

White Paper

Ubiquitous & Affordable Ethernet: A Perspective on XO's Ethernet Hub Service

Prepared by

Stan Hubbard
Senior Analyst, *Heavy Reading*



www.heavyreading.com

On behalf of



XO Communications
www.xo.com

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EXECUTIVE SUMMARY

Enterprises from all types of industry verticals are increasingly embracing next-generation Ethernet services to cost-effectively scale and adapt with changing communications requirements and to improve their productivity and competitiveness in today's on-demand business environment. Enterprises are looking to purchase flexible and tailored Ethernet offerings from service providers that can quickly deliver always-on connectivity to all of their required locations.

Service providers have increased investments in carrier Ethernet network technology to meet the growing demand for higher-performance Ethernet services, but they still face challenges in accelerating more rapid adoption. This includes the need to overcome hurdles related to:

- Ethernet service availability
- External network-to-network interconnection (E-NNI) among Ethernet service providers
- Scaling the network to meet the demands of many customer endpoints where multiple services may be converged over a single user network interface

XO is addressing requirements for reliable, broadly available Ethernet connectivity by building a nationwide, next-generation network capable of providing Ethernet services with a common look and feel within and between its many U.S. metro markets. In 2008, XO expanded its Ethernet portfolio to include a new wholesale point-to-multipoint Ethernet Hub service that is capable of reaching nearly 4 million building endpoints. XO is able to offer such extensive coverage by taking advantage of multiple on-net and off-net access options.

While the industry works to finalize and implement E-NNI standards, XO is helping to smooth the exchange of traffic between operators by offering a flexible solution with predictable, dedicated bandwidth between hub and spoke sites. The Ethernet Hub service enables carrier customers to extend their own service reach by purchasing a single 1-Gbit/s Ethernet connection and adding lower-level sites with speeds ranging from 5 Mbit/s to 500 Mbit/s.

XO has adopted VLAN stacking on a nationwide basis to address scalability needs and to provide a fully transparent service. Its Ethernet Hub solution allows convergence of multiple services with different VLAN tags – such as VoIP, videoconferencing, and dedicated Internet access.

Available market data suggests a point-to-multipoint Ethernet service such as XO's can deliver more than twice the bandwidth between hub and spoke sites for the same price as traditional NxT1 private line connections between these locations.

I. Introduction

Enterprises worldwide increasingly are shifting investment away from legacy Frame Relay, ATM, and TDM private line services toward next-generation Ethernet services to cost-effectively scale and adapt with changing communications requirements. Enterprises are looking to purchase flexible and tailored Ethernet offerings from service providers that can quickly deliver always-on connectivity to all of their required locations.

Service providers both large and small are expanding their Ethernet service offerings and investing in new access technologies to meet burgeoning enterprise interest in Ethernet and add new customer endpoints to their networks. They are rolling out sophisticated yet cost-efficient Ethernet services with enhanced performance, reliability, scalability, and flexibility. Many operators are establishing partnerships with one another to extend their service footprint without making big capital investments during a time of economic uncertainty.

This white paper explores Ethernet's compelling value for enterprises and operators and focuses on XO Communications, an advanced communications service provider that has played a leading role in driving the adoption of Ethernet services in North America. We examine XO's new wholesale Ethernet Hub service and highlight how it enables carrier customers to deliver reliable Ethernet connectivity on an unprecedented basis within the U.S. by leveraging its nationwide fiber footprint and a combination of new Ethernet access technologies.

The paper also analyzes the financial savings that an Ethernet point-to-multipoint service has the potential to offer compared to legacy TDM private line services. The white paper concludes by sharing key questions that carrier customers should consider when evaluating solutions from Ethernet service providers.

II. Ethernet's Value & Key Customer Requirements

Enterprise Ethernet services are among the fastest-growing revenue opportunities in service providers' data communications portfolios. It is not uncommon to hear about service providers achieving double-digit annual revenue growth rates for Ethernet services even off of relatively large revenue bases.

The compelling value of Ethernet to both enterprises and operators gives *Heavy Reading* confidence that the Ethernet services market will increase for many years to come, even during the global economic recession. Indeed, while macroeconomic troubles will reduce or delay some carrier investment in next-generation networks, many enterprises may actually accelerate the shift to Ethernet to get better control over their communications costs and drive productivity off of smaller IT and communications budgets.

The discussion below examines why today's Ethernet services are so attractive to both enterprises and carriers. We highlight the key requirements enterprises have in choosing particular Ethernet services and Ethernet service providers. We also raise some of the key challenges operators have in addressing enterprise needs.

2.1 Enterprise Perspective & Key Requirements

Market feedback and survey data from *Heavy Reading* indicate that enterprises are embracing Ethernet first and foremost for the ease with which it allows them to cost-effectively scale with rising bandwidth requirements. Two thirds of enterprise respondents in *Heavy Reading's 2007 User Survey on Ethernet Services* said the ability of Ethernet to deliver "more bandwidth for the money vs. legacy data services" and enable "easy, scalable growth" were critical/very important factors in motivating them to consider Ethernet services.

Figure 2.1: Enterprise Survey Results – What Is Essential/Very Important to Users?

RANK	WHAT MAKES ETHERNET ATTRACTIVE?	WHAT SERVICE FEATURES ARE MOST IMPORTANT?	WHAT IS MOST IMPORTANT WHEN CHOOSING A PROVIDER?
1	More bandwidth for the money vs. legacy data services 68%	High service uptime/reliability 77%	Service reliability 87%
2	Easy, scalable growth 66%	High levels of security 71%	Deliver Ethernet services to all required locations 66%
3	QoS/CoS options for various applications 63%	High bandwidth 64%	Quick delivery/quick deployment of moves/adds/changes 62%
4	Multiple services over a single UNI 62%	Low packet loss 63%	Price 60%
5	Very high-bandwidth WAN connections 61%	Physically separate core not accessible by public Internet 60%	Offer on-network services all the way to the premises 58%

Source: *Heavy Reading, 2007 User Survey on Ethernet Services*

As Ethernet has become more feature-rich, enterprises have also been attracted by its ability to support multiple services, such as VoIP, videoconferencing, storage extension, and access to MPLS/IP VPNs, over a single user network interface (UNI).

While enterprises are generally enthusiastic about using Ethernet, many are placing high demands on operators to deliver more robust services. More than 70 percent of surveyed IT managers told *Heavy Reading* that they viewed service uptime/reliability and security as "critical" or "very important" in any offering. At least 60 percent of respondents also indicated that their companies place a premium on high bandwidth, low packet loss, low latency, low jitter, and a physically separate core that is not accessible by the public Internet.

2.2 Why Service Providers Have Embraced Ethernet

Service providers have embraced high-performance Ethernet to deliver a richer set of revenue-generating connectivity services. Ethernet is a widely used, simple, cost-effective, granular, and scalable technology that can enable service providers to roll out and quickly provision a range of tailored services at competitive prices – leveraging a lower cost base than that of traditional transport and switching technologies.

When carriers provide Ethernet services to enterprises, they can generally do so promising greater operational efficiencies compared to ATM or Sonet services, because Ethernet is so familiar – transporting 98+ percent of business LAN traffic – and often requires minimal staff, training, and operational restructuring on the part of the enterprise customer.

Ethernet services benefit from the seamless extension of the Ethernet protocol from the LAN to the metro-area network (MAN) and wide-area network (WAN). While legacy services introduce costly multilayering inefficiencies as Ethernet is converted from the LAN to transport protocols to transit the MAN/WAN, and then reconverted back to Ethernet at the end LAN, Ethernet services require no such complex protocol conversions.

Ethernet enables operators to deliver more granular service than Sonet and to scale to higher speeds than Frame Relay and ATM. Ethernet services can be delivered in 1-Mbit/s increments, unlike TDM, which scales at much bigger steps – 1.5 Mbit/s (T1), 45 Mbit/s (T3/DS3), 155 Mbit/s (OC3), etc. And while legacy TDM services require separate access lines per service and lots of human activity every time a service is added, Ethernet simplifies the network and speeds service activation by supporting multiple services over a single interface, as well as remote provisioning.

Service providers are not just interested in offering Ethernet in an effort to win customers away from competitors. We have heard that operators increasingly are looking to convert their own NxT1 customers to mid-Band Ethernet services. They want to do this because:

- The old TDM-based business model does not cost-effectively scale with incremental increases in bandwidth demand.
- New Ethernet-over-copper access options now give operators a non-fiber-based option of scaling Ethernet up to DS3 speeds.
- They do not want to risk losing existing customers to a competitive Ethernet provider.

2.3 Key Service Provider Challenges in Addressing Enterprise Demand

While operators have made great strides in the past few years in rolling out higher-performance Ethernet services, they still face challenges in accelerating more rapid adoption. This includes the need to overcome hurdles related to:

- Ethernet service availability
- External network-to-network interconnection (E-NNI) among Ethernet service providers
- Scaling the network to meet the demands of many customer endpoints where multiple services may be converged over a single user network interface

Increase Ethernet service availability. *Heavy Reading* research has shown that the greatest single factor limiting growth of the Ethernet services market has been the inability of enterprises to obtain Ethernet connectivity at every required location. Traditionally, Ethernet adoption was impeded by the fact that customers needed to be connected by fiber, and only 12 percent to 15 percent of buildings in the U.S. have fiber connectivity.

New Ethernet-over-bonded copper pair, Ethernet-over-TDM access circuit, and other access technologies are helping overcome this hurdle and opening up opportunities to affordably address connectivity requirements of a broader set of end users, including small and medium-size businesses and remote offices of larger enterprises. In coming quarters, operators will be exploring a variety of ways to extend geographic reach into new markets and increase coverage density within metro areas, while keeping a lid on capital investments as much as possible.

Smooth external network-to-network interconnection. Delivering predictable end-to-end performance for Ethernet services that may flow over two or more carrier networks has been hampered by a lack of E-NNI standards dealing with items such as service and link protection and quality of service (QoS). Until now, operators have been negotiating one-on-one agreements with each other to help ensure that their customers have some consistency.

Many of the world's leading service providers are now working within the Metro Ethernet Forum (MEF) to develop the industry's first E-NNI standard, which aims to establish a common approach for handling Ethernet traffic as it transits the demarcation point between different carrier networks. The MEF's E-NNI initial specification should be available in the second half of 2009.

Scale with service and application demands. One of the important advantages of Ethernet is the ability to converge multiple services and applications over a single user connection, but not all operators are in a position to scale with demand and deliver the type of reliable performance that enterprises seek. This is partly due to mathematical limits imposed by standard Institute of Electrical and Electronics Engineers (IEEE) 802.1Q virtual LAN (VLAN) technology.

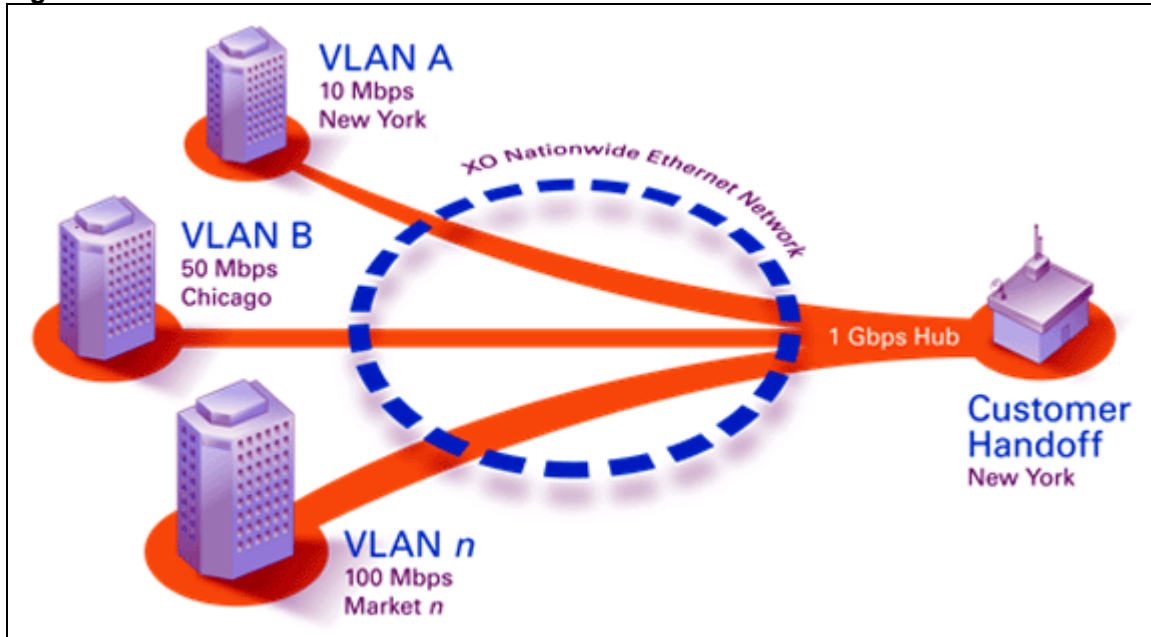
With VLAN services, Ethernet traffic is switched through the network based on VLAN tags within each Ethernet frame. The tags act as identifiers within data packets and separate traffic types as they traverse a single network. The 802.1Q standard permits the use of up to 4,096 VLAN IDs to distinguish among the various VLAN-tagged packets and differentiate traffic on an Ethernet switch. While 4,096 separate LANs is more than satisfactory for any enterprise, it still represents a significant limitation for carriers, which aggregate traffic from many, independent enterprises. Unfortunately, the limited quantity of VLAN IDs can be fairly quickly consumed in a carrier's network as the number of end users scale and each end user creates and sends many VLAN tags.

The IEEE 802.1ad (Q-in-Q) standard defines a common way to overcome this VLAN scalability problem by enabling VLAN stacking on Ethernet switches. Operators that support VLAN stacking across their network are in a better position than competitors to scale as enterprises increase the number of applications converged at Ethernet endpoints.

III. XO's Ethernet Hub Service

During 2008, XO rolled out a new point-to-multipoint Ethernet Hub service to help wholesale customers deliver Ethernet to more locations across the country and within metro markets, ensure consistent performance for services delivered across multiple carrier networks, and improve service scalability as endpoints are added. The Ethernet Hub service is built on a variety of next-generation Ethernet platforms.

Figure 3.1: XO's Ethernet Hub Service



Source: XO Communications

3.1 National Footprint With Dense Metro Coverage

One of the key advantages of XO's Ethernet Hub service is the operator's extensive on-network and off-network service footprint. XO is capable of reaching nearly 4 million building endpoints. XO is able to offer such broad coverage by taking advantage of its large fiber network and investment in new Ethernet-over-fiber, Ethernet-over-bonded copper pair, and Ethernet-over-TDM access platforms.

XO's fiber network consists of 18,000 long-haul route miles and 1.16 million metro fiber miles in dozens of major cities. The Hub service can currently be delivered with fiber connectivity to ~1,500 on-network buildings as a standard offer, and thousands more on a case-by-case basis.

XO was one of the first major operators in the world to mass-deploy Ethernet-over-bonded copper pair access platforms to help overcome the Ethernet connectivity hurdle, and it now has what appears to be the largest Ethernet-over-copper access footprint of any U.S.-based carrier. XO currently supports 10 Mbit/s typically up to 11,000 feet; and 20 Mbit/s typically up to 7,000 feet from the central office when using Ethernet-over-bonded copper pairs. This allows the company to provide cost-effective, dense service coverage within metro markets.

XO also offers Ethernet-over-TDM access for its Ethernet Hub service on a national basis. While Ethernet-over-TDM access is more expensive to deliver because it rides on top of bonded or non-bonded TDM private lines, this type of access does not face the distance limitations of Ethernet-over-copper access and can be rapidly turned up where TDM lines are already in service.

3.2 Flexible Exchange of Traffic With Dedicated Connectivity

XO's Ethernet Hub service helps smooth exchange of traffic between networks by offering a flexible solution with predictable, dedicated bandwidth between hub and spoke sites. XO enables carriers to extend their own service reach by buying a single 1-Gbit/s connection at the hub and adding lower-level sites with speeds ranging from 5 Mbit/s to 500 Mbit/s. An Ethernet switch aggregates circuits at the hub – without oversubscription – and ensures that each customer's traffic is switched to its destination in real time.

Figure 3.2: XO's Ethernet Hub Service End-Link Bandwidth Options

BANDWIDTH	EoCu	EoDS1	EoDS3	ON-NET FIBER
5M	✓			
10M	✓	✓		✓
15M	✓			
20M	✓			✓
30M				✓
40M				✓
44M			✓	
50M				✓
60M				✓
70M				✓
88M			✓	
100M				
200M				✓
300M				✓
400M				✓
500M				✓

Source: XO Communications

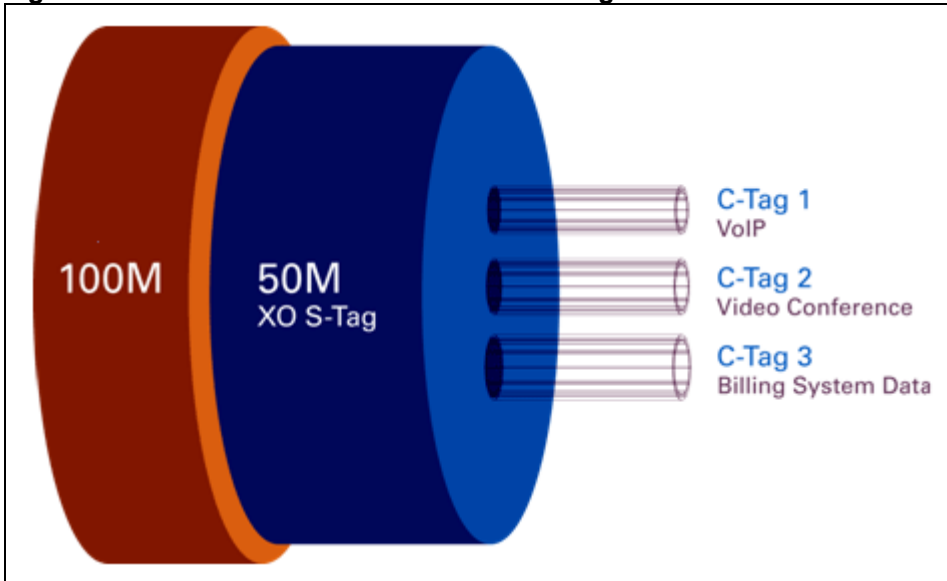
3.3 VLAN Stacking – Scale, Transparency, Rate Limiting, Security

XO's Ethernet Hub solution allows convergence of multiple services with different VLAN tags – such as VoIP, videoconferencing, and dedicated Internet access. The operator has adopted VLAN tag stacking on a nationwide basis to improve service endpoint scalability, segment traffic by application and/or user groups, keep each end user's location unique, and preserve and transport original customer traffic/settings.

An end user defines a customer tag (C-tag(s)) and XO stacks its own supplier tag (S-tag) on top of each C-tag originating at an end user site. VLAN stacking permits the consumption of only one VLAN tag from the VLAN pool instead of multiple C-tags, since the network now ignores the C-tags and directs a packet by its outer S-tag.

The Ethernet Hub service uses one S-tag per spoke. All of the spoke S-tags are aggregated over the hub interface. XO does not apply priority bits to S-tags because the Ethernet Hub service is a dedicated/uncontested service where all traffic is sent in real time. If priority bits exist within the C-tags, XO will pass them transparently. XO plans to provide a class-of-service (CoS) option in the future.

Figure 3.3: Ethernet Hub Service VLAN Stacking



Source: XO Communications

The outer S-tag that XO inserts into each Ethernet frame acts as an indicator for any rate-limiting thresholds that need to be applied to the traffic. In addition, XO offers customers the option of using security based on VLAN validation. Although XO does not switch traffic by C-tags, it can validate the C-tags and blocks traffic associated with any C-tags that are not on an approved list.

V. Conclusion

Heavy Reading's multi-year analysis of the North American Ethernet market leads us to conclude that XO's Ethernet Hub service offers compelling value to wholesale customers both in terms of its extensive reach – based on on-net and off-net access solutions – and its apparent performance/price advantage over legacy NxT1 private lines. XO's strategic decision to build out a next-generation carrier Ethernet-based network should enable the operator to adapt well with market requirements.

5.1 Questions You Should Ask When Evaluating a Service Provider

Heavy Reading suggests wholesale service customers should consider asking the following questions when evaluating potential service provider:

- 1. Coverage – Can you deliver Ethernet to all of my required locations, and at what speeds and cost?** Enterprises seek assurances that they can receive Ethernet at every site where they need connectivity, so that they can take full advantage of Ethernet's ability to lower their communications costs and increase productivity. Failure of a provider to offer lower speeds of 2 Mbit/s to 45 Mbit/s with broad coverage will limit a wholesale customer's ability to transition T1 private line and Frame Relay customers to Ethernet.
- 2. Operations – How quickly can you install on-network and off-network circuits?** An operator should be able to install on-network and off-network circuits at least within the timeframe it takes to turn up traditional private line connections.
- 3. Network – Do you oversubscribe traffic at hub sites? How do you treat CoS and how much does it cost to implement CoS?** Operators that oversubscribe traffic are able to make more efficient use of network resources, but their customers face the potential that the flow of their lower-priority traffic could be impeded in cases of bandwidth contention at the hub site. Service providers that transport traffic in real time over dedicated connections, without oversubscription, give carrier customers greater flexibility to control the quality of their own value-added services.
- 4. Service Transparency – Does your service alter any of the original traffic?** Honoring original traffic/settings is vital to any carrier-grade service.
- 5. Product Set – Do you offer one consistent product nationwide?** Having a common service is important to being able to effectively manage your internal operations and support the same functionality at each location.