>BUSINESS MADE **SIMPLE**

Provider Backbone Transport

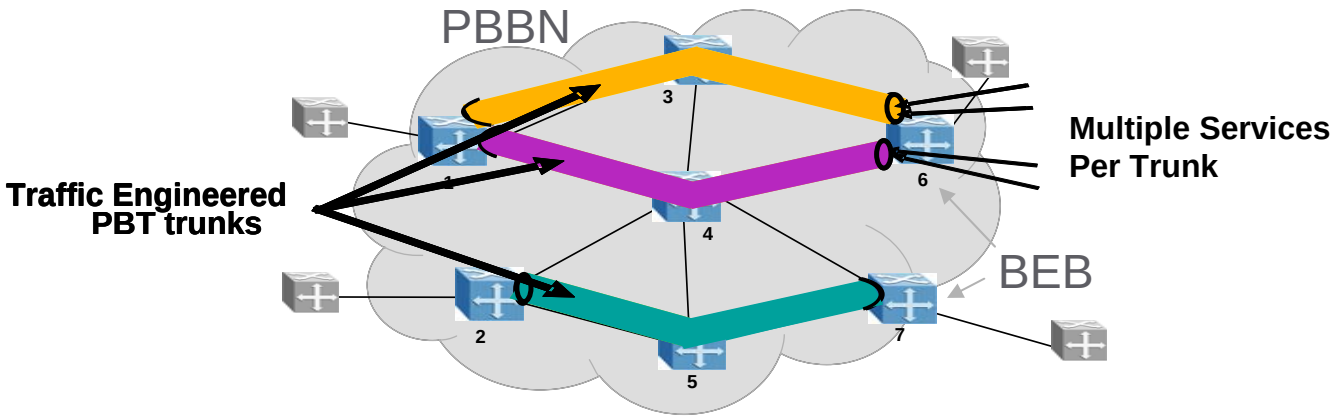
Paul Bottorff pbottorf@nortel.com
David Martin
Glenn Parsons
Dinesh Mohan
July, 2006

NORTEL

Agenda

- Reference:http://www.ieee802.org/1/files/public/docs2006/ah-bottorff-pbt-v1-0506.pdf
- PBT Overview & Value Proposition
- Services supported with PBT
- Connection management with Protection using OAM (802.1 ag)
- Managing & Control Planes
- What Would the IEEE Need To Do to Support PBT

What is Provider Backbone Transport (PBT)?



> PBB provides customer-carrier isolation (encapsulation), mpt, pt-mpt, and pt-pt services based on B-VLAN tunnels routed by MSTP, and defines a management domain

> PBT is a feature added to a PBBN supporting engineered pt-pt trunks. These trunks are used in place of B-VLANs to carry pt-pt, pt-mpt, or mpt services.
  - Removes constraint of following MSTP topology for path engineering
  - Provides bandwidth management allowing traffic engineering over path
  - Any number of 802.1ah services may be carried over a PBT trunk

> Both PBB and PBT use 802.1Q MAC address based relays.

> Leverage Emerging standards for:
  - Provider Isolation – PBB (802.1ah)
  - OAM & Protection(802.1ag & ITU-T Y.1731/G.8031)
  - PWE Carriage (IETF Dry Martini)
  - Management system or GMPLS for provisioning
  - PBT is currently on the living list at ITU-T SG15 PBT architecture description G.pbt

PBT Values

- **Traffic Engineering**
  - Control of routing
  - Admission control / policing
- **Connectivity monitoring (IEEE 802.1ag)**
  - Strong service management when coupled with Traffic Engineering & Service Assurance
- **Stronger resiliency and Protection (w/ ITU-T Y.1731 / G.8031)**
  - Eliminates Spanning Tree for tunnels
- **Easier management fit with auto-discovery (w/ IEEE 802.1AB)**
  - Fits with current transport operational model
- **Clear profit/business case for any given service**
  - Can map a service to its path & resources
- **Simply Scalable**
- **Reuses existing hardware and standards**
  - Maximizes the potential of today's ethernet forwarding hardware
  - Many IVL switches require only software changes to support PBT!
    12-bit VLAN/Route Discriminator & 48 bit global address

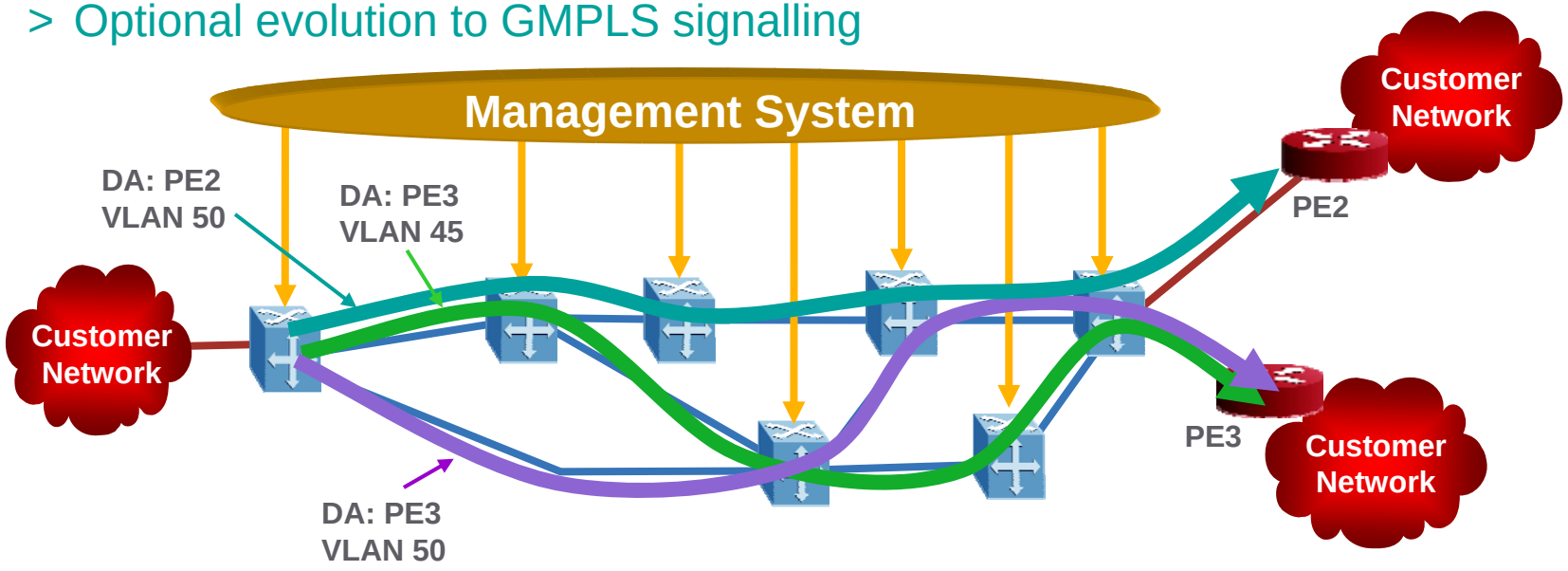
Delivers a lowest cost, dependable, easy-to-manage infrastructure

PBT MAC Forwarding

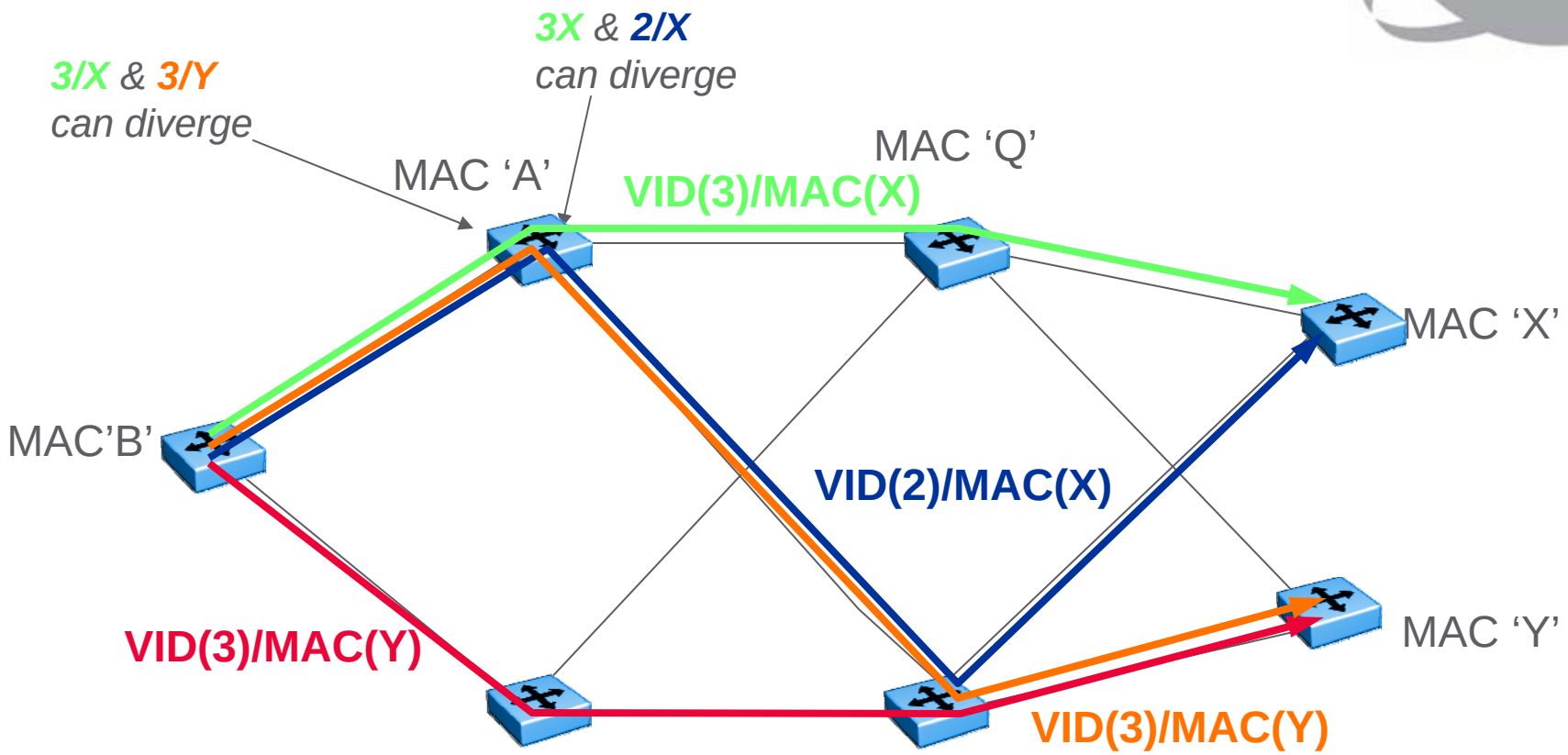
- PBT frames are forwarded based on B-DA MAC + B-VID using 802.1Q bridge relays just like normal bridge frames.
- The B-DA determines the BEB destination as normal.
- The B-VID determines the route tree for this B-DA MAC.
  - No VLANs exist in the PBT domain.
  - This is the key conceptual difference. The B-VID does not determine a VLAN, instead B-VIDs select a path for a destination.
  - The conceptual change does not change the operation of a 802.1Q relay. It is just conceptual!
- Each B-VID is reused for path selection for each B-DA. The total number of B-VIDs required is the number of independent paths needed to each destination.
- Things which are different than a standard 802.1Q ports and relay.
  - PBT must have control of a PBT B-VID address space and the port state for this B-VID address space.
  - PBT ports must start up with learning off and forwarding on.
  - Unknown or broadcast frames received at any PBT port must be discarded, not flooded.
- The PBT relay scales just as the Ethernet relay. It is possible to have 70 trillion destinations each with as many as 4094 paths.
  - Each relay carries a filtering table only as large as the number of PBT trunks passing through its relay.

PBT Control and Management

- So we split the B-VIDs, turn off MAC learning, Broadcast Unknown, and STP
  - Use PBB hierarchy to separate customers from the Provider network, and add hierarchical dataplane OAM for instrumentation and protection.
- Place under a Comprehensive Management system
  - Use a base spanning tree to control switches using SNMP
  - Management build complete topology model using auto-discovery base on 802.1AC
- Management sets up connections, populating switch bridging tables:
  - The VLAN tag is no longer a network global : scaling issues are removed;
  - VLAN tags now used to set up per destination alternate paths
  - A range of VLANs can be used for bridging and another range for PBT
- Optional evolution to GMPLS signalling



Dataplane Example



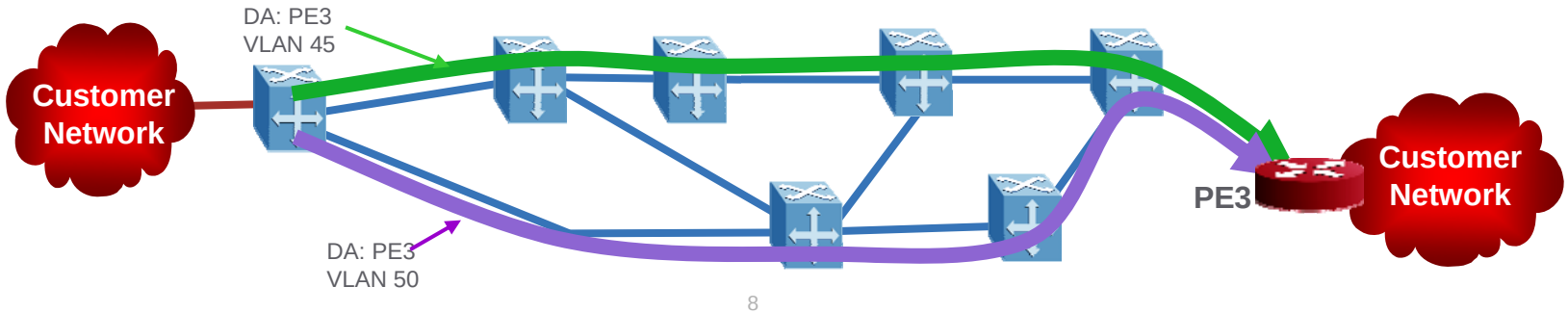
Note that MACs and VIDs can overlap, it is the combination of both that is unique and allows diverse routing

QoS and Resiliency

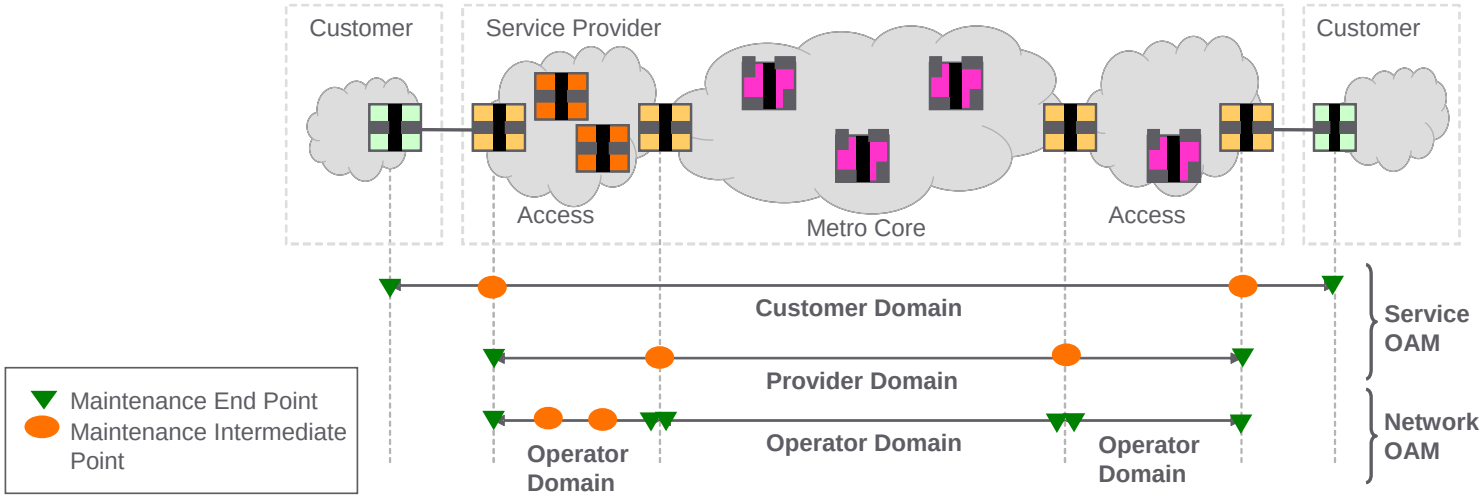
> Bandwidth can be reserved for the tunnel at each end point
  - The management system (or external control plane) does bandwidth allocation for the PBT trunk and each service over the trunk.
  - The bridges just forward frames they do not need any additions

> Ethernet VLAN “p” bits for differentiated services
  - One tunnel can provide per packet CoS
  - Can also support per packet pre-emption for resiliency

> Backup Trunks can be pre-provisioned for redundancy
  - Defined in G.8031 (Ethernet PS coordination) - *ITU SG15/Q9*
  - Ethernet CFM provides fault notification in millisecond time frames
  - Synchronizes PS state at both ends of a path
  - PS type (1+1, 1:1, etc.)
  - Administrative state (what is working, manual switch etc.)
  - Administrative control (force switch, revertive/non-revertive etc.)
  - Primary utility for maintenance operations



PBT OAM Key Principles



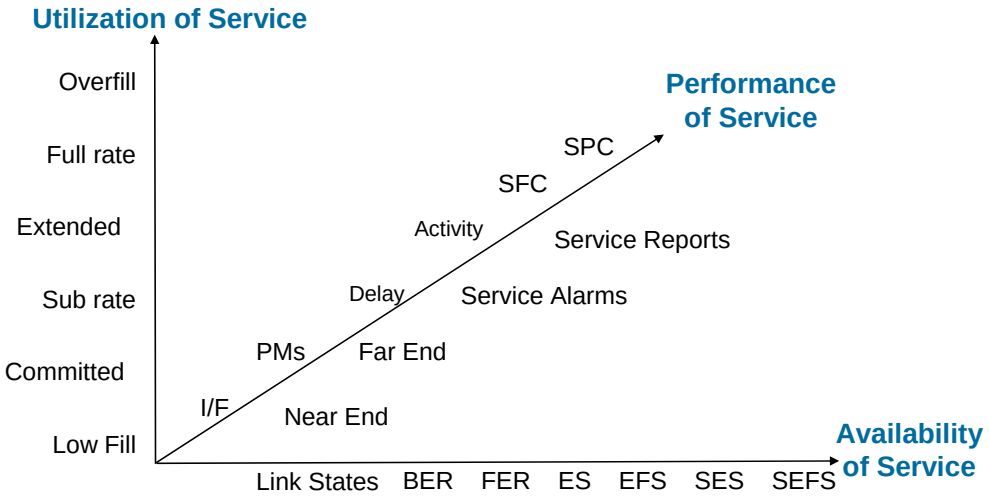
> **PBT can reuse all the Ethernet OAM initiatives in the IEEE and ITU**
  - Fault detection and notification (IEEE 802.1ag)
    > **CFM hierarchy** (IEEE 802.1ag)
  - Service Monitoring and performance (ITU-T Y.1731)
  - Resiliency and Protection switching (ITU-T G.8031)
  - Link layer discovery (IEEE 802.1AB)

> **Each PBT packet is self identifying**
  - Where did it originated (SA MAC)
  - Where is it going (DA MAC)
  - Which maintenance level is it (CFM)
  - What action/functionality does this frame represent.

> **No need to involve an unreliable control plane**
  - MPLS OAM relies on control plane
    - Determinism? Scalability?

Ethernet SLA Management Features ITU/MEF

1. **Performance of Service**
   a) **Frame Loss Ratio (FLR)** parameter is the number of service frames marked green on a per {VID, Pbits, CoS} basis that are delivered by the Provider network versus the total sent.
   b) **Frame Delay (FD)** Measurement of round trip frame delay by ultiizing the OAM frames as defined in ITU-T Y.1731



   c) **Frame Delay Variation (FDV-Jitter)** Measurement of delay using time stamps of consecutive OAM frames.

2. **Availability of Service**
   a) AoS is currently defined in Y.1731 as the amount of time that the PoS (i.e., FLR, FD, FDV for a given service) is satisfied versus the overall period of time in service.
3. **Utilization of Service**
   a) UoS is a proposed parameter derived from the OUTOCTETS count on a per {VID, P bits, CoS} basis The counter is read periodically (e.g., every second) and binned to some intermediate value (e.g., 1 minute), when an average utilization metric can be calculated
   b) Usage: Tracks bandwidth usage over time, fault detection,

Items in ORANGE are not available in MPLS OAM

What Would IEEE Specify?

> Add to or amend 802.1ah

> Things which are required for PBT relay:

- 1)Must provide a method for splitting B-VID address space between different topology protocols
- 2)Must provide PBT states which force the port PBT port state to learning off and forwarding on
- 3)Must provide a feature to disable broadcast and unknown forwarding

> Not required for PBT, but would be nice:

- Provide 802.1ag features for CC, LB, and LT (derived from Y.1731)
  - All CFM frames delivered over PBT must be unicast B-DA
  - For responses frames must a PBT TLV with the reverse B-VID
  - Definitions for PBT trunk group management
- Provide IEEE protection switching features (derived from G.8031)

Proposal For PBT Support

- Define a special MSTID called the PBTID (use 0xFFE) which identifies PBT rather than a MSTI.
  - An MSTIDs not in the MSTI list indicates some protocol other than MSTP that may run in parallel to MSTP (802.1Q-2005 12.12.1 and 8.6.2)
- Allow the FID to MSTID Allocation Table (12.12.2) to allocate a FID to the PBTID. (i.e. FID=0xFFE to PBTID=0xFFE)
- Allow the MST Configuration Table (12.12.3) to allocate VIDs to the PBTID.
  - The PBTID code of 0xFFE in the MST Configuration Table means “this B-VID is not allocated to an MSTI and is available to PBT for use as a route selector“.
- All VIDs allocated to PBT have a port state at each bridge port who’s state is forced to forwarding=on and learning=off (change 8.4)
- Add a static filtering entry type for all unicast addresses, for which no more specific static filtering entry exists (change 8.8.1 bullet a))
- Informative Annex explaining the use of PBT