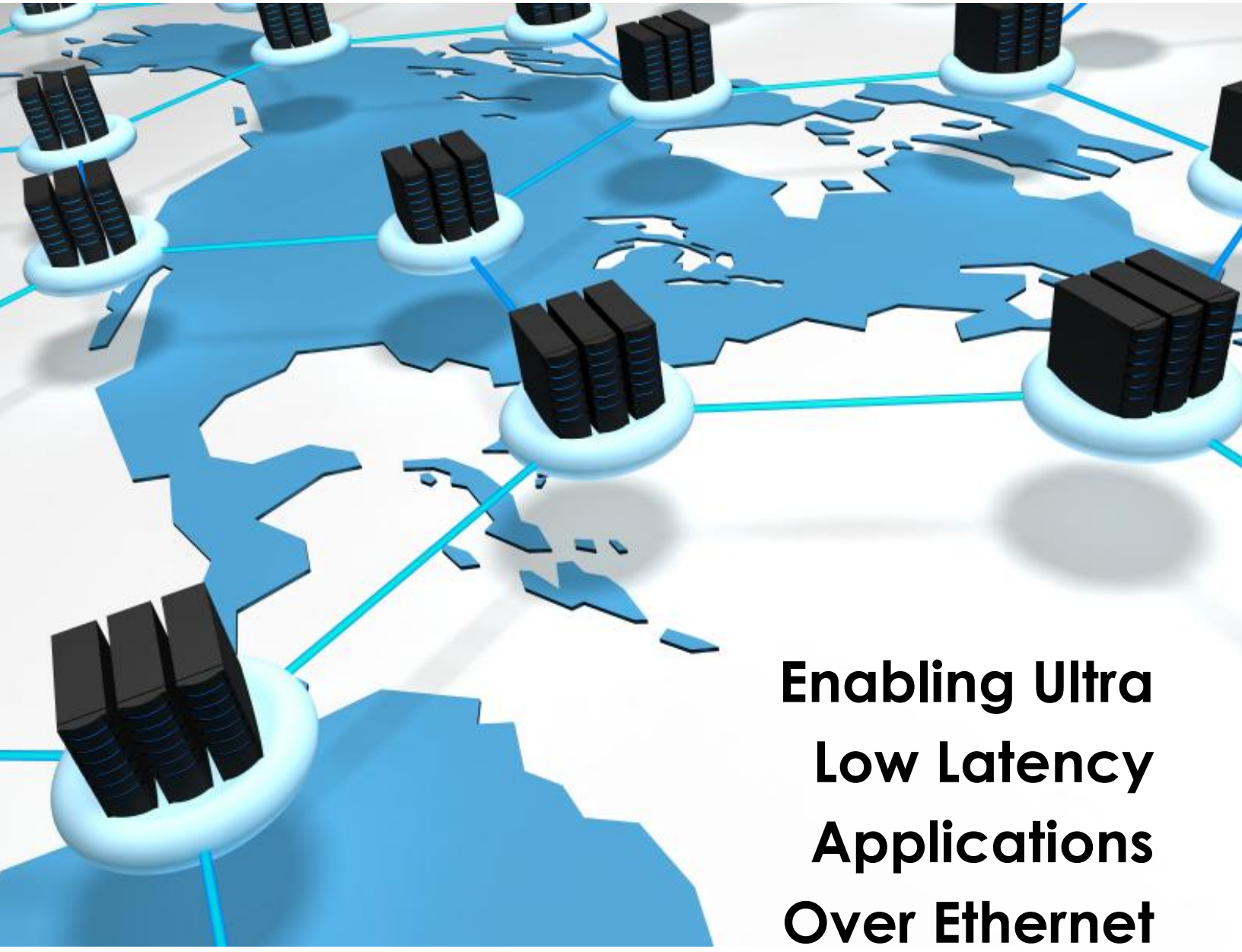
A PacketExchange White Paper



Enabling Ultra Low Latency Applications Over Ethernet

By Grant Kirkwood

CTO, PacketExchange

Overview

With the explosion of content and multimedia on the Internet over the past few years, it's not surprising that Internet Service Providers (ISPs) and carriers that make up the backbone of the Internet have been challenged with delivering quality, high performance data at such an accelerated pace. In the past few years, the Internet has transformed from non time-sensitive traffic such as email, web browsing, and "instant" messaging to more real-time multimedia and interactive sessions. Today, nearly all users access real-time Internet applications, such as digital broadcast IPTV, VoIP, Internet video and gaming. This change is placing an increased demand on the Internet and the packet-based networks on which these services reside.

Continual improvements in the wireless arena are also increasing these demands, as voice optimized 2G networks move to data-optimized, video-enabled 3G and 4G networks.

The Enterprise sector has its specific demands as companies move from dedicated connections such as traditional T1/E1-T3/DS3, Frame Relay, ATM, digital PBX to Ethernet, virtual circuits, IP PBX and VoIP technologies.

The Internet was designed to send small packets rather than constant streams of data, most commonly used today. This poses a challenge for Network Providers who are now forced to deliver high quality data and content, even though many underlying networks were not built to accommodate this type of traffic. As the demand for real-time delivery of IP-based data continues to grow, how can service providers offer quality services, efficiently and cost-effectively?

This white paper explores and discusses the demands for quality IP and the ways service providers augment their networks to accommodate the quality required to deliver more real-time content and multimedia services.

The Internet Peering Ecosystem

The Internet Peering ecosystem has seen a dramatic shift in recent years away from the traditional Tier 1 carriers as more and more users and content have shifted to the edge, closer to end-users serviced by more local or regional broadband providers. In fact, a study released by Arbor Networks[1] in October 2009 revealed that most Internet traffic bypasses Tier 1 networks. According to this study, the majority of Internet traffic now goes through direct peers and does not flow through incumbent Tier 1 telecom networks. Today we are seeing that these regional and local providers, forced to compete with the 'giants,' have the flexibility to employ cutting-edge techniques at the network level to optimize the streaming experience for end-users.

Another trend forcing companies to re-consider their network infrastructure design is the consolidation of companies that control the Internet. According to Arbor Networks' study, there are about 30 large companies, including Facebook, Google and Microsoft that control nearly a third of all Internet traffic today. Up to two years ago, it took more than 5,000 companies to handle just half of the world's Internet traffic; today the volume is controlled by about 150 companies, Google alone controls 7% of the world's Internet traffic. In addition, application providers are developing more bandwidth-intensive services for both the Enterprise and Consumer markets. Now we are seeing that services such as Google apps, CNN Video, Salesforce.com, Microsoft, Amazon Web Services, are delivering high-speed applications via Ethernet and fiber, thus driving an increase in demand in quality network services.

The Enterprise's Changing Network Demands

Enterprise businesses today are leveraging increased access to quality bandwidth for their applications and wide-area-networking, but they are also enabling more of their workforce to telecommute. This increase in workforce mobility requires seamless access and high-speed transmission from not only home offices, but also from smart phones, laptops, and hand-held devices. All of those devices are making information more accessible, further driving the demand for interactive applications. Other technologies such as virtualization and cloud-based applications are slowly maturing, also adding to the accessibility of Enterprise network data and applications**.** Furthermore, the consumer market is demanding access to more online video and Web 2.0 applications that require high-speed bandwidth. Companies like Xbox, YouTube, Vonage, Skype, Joost, Verizon FIOS, and iPhone are escalating the adoption of online video and Web 2.0 applications, as well as increased mobile data penetration and improved ease of

[1] Arbor Networks collected data from nearly 3,000 peering routers across 110 large and geographically diverse networks. The data mining consisted of nine Tier 1 carriers, 48 Tier 2 carriers and and 33 consumer and content providers throughout the Americas, Asia, and Europe.

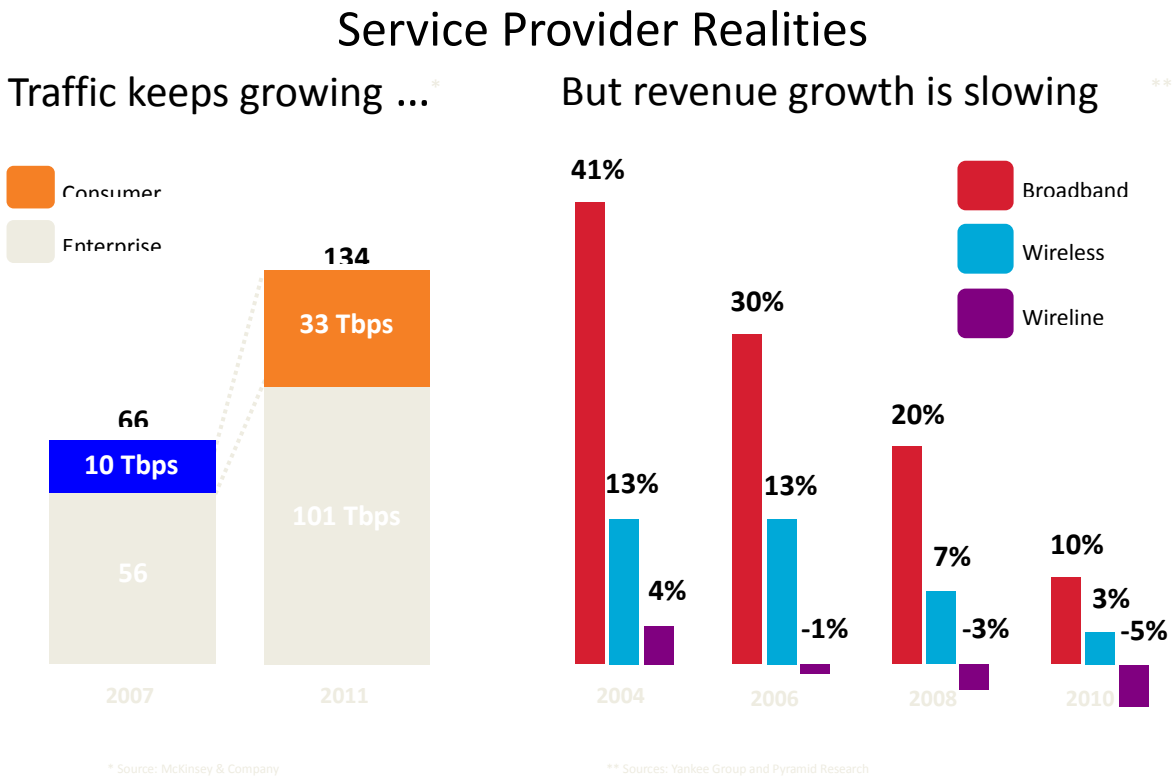
use. Now Quality of Service (QoS), which was once important only at the carrier and Enterprise level, is key even at the consumer level**.**

When you look at the marketplace as a whole - both consumer and Enterprise - you see that across the board new applications are created daily that are becoming more and more sensitive to network conditions. New QoS policies are being created to support these technologies, creating challenges for both service providers and businesses**.**

Service Provider Reality

Traffic on Service Provider networks continues to grow, forcing companies to re-examine their infrastructure and to allocate additional OPEX to meet the market demands. While traffic keeps growing, the price for bandwidth is falling. This is putting pressure on company's revenue targets, which at best are remaining the same, where most have seen revenue falling. From 2007 to 2011, there was an increase of over 100% from 66 Tbps to 134 Tbps of traffic, of which consumer traffic made up 33 Tbps of that total or 25% of all Internet traffic (source: McKinsey & Company). Both the Yankee Group and Pyramid Research have indicated that as broadband, wireless and wireline services demand increase, there is a sharp revenue decline over the past few years. Broadband service revenue in 2004 used to make up 41% of the offerings and it is predicted that by 2010 it will only make up 10% of the market.

See the chart below for more information:



* Sources: McKinsey & Company and Yankee Group and Pyramid Research.

The good news is that technology is advancing rapidly and there are techniques that optimize the end-user experience for Internet video, streaming, and heavy content viewing.

The Tier 2 Solution

By interconnecting and peering with Tier 2 networks and broadband providers that provide services closer to the edge, customers can be assured their streaming traffic is more efficiently routed, reducing packet loss and latency, by going directly to the networks that provides

services to the end-user. Additionally this type of peering model ensures resiliency through multiple connections with a variety of providers in many global locations.

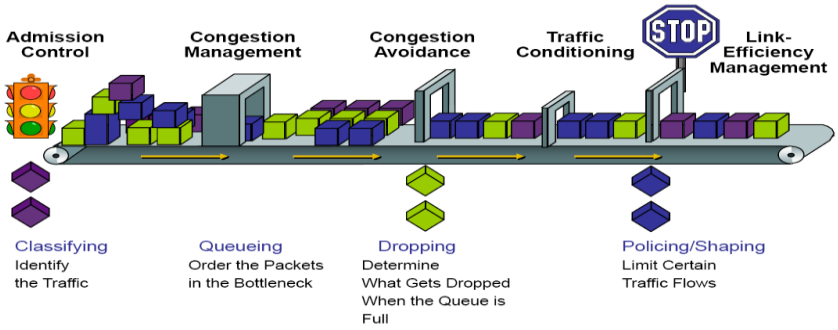
By implementing focused traffic management techniques, including bandwidth policing, traffic filtering and shaping, it is possible that a carrier's quality of service (QoS) can be enhanced, ensuring optimized packet-delivery over existing multi-vendor, multi-technology, and multi-carrier networks. Combined with developments in technology that allow near-zero latency, the potential exists to have a much more successful approach to delivering new services and applications seamlessly.

With global Ethernet becoming more prevalent, it is becoming easier for companies to transport high capacity data, quickly and efficiently. Ethernet QoS is measured by overall end-to-end packet loss, latency, and jitter. With users dependent on public and private IP network communications, improvements to the overall quality can be more efficiently measured. This is important as we consider that not all applications are created equal. Different applications are sensitive to different performance metrics. This is important to recognize to ensure that as a company designs its network, the highest and most sensitive applications are kept in mind – since the network is only as good as the best application it carries.

But it's not as simple as providing Class of Service (CoS) and QoS, since both metrics are comprised of many moving parts. As more companies specialize in delivering regional services, more networks are converging – easily enabled by Ethernet. These converged networks have applications that require different quality metrics. When you combine that with fundamental network performance being relatively static and the reality of network congestion and various network events, you can see the global challenge presented to global service and network providers.

Another important factor to consider is a network's defined policy and data classification design. The key is to define, as accurately as possible, the data classification in order for packets to be delivered most efficiently. It's no longer the 'norm' to rely solely on traditional methodologies such as bandwidth policing as types of data continue to evolve. For instance, in the traditional approach, metering traffic drops packets without discretion. Any congestion across the network causes routers to buffer the data, and buffering causes latency affecting the quality experience of real-time applications. Using precise classification, a network provider can enhance the end user experience by prioritizing time-sensitive traffic over static content.

QoS Modeling diagram



With today's technology and network optimization techniques, it is achievable to provide end-to-end QoS. However, as a multi-vendor, multi-carrier or multi-technology network, there are challenges that need to be overcome. Everyday new technologies are being developed to address this limitation. Until the technologies further evolve, there are other ways to address these issues.

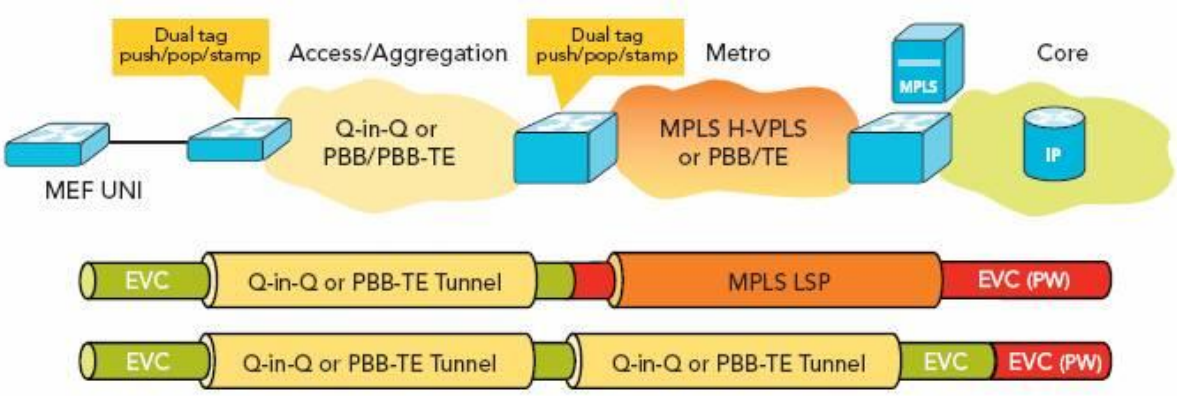
Enhanced Network Design

PacketExchange has designed its network to provide optimal end-to-end service, using exact classification techniques coupled with traditional QoS metrics. By implementing Ciena's Carrier Ethernet Service Delivery (CESD) technology, PacketExchange has been able to transform its service delivery while drastically cutting costs and time to market. This technology has also provided PacketExchange with a true competitive edge in the enterprise marketplace.

PacketExchange's implementation of Ciena's Carrier Ethernet Service Delivery product portfolio complements and integrates seamlessly with PacketExchange's existing Layer 3 backbone increasing network flexibility, manageability and cost-effectiveness, improving the company's capital position in its infrastructure. The key benefits of implementing this solution are as follows:

- Dramatic reduction in service delivery time from 45-60 days to just 2 days
- Significantly reduced network management costs, time and complexity for customers, enabling more competitive pricing in the market
- Cost of equipment is one fifth of like-for-like Layer 3 solutions

Today, PacketExchange has implemented a solution based on the CN 3940 Service Delivery Switch and the CN 5305 Service Aggregation Switch (both part of Ciena's Carrier Ethernet Service Delivery product family). This solution uses Provider Backbone Bridging – Traffic Engineering (PBB-TE) technology, which combines the benefits of connection-oriented networks with the low cost, simple-to-deploy features of Carrier Ethernet. This also provides enhanced Ethernet connectivity solutions using VLAN bridging or tunneling between Layer 2 MPLS networks and Layer 3 MPLS networks. Provider Backbone Bridging is a traffic engineering technology that provides end-to-end QoS based on the most stringent performance metrics. It is the first Carrier Ethernet protocol that is not integrated into a Layer 3 protocol (MPLS) making it much more efficient to interconnect different types of networks.



Seamless service/tunnel interworking between PB (Q-in-Q)

PacketExchange's integration of Ciena's state-of-the-art Carrier Ethernet Services Delivery technology, coupled with the company's leading technology PBB-TE Ethernet Transport network, provides PacketExchange's customers with the highest quality, seamless, integrated global solution available in the market. The network is tested on regular intervals to ensure quality, Frame Delay, Jitter, and Frame-Loss to ensure data packets are delivered end-to-end in the most optimal way - providing true carrier Ethernet with end-to-end QoS.

For more information about PacketExchange, please visit www.PacketExchange.net or email info@PacketExchange.net.