Pipeline

Knowledge is Power.

Multi-Dimensional Service Aware Management for End-to-End Carrier Ethernet Services

By Peter Chahal

We all know Ethernet based on its long history as the LAN connectivity technology of choice. Recently, Ethernet has made a transition from these traditional roots, maturing into a technology that can boast the same levels of reliability as frame relay and ATM, but can equally still tout its primary benefits as the most scalable and cost-efficient technology. As a WAN service, Ethernet has been complemented with carrier-grade technologies such as multi-layer OAM and end-to-end MPLS/VPLS, so we can rely on it to safely and securely run our most critical business applications and our most critical home applications.

But, engaging in the maturation process is no guarantee that you have fully matured. Carriers must become more operationally efficient to respond to the complexities of an on-demand and IP-converged world. Above all, to stay competitive, their network management systems must evolve to drive new Ethernet service revenues and deliver guaranteed end-to-end SLAs.

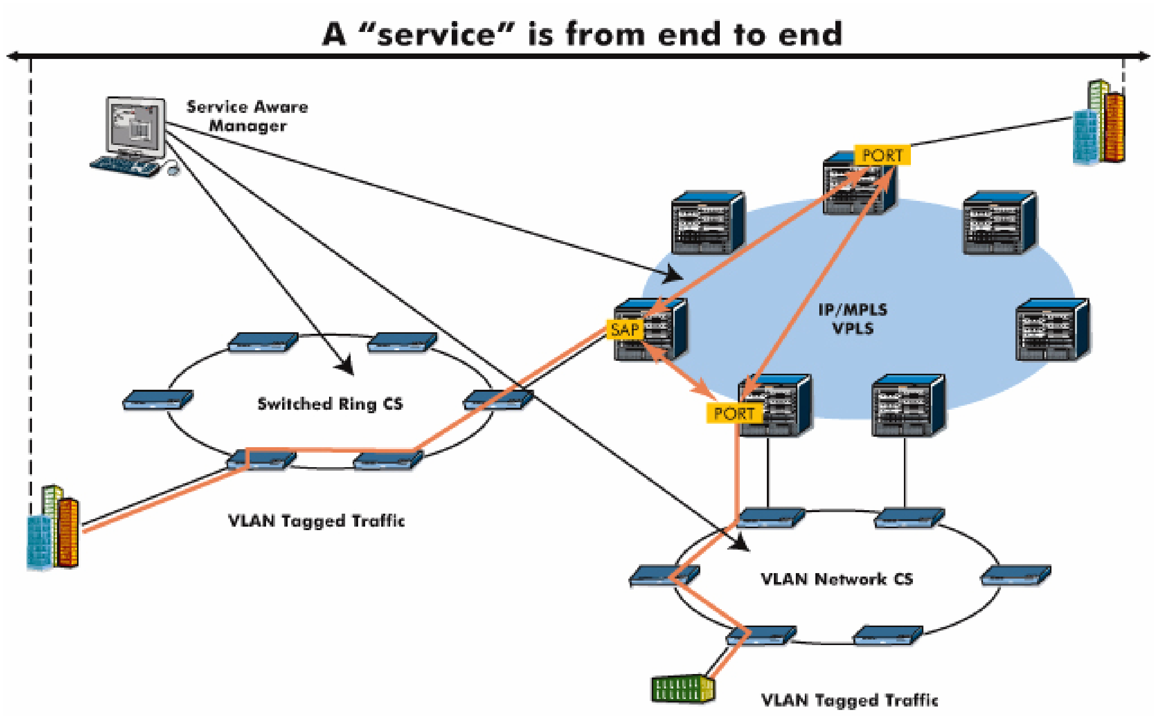
Service assurance is particularly critical for Ethernet services aimed at the Enterprise market as they have high expectations, based on their previous experience with frame relay and ATM, and their dependence on the network has a direct impact on their bottom line. They need detailed, stringent SLAs with appropriate levels of priority and security for all their voice, data, and video traffic on a converged, packet-based network.

Knowledge Provides Profitability and Efficiency

Carrying out fault management and troubleshooting for Ethernet services is quite different than for private line services, even when the Ethernet services are carried over a SONET/SDH network. Packet-based services generate significantly more statistics related to the underlying conditions of the service and the various applications being carried on the service. These statistics, relating to packet latency, throughput, packet loss and jitter, among others, are vital for fault management and ensuring that SLAs are met.

Modern MPLS-based Ethernet services, such as VPLS, provide a rich service layer, but with that richness comes some complexity. Complex networking solutions often use multiple service types, configured in service hierarchies sometimes called “composite services” (CS), to provide an overall networking solution. For example, Figure 1 illustrates an overall service composed of a VPLS network that is connected to two customer located equipment (CLE) Ethernet rings for service delivery. This particular deployment uses two technologies – Layer 2 switching and VPLS for the service delivery. The interworking interface between services, whether logical or physical, is called a service connection point (SCP).

Figure 1 – Simple Ethernet Service Composed of Multiple CS



A significant challenge posed by such a configuration is that the combination of CSs that make up the end service can span technologies and domains, and are often managed by disparate element managers. From a customer perspective, the collection of CSs is a single entity, and service providers would benefit greatly from being able to manage it as such, regardless of the technology nuances.

Service providers can overcome the challenges created by disparate element managers by using multi-dimensional service aware management to provide end-to-end fault management for "always on" services. Multi-dimensional service aware management enables the carrier to provide network and service management from a single entity as opposed to many one-dimensional element managers.

The service aware manager understands the hierarchy and relationships among the collection of CSs with which an end service is constructed, which enables the management system to react to individual nodal and CS events. Information can be correlated and presented to the operator relationally, allowing rapid recognition of and reaction to problems. Consider a carrier Ethernet VPN for an enterprise that is carrying VoIP, video, and data traffic with the appropriate service levels. The Ethernet VPN uses a VLAN in the access network and converges into a VPLS VPN at the provider edge (PE). Service aware management binds these two technology CSs (VLAN and VPLS) together to form an end-to-end picture of the service. By doing this, when problems occur on the CS, the carrier knows where the problem is and, more importantly, to what degree the end user's experience is compromised.

Operational Simplicity with Ethernet OAM

Ethernet OAM is seen as a prerequisite for efficient rollout of carrier Ethernet services. End-to-end network management for Ethernet virtual circuits (EVCs) is dependant on OAM tools in the data plane and control plane to verify continuity, connectivity and performance of the EVC. For in-band testing, the OAM packets closely resemble customer packets to effectively test the customer's forwarding path, but they are distinguishable from customer packets so they are kept within the service provider's network and not forwarded to the customer.

Figure 2 and the associated table below illustrate the benefits of integrating OAM functions with service aware management for sophisticated MPLS-enabled Ethernet services such as VPLS, H-VPLS, VLL and IP-VPNs. Note that the figure and table list the features service providers *should* get from a vendor. However, providers will want to evaluate each vendor's offering carefully since this level of functionality will not be available from every vendor.

Figure 2 – Service Aware OAM Toolkit

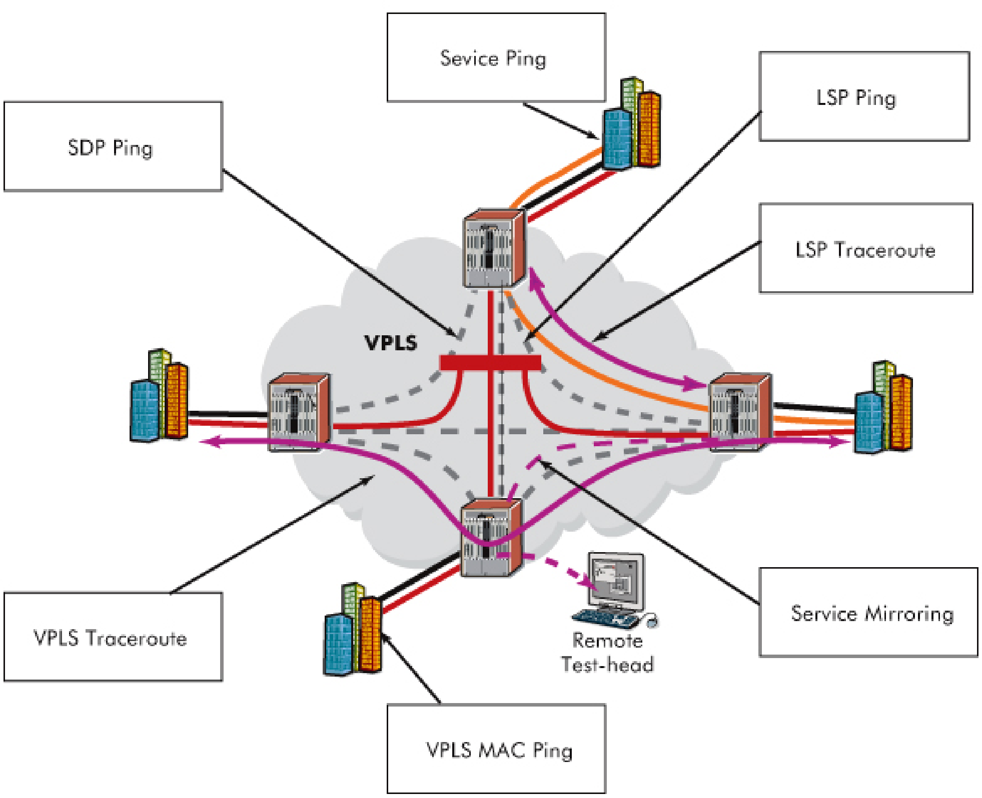


Table 1 – Carrier Ethernet Service OAM Tools

Diagnostic Test	Description
> LSP Ping	> In-band utility used to detect data plane failures in LSPs and LSP connectivity > Allows the operator to test that the LSP tunnel is working in both directions > Based on Internet Draft draft-ietf-mpls-lsp-ping-02.tx
> LSP Traceroute	> In-band utility used to determine the hop-by-hop path for an LSP > Allows the operator to know the destination path of the packets > Based on Internet Draft draft-ietf-mpls-lsp-ping-02.tx
> SDP Ping	> In-band utility used to test a service distribution point (SDP) for unidirectional or round trip connectivity with a round trip time estimate > Allows the operator to know if the service tunnel is reachable end to end and whether SLA delay metrics are being met
> SDP MTU	> Performs in-band maximum transmission unit (MTU) path tests on an SDP to determine the largest MTU that can be supported on the SDP > Allows the operator to get the exact MTU supported between the service ingress and service termination points (accurate to one byte)
> Service Ping	> Provides end-to-end connectivity testing for an individual service. > Verifies round-trip connectivity and delay to the far end of the service > Allows the operator to know if an individual service is provisioned accurately

> VPLS MAC Ping	> In-band and out-of-band utility that provides the means to test the learning and forwarding functions of a VPLS service instance; can also be used to display all operationally active SAPs within the VPLS service instance > Allows the operator to know if a specific destination can be reached > Based primarily on the IETF document draft-stokes-vkompella-ppvpn-hvpls-oam-00.txt
> VPLS MAC Traceroute	> In-band or out-of-band utility used to determine the hop-by-hop path for a destination MAC address within a VPLS service instance > Allows the operator to know the destination path of the packets > Based primarily on the IETF document draft-stokes-vkompella-ppvpn-hvpls-oam-00.txt
> VPLS MAC Populate	> Used to send a message through the flooding domain to learn a MAC address as if a customer packet with that source MAC address had flooded the domain from that ingress point in the service > Allows the provider to know if the FIB table is accurate by testing forwarding plane correctness and is generally followed by MAC ping or MAC trace to verify if correct learning occurred > Based primarily on the IETF document draft-stokes-vkompella-ppvpn-hvpls-oam-00.txt
> VPLS MAC Purge	> Used to clear the FIB of any learned information for a particular MAC address, allows the FIB to be populated only via MAC Populate and can be used to flush all nodes in a service domain > Allows an operator to do a controlled OAM test without learning induced by customer packets > Based primarily on the IETF document draft-stokes-vkompella-ppvpn-hvpls-oam-00.txt
> IP VPN Ping	> In-band and out-of-band utility that provides the means to test the learning and forwarding functions of an IP-VPN service instance; can also be used to display all operationally active SAPs within the IP-VPN service instance > Allows the operator to know if a specific destination can be reached
> IP VPN Traceroute	> In-band or out-of-band utility used to determine the hop-by-hop path for a destination IP address within an IP-VPN service instance > Allows the operator to know the destination path of the packets
> Service Mirroring	> Copies packets from a specific service to any remote destination point in the network, for troubleshooting > Allows the operator to examine packets as they traverse the network and meet law enforcement requirements (e.g., CALEA) > Service mirroring allows an operator to see the actual traffic on a customer's service with a 'sniffer' sitting in a central location, reducing the need for a costly overlay sniffer network

Service aware management can enable a policy-driven approach to OAM testing, which is critical in an environment with domain-driven constraints. As an example, the CLE environment uses Metro Ethernet Forum or IEEE ping tests, while the VPLS environment may use MAC or service pings. Because a service aware manager knows which tools are relevant in which domains, users of service aware management are able to write service verification policies that may be generically applied to a richly modeled and complex service. Examples of this include policies for full mesh testing, local mesh testing, and hierarchical testing of the outer VPLS tunnel in combination with local VPLS domain testing, and so on. The service aware policy will apply the right OAM test to the right technology.

Ethernet OAM enables the carrier to provide fast, accurate and efficient resolution to the customer service problem. Where in the past it may have taken hours or days to resolve an issue, it can now be diagnosed in a matter of minutes and corrective action taken. The customer SLA is not compromised and the service providers benefits from reduced OPEX.

Enterprise Service Portal

Service portals allow enterprises to monitor their services. Carriers can use the statistics generated by the service aware manager to enable the enterprise to develop its own reports on the health of its services. Some carriers are already offering customer-facing tools with GUI interfaces to allow their customers to perform these statistics-reporting functions. These tools can then be charged for, providing incremental revenue to the carrier.

Portals can also allow enterprises to dynamically change the bandwidth and other parameters of their services. Once again, carriers are building these customer-facing tools and producing incremental revenues.

Service Aware Management Comes of Age

A carrier class Ethernet network must enable service providers to efficiently provision services, manage faults, and troubleshoot the network. To meet these requirements in an increasingly competitive and demanding environment, service providers must have superior OAM capabilities in their network management systems. A multi-dimensional, service aware manager transcends the capabilities typically found in element managers, with its integrated and service-oriented architecture and applications that present the network to the management system as a single virtual node, thus simplifying service activation and assurance.

The resulting benefits, leading to reduced OPEX for the carrier are:

- Reduced cost and complexity through the composite service model
- Improved provisioning, service activation, and fault management
- Reduced human operator errors
- Faster mean time to repair – direct correlation of network faults to service impact

The capabilities of a multi-dimensional, service aware manager enable services providers to offer the service assurances their customers need and to back up their services with stringent SLAs. Without these capabilities, service providers will be relegated to providing best-effort services at commodity pricing.