The Gateway to the Connected Life: DOCSIS 3.0

Many of today's subscribers are no longer satisfied with the choices provided by traditional broadcasting. More and more, they are embracing a Video 2.0 world where usage is interactive, content is personalized, and content choices are delivered to multiple devices anywhere and anytime.

Until recently, we have lived in a "Video 1.0" world of traditional broadcast television where content is available only on the television and most people watch "live" content based on the programmers' schedules. Video 2.0 changes all that – we won't be just "watching television" anymore. We will be viewing rich media content on a multitude of screens, and from a multitude of sources.

With Video 2.0, video becomes fundamental to nearly every experience in what Cisco calls the "Connected Life." We will be able to generate our own content and share it with others. We will be searching for "just the right video" from a vast body of content to suit all tastes – rather than browsing through a content guide designed for the masses. And we will do all this in a personalized way, based on our own preferences and our own needs.

To address these new expectations and fend off competition, cable operators must provide a means for users to get any content from anywhere at anytime. In essence, service providers have to become more of an experience provider and enable integration of new and innovative applications into their service mix at an increasingly rapid pace.

The Cisco® IP Next-Generation Network (IP NGN) architecture enables convergence of networks and services and provides the intelligence to allow seamless movement of content and services. Operators can deliver the Connected Life to consumers, addressing their immediate needs while laying the foundation for rapid deployment of next-generation services.

A DOCSIS® 3.0 next-generation cable access network is one of the key components of the Cisco IP NGN. Cisco has both integrated and modular cable modem termination systems (I-CMTS and M-CMTS) DOCSIS 3.0 solutions. DOCSIS 3.0 is a cable standard developed by CableLabs® that enables high-bandwidth access networks, and M-CMTS is an accompanying standard that provides guidelines on using Universal Edge Quadrature Amplitude Modulation (U-EQAM) as DOCSIS downstream channels. U-EQAMs provide features and capabilities that enable an operator to use traditional video EQAMs for DOCSIS.

DOCSIS 3.0 helps operators address the current network speed limitations by enabling them to increase upstream and downstream speeds to 120 Mbps and 160 Mbps, respectively. To achieve these ultra-high speeds and help cable operators deliver more content over their existing networks, DOCSIS 3.0-compliant channel-bonding technology from Cisco uses multiple channels to deliver more packets simultaneously, providing high-speed data rates several times faster than existing DOCSIS 2.0 equipment. The M-CMTS standard complements the DOCSIS 3.0 standard by providing a means by which a CMTS could expand its downstream capacity by using Universal EQAM modulators at a fraction of today's downstream cost.

Challenges for Cable Operators

Challenge 1: Delivering Higher Bandwidth

The main challenge that operators face to provide a Connected Life experience is lack of available bandwidth. Operators need to deliver more downstream and upstream bandwidth to provide a fat pipe to and from the home.

Solution: DOCSIS 3.0

DOCSIS 3.0 addresses the bandwidth crunch in both the upstream and downstream directions.

Challenge 2: Delivering that Higher Bandwidth at a Reduced Cost per Bit

While the need for bandwidth is enormous, operators have to be able to deliver next-generation, high-bandwidth services at a reduced cost in order to stay competitive in the marketplace.

Solution: M-CMTS and I-CMTS

The modular M-CMTS and I-CMTS solutions provide the building blocks to enable operators to offer highly competitive, high-bandwidth services at a reduced cost per bit. By using M-CMTS and deploying U-EQAM modulators, operators now can easily migrate to a high-bandwidth service to the home and enjoy greatly reduced capital expenditures (CapEx). I-CMTS provides a similar migration solution at a reduced scale.

Challenge 3: Faster Time to Market, Targeted Deployment, and Minimizing Risk in DOCSIS 3.0 Transition

As operators migrate to DOCSIS 3.0, in addition to cost, their other key concerns are flexibility, speed of deployment, and minimizing the risks associated with deploying new services.

Solution: M-CMTS

M-CMTS provides targeted insertion of DOCSIS 3.0 solutions on a node-by-node and customer-by-customer basis. It also minimizes migration risk by using proven hardware that has been deployed for over two years, delivering service to more than 700,000 channel-bonded subscribers worldwide. Deployment is accelerated by the fact that the Cisco M-CMTS solution requires minimal wiring changes to migrate the network to DOCSIS 3.0.

Cisco Next-Generation Converged Access Networks for Cable

Cisco High-Speed Data (HSD) solutions blend broadband cable radio frequency (RF) technology with Cisco's highly scalable, secure, and flexible IP core technology. The Cisco portfolio includes industry-leading, DOCSIS-compliant CMTSs, leading-edge business and home data and voice cable modems, and advanced IP backbone and edge products. Cisco provides both an M-CMTS-based DOCSIS 3.0 solution as well as a traditional I-CMTS-based solution.

The Cisco family of DOCSIS-compliant CMTSs includes the high-capacity Cisco uBR10012 Universal Broadband Router, the mid-range uBR7246, and the uBR7225. The Cisco RF Series provides a scalable M-CMTS DOCSIS 3.0 solution. And Cisco recently introduced a DOCSIS 3.0-certified cable modem (model DPC3000) and a DOCSIS 3.0-certified cable modem with a PacketCable™ 1.5-certified embedded Media Terminal Adapter (eMTA) for voice-over-IP service (model DPC3202).

This next-generation solution incorporates DOCSIS 3.0-defined channel-bonding techniques that dramatically increase peak bandwidth available to the subscriber through existing cable plant. Channel bonding can be implemented on a node-by-node basis, responding to competition as it arises.

Benefits of the Modular CMTS Architecture

According to ABI research, the market size for universal edge QAMs will grow from around 200,000 QAM channels in 2009 to 1.5 million QAM channels shipped worldwide by 2013. This is an overall growth of 650% over 5 years. Cisco's Modular CMTS (M-CMTS) solution allows the operator to take advantage of these Universal edge QAMs for DOCSIS 3.0. And M-CMTS offers scalable downstream capacity to support the dramatic growth of traffic and video streaming over the Internet.

According to a recent report by Nielson, watching video on the Internet is no longer a novelty and 119 million unique viewers viewed 7.5 billion video streams in May 2008. Another study conducted by Cisco, the "Cisco Visual Networking Index Forecast," predicts that video will comprise more than 50 percent of Internet traffic and the growth in video traffic will reach a compound annual growth rate (CAGR) of 41 percent between 2007 and 2012 (Figure 1).

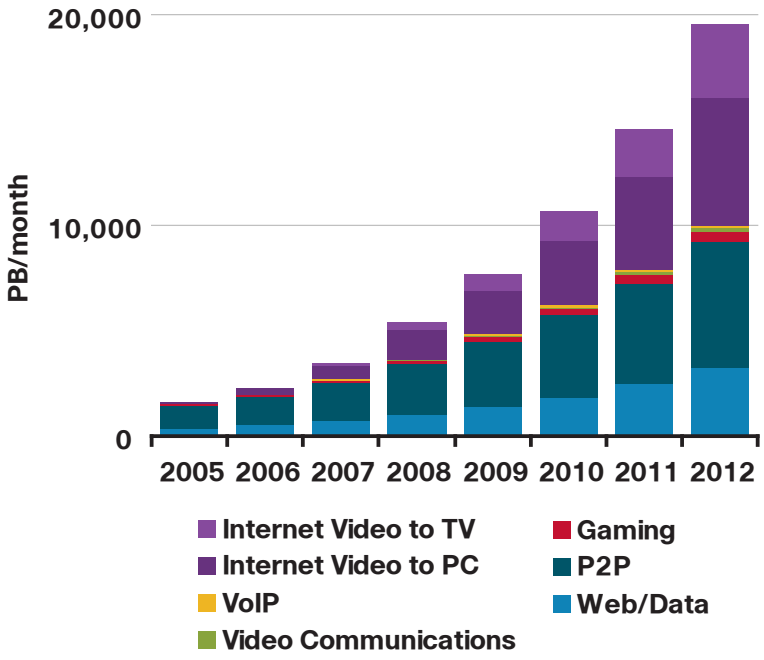

Figure 1. Global Consumer Internet Traffic Mix

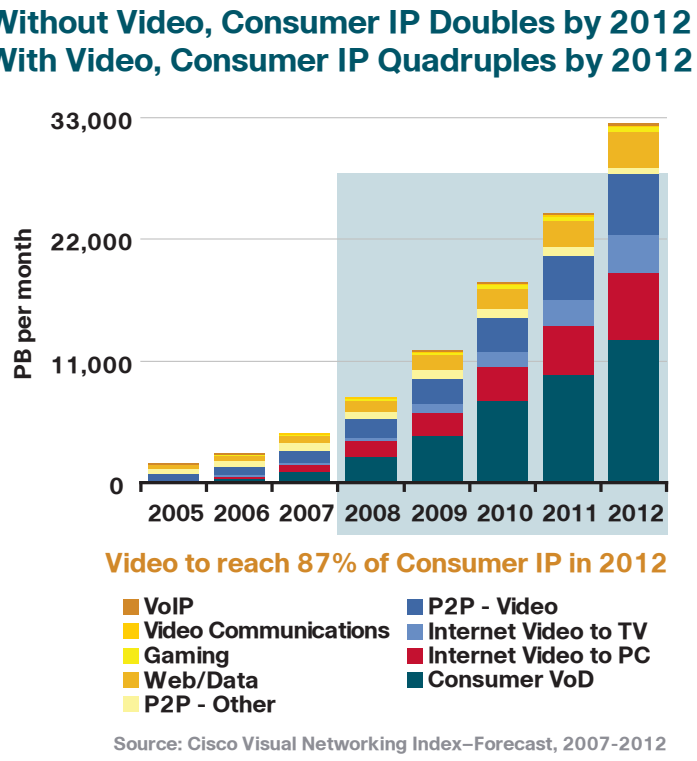

Figure 2. Impact of Video on Network Traffic

The same study also shows the shift of Internet traffic to video by more than 50 percent (Figure 2). The study predicts that average monthly consumer Internet traffic will increase by a 32 percent CAGR in the coming years. That equals a 382 percent increase between the end of 2008 and 2012. Bottom line: infrastructure not only has to deliver more peak speed per subscriber but also must scale up to address the change in the behavior of user traffic.

The M-CMTS solution provides operators with the scalability and density to support this bandwidth-intensive trend. Migration from DOCSIS 1.1/2.0 to DOCSIS 3.0 is achieved by adding a shared port adaptor (SPA) line card and a timing card to the Cisco uBR10012 in conjunction with the RF Gateway Series Universal EQAM. The first DOCSIS 3.0 migration option doubles the downstream capacity of the Cisco uBR10012 to 88 QAMs. A second option provides four additional SPA modules to increase the total capacity of the uBR10012 by four times, to 184 active QAMs per chassis. A third option provides 20 downstream QAMs per line card by introducing the MC2020 line card for a total of 304 active QAMs per chassis. A fourth option leverages a new 3G60 line card providing a CMTS chassis with 512 downstream QAMs and 480 upstream channels.

One of the key advantages of this architecture is that cable operators can add capacity to their existing cable modems by adding QAMs from the SPA module to each service group and load balancing the existing cable modems while also delivering 100+ Mbps speeds to DOCSIS 3.0 cable modems. This approach enables operators to reduce node splits and node de-combines, which significantly reduces CapEx and OpEx, and also allows operators to add downstream capacity at a fraction of the cost of adding traditional integrated downstream channels. The Cisco M-CMTS DOCSIS 3.0 solution, which is based on proven SPA hardware that Cisco has been shipping since 2007, significantly reduces the risks inherent in deploying increased bandwidth and new services.

The Cisco M-CMTS solution:

- Enables operators to increase capacity to their existing DOCSIS 1.x/2.0 customers at a fraction of the cost of an integrated downstream QAM
- Reduces node splits and other bandwidth-management CapEx by allowing operators to add downstream QAMs and load balance
- Minimizes operators' DOCSIS 3.0 time to market and deployment risk with proven SPA hardware
- Provides a targeted DOCSIS 3.0 migration that meets customer needs and outpaces the competition

DOCSIS 3.0 Migration

Cisco offers unique capabilities for an end-to-end solution that can help you deliver the Connected Life, expand your offerings, and get the most from your infrastructure. The Cisco IP NGN architecture offers the only end-to-end, comprehensive, ultra-high-bandwidth, field-proven, highly scalable DOCSIS 3.0 solution. It starts with the Cisco CRS-1 Carrier Routing System in the core, the uBR7600 Series in the metro, the uBR10012 CMTS with the RF Gateway Series EQAM at the edge, and continues to the DOCSIS 3.0 cable modem- and eMTA-based Connected Home solution at the customer premises.

Cisco has both Modular CMTS (M-CMTS) and Integrated CMTS (I-CMTS) solutions that provide efficient and cost-effective migration of existing cable access networks to DOCSIS 3.0. The I-CMTS solution is ideal for relatively smaller hubs while the M-CMTS solution could be targeted to relatively larger hub locations. Cisco's solutions provide the operator with flexibility to create optimal solutions based on hub size and subscriber traffic profile.

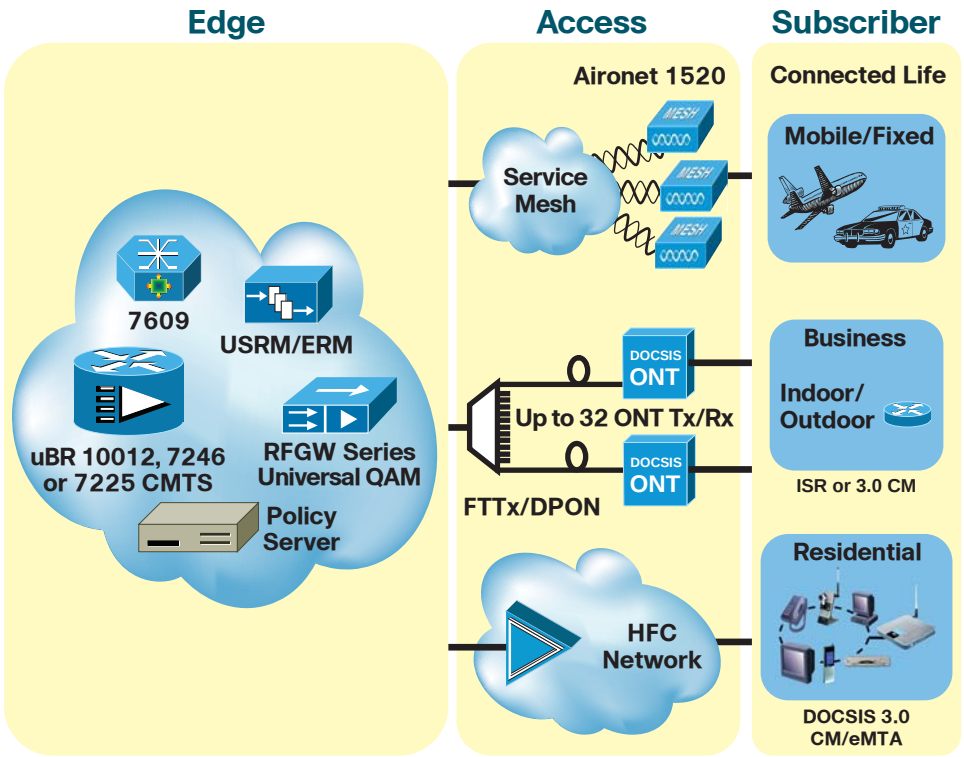

Figure 3. Cisco Next-Generation Access Architecture

The M-CMTS solution provides DOCSIS 3.0 downstream bonded service, as well as more downstream bandwidth to existing DOCSIS 1.x/2.0 customers, at a fraction of the cost of adding bandwidth using traditional CMTS line cards. Because Cisco implements channel bonding in full accordance with the DOCSIS 3.0 standard, current deployments can be migrated to full DOCSIS 3.0 by using SPA technology, a Universal EQAM, and DOCSIS Timing Interface (DTI) technology. The operator becomes fully capable of delivering up to 155 Mbps service in the downstream direction and 120 Mbps in the upstream direction to every subscriber that has a four-channel DOCSIS 3.0 modem.

In other words, the Cisco M-CMTS-based DOCSIS 3.0 solution allows operators to add modular downstream channels to a service group using the Cisco RF Gateway Series Universal EQAM. This provides additional bandwidth to existing non-bonded services while enabling the addition of ultra-high-bandwidth bonded downstream service to a DOCSIS 3.0 cable modem.

Figure 4 shows a complete lineup of Cisco's DOCSIS 3.0-based solution, which includes:

- High-capacity, DOCSIS 3.0 Bronze-qualified Cisco uBR10012 CMTS
- Cisco RF Gateway 1 and 10 Universal EQAMs
- Cisco DPC3000 four-channel DOCSIS 3.0-certified cable modem
- Cisco DPC3202 four-channel DOCSIS 3.0-certified and PacketCable 1.5-certified eMTA

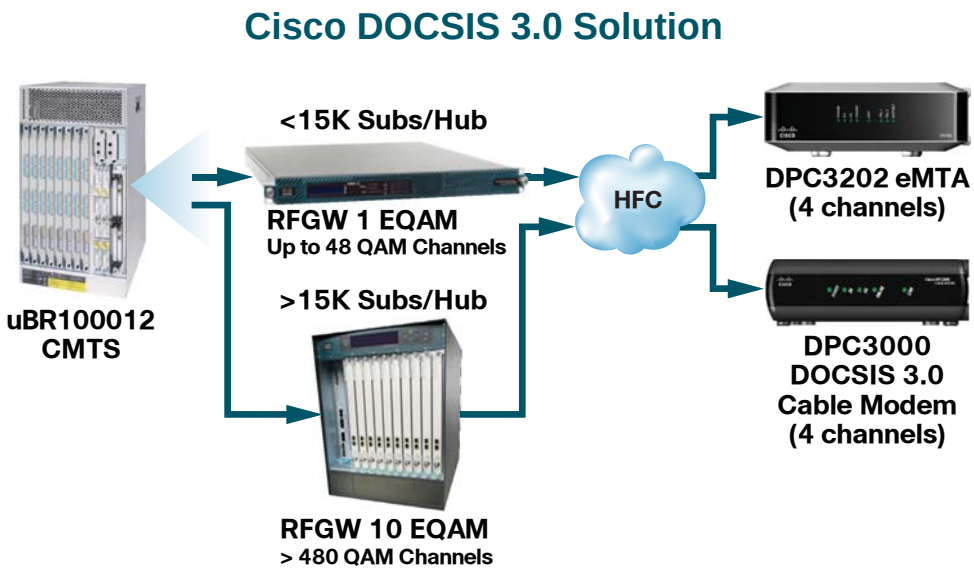

Figure 4. M-CMTS and DOCSIS 3.0 Downstream Channel Bonding

The Cisco RF Gateway

The Cisco M-CMTS solution provides cost per QAMs that are among the lowest in the industry along with some of the highest QAM density per chassis available. This is enabled by the high-capacity CMTS core and the high-density Cisco RF Gateway Series Universal EQAM. The Cisco RFGW family of EQAMs consists of the RFGW 1 Stackable EQAM and the chassis based carrier class, RFGW 10 universal EQAM. The Cisco RF Gateway Series Universal EQAM gives operators the flexibility to deliver next-generation services from the smallest to the largest hub sites, with either stackable or chassis-based form factors that best meet their needs. It also allows operators to deliver the Connected Life to their customers at very competitive price points while providing the scalability needed to meet future customer demands. The RFGW 10 has the industry's leading EQAM capacity and is an EQAM built with full high availability. The high QAM capacity of the RFGW 10 enables highly efficient QAM sharing in a converged MPEG and IP environment. Both the RFGW 1 and RFGW 10 fully support video and DOCSIS services.

Figure 5. The Cisco RF Gateway Series Universal EQAMs

DOCSIS 3.0 Future Roadmap

As noted earlier, the first set of DOCSIS 3.0 features are delivered through the M-CMTS on the Cisco uBR10012. The SPA technology used for M-CMTS provides the mechanism to continually increase the downstream capacity of the CMTS. Cisco will continue to evolve the M-CMTS and its I-CMTS DOCSIS 3.0 solutions.

Figure 6 shows how Cisco's DOCSIS 3.0 solution increases the CMTS capacity by more than 120 percent while reducing the cost of a downstream port by 85 percent.

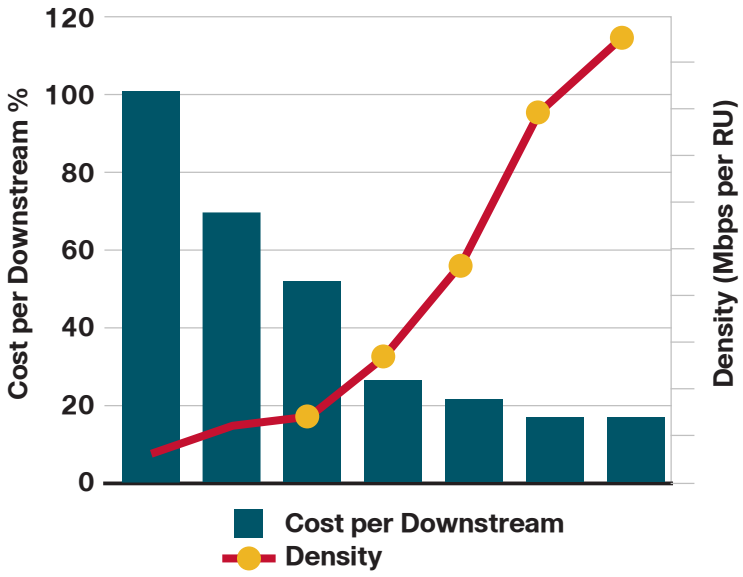

Figure 6. Cisco uBR1000 CMTS Cost and Density Curve

Conclusion

Cisco has combined M-CMTS and I-CMTS technology to provide operators with a scalable solution to rapidly increase bandwidth and deploy DOCSIS 3.0 services with minimal risk by using proven hardware and software technology. The key highlights of Cisco's leadership and commitment to revolutionize the cable industry include:

- Invented channel bonding (Wideband) in 2001
- First CMTS IPv6 demo in 2004
- First public demo of DS Channel Bonding in 2005
- First CMTS Multicast demo in 2005
- First DOCSIS 3.0 + M-CMTS integration in 2006
- Highest-speed channel bonding trial – 293 Mbps
- First U.S. Channel Bonding interoperability in July 2007
- DOCSIS 3.0 Bronze Qualification in Cert Wave 56 Oct 2007
- More than 600,000 Wideband paying subscribers in February 2008
- First chassis-based QAM shelf with high availability in 2008

Cisco's initial DOCSIS 3.0 solution:

- Allows operators to provide DOCSIS 3.0 speeds and services
- Provides operators with the ability to increase downstream capacity to the existing customer base of DOCSIS 1.x/2.0 subscribers at a fraction of the cost of a traditional downstream channel.
- Allows operators to target the insertion of DOCSIS 3.0 bonded service.
- Greatly minimizes operator's DOCSIS 3.0 time to market and deployment risk.

Cisco is leading the DOCSIS 3.0 and convergence race and is in the forefront to deliver the highest DOCSIS 3.0 capacity in a single chassis at the lowest possible price point, exceeding its initial goal of gaining 10 times the bandwidth at one-tenth of the cost.

Americas Headquarters
Cisco Systems, Inc.
San Jose, CA

Asia Pacific Headquarters
Cisco Systems (USA) Pte. Ltd.
Singapore

Europe Headquarters
Cisco Systems International BV
Amsterdam, The Netherlands

Cisco has more than 200 offices worldwide. Addresses, phone numbers, and fax numbers are listed on the Cisco Website at **www.cisco.com/go/offices.**