

# The Business Benefits of Deep Fiber

## Delivering Ultra-Broadband Services

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By deploying fiber deeper into the access network, service providers can swiftly deliver more capacity and successfully compete in an increasingly competitive marketplace.

## Overview

Cable operators and telecommunications carriers are competing for customers, and the winners in the long term will be those service providers that build the infrastructure capacity to deliver Ultra-Broadband services.

Service providers continuously struggle with how to balance infrastructure investments against the need to deliver stronger financial returns, and selecting the ideal solutions for access networks is a major challenge. Optical fiber access connectivity affords a whole new opportunity for service providers to invest in and capture the next-generation Ultra-Broadband consumer wave.

Commonly defined as greater than 50 Mbps symmetrical throughout, Ultra-Broadband optical fiber solutions, such as Fiber-to-the-Home (FTTH) and Fiber to the Premises (FTTP), can easily service today's broadband needs and gracefully scale to Ultra-Broadband access networks that support hundreds of megabits of symmetrical throughput to each subscriber.

Service providers can also deliver Fiber-to-the Node (FTTN) Ultra-Broadband services by leveraging copper infrastructure and Digital Subscriber Line (DSL) technology. This white paper discusses the need for Ultra-Broadband services and explains how Motorola offers best-in-class copper and FTTH and FTTN solutions for building out access infrastructure to support Ultra-Broadband service delivery.

## Consumers Shift Toward Ultra-Broadband Services

By deploying fiber deeper into the access network, service providers can swiftly deliver more capacity and successfully compete in an increasingly competitive marketplace. Existing service provider access networks are strained by the needs to provide more:

- Downstream bandwidth to support the growing number of available High-Definition (HD) channels.
- Narrowcast bandwidth to support a significant shift towards unicast Video On Demand (VOD).
- Upstream and downstream bandwidth to support commercial services and interactive consumer services such as social networking.

Service providers face additional challenges as they struggle to support new services while balancing capital investments in infrastructure with operational expenses, as well as the ongoing challenge of providing new and exciting services that bind subscribers to the network and increase Average Revenue Per User (ARPU) ratios. As service providers leverage existing investments in network infrastructure while increasing capacity and offering new services, deep fiber solutions will allow them to:

- Adjust node serving sizes to deliver more narrowcast services and increase return capacity—without stranding initial investments.
- Better balance node and serving area sizes by placing satellite nodes at optimal locations.
- Provide increased throughput performance by pushing fiber closer to the home.
- Establish Ultra-Broadband service levels—even with limited fiber count from the hub or Central office.
- Eliminate active equipment on the access network, thereby lowering operating expenditures and increasing network reliability.

Service providers need to successfully anticipate demands for new, bandwidth-consuming services so they can achieve a competitive advantage by having the bandwidth delivery infrastructure in place to swiftly offer new services that less forward-thinking competitors cannot yet deliver.

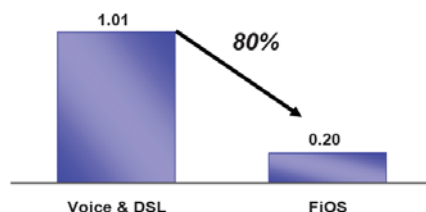
## Balancing Infrastructure Investment Options

Service providers throughout the world are deploying Ultra-Broadband optical FTTH and deep fiber FTTN technologies in response to the growing consumer demand for high-throughput services and competitive pressures to differentiate their offerings.

Fiber-based service delivery via Passive Optical Networking (PON) offers massive scalability potential and reduces the cost of managing and operating the access network by as much as 80% because it eliminates active network components. And since it relies on fewer products, it therefore has fewer potential points of failure.

### Operational Efficiency: Cost to Serve

#### Network Report Rate Outside Plant



**“Total field maintenance dispatches and OSP-related dispatches are already showing solid declines”**

Verizon Communications Inc. FiOS Briefing Session. September 27, 2006

#### Source of Savings

- Fewer physical failures
- Fewer sites to maintain
- No space and power costs in outside plant
- Consolidated triple play platform
- Software provisionable upgrades

At a time when the economics associated with an all-optical access network deployment continue to improve, services providers are asking “when” to make the investment in fiber plant—not “if”—and to a large degree the answer will depend on the service capacity demand and the ability of existing access networks to deliver throughput at Ultra-Broadband levels. In other words, will consumers’ demand for high-throughput services outpace your current access network’s ability to deliver 30 Mbps, 40 Mbps, even 50+ Mbps to every subscriber’s home?

Competitive pressures also play a major role in infrastructure investment decisions, and the ability to offer a rich array of differentiated services while reducing the outside plant maintenance costs of access infrastructure are also key factors in analyzing buildout options.

Tied to the success of any access network deployment is the broader understanding of the end-to-end network and opportunities to capture additional revenue from incremental services. Service providers need to successfully anticipate demands for new, bandwidth-consuming services so they can achieve a competitive advantage by having the bandwidth delivery infrastructure in place to swiftly offer new services that less forward-thinking competitors cannot yet deliver.

## Delivering “Parity Plus”

Merely achieving parity in service models is not enough to gain a true competitive advantage, but the ability to deliver higher access speeds than those offered by competitors can provide dramatic competitive advantages. This premise is supported by a recently published independent research effort initiated by Motorola, Inc., where several

Consumers have a great deal of options to consider when selecting service providers, and those service providers that can meet today's needs while offering the promise of even greater bandwidth to support high-quality video and robust interactive programming will capture subscribers from those service providers that can not achieve "parity plus."

key consumer broadband trends were identified. Wherein the past price has been the key factor, this survey identified:

- Speed is now the top concern, with approximately 58 percent citing this as their reason for subscribing to their selected broadband service.
- Quality is the second most important factor, selected by approximately 17 percent of respondents.
- The freedom broadband brings to effortlessly access content such as movies and games was of top concern to 14 percent of respondents.
- Price was only a top concern for approximately 9 percent of respondents.

By building out access infrastructure in support of increasingly higher-bandwidth access, service providers can achieve "parity plus" and establish strong competitive differentiation by establishing their value in the minds of consumers as being tied to the delivery of quality Ultra-Broadband services not offered by competitors.

Customer churn is also a major problem facing every service provider, and consumers worry whether their existing bandwidth providers will be able to support their future needs. By achieving "parity plus" and the ability to offer higher-quality, higher-speed services now and in the future, service providers can establish and enforce brand preference and build longer-lasting relationships with both commercial accounts and consumers.

The greatest challenge is to determine how much bandwidth capacity is needed to achieve "parity plus" as well protecting from under-investment by understanding the service capacity demands of the not-too-distant future.

Investing in buildouts that add limited capacity will be considered wasteful in the future as consumers demand new services. Only ten years ago, the term "broadband" was often used to refer to dial-up analog modem speeds of 56 Kbps. Sessions were largely asymmetric, with most of the bandwidth allocated to downstream flows. Now, bandwidth delivered to the consumer is measured in megabytes—not kilobytes—and this trend toward richer, higher-speed services will only continue.

For the first time:

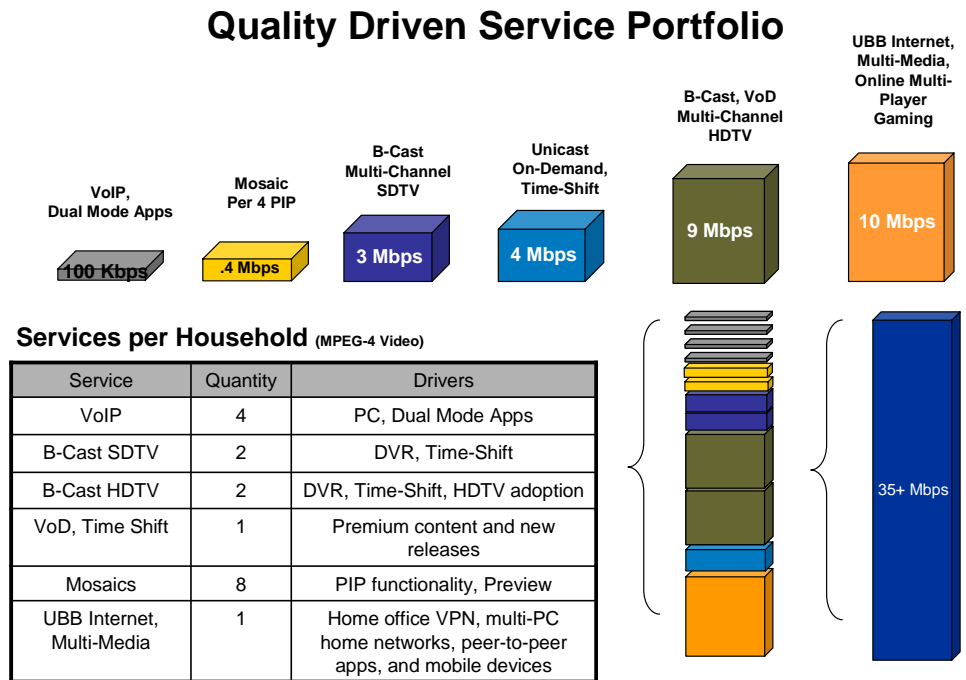
- Consumers are demanding increased upstream or symmetric bandwidth to support social networking applications.
- Television is being redefined from "prime time" to "my time" as service providers offer time-shifted television, VOD, Networked Personal Video Recorder (NPVR) services, and Follow-Me Video™ services that make content available to the increasingly mobile consumer.
- Consumers are evolving into "prosumers" that develop, push, and demand access to custom content—whenever they want it.
- The nature of program delivery is being complemented by a high-level of unicast programming of specialized content to targeted individual consumer groups.

Consumers have a great deal of options to consider when selecting service providers, and those service providers that can meet today's needs while offering the promise of even greater bandwidth to support high-quality video and robust interactive programming will capture subscribers from those service providers that can not achieve "parity plus."

Preparing for Ultra-Broadband services is not something that needs to be done in the future; it is something that service providers must consider today as they evolve their networks. It is easy to see how service providers can quickly run out of bandwidth "budgets" for consumer services. While service providers can best meet their long-term

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objectives by focusing on "parity plus," they should do so in the context of evaluating service capacity demand and ensuring near-term competitive and future consumer requirements are met.



Deploying 50 Mbps or more bandwidth to consumers allows cable operators and telecommunications carriers the ability to capture a leadership position by offering the promise of exciting new services that can't possibly be met by networks designed to deliver first-generation broadband services. No service provider wants to over-invest and build bandwidth that will go unutilized for years to come, but the tradeoff is the risk of under-investing to meet immediate goals while carrying forward the need to re-invest in the near term to meet increased consumer demand.

Even if consumers are unlikely to utilize all of the bandwidth available in a high-speed service offering they are already showing a market preference for providers that can best meet potential Ultra-Broadband service requirements in the future. No consumer wants to select services that have bandwidth limitations that will restrict their online experience, and service providers that offer higher-bandwidth services will capture customers from service providers that are perceived as offering limited options.

Bandwidth serves as the building block for broadband services, and by analyzing typical usage scenarios you can see how service providers will quickly utilize existing budgets. Consider the requirements of a typical family that has multiple voice connections, Standard-Definition (SD) and HD televisions, actively uses on-demand services, has multiple PCs connected to Internet services, and relies on social networking, peer-to-peer, and interactive gaming applications.

- Family members watch one HDTV program while recording another on their home DVR (18 Mbps).
- The Mosaic picture-in-picture service is enabled and left on (.4 Mbps for every four Mosaics).

Deep fiber enables success-based deployments and allows service providers to drive down OPEX costs by reducing the number of active equipment elements in the access network.

- The kids are watching a VOD movie in the den (Unicast 3.75 Mbps, minimum allowed by studios).
- At the same time, a family member uploads the weekend set of five-megapixel digital images, with each photo a 2 MB file (5 Mbps down, 2 Mbps up service guarantee).
- A time-shifted SD signal in the kitchen—the six o'clock news—restarted at 6:15 (Unicast 3 Mbps).
- Combine the above and this scenario alone requires 30 Mbps of bandwidth.
- Then consider that last year, 51 % of the televisions purchased in the U.S. were HDTVs, and fifteen percent of those HDTV purchases were the second HDTV in a home. If this family replaced an SDTV with an HDTV, you would need to subtract the 2 Mbps SD stream and add another 9 Mbps HD stream.
- The new scenario requires 37 Mbps of bandwidth.
- As HDTV prices continue to erode, in a year or two that family might want to replace the remaining SDTV television sets with HDTV, in which case they would need nearly 50 Mbps of bandwidth.

Investing now to buildout 20-25 Mbps of access network bandwidth will not be enough to meet consumer needs in the near future. A respectable floor of 35+ Mbps is about the minimum bandwidth level service providers can deploy to compete successfully and the minimum investment operators should make to remain competitive. Most service providers would be best served by building out access infrastructure to support Ultra-Broadband speeds of 50 Mbps or more—which is what leads to the need for deep fiber access network solutions.

## Deep Fiber = Short Copper or Coax

Building out a deep fiber access network increases reliability while reducing network maintenance costs associated with fewer active components than are found in today's copper and coax service delivery networks. To truly maximize infrastructure investments and operational savings, service providers should avoid placing nodes further than 3,000 feet (three Kft) from customer locations and strongly consider the deepest of all fiber access architectures—FTTH—since the fiber would terminate “zero feet” from the customer premises.

Copper-based FTTN networks can support multiple tens of megabits to each subscriber, while PON-enabled FTTH architectures can support hundreds of megabits of bandwidth directly to the subscribers premises. Deep fiber is a good offense, because it changes the competitive playing field. It is also a good defensive investment strategy since it will allow cable operators and carriers to plan for capacity to compete against service providers that are already planning Ultra-Broadband service offerings. Deep fiber enables success-based deployments and allows service providers to drive down OPEX costs by reducing the number of active equipment elements in the access network.

## Copper Based Ultra-Broadband Solutions

Asymmetric DSL2+ (ADSL2+) extends the capability of basic ADSL by doubling the number of downstream bits. By deploying ADSL2+ to the node within 3 Kft from the customer premises, service providers can comfortably deliver 20 Mbps of bandwidth—which will be insufficient for broadband services in the very near future. Bonded ADSL2+ allows service providers to logically bind two ADSL2+ connections to double this

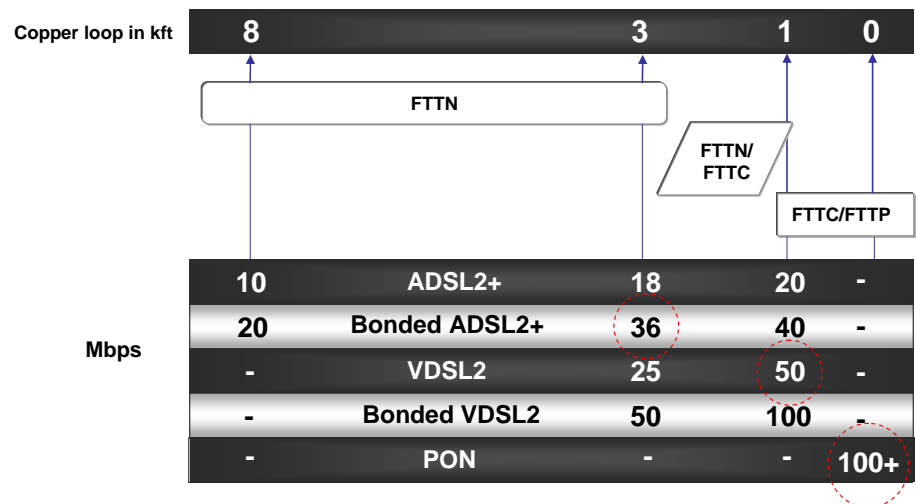
PON deployments reduce the operational and maintenance costs over other FTTH options and are currently riding the same cost curve reductions, with the introduction of the ITU-T Ethernet based GPON standard, i.e. Ethernet components and optical lasers.

capacity, so Bonded ADSL2+ to nodes located within three Kft from the customer premises will allow service providers to deliver a more acceptable 40 Mbps of bandwidth.

Very high bit rate DSL2 (VDSL2) provides faster throughput rates over a single twisted pair, and service providers deploying VDSL2 to a node 1 Kft from the customer premises are immediately in a position to deliver Ultra-Broadband services. Bonded VDSL2 allows service providers to logically bind two VDSL2 connections to deliver up to 100 Mbps Ultra-Broadband services to locations within 1 Kft of the node.

Copper is a viable option for building out Ultra-Broadband broadband infrastructure. Carriers looking to deploy Ultra-Broadband via ADSL2+, Bonded ADSL2+, VDSL2, and Bonded VDSL2 want to ensure optimal throughput performance and should evaluate performance characteristics of these latest DSL technologies with the goal of node placement within 3 Kft of the farthest subscriber.

### Deep Fiber Access Architectures



Source: Motorola Installed Base and Estimates Using ADSL2+ FEXT G.992.5 and VDSL2 FEXT G.993.2

ADSL2 alone does not provide sufficient bandwidth for emerging services, but Bonded ADSL2+ provides acceptable bandwidth for an infrastructure upgrade. VDSL allows operators to support Ultra-Broadband services, Bonded VDSL2+ supports 100 Mbps of access bandwidth, and PON solutions enable the delivery of 100 Mbps or more bandwidth to consumers.

### Fiber Based Ultra-Broadband Solutions

A PON is an access network architecture that provides connectivity from the host Optical Line Terminal (OLT) to the Optical Network Terminal (ONT) located at the customer premises. The term "passive" simply describes the fact that the optical transmission is powered directly from the OLT to the ONT with no active electronics in between. PON deployments reduce the operational and maintenance costs over other FTTH options and are currently riding the same cost curve reductions, with the introduction of the ITU-T Ethernet based GPON standard, i.e. Ethernet components and optical lasers.

Optimized for the delivery of video-centric services as well as quality voice and high-speed Internet, Motorola enables operators to deploy a network that delivers personalized entertainment and communications services to their customers.

Passive optical splitters are used to enable a single optical fiber to service multiple premises and locations and can be engineered for 1:32 or 1:64 split ratios and support residential, small business, and dedicated commercial services. With current GPON throughput rates of 2.5 Gbps downstream and 1.2 Gbps upstream, combined with proven sustainability of 200 Mbps and burst rates of 400 Mbps to the subscriber, the value of GPON service delivery is in its inherent design flexibility and support of scaleable Ultra-Broadband access network architectures.

As the development of PON technologies continues, the evolution from globally accepted ITU-T compliant Gigabit PON (GPON) to next-generation ITU-T driven 10G-PON or WDM-PON offers service providers unique investment protection opportunities other FTTH technologies cannot. In the end, service providers must carefully consider their deep fiber access architecture options and select solutions that best meet the demands of their consumers and the economic realities of their business.

## Ultra-Broadband Solutions from Motorola

Motorola builds upon core competencies in carrier-class networking and digital video entertainment technologies to deliver Ultra-Broadband services via next-generation DSL and PON solutions that allow service providers to buildout their access networks to provide Ultra-Broadband services. Motorola offers market-leading solutions that deliver the Ultra-Broadband service levels needed to support emerging services.

Optimized for the delivery of video-centric services as well as quality voice and high-speed Internet, Motorola enables operators to deploy a network that delivers personalized entertainment and communications services to their customers. There is a direct relationship between the bandwidth consumers need and the size of the node. If the fiber goes directly to the home of consumers, service providers maximize throughput and can potentially deploy hundreds of Mbps of bandwidth. PON and DSL solutions each have their own advantages, and Motorola offers fiber and copper solutions that provide maximum flexibility and scalability in each scenario.

One question that service providers should ask themselves is, "how far from the subscriber's home can we afford to place the electronics?" If the answer is zero feet, the solution is FTTH; but if the answer is 3 Kft, Bonded ADSL2+, VDSL2, and Bonded VDSL2 are viable options. Motorola offers both copper and fiber Ultra-Broadband solutions.

The Motorola IP DSL Access Multiplexer (IP DSLAM) is a multi-service access solution that integrates all major voice, data, and video network services onto a single high-bandwidth platform, thus offering service providers a single, fully manageable infrastructure for provisioning any package of services to any access network subscriber over a single line. It supports ADSL2, Bonded ADSL2+, VDSL2, and Bonded VDSL2, providing operators maximum flexibility for DSL deployments. Motorola also offers proven DSL customer premise solutions through its recently acquired Netopia product family.

Motorola's line of all-optical FTTH access solutions can deliver tomorrow's Ultra-Broadband access network today. The Motorola AXS2200 and AXS1800 Optical Line Terminals (OLT) are designed with a 200 Gbps switching and backplane architecture and can deliver a full range of non-blocking high-speed uplinks and enable both PON-based FTTH and IP DSLAM-based FTTN access network architectures.

Motorola also offers a complete family of residential, business, and multi-dwelling unit Optical Network Terminals (ONTs) to help network operators build out their network infrastructure. The ONT family bridges the gap between the optical network and the subscriber's home wiring by incorporating in-home network technologies that allow re-use of existing in-home coaxial networks. Augmented by system features such as flow-through provisioning, auto-discovery, and pre-emptive maintenance procedures, the

Motorola offers a wide array of set-tops, eMTA platforms, and gateways to support the delivery of high-speed services to the customer premises and provides cellular handsets and mobile devices that allow broadband operators to enable seamless mobility of broadband services.

Motorola ONT becomes a low-cost solution enabling rapid deployment, auto-service establishment, and key maintenance tools that find 'soft faults' before they become 'hard failures'.

### **Ultra-Broadband Expertise from Motorola**

Motorola offers the products and services that allow service providers to efficiently deploy Ultra-Broadband solutions that provide a competitive advantage and support the development of new services and incremental revenue streams. Creating quality voice and Ultra-Broadband Internet and video solutions of tomorrow means that service providers need knowledge on all of these technologies today, and the Motorola Services Group stands ready to help service providers deploy deep fiber solutions to provide high-speed access via DSL or PON.

Motorola not only offers PON and DSL solutions that allow network operators to deliver Ultra-Broadband services; we also understand the technologies inside the home that will be capitalizing on the availability of increased bandwidth. Motorola offers a wide array of set-tops, eMTA platforms, and gateways to support the delivery of high-speed services to the customer premises and provides cellular handsets and mobile devices that allow broadband operators to enable seamless mobility of broadband services.

As service providers plan network upgrades, the migration to Ultra-Broadband speeds of 50 Mbps or more is inevitable. Motorola has a successful track record of designing and implementing video-optimized IP DSLAM and optical access solutions that can scale to support new services and subscribers. Motorola offers the PON and DSL solutions that support cost-effective buildouts that leverage existing infrastructure, support the delivery of IPTV and other advanced, broadband services, and allow network operators to build longer-lasting relationships with consumer and commercial subscribers that can increase ARPU levels and drive the growth of revenues and profits.



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