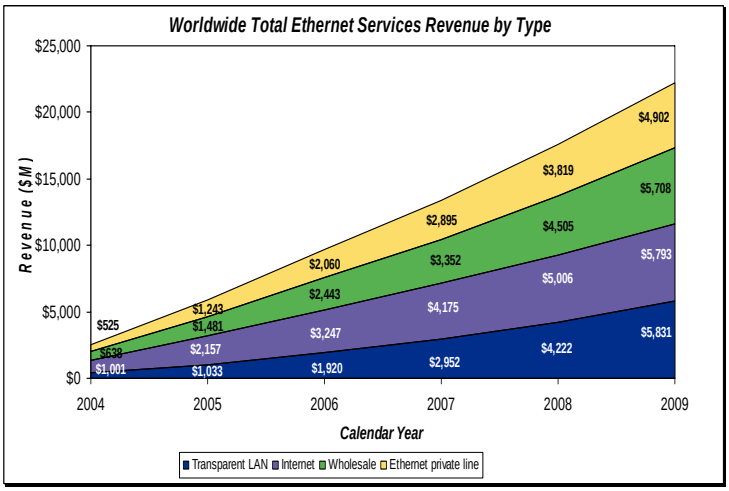
Pipeline Knowledge is Power.

The Intelligent Ethernet
By Fred Ellefson

Ethernet has dominated the enterprise local area network environment for the last several decades, and will continue to for the foreseeable future. Ethernet as a carrier service however is in its infancy, but is about to experience rapid growth. Infonetics Research forecasts carrier-based Ethernet services to grow to over $22B by 2009, up from $2.5B in 2004 (Figure 1). This is an opportunity that carriers will not want to miss out on. It provides one of the best opportunities to grow revenue at the same time that many of carrier's traditional services are shrinking.

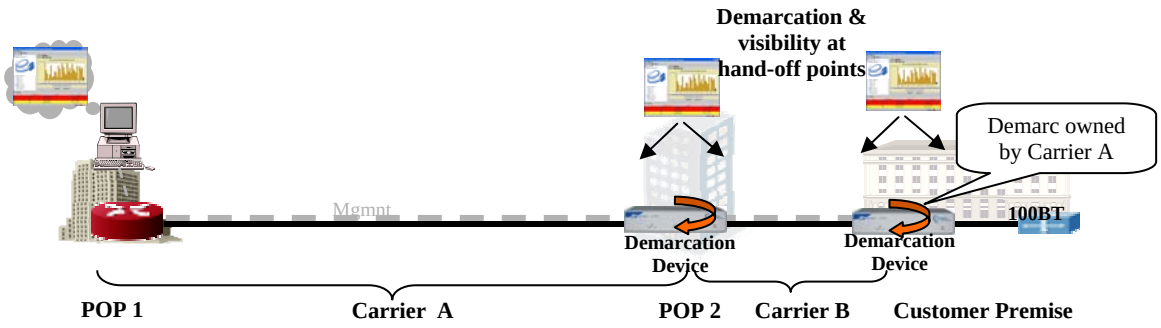


As carriers roll out Ethernet services and attempt to increase their Ethernet revenues, it is critical that they move from the early adopters into the mass market. Early Ethernet services are often best effort services and early adopters are willing to accept these services due to their increased bandwidth or lower cost per bit. However, to move Ethernet services into the mass market requires Ethernet Service Level Agreements (SLAs) and service intelligence comparable to those found in traditional data services. According to Vertical Systems Group, 82% of Ethernet service purchasers are switching from a traditional data service such as frame relay, private line or ATM to Ethernet. Without an Ethernet SLA, many of these users will stick with their traditional services.

Early frame relay services were also offered un-managed, without SLAs and carriers quickly determined that in order to ensure profitability, these services needed to be managed, automated and that customers required SLAs. Ethernet is going through the same evolution with un-managed services being replaced by more intelligent services and with demarcation devices being deployed at the customer premises. Ethernet demarcation devices are necessary to enable remote management, SLA monitoring, and craft automation. They also enable advanced service capabilities such as customer network management and web portals for real time visibility and control of an end-users service. Recognizing this need the standards bodies are developing standards for link OAM (IEEE 802.3ah), service/connectivity OAM (IEEE 802.1ag/ITU

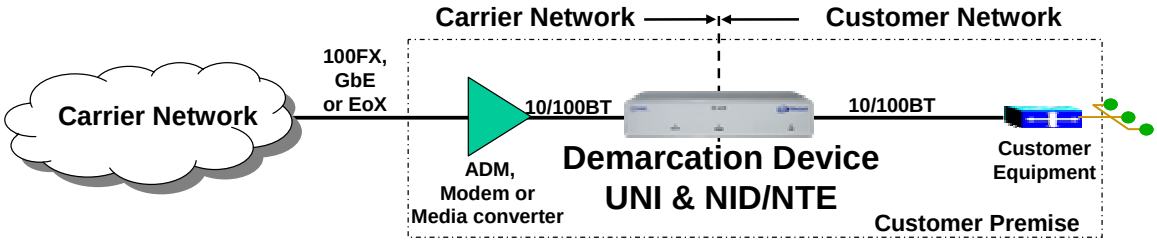
Ethoam), Ethernet UNI (Metro Ethernet Forum - MEF) and for demarcation devices (IEEE 802.1aj).

In addition, Ethernet wholesale services are becoming more prevalent as carriers follow their customers both in region and out of region. Infonetics Research expects wholesale Ethernet services to make up 25% of the Ethernet market through their entire 2005 to 2009 forecast horizon. Selling Ethernet services to other carriers is a much different proposition than selling to an Enterprise. Carriers tend to be more sophisticated customers who demand end-to-end SLAs for their UNI-to-NNI or UNI-to-UNI services. Often these SLAs will have rebates or guarantees associated with them and must be verified remotely in real time while the service is active for billing or rebate purposes. Again, Ethernet demarcation at both the UNI and NNI interfaces is critical to being able to address this key need of a major Ethernet market segment.



Ethernet Demarcation – What Should Carriers look for?

Customer premise Ethernet demarcation devices are now available that enable delivery of intelligent differentiated Ethernet services and provide a function that is analogous to a smartjack or CSU/DSU in a traditional data service. It is a critical step towards making Ethernet “carrier grade” for replacing traditional data services for mission critical enterprise applications. Demarcation also ensures that Ethernet services are profitable since the majority of operations expenses occur at the edge of the network where demarcation devices can reduce expenses at the same time that they are providing more service intelligence.



Ethernet demarcation requires a Network Interface Device (NID) for Operations, Administration & Maintenance (OA&M) functionality plus a User Network Interface (UNI) for providing advanced services definition. The NID OAM capabilities should include service monitoring functions such as SLA monitoring to determine service availability, dropped frames, frame delay and frame jitter. It should also incorporate maintenance and test functions such as: test pattern generation and port/VLAN level loopbacks to enable RFC-2544 testing. The service UNI is necessary to provide service intelligence for defining CIR (committed information rate), EIR (excess information rate) and burst-size of individual ports, priorities or VLANs. It should use 802.1p, 802.1q, TOS or DSCP to classify traffic into an EVC, VLAN or priority level. In short, the UNI provides the service personality of the Ethernet offering.

The combination of a UNI and NID found in Ethernet demarcation devices enable carriers to deliver Ethernet services with more service intelligence and flexibility than frame relay or private line. In particular, Ethernet provides the ability to remotely change service bandwidth without requiring a site visit to add T1s or swap a T1 for a T3. It provides the foundation for customer network management systems that will provide more service intelligence and flexibility than those found in frame relay and private line services

Intelligent Ethernet Services

The Metro Ethernet Forum has defined a set of Ethernet services that is gaining widespread adoption by carriers deploying Ethernet services. They define two service types E-Line and E-LAN which represent point-to-point and multipoint-to-multipoint service types. The vast majority of Ethernet services today are E-Line services, but many carriers are also rolling out E-LAN services as well.

In order for Ethernet services to replace legacy frame relay and private line data services, it is critical that Ethernet performance parameters be incorporated into service level agreements that include penalties and rebates. The following four service parameters are critical to defining a carrier grade intelligent Ethernet service:

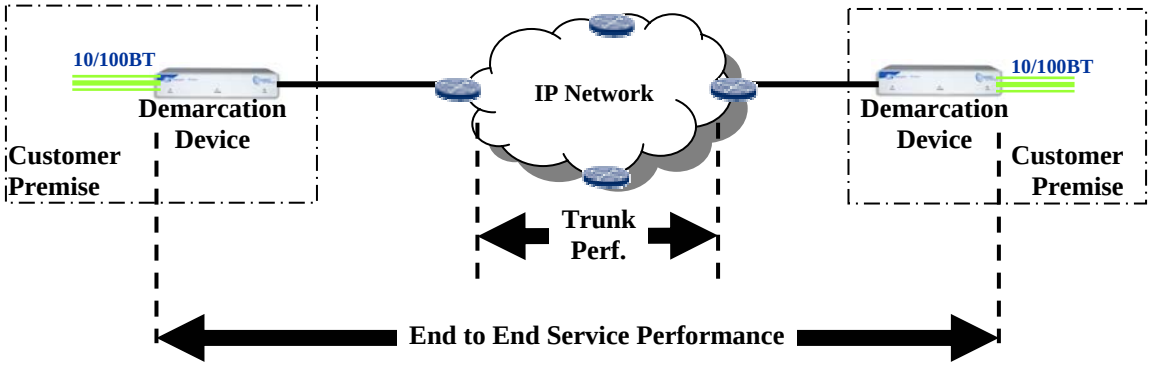
- **Availability** – Service uptime expressed as a percentage of time e.g., 99.99% or 99.999% availability for the service
- **Frame Delay** – The maximum frame delay for X percent of CIR conforming frames are continuously monitored over a specified interval – can be specified on either a round trip or one-way basis. Round trip is adequate for most application, while one-way is important for broadcast applications such as video.
- **Frame Jitter** – Defined as difference between the max and min delays in the frame delay test.
- **Frame Loss** – The percentage of CIR conforming frames that are dropped during transport.

These service parameters can be utilized to define a SLA as:

- **Availability** – Service availability shall be measured continuously on an end-to-end basis. Service shall be available 99.99% of time in a given billing month. This equates to no more than 5 minutes downtime a month.
- **Frame Delay** – Frame delay is measured continuously on an end to end (service) basis. The maximum (and minimum) frame delay for 99 percent of CIR conforming frames are continuously monitored over 15 minute intervals, and reported on a monthly billing cycle. Round trip delay will not exceed 50ms for more than three 15 minute intervals per billing cycle.
- **Frame Jitter** – Frame jitter shall be measured continuously on an end-to-end (service) basis. It will be calculated over 15 minute intervals and reported on a monthly billing cycle basis. It shall not exceed 30 ms for more than three 15 minute intervals.
- **Frame Loss** – The number of CIR conforming frames that are accepted at the service ingress UNI is continuously monitored and compared with the number of frames delivered at the service egress UNI. On a month basis, 99.95% of accepted frames will be transported without error to the far end.

SLA Verification

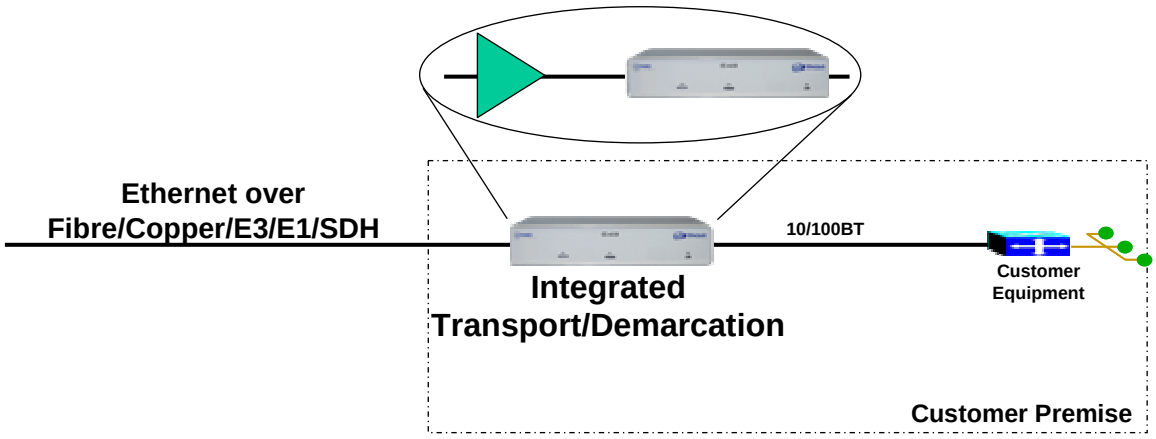
Measuring Ethernet performance can be challenging for carriers, especially on an end-to-end (service) basis. It is even more difficult when you consider that 25% of services will be carried over wholesale services leased from other carriers. This has resulted in many carriers specifying trunk level or network core performance in their SLAs instead of end-to-end service level performance. While this may satisfy some enterprises, most desire end to end performance more in line with the types of SLAs that exist for existing frame relay and private line data services. Since the majority of Ethernet users (82%) will be migrating from a traditional data service to Ethernet, SLAs are a necessary step towards ensuring that customers will make the migration.



Delivering intelligent Ethernet services requires a network architecture that can support both robust service delivery and verification of SLAs. Customer premise

located Ethernet demarcation devices based on emerging 802.1ag, ITU, and MEF recommendations can provide end-to-end visibility of SLA on both an in-service and an out-of-service basis and let carriers provide a differentiated intelligent Ethernet service. These devices can be used to measure all four Ethernet service parameters on a continuous basis, and provide 15 minute and daily measurement intervals necessary for SLAs.

Demarcation technology is being integrated with Ethernet transport or media conversion devices which are required for most Ethernet services. This provides an optimized service delivery platform, which reduces the number of network elements required at the customer premise and increases reliability while lowering capex/opex costs. Supporting a variety of transport technologies enables delivery of a ubiquitous Ethernet service, allowing carriers to support multi-site customers both in-region and out of region.



Coaxing Enterprises customers to move from traditional data services to Ethernet requires evolving Ethernet from a best effort service to an intelligent Ethernet service that is carrier grade and incorporates SLAs. With new Ethernet standards and demarcation equipment, intelligent Ethernet can be deployed ubiquitously to profitably move Ethernet into the mass market environment.