Recent Advances in Carrier-class Ethernet Transport

Abhay Karandikar (IIT Bombay) and M Vinod Kumar (Tejas Networks Ltd.)

In the last decade, Ethernet has been upgraded with many carrier grade features like scalability, protection and restoration and operations, administration and maintenance (OAM) making it an ideal packet transport for core networks. In this article, we review these developments that have taken place in Ethernet standards.

IEEE 802.1ad Provider Bridges (PB) standardized in 2005 [1] was the first step towards applications of Ethernet Bridges in service providers' networks by separating the Customer virtual LAN (VLAN) from the service provider VLAN (S-VLAN). However, it still suffers from scalability problem. This problem was addressed in IEEE 802.1ah Provider Backbone Bridging (PBB) [2]. A PBB network comprises of Backbone Edge Bridges (BEB) and Backbone Core Bridges (BCB). Customer frames are encapsulated/de-capsulated at the BEB with Backbone Source MAC address (B-SA), Backbone Destination MAC address (B-DA), Backbone Service Identifier (BSI-ID or I-SID) and a Backbone VLAN ID (B-VID). While B-SA and B-DA are the MAC addresses of ingress and egress bridges within PBBN, 24 bit I-SID identifies the service in the PBB network. By separating the customer and provider MAC address space and separating service tag from forwarding tag, PBB leads to a scalable metro network design.

While PBB has addressed the issue of scalability, it does not have the capability of Traffic Engineering (TE). A new standard IEEE 802.1Qay [3] ratified recently in June 2009, addressed this problem by establishing traffic engineered paths called Ethernet Switched Paths (ESP). This is achieved by disabling address learning and spanning tree for a range of B-VID (called ESP-VID) in PBB and configuring them by an external management plane or control plane. Along with Connectivity Fault Management (CFM) [4], PBB-TE provides a highly scalable architecture for deploying Ethernet in core network.

PBB-TE specifies only 1:1 end-to-end point to point (P2P) tunnel protection switching and does not take advantage of possibility of local repair. New ongoing IEEE project 802.1Qbf PBB-TE infrastructure protection switching [5,6] addresses the relatively high failure rate of particular links or bridges within a network in an efficient way by performing local repair. A sequence of LAN ports (called Infrastructure Segment) over which at-least one PBB-TE tunnel is configured are identified and monitored through continuity check messages (CCM). See Figure 1. Upon absence of CCM, tunnels are diverted (without altering the end-to-end tunnel identifier) from working/primary infrastructure segment (WIS) to backup infrastructure segment (BIS). See Figure 2. WIS and BIS together form a segment protection group (SPG). Infrastructure Protection is applicable for both P2P and branches of Point to Multipoint (P2MP).

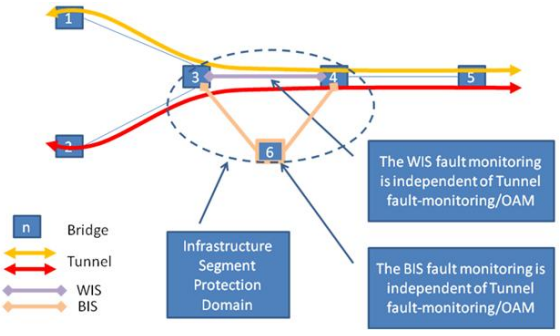

Figure 1: Before PBB-TE Infrastructure Segment Protection Switching

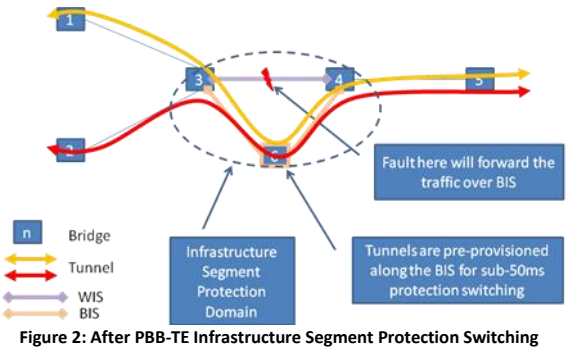

Figure 2: After PBB-TE Infrastructure Segment Protection Switching

IEEE 802.1Qbf will enable scalable and manageable backbone transport network. Service Provider can locally and cost-effectively protect a group of tunnels flowing over an infrastructure segment without modifying the tunnel identifier. Further, fault localization is still possible because tunnel identifier is not changed for customer frames and is globally unique thereby offering a true carrier class local-restoration functionality. Service Providers can perform

maintenance activities in one infrastructure segment of a network without disabling protection in another infrastructure segment. IEEE 802.1Qbf is still work under progress. In summary, several significant amendments to Ethernet will lead to truly scalable carrier class Ethernet with protection and manageable transport network.

REFERENCES

[1] IEEE 802.1ad, "Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks – Amendment 4: Provider Bridges", 2005.

[2] IEEE 802.1ah, "Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks – Amendment 6: Provider Backbone Bridges", 2008.

[3] IEEE 802.1Qay, "Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks – Amendment 10: Provider Backbone Bridging with Traffic Engineering", 2009.

[4] IEEE 802.1ag, "Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks – Amendment 5: Connectivity Fault Management", 2007.

[5] PBB-TE Infrastructure Protection Proposed PAR, IEEE 802.1 May 2009 Interim Meeting, Pittsburgh, PA., USA, http://www.ieee802.org/1/files/public/docs2009/new-sultan-infrastructure-segprot-proposed-par-0509-v05.pdf, 2009.

[6] IEEE 802.1Qbf "Draft PAR for Local and Metropolitan Area Networks, Virtual Bridged Local Area Networks – Amendment: PBB-TE Infrastructure Segment Protection", http://www.ieee802.org/1/files/public/docs2009/new-qbf-jeffree-draft-par-0609-v01.pdf, 2009.

Abhay Karandikar earned his M.Tech. and Ph.D degrees in Electrical Engineering from the Indian Institute of Technology, Kanpur in 1988 and 1994, respectively. He is currently a Professor in the Department of Electrical Engineering, IIT Bombay. At IIT Bombay, he started many technology development projects, including the one on Open Source MPLS and Linux based MPLS emulator. He co-founded the venture backed company Eisodus Networks. He is currently leading TTSL-IIT Bombay Center for Excellence in Telecom. His research group at IIT Bombay is currently focused on resource allocation in wireless networks. He has recently made several contributions to IEEE 802.1 and 802.16m WiMAX standard. Dr Karandikar has lectured extensively in various international fora and given tutorials in IEEE GLOBECOM, MILCOM. He has consulted for industries in the area of communications and networking.

Mr. Vinod Kumar received his B.Tech degree in Electrical Engineering from the Indian Institute of Technology, Madras in 2003. Subsequently, he completed his post graduation in Telecommunication from the Indian Institute of Science, Bangalore in 2005. Since then he is with Tejas Networks Ltd. working in Standards and Technologies Team. His primary focus is Optical Transport systems, Protection Switching, Quality of Service, Traffic Engineering, Networking Algorithms, Wireless Backhaul for 2G, 3G, 4G, Wi-Fi and mobile-WiMax, L2-L3 interworking, IP/MPLS and Carrier-Ethernet. Towards this end, he has applied for several patents. Mr. Vinod Kumar has made several contributions towards IEEE 802.1Qbf. His other areas of interest are Synchronization, TDM-Ethernet Circuit Emulation Service, Data-Centre Bridging and Load-balancing.