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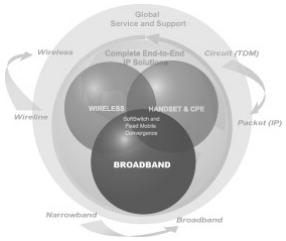
Ethernet-based Access Networks: The Chasm and Beyond



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Geoffrey Moore's well-known concept of "crossing the chasm" provides an interesting model for evaluating the adoption of Ethernet-based access networks. In this model (Figure 1), Moore classifies buyers into five categories and places them along a technology-adoption timeline. The "Innovators" are the first adopters of a new technology. These are often buyers who have specific requirements but lack a concrete business case to back them up. Next up are the "Early Adopters" who are exploiters—as opposed to experimenters like the Innovators—who see a business opportunity in being early users of a new technology.

These buyers reside on the left side of the chasm, which represents the gap between those who are willing to take a leap of faith and those who prefer to wait for a proven solution.

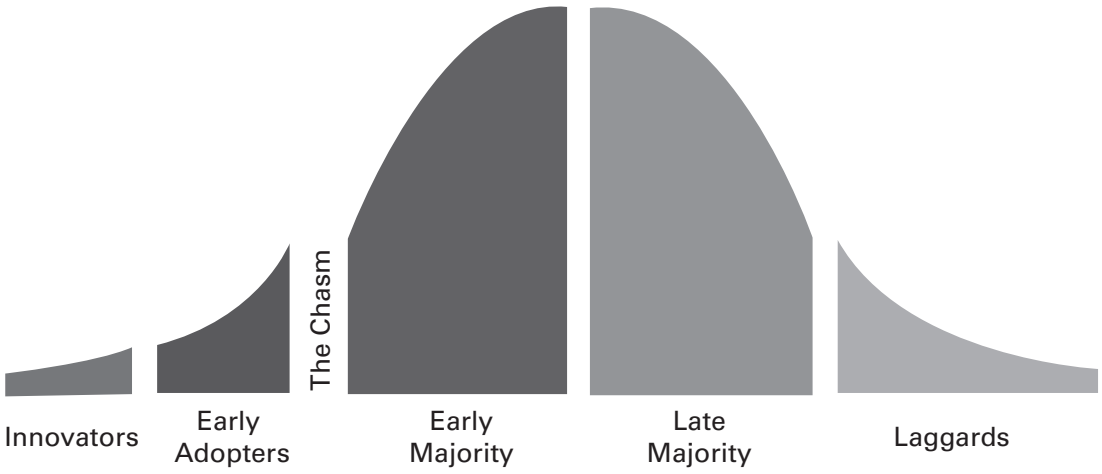

Figure 1: The Technology Adoption Lifecycle (adapted from Moore, 1999)

On the other side of the chasm reside the "Early Majority" and the "Late Majority," which comprise over two-thirds of the total market, and the "Laggards" or skeptics. From left to right, these three groups are increasingly risk averse and therefore require increasing amounts of reassurance before adopting any new technology.

To appeal to the mainstream (right-side) market, a new technology has to gain a level of maturity that convinces risk-averse buyers that they are not serving as pioneers while also persuading them that they should not be left behind in the migration to the new technology.

Ethernet versus the Chasm

Ethernet is fast becoming the global access medium—a position that was once thought to be reserved for ATM. The high complexity of designing and engineering ATM-based networks led to prohibitively high costs for ATM equipment and the industry soon realized that it is possible to get a better return on investment (ROI) with Ethernet technologies.

The key drivers were the simplicity of Ethernet-based networks and the higher efficiency of carrying IP traffic on an Ethernet-based Layer 2 network. IP itself is now positioned to occupy the status of a global language with almost every device becoming network addressable.

Examining the Ethernet-based Technologies

Taking a closer look at Ethernet-based access networks, these can be classified into three distinct categories:

- IP-based DSL access multiplexers (IP DSLAMs)
- Multi Service access nodes (MSANs; also called MSAPs or BLCs)
- Fiber-based access systems

Applying Moore's model, each category has reached a different stage of the technology adoption lifecycle.

DSLAMs

Among the three Ethernet-based access technologies, IP DSLAMs are the farthest along the adoption curve: the carrier-class IP-based DSL architecture was first introduced in 2001.

The Yahoo! BB broadband service in Japan (from Softbank Corp.) was one of the Early Adopters of the IP DSLAM technology. It saw a great business opportunity in using the new IP-based DSLAM technology to provide cheaper DSL access to its target customers. Unlike an ATM infrastructure, this architecture consisted of regular DSL lines facing the subscriber and Ethernet switches or routers on the network side. The business case was solidified by the fast rollout and low capital requirements of the core infrastructure.

Since then, IP-based DSLAMs have come a long way, crossing the chasm and achieving adoption by even the Late Majority. However, moving IP DSLAM this far along the technology adoption lifecycle has not been easy. Vendors have had to prove that it could do everything ATM-based DSLAMs do and much more—and do it with a simpler architecture. The biggest challenge was establishing an architecture for IP-based QoS that matched the proven and well-defined ATM-based CoS methodology. Buyers of ATM equipment and the vendors who provide it were equally staunch in their opposition to this architecture. Their resistance was based mostly on the notion that IP flows cannot be managed or controlled as easily as ATM streams.

The process of crossing the chasm was a patient and painful one. Following Moore's model, Yahoo! BB served as visionaries or Early Adopters. They exploited the technology as they had a strong business case for the offering—and they also had the attacker's advantage in an ATM-centric DSLAM market that was dominated by NTT. However, to appeal to the Early Majority beyond the chasm, the endorsement of a visionary is never enough. These pragmatists need to know that the new technology works well and is compatible with their existing infrastructure.

Considerable effort, led mostly by UTStarcom and joined later by other Asian DSLAM vendors, targeted pragmatic, mainstream carriers such as Tiscali, Verstatel and C&W—and eventually produced positive results. That effort focused on changing the beliefs and shifting the energies of a critical mass of customers, ultimately creating a self-reinforcing feedback loop that generated greater acceptance of IP DSLAMs. Author Malcom Gladwell calls this phenomenon "The Tipping Point." Once an idea reaches the tipping point, an epidemic breaks out and the concept spreads like a virus.

Today, most Tier 1 carriers have stopped buying ATM equipment, instead moving to IP-based DSLAMs. Even the Laggards are now finding it hard to resist the switchover to IP DSLAMs. Asia led

the way in this migration, followed by Europe, Central America and Latin America. The U.S. carriers were among the Late Majority; however, recent decisions by both SBC and Bell South to procure Alcatel's new IP-based DSLAM has firmly set the trend for this market, too.

MSANs

Multi Service access nodes are the second category of access devices that have been re-engineered with an Ethernet-based architecture. After successfully replacing ATM with Ethernet-based systems in broadband data networks, vendors of Ethernet hardware turned their attention to replacing TDM-based access networks.

This migration is a bit more difficult than that from ATM DSLAM to IP DSLAM, primarily because TDM-based access networks and PSTN voice networks have been the foundation of all telecom networks. Every major carrier turns into a traditionalist when faced with the prospect of completely revamping their TDM networks.

For the purposes of this discussion, MSANs can be split into two subsections. The first subsection is voice. VoIP as a technology has successfully crossed the chasm and a large number of Early Majority users are adopting it. However, this acceptance did not gain momentum until after VoIP had gone through a period of consistently proving that its performance is equivalent to traditional POTS services.

The second subsection is TDM-based data access networks, primarily leased lines. During many 2005 tradeshows, a major buzzword was PWE3 (Pseudo-wire), a technology that allows TDM-to-MSAN migration by providing T1/E1-like services over Ethernet. The enthusiasts are already familiar with this technology and smaller carriers have been the main Early Adopters. Chipset vendors such as Zarlink as well as BLC vendors such as Calix and Entrisphere have been promoting the advantages of the technology. Recently, Time Warner announced the rollout of a Pseudo-wire network, an indication that this technology may also be crossing the chasm.
Fiber-based Access Networks

The Ethernet-based passive optical network or EPON was the Ethernet industry's answer to the various technologies that use PONs to carry TDM and ATM traffic: APONs, BPONs and now GPONs. Until recently, few providers have taken advantage of EPON technology. As a residential access medium, EPON is still far from crossing the chasm. However, this must be considered in light of the fact that fiber itself has not crossed the chasm to join copper as a well-accepted residential access medium.

With regard to bandwidth to the home, the requirements of emerging applications like IPTV and online gaming demand bandwidths that can be achieve only via fiber access to each residence. Currently, EPON vendors and the EFM forums are making a compelling case for this architecture—a case that should eventually hit the tipping point for Ethernet-to–the-home technologies.

The Case for Packetizing at the Edge

As noted above, various segments of the Ethernet-based access networks are at different stages along the technology adoption lifecycle. Regardless, a compelling case exists for the advantages of moving to an all-Ethernet access network. What's more, there is a general consensus within the industry that this migration will eventually take place.

While the EFM Forum envisions a world connected with Ethernet all the way to the home, Moore's

concept of crossing the chasm revolves around the notion of appealing to the Early Majority by providing compatibility with the existing infrastructure. Even in the case of IP DSLAMs, these did not reach the tipping point until vendors provided ATM network interfaces as a migration step. Similar concepts and architectures must be implemented in MSANs and BLCs to enable them to reach the tipping point—a development that will make the case for packetizing at the edge as opposed to providing Ethernet directly at the customer premise.

While VoIP services can be provided by placing the ATA at the customer premise and using a packet layer all the way from the customer premise, this will not enable service providers to retire their Class 5 TDM switches until all subscribers have adopted broadband access and ATAs at their premises. Instead, with packetizing at the edge, the existing two-wire universal interface to black phones can be preserved and service providers can retire their TDM switches and move to a SIP-based Soft Switch architecture. It is much easier to sell this concept to an incumbent carrier than to make the case for VoIP at the customer premise.

Similar arguments apply for providing PWE3 (CESoE) interfaces on the access edge. As an example, TDMoIP services can be provided by using a PWE3 device at the customer premise over an Ethernet link (VDSL/ADSL2+/EPON) or by providing the same conversion at the edge device. While it is perfectly reasonable to expect a migration to Ethernet from the premises architecture, today's networks contain considerable legacy infrastructure that can be adapted to make use of a packetized core. By providing CESoE interfaces, Ethernet-access edge devices can enable service providers to retire their TDM/ATM core elements and replace them with IP/Ethernet core devices—without any changes in the network facing the customer premises. This provides a compatibility story that should appeal to—and win over—the Early Majority market.

Beyond the Chasm

The natural direction for Ethernet access vendors is to move towards an integrated multimedia network edge that will provide all access interfaces from a single edge device and will have a single Ethernet (n * 10G) interface to the core network. The all-encompassing MNE will be a box that unshackles the word "access" from the qualifying adjectives - wireline, wireless and fiber. A system containing a simplified high speed 802.3 backplane will be able to take in interface modules that support all flavors of traditional wireline xDSL interfaces, POTS interfaces, TDM interfaces, WiMAX interfaces and PON interfaces.

Eventually, the MNE concept will be pushed to the customer premise and the Ethernet-based core will continue its expansion. This will happen once the network moves to a model that uses a wide-bandwidth pipe—copper (VDSL2 or EFMc) or fiber (EPON)—to transport Ethernet all the way from the customer premises.

Looking to the future, continuing advances in Ethernet technology will be the key driver behind the paradigm shift from the "dumb access pipe" architecture to the "Intelligent Service-Aware Access Architecture" or ISA3. Of course, as with the technologies described above, ISA3 will face the challenge of proving its value to the Early Majority before it can cross the chasm and reach a tipping point that leads to widespread adoption.

References

1. Crossing the Chasm: Marketing and selling high-tech products to mainstream customers, Geoffrey Moore

2. The Tipping Point: How Little Things Can Make a Big Difference, Malcolm Gladwell

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Acronyms

ADSL	Asymmetrical Digital Subscriber Line
APON	ATM Passive Optical Network
ATA	Analog Telephone Adapter
ATM	Asynchronous Transfer Mode
BLC	Broadband Loop Carrier
BPON	Broadband Passive Optical Network
CESoE	Circuit Emulation Services over Ethernet
CoS	Class of Service
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexer
EFM	Ethernet in First Mile
EFMc	Ethernet First Mile Copper
EPON	Ethernet Passive Optical Network
GPON	Gigabit Passive Optical Network
IP	Internet Protocol
IPTV	Internet Protocol Television
ISA3	Intelligent Service Aware Access Architecture
L2	Layer 2
MNE	Multimedia Network Edge
MSAN	Multi Service Access Node
MSAP	Multi Service Access Platform
PON	Passive Optical Network
POTS	Plain Old Telephone Service
PSTN	Public Switched Telephone Network
PWE3	Pseudo Wire Emulation Edge to Edge
QoS	Quality of Service
RoI	Return on Investment
TDM	Time Division Multiplexing
VDSL	Very High Speed Digital Subscriber Line

About the Author

Bala Thekkedath is a Product Marketing Manager at UTStarcom Inc. for the Broadband Access Products. Bala has 12 years of telecom industry experience and prior to joining UTStarcom has worked for Lucent Technologies and Tata Telecom. Bala holds a Bachelors degree in Electronics and Communications Engineering from Maharaja Sayajirao University of Baroda, India and is currently pursuing a Masters degree in Telecommunications Business Management at Stevens Institute of Technology.

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