BUSINESS MADE SIMPLE

Provider Backbone Transport

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

> 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 utilizing 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