-TE trunk functionality
  - Full range CCIs
  - QoS trunks
  - RDI processing

EANTC event verified interoperablity with 9 PBB-TE (PBT) vendors for CEWC

Testing PBB-TE Control Plane

- Stateful protocol implementation
  - Run 802.1ag customized for PBB-TE application, some changes to standard implementation for example destination MAC address is configured and does not include Linktrace
- Setup PBB-TE trunks
  - Trunk scale depend on module and ranges from 30 – 3500 per port
  - CCMs are required to keep trunk state “up”
- Track PBB-TE trunk state
  - View CCMs received on each trunk
- Perform Loopback testing on each PBB-TE trunk
  - Loopback Messages (LBMs) can be initiated on each trunk to verify reach-ability and measure round trip delay

PBB-TE Performance Testing

- **Stress PBB-TE BEB**
  - Scale PBB-TE trunks to DUT endpoint with CCI down to 3.33ms
  - Increase number of unique Customer MAC/VLAN addresses to stress forwarding table size
  - Test QoS by setting priority bits and configuring the DUT to examine/enforce/remark QoS
  - Test with broadcast and multicast traffic
- **Stress PBB-TE BCB**
  - Increase number of unique Customer MAC/VLAN addresses to stress forwarding table size
  - Test QoS by setting priority bits and configuring the DUT to examine/enforce/remark QoS
  - Test with broadcast and multicast traffic
- **PBB-TE Convergence Performance**
  - 2-port service interruption measurement
  - 3-port failover measurement
  - Precisely characterize the DUT (IXIA is PBB-TE endpoint)

Conclusion

- PBB-TE pre-standard has been implemented by many vendors
- Standard 802.1Qay is moving forward quickly
- Provides alternative to extending MPLS into the Metro network
- Works with all other technologies since Ethernet is agnostic to what it carries
- It has been through interoperability public testing
- Scaling and performance is not proven yet
- Theoretically very high scale
- Possible to achieve sub 50ms recovery
- Not fully mature, still developing
- Needs to be tested!

Thank You!
Questions?

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