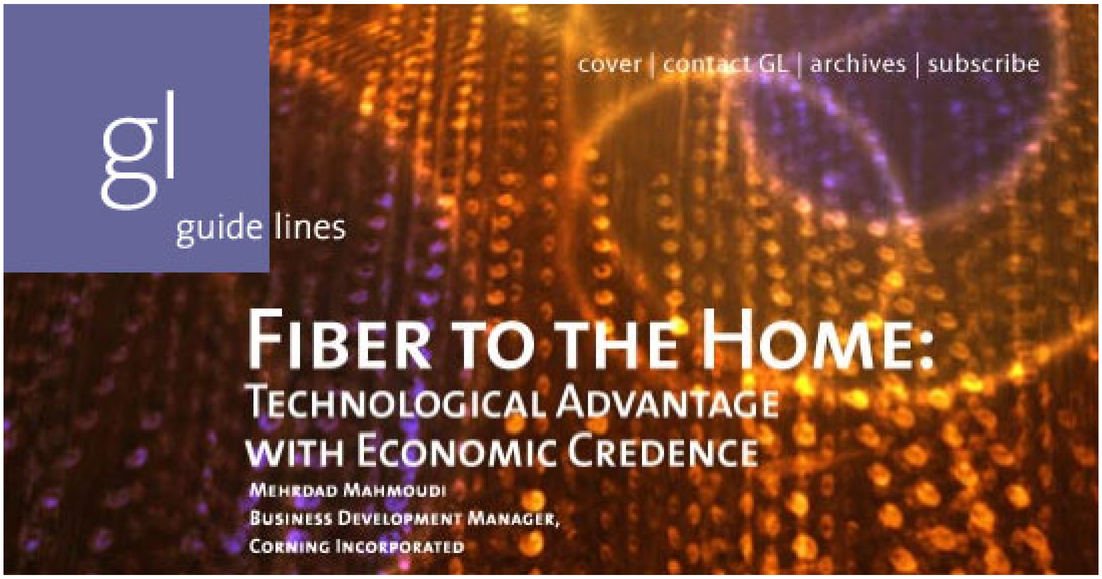

In the competitive communications landscape of the modern world, both the telecommunication and the cable service provider industries have concurred that unless operators can reach consumers with a triple play of services (phone, data, and video), they will fail to economically and technically position themselves as viable, competitive market players for the long run.

Ever Increasing Demand for Bandwidth

With the introduction of high speed Internet and more recently HDTV, today's upper bandwidth requirements are around 20-25 Mb/s per subscriber and there are predictions that this will increase to 50-60 Mb/s by the end of the decade. Recently introduced advanced compression technologies have reduced the bandwidth required for HDTV to the order of 8 to 16 Mb/s, but HDTV still requires always-on data rates higher than any standard high-speed Internet offering from cable or digital subscriber lines (DSL). Further advances in signal compression technology may enable HDTV at lower bandwidths but further compression simply can't be achieved without some consumer-apparent sacrifices in picture quality.

As a consequence, today, most copper-based technologies such as ADSL are already at their bandwidth limits.

Architecture Technologies

To address the need for increased bandwidth demand, service providers are using several different technologies to service and reach their customers with broadband solutions. The three most commonly deployed technologies are FTTH, DSL, and hybrid fiber coax (HFC). Each technology has particular strengths, but FTTH is unique in that it supports nearly unlimited[1] bandwidth. With countries like Japan and the United States rapidly deploying

[1] Unlimited bandwidth based on fiber theoretical bandwidth capability

FTTH, the broadband network deployment trend is becoming more focused on FTTH and less on DSL and HFC.

Although each architecture uses fiber to some degree, usually from the head end (HE) or central office (CO) to some distribution point, FTTH is the only architecture that takes fiber all the way to the premises of the customer. Given the unsurpassed bandwidth capability of fiber, FTTH gives the service provider the flexibility to upgrade the system in the future to provide higher bandwidth with little or no change to the overall architecture. FTTH networks also allow the operator to build the network primarily as a passive system, which requires no power or active elements to be deployed outside of the head end or central office and the customer, thereby drastically reducing in-field maintenance costs.

FTTH networks can be configured as point-to-point systems or passive-optical networks (PONs). Although point-to-point FTTH technology has the advantage of providing a dedicated fiber to each subscriber and therefore can offer unrivalled security and bandwidth provisioning per subscriber, point-to-point FTTH needs active components in the field. By contrast, FTTH PONs have an architecture that contains no active electronics in the field. The active components of the system are located in the head end or central office and the customer site. As a result, both the CAPEX and the OPEX of a PON are greatly reduced. PONs are also very adaptable, allowing the service provider to reach up to 32 or even 64 customers as far as 20 km away, without the need to regenerate the signal, and today's PON technologies, such as Gigabit Ethernet PON (GPON), can provide up to 1.25 Gb/s down to the passive splitter in the field.

DSL technology has the advantage that it allows operators to leverage legacy installed copper plant with proven technology and a wide coverage area. However, DSL technology is limited in many respects when compared to FTTH. Basic DSL, ADSL is very limited in terms of bandwidth capabilities and can't offer triple play services. DSL can provide higher bandwidth to a narrow consumer base via VDSL, which utilizes fiber feeds to take active distribution centers (DSLAMs) to within a few hundred meters of the subscriber's home. In doing so, the number of homes serviced by each DSLAM is reduced and active equipment is deployed in the field, thereby increasing both the installation and operational costs of the network. DSL bandwidth capability is also distance limited, which restricts either the bandwidth delivered to the consumer or restricts the service coverage area, i.e., the number of subscribers who can be offered high speed services.

In an HFC network topology, the transport backbone is fiber and the distribution network is coaxial cable. Within this scenario, data and video are transmitted in a shared RF spectrum. On the surface HFC seems to offer a fundamentally high bandwidth, but in reality the HFC bandwidth is shared among a large number of subscribers, resulting in lower bandwidth provisioning per subscriber at peak times of usage.

With the evolution of modern FTTH technology, FTTH deployment for broadband service provision now makes practical sense from a technological perspective. It offers many unrivalled advantages that will allow FTTH networks to meet the demand for ever-increasing bandwidth now, and for the foreseeable future.

Increasing Bandwidth and Architecture Technologies

FTTH for broadband networks is the clear technological leader, but service providers have continued to deploy DSL due to the belief that FTTH deployment does not make for a sound business case. In the past, this belief was justified as the cost per home connected was in the region of $4,000. However, the last few years have brought significant advancements in fiber and cable technology and that, coupled with the economies of scale associated with the large scale FTTH deployments in the U.S. and Japan, has enabled costs to come down such that the cost per subscriber connection is now in the region of $1,000. Consequently, FTTH is now not just the technological solution of choice, but also a cost-effective solution.

Companies understand that to compete with the cable companies and the rest of the telcos, they must update their infrastructure to provide higher bandwidth to enable triple-play services. To do this they have chosen to deploy FTTH. Today with the reduction of FTTH installation costs and with the lower OPEX associated with fewer electronics in the field, they have an economic motivation to pursue this strategy.

In order to better illustrate the economic viability and advantages of a FTTH approach versus DSL and HFC, it is useful to briefly analyze the deployment and operational costs of PON FTTH, VDSL, and HFC networks within a generic economic business model. The model has been developed and validated through a number of different sources in order to analyze economic impacts of the main broadband network infrastructures commonly employed.

The chosen model analyzes the economics of an overbuild network built over a three-year period in a mid-sized U.S. city covering 100 sq. miles, and encompassing 150,000 residences and 12,000 businesses. It is assumed that 65 percent of the cable deployed will be aerial and that the network will be built with a 25 percent capacity reserve.

The model also assumes that the penetration rate is 70 percent; meaning that 70 percent of the homes passed will subscribe to at least one voice, data, or video service offered by the company. All the architectures use the same penetration rate and each residence utilizes the same number of services for the purposes of this model.

Figure 1 compares the operating expenditures of three network architectures, PON, HFC, and VDSL, over a 20-year period. As the community grows and adds more houses, the OPEX of all three network types continues to grow, as one might expect. However, a PON has a lower starting level of OPEX, so its OPEX costs grow more slowly with increasing population than the OPEX costs of the other two infrastructures.

The FTTH Advantages

Throughout their lifetime, PONs will always have lower OPEX costs than HFC or DSL networks. This is because a PON has lower maintenance costs due to the lack of active components in the field and the more resilient nature of fiber. These features result in fewer field issues that require expensive intervention by maintenance personnel. Consequently

PONs are a network infrastructure that is much more efficient to run and maintain throughout its lifetime, and this is reflected in the consistently lower OPEX cost shown in Figure 1.

Figure 2 compares the net income of PON, HFC, and VDSL networks as deployed in our model city. Figure 2 is really an extension of the OPEX graph shown in Figure 1. With lower operating expenditures, a PON enables more profit margin from revenues and therefore can create more income over time when compared to the other architectures. All three architectures realize an increase in net income due to expected price increases and the number of homes added to a community over the years. However, Figure 2 demonstrates that a PON, with its higher profit margin, will bring in significantly more net income each year than an equivalent HFC or DSL network. Additionally, due to its significant bandwidth advantage, a PON operator has the flexibility to add additional services to further increase profit margins and associated net income in the future.

With demand for HDTV services on the rise and other bandwidth-intensive applications coming online, it is easy to see that bandwidth requirements will continue to grow for many years to come. Such a consistently increasing bandwidth demand requires a robust solution that can satisfy both current and future requirements. It is widely recognized that from a technology perspective such a solution can only be delivered with a FTTH architecture. However, as our understanding of FTTH business models has improved, it has become apparent that FTTH is not just the technological broadband network solution leader, but also offers an economically advantaged solution with low operating and maintenance costs that enable enhanced profitability both now and in the future.