



Broadband Redefined

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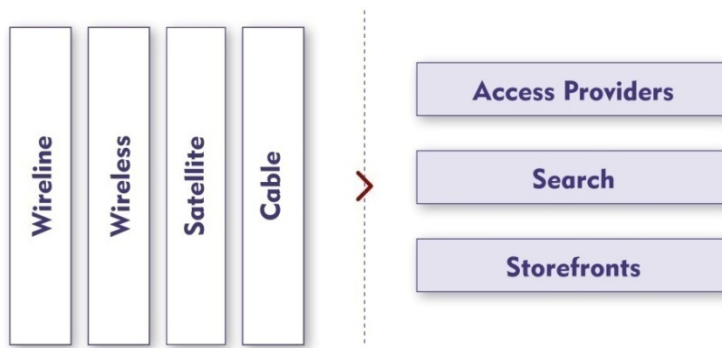
It's been three years since Thomas L. Friedman declared, "The World Is Flat." In that time, the communications floodgates have opened further and the global economy is now a reality. The Internet, with its broad availability and real-time, world-wide access to information, has rendered time zones and country borders obsolete. However, what Thomas L. Friedman didn't tell you is that in many ways the global changes that he foresaw begin at your house, with your local broadband connection.

Dating back to the 1960's, the term "broadband" was first applied to radio communications. At that time, *narrowband* was Morse code and *broadband* was voice or music. As of today broadband is defined by Merriam-Webster as, "*of, relating to, or being a high-speed communications network and especially one in which a frequency range is divided into multiple independent channels for simultaneous transmission of signals.*" Given the current definition, *narrowband* is best illustrated by traditional TDM dialup modem lines and *broadband* as DSL or FTTP. In more general terms, the FCC, and most consumers, define *broadband* by the characteristics of networks or access bandwidth. The FCC specifically defines the broadband baseline at 768 kbps (previously it was 200 kbps), while many consumers call broadband anything above 2 Mbps. As all these definitions illustrate, *broadband* is a relative, time-sensitive term, which must be placed in context to have meaning.

State of the Industry

Over the past 25 years, the Internet has faced exponential growth and evolved from a collection of information to become the cornerstone for our modern day communications network. Today, the Internet is globally accessible by over 1.46 billion people, or 22 percent of the world's population. In the United States alone, the number of consumers with Internet access is 220 million, or 72.5 percent of the population. In terms of broadband access, 81 million households, or roughly 62 percent, have cable modem, DSL, or FTTH.

Behind the numbers, you'll find a less obvious reason for the Internet's massive success, Internet protocol (IP). IP's ingenious design has torn down the highly structured vertical network boundaries (wireline, wireless, satellite, and cable) and replaced them with a stratified, standards-based, and highly flexible service delivery model designed to connect consumers to content.



While this new model is a welcome change for consumers, it presents significant challenges for service providers in the realm of inter-carrier compensation and equipment cost recovery for broadband expansion in underserved and sparsely populated rural deployments. This topic is provoking much debate in Washington. It will be a significant challenge for the new FCC chairman and the new President as they propose new strategies to continue the advancement of broadband in the United States.

Delivering Consumer Services

It's no secret that different generations view communication services from very different vantage points, and these different vantage points challenge some fundamental assumptions of broadband network design. For example, look at the most basic communication service – voice. Incumbent local exchange carriers (ILEC) have spent most of the past 100 years building high-quality, carrier-grade voice networks, designed to deliver the same voice services to both urban and rural America. If a competitor wants to target an ILEC's customer base, the competitor would become a competitive local exchange carrier (CLEC) and do one of two things: physically overbuild a community (which is expensive) or lease lines from the ILEC (which exerts margin pressure). In either case, the CLEC requires a compelling business case before taking action.

Today the rules have changed. If a competitor wants to target your customer base, the competitor can now offer your customers software or hardware that converts TDM voice to voice over IP (VOIP) -- and do so, literally, overnight. A competitor can leverage your consumer's broadband connection to deliver local phone services via the Internet -- even if that competitor is half a world away. Meanwhile, consumer behavior has also changed.

Consumers from the Baby Boomer generation (ages 44-61) often prefer a lifeline voice service because they place a high value on voice quality and service availability (99.999% uptime). However, most adult Millennials (ages 18-28) and Generation X'ers (ages 29-43) place a higher value on mobility and price, and are willing to sacrifice some voice quality and service availability. In today's competitive environment, there is no such thing as customer loyalty, and customer churn can rapidly erode broadband profits.

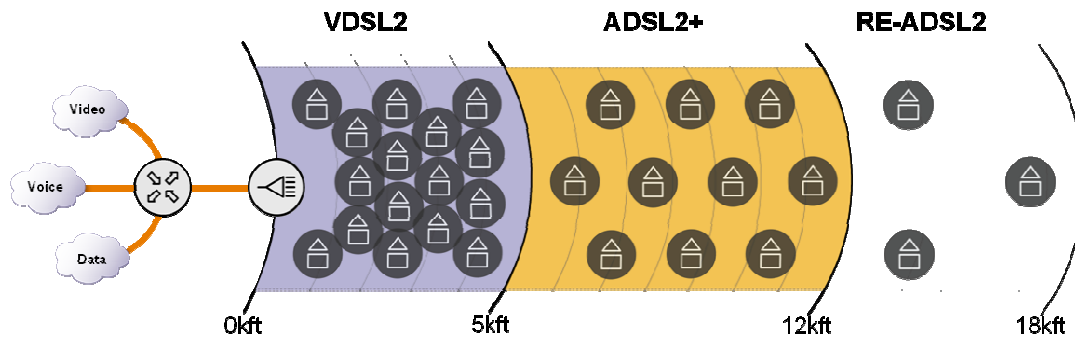
As for video services, you'll find that Baby Boomers generally prefer a simpler, traditional broadcast video model, while Millennials and a portion of Generation X prefer an element of interactivity, utilizing video on demand (VOD) and broadband video on a regular basis.

While there is some cross-generational overlap, the differences in consumer behavior illustrate one of the fundamental challenges in broadband deployments: who do you build your network to serve? The majority of today's traditional consumer revenue comes from Baby Boomers and Generation X'ers, while the Millennials are more progressive and will most heavily utilize the broadband connection and the services running over the top.

You might think the answer resides solely in selecting the most "future proof" broadband technology. But the reality is that most networks will require both copper and fiber broadband technologies to cover entire serving areas. It's also important to remember that new access technologies emerge every 5 to 10 years, making service delivery flexibility the key to a successful broadband deployment. The bottom line: All services must be deployable across all broadband technologies, creating a unified access infrastructure.

Broadband Access Solutions

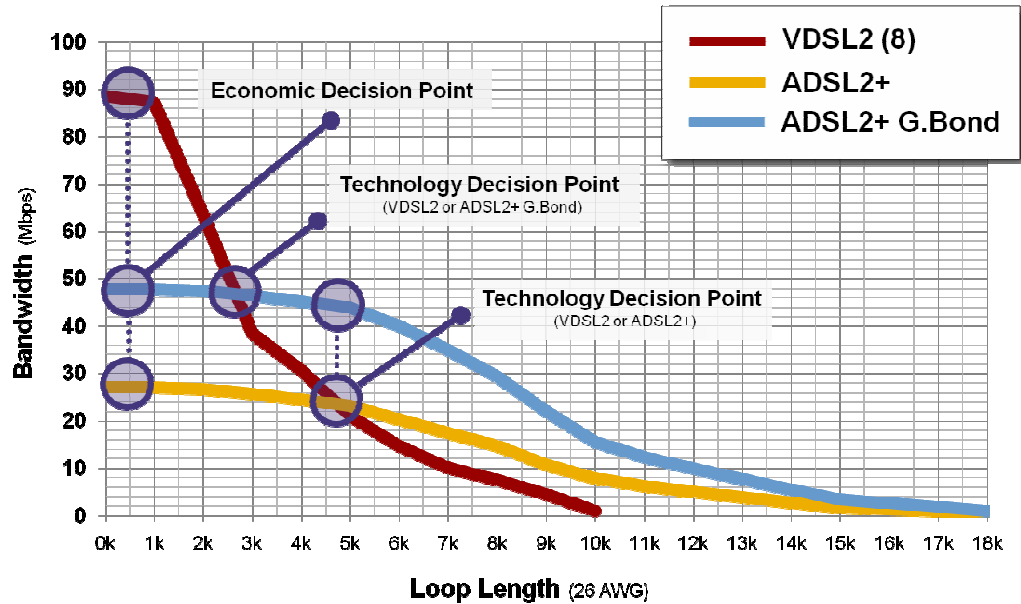
Most traditional telecommunications services are delivered from a central office (CO) or remote terminal (RT), with carrier serving areas (CSA) ranging between 12,000 feet and 18,000 feet. Based on these loop lengths, ADSL and ADSL2+ services have been utilized for most high-speed internet service delivery.



With the rapid expansion of IPTV and ever increasing bandwidth requirements, service providers have two primary architectural choices:

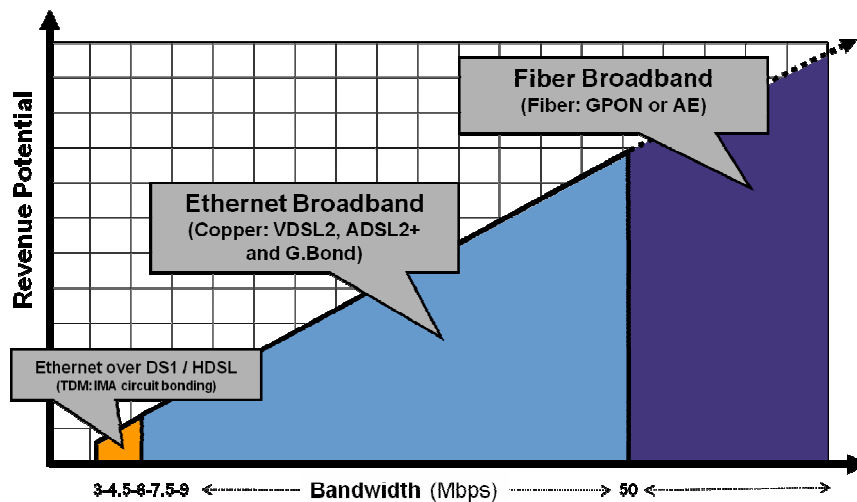
- **Abandon copper and deploy fiber:** PON for residential and business, point-to-point or Active Ethernet for dedicated business services
- **Shorten or bond together copper loops for residential or business customers:** VDSL2 for loops less than 5,000 feet, ADSL2+ for loops greater than 5,000 feet.

With the exception of greenfield deployments or locations requiring OSP rehabilitation due to cable age or damage, the use of the existing copper infrastructure maximizes economic advantages by leveraging depreciated OSP facilities. In many instances, using existing copper may be the only practical, cost-effective option for delivering 20 Mbps or greater broadband services.



If loops are less than 5,000 feet, VDSL2 can be leveraged to deliver 30 to 50 Mbps from a CO or a node. VDSL2 chipsets utilized in a new generation of broadband access platforms have been optimized for North American loops through the implementation of VDSL2 profiles. Profiles allow transmit/receive power optimization and control the frequency spectrum to minimize interference with existing technologies. These profiles, in turn, deliver more bandwidth over smaller CSAs, while retaining ADSL2+ fallback mode for larger loop CSAs. It's common for access platforms to support the VDSL2 profiles 8a, 8b, 8c, 8d, 12a, 12b, and 17a, allowing up to 100 Mbps to be achieved on very short loop lengths.

A new generation of access products have started to support the ITU-T standard G.998.1 (G.bond) loop bonding, allowing up to two ADSL2+ ports to be logically bonded together to deliver increased bandwidth to the customer premises or CSA extension for broadband services.



As fiber-to-the-premises (FTTP) technologies have matured, the economics supporting the deployment of fiber have improved to the point that many service providers are going directly to FTTP for greenfield deployments. With fiber-based GPON and Active Ethernet technologies deployable beyond 40 km, service providers can now serve a larger percentage of their customer base from each central office or remote terminal; the benefit is dramatically lowered broadband capital expenditures. Another set of service providers are converting copper access networks to fiber as traditional network maintenance issues drive upgrades, taking advantage of fiber's immunity from binder group disturbers and maximizing operational savings.

In the case of FTTP architectures, a copper-based node can also be the location of a FTTP passive optical network (PON) splitter or Active Ethernet optical line terminal (OLT). This migration path permits service providers to offer competitive triple-play services with minimal initial investment, transitioning to a pure fiber model when the technology, price points, or customer demand require the next step in network evolution.

Pay It Forward

There's no question that broadband is the future for service providers. While it may seem difficult to justify, network *flexibility* is the key to delivering a multitude of services that support a rapidly expanding portfolio of Internet-connected customer premises devices. In your network, it's safe to say that broadband will:

- Come in different flavors (copper, fiber, wireless)
- Use a variety of technologies (VDSL2, GPON, Active Ethernet)
- Support many different bandwidths, depending on deployment location (CO, RT, node, mobile)

However, no matter how you slice it, the dominant service provider in a given market will be defined as the provider who can deliver the highest service capacity with the fastest service velocity, over the lowest installed CAPEX and OPEX, across a unified access infrastructure.



Broadband has been redefined – welcome to the Exponential Era of information communication. A world of opportunity awaits you.