White Paper

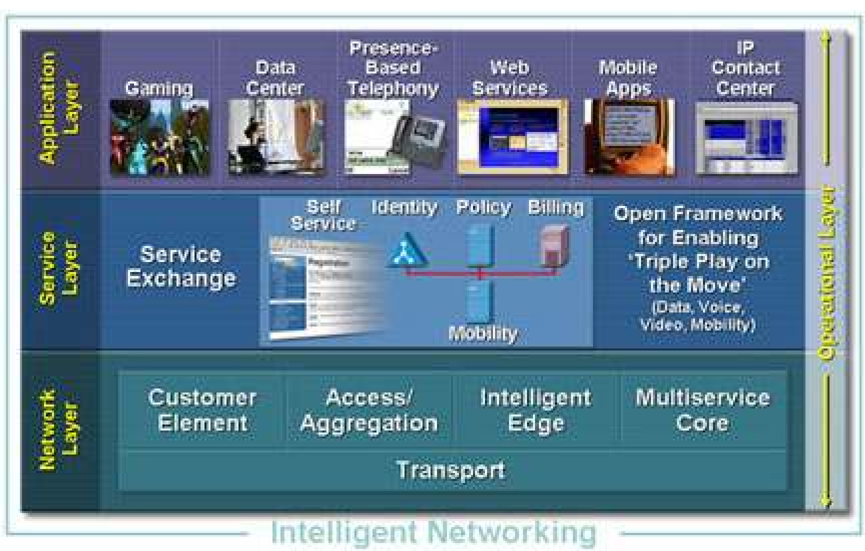
Wideband: Delivering the Connected Life

Subscribers are increasingly demanding "many services to many screens." They want the convenience of having services available anytime, anywhere, and on any device. To offer such services, cable operators must transform themselves from "service providers" into "experience providers." An experience provider is a company that integrates internal and external innovations to deliver the "Connected Life" to consumers and businesses. The experience provider manages constant and rapid innovation to provide differentiated products and services.

To deliver many services to many screens, cable operators require an innovative, converged infrastructure that enables the delivery of current services more efficiently while also providing the means to deliver tomorrow's new, application-intensive residential and commercial services. Deploying solutions that provide greater network intelligence, integration, and overall flexibility will not only provide cable operators with short-term relief but also ultimately enable them to combat competitive pressures and address new market opportunities. The IP next-generation network (IP NGN) architecture is designed to address these requirements, and Cisco Systems® Wideband is a primary component.

The IP NGN architecture has three layers of convergence: the network layer, the service layer, and the application layer. Together, functionality at all three layers enables a competitive "triple play on the move" service offering. See Figure 1.

Figure 1. IP NGN Framework



The Cisco® IP NGN brings a transformation that encompasses not only the cable operator's network but also its entire business. It is about enabling cable operators to meet subscriber needs efficiently and economically, while providing the basis for delivering applications that enable sustainable profitability. The phased development of the IP NGN involves creating an intelligent infrastructure from which application-aware services are delivered by a service-aware network infrastructure. This type of intelligent will opens new opportunities for cable operators to offer end customers advanced, value-added, and personalized all-media services securely and seamlessly over broadband and wireless connections.

As convergence takes place and cable operators offer "many services to many screens," IP will be the protocol on which most of these new services will be based. There are a number of reasons for this. First, the Internet is the world's largest content store, and it is all based on IP; getting access to the broad array of web content is therefore most easily done through IP. Second, new standards such as PacketCable™ Release 2, which includes IP Multimedia Subsystem (IMS), are based on IP, so any new service based on these standards will also by definition be IP-based. Third, the common language of many client devices, from PCs to mobile phones to personal digital assistants (PDAs), is IP. All these devices typically have an IP stack and a browser built in. For these reasons, the simplest way to deliver a new service to many devices is to base that service on IP.

For the reasons just described, many new services, including highly bandwidth intensive services such as High Definition (HD) video, will be delivered over IP. These new services will push DOCSIS® bandwidth requirements beyond what can be offered over current DOCSIS deployments. Cisco Wideband eliminates this limitation and is a major necessity for cable operator networks.

CHALLENGE

The only thing constant about bandwidth is the demand for more of it and at a lower cost of ownership. Particularly in today's highly competitive broadband environment, where higher and higher bandwidths are offered at ever decreasing prices, cable operators need to differentiate themselves and earn premium margins by increasing the bandwidth of their high-speed data offerings. They can also offer new revenue-generating services, such as video services based on DOCSIS, which require higher bandwidth. This results in 2 key challenges: bandwidth and cost.

When cable modems arrived in the marketplace, in particular cable modems based on DOCSIS, they offered 10x to 100x the bandwidth of dial-up modems with a customer premises edge product and a service offering that was within twice the price of the dialup customer premises edge and service costs. Cable modems have been extremely successful over the last 10 years. However, as with analog modems, the channel capacity of the cable modem has an upper limit. The current generation of cable modem termination systems also has a lower limit to its downstream cost basis because of the tight coupling of upstream to downstream channels.

Key Challenge #1: Dramatic Increase in Bandwidth

Wideband solves the bandwidth challenge by adding one or more additional downstream channels to the standard broadband DOCSIS system. This new set of downstream channels is bonded into one larger virtual channel known as a wideband channel.

Key Challenge #2: Dramatic Decrease in Cost per Bit

Wideband modularity provides a solution for cost reduction. The cost challenge is solved by allowing downstream channels to be added independently of upstream channels and by making use of the decline in pricing of external edge quadrature amplitude modulation (QAM) devices. The goal of the wideband protocol for a DOCSIS network is to provide much higher bandwidth at a lower cost.

Subscriber Demand for Very High Speed Data

Today, in North America, a cable operator high-speed data service has a maximum downstream speed between 3 Mbps and 6 Mbps. The DSL downstream speed is lower, typically around 1.5 Mbps. Cable operators use the higher broadband bitrates in order to avoid the commodity pricing typically seen with lower speed DSL offerings, which can cost as little as $13 per month. In other parts of the world, the situation is similar – though short copper loop lengths and other factors facilitate higher downstream bandwidth than in the United States.

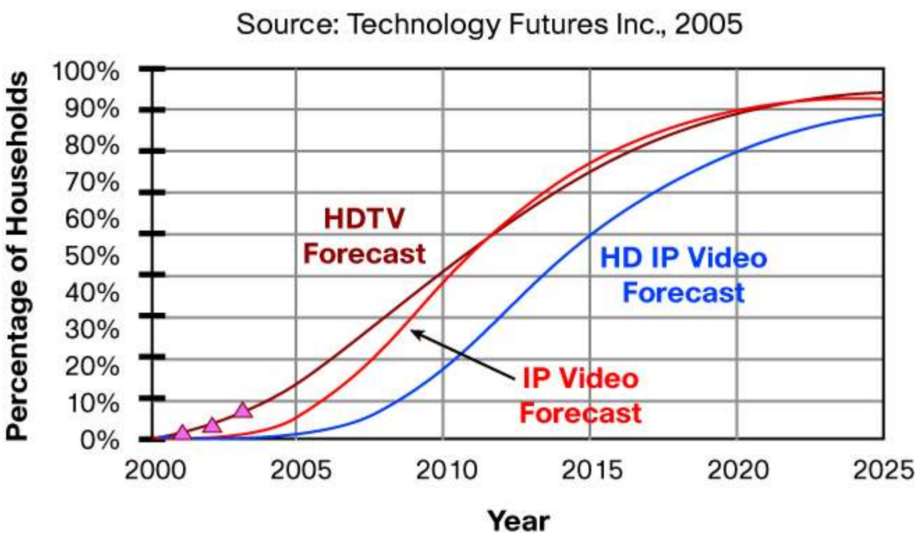
In many areas, broadband competitors are now competing on the basis of speed, enticing new subscribers by offering higher bandwidths. Soon 10 Mbps, then 20 Mbps, and then 50 Mbps downstreams might be the norm. Without channel bonding, offering very high speed services over DOCSIS is impossible. With wideband, however, up to 24 downstream channels (for an aggregate bandwidth of up to nearly 1 Gbps) will be possible after wideband cable modems supporting these speeds become available. Initial wideband cable modems support up to 240 Mbps data rates.

Subscriber Demand for High-Bandwidth IP Services

High-speed broadband is not everything. As subscribers demand "many services to many screens," cable operators are increasingly being pushed to offer new bandwidth-hungry services, including video, to additional devices in the home, including PCs, cell phones, and PDAs. The "language" shared by these devices is IP, so DOCSIS—which was developed to deliver IP over MPEG transport in the HFC network—is the logical way to deliver these services.

Figure 2, from Technology Futures, shows how IP video services are projected to increase through 2025. By 2010, nearly half of all households are expected to be using their broadband connections for IP video, and nearly one in five households will receive high-definition television over broadband. To make this a reality on the cable network, wideband is a necessity.

Figure 2. Growth in IP Video

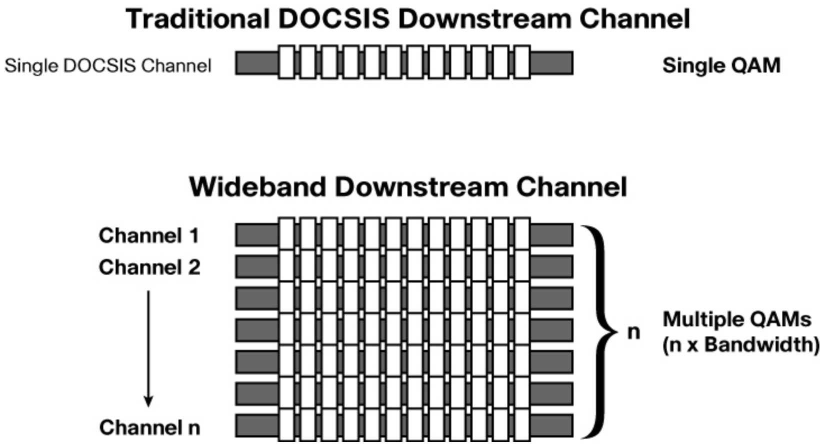


Services being considered by various cable operators include multicast streaming of the broadcast TV lineup to the PC, unicast or multicast delivery of niche content to PCs or set-top boxes enabled by DOCSIS. These applications require a significant amount of bandwidth, and wideband is the only hybrid fiber-coaxial (HFC) technology that can provide it at present.

Wideband Channel Bonding Increases Bandwidth

A major component of wideband is channel bonding. Channel bonding works by load sharing traffic across multiple DOCSIS channels. While each DOCSIS channel carries a payload of about 35 Mbps in DOCSIS (50 Mbps in Euro-DOCSIS), load sharing traffic across multiple channels allows a maximum bandwidth of up to n x 35 Mbps (or n x 50 Mbps), where n is the number of channels being bonded. A separate 6-MHz or 8-MHz frequency is used for each of the bonded channels. The actual channel bonding technique, defined in DOCSIS 3.0, is called "packet bonding." See Figure 3.

Figure 3. Wideband Packet Bonding



Packet bonding in DOCSIS works similarly to the bonding technique used in Multilink Point-to-Point Protocol (MLPPP), a protocol used in dial-up connections to load share across multiple physical links. Packets destined for the wideband channel are then transmitted in round robin fashion through each of the individual DOCSIS channels that make up the wideband channel. Sequence numbers are added to each packet so that receiving modems can help ensure that all packets are kept in the correct order. This is a very efficient load-sharing technique and helps ensure maximum bandwidth utilization on each channel.

In order to increase downstream throughput, where bandwidth demand is greatest, wideband packet bonding will initially be in the downstream direction. Greater downstream bandwidth is needed to enable new services such as broadcast-quality video streaming. The same technology can in the future be applied for bonding in the upstream direction when applications or consumer demand requires it.

With the wideband technology, any number of channels can be bonded, providing a virtually unlimited downstream bandwidth capacity. In practice, however, the downstream bandwidth is limited by both of the following:

- The cable modem, which must have a separate tuner for each channel frequency.
- The frequencies available for use on the cable operator's plant.

Wideband Components

A number of new Cisco uBR10012 Universal Broadband Router products enable wideband. First, there is a new shared port adapter (SPA) that is connected using Gigabit Ethernet to an edge QAM, which can support up to 24 QAM channels. The CMTS is able to bond up to 8 of these channels together using packet bonding. In addition to the Scientific Atlanta eXtra Dense QAM Array (XDQA), a number of other vendors' QAM devices are also supported.

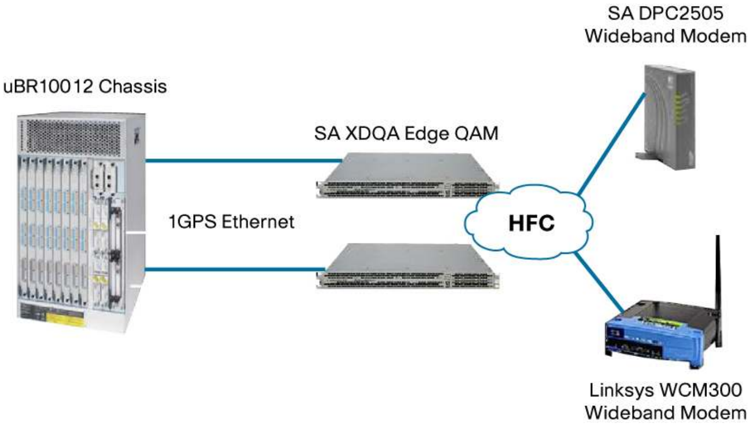
Each Cisco uBR10012 Universal Broadband Router chassis can take up to two SPA modules, for a total of 48 downstream channels that can be dedicated to wideband services. SPA modules fit into a carrier module called the SPA interface processor (SIP). The SIP module fits into one of the WAN slots in the Cisco uBR10012 Universal Broadband Router chassis.

Wideband also requires a wideband-capable cable modem at the premises. Traditional cable modems only have a single tuner and only support a single channel. A wideband cable modem, by contrast, has multiple channels. Cisco wideband currently supports two different types of wideband cable modems: a three-channel modem from Scientific Atlanta called the DPC2505 and a Linksys 8-channel cable modem called the WCM300. By offering multiple cable modem options, Cisco enables cable operators to provide each customer the cable modem that better meets their bandwidth and cost requirements.

How Wideband Reduces Cost

The Cisco Wideband offering is about much more than simply enabling more bandwidth. It also significantly lowers the cost of bandwidth compared to other offerings. This is a result of the modularized wideband architecture, shown in Figure 4, and will be described in more detail in the following sections.

Figure 4. Wideband Architecture



Low-Cost Edge QAMs

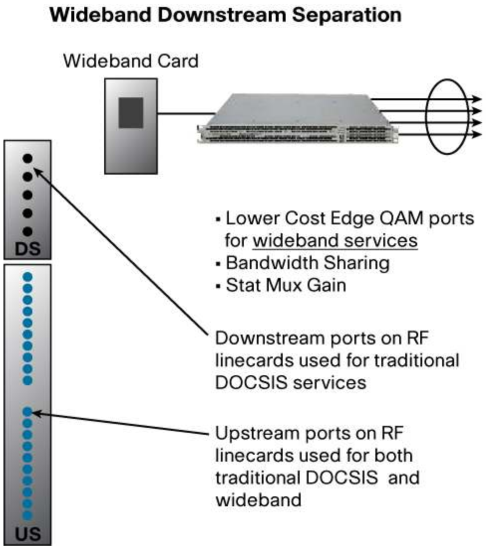
Cisco Wideband uses existing field-proven edge QAMs: the same edge QAMs cable operators are rolling out today for their video-on-demand (VoD) offerings. RF ports on these edge QAM devices have traditionally been from one-third to one-fourth the price of RF downstreams on cable modem termination systems. As a result, Cisco Wideband is a tremendously cost-effective solution and enables cable operators to offer higher bandwidths at a low price.

Because the edge QAMs deployed with a Cisco Wideband system are the very same edge QAMs used in VoD deployments, they have been proven in the field, and there is typically no need to have them requalified through cable operators' lab testing procedures. Furthermore, Cisco Wideband supports a variety of different edge QAM devices, including the SA eXtra Dense QAM Array (XDQA).

Separation of Downstream from Upstream

Cisco Wideband does not simply reuse existing modules in the Cisco uBR10012 Universal Broadband Router chassis. Existing modules have a fixed ratio of upstream and downstream ports (for example, 20 upstreams and 5 downstreams on the 5x20 card); to reuse these same cards with wideband would mean stranding a large number of upstream ports. Instead, wideband downstream channels can be added independently of upstream channels; edge QAMs have RF ports for the downstream only. As a result, there is no need to pay for unused upstream channels, and Cisco Wideband is very cost-effective. See Figure 5.

Figure 5. Wideband Separation of Downstream from Upstream



Doubled Downstream Capacity on the Cisco uBR10012 Universal Broadband Router

Cisco Wideband is very cost-effective because of the high density of the solution. Before wideband was introduced, the Cisco uBR10012 Universal Broadband Router already had a very high density cable modem termination system, with support for 160 upstreams and 40 downstreams in a single chassis.

Now, with wideband, the Cisco uBR10012 Universal Broadband Router has more than doubled downstream capacity. Rather than using the same I/O slots that are now being used for nonwideband DOCSIS services, the new UBR10-2XWB-SIP carrier module can take up to two SPA-24XWB-SFP modules. Each of these SPA modules can connect to an edge QAM device, with up to 24 downstream QAMs each, using Gigabit Ethernet Small Form-Factor Pluggables (SFPs).

Because the SIP carrier and SPA modules are all populated in the WAN slot, cable operators can continue to use the eight RF module slots for nonwideband services. As a result, it is now possible to support up to 88 downstreams (40 traditional DOCSIS QAMs and 48 wideband QAMs, using two edge QAM devices) in a single Cisco uBR10012 Universal Broadband Router chassis. Downstream density is more than doubled with an upgrade to wideband.

SUMMARY/CONCLUSION

Wideband is an important enabling technology that allows cable operators to stay ahead of the broadband competition in offering very high speed broadband and to enable new IP services, including video services. New IP services are being driven by the need to leverage web-based content and the push for “many services to many screens.”

Wideband uses channel-bonding technology to offer downstream speeds far greater than what is available with traditional DOCSIS. In addition to enabling higher bandwidth through channel bonding, Cisco Wideband also makes use of low-cost, field-proven edge QAM modulators to dramatically lower costs and also to increase density.

Most cable operators will choose to deploy wideband in order to offer higher peak bandwidth for premium tier customers. Over time, different wideband cable modem offerings will become available, with varied numbers of channels. Furthermore, as wideband cable modem costs drop, wideband-based services will gradually become the standard cable broadband offering. Wideband is the technology that will truly enable “many services to many screens” and deliver “The Connected Life” that subscribers seek.

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