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The Road to DOCSIS 3.0

Another Take on Migration Strategy

By John T. Chapman and Shalabh Goel, Cisco Systems

Cable operators today have a tremendous opportunity to transform their businesses while at the same time outdoing their competitors by expanding the breadth of their services. With competition coming from wireline and wireless networks and from Internet-based providers such as Skype and Vonage, building up the cable provider infrastructure is not an option; it's a requirement.

Subscribers are in the driver's seat, and they're developing a taste for high-speed, high-quality data, voice, video and mobile services. They want service on an array of network-addressable devices and more service options, faster service activation, faster access speeds, and competitive pricing. How should cable providers respond?

"Experience provider"

The cable industry is well aware of these competitive challenges and new customer requirements. Savvy operators know that they must provide more than connectivity, that to survive and thrive they must transform themselves into "experience providers." Experience providers differentiate themselves competitively by how well they deliver and brand a consistently high-quality experience. This experience must be delivered across applications and devices to satisfy the needs of customers who expect a connected lifestyle at home, at work and on the go.

To deliver high-speed, triple-play and mobility services with such coverage and flexibility requires a different network architecture. The CableLabs DOCSIS version 3.0 defines specifications for a state-of-the-art Internet protocol (IP) transport over the HFC cable plant that will support high-speed data, voice and video services and many other features that empower the experience provider infrastructure.

Cable operators have existing infrastructures. Retooling them can be prohibitively expensive if not done prudently. Operators can make use of existing infrastructure investments while adding new ones incrementally and converging their networks over IP. Such a migration is a cost-effective strategy that supports DOCSIS 1.x, 2.0 and 3.0 features simultaneously. The benefits of this approach include higher customer satisfaction, new service revenue, premium margins, and reduced long-term

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new service revenue, premium margins, and reduced long-term capital and operational expenditures.

Converging over IP

As more and more cable operators converge their networks, IP is emerging as the protocol on which most new services are based. Not only is the world's largest content source—the Internet—based on IP, but so are new standards such as PacketCable Release 2, which includes IP multimedia subsystem (IMS). Any new service using these standards will also be IP-based. The common language of many client devices—from PCs to mobile phones and PDAs—is IP. These devices typically have an IP stack and a browser built in, and the simplest way to deliver a new service to them is to utilize IP protocols. New broadband services based on IP, such as Internet generated high definition (HD) video, will push traditional DOCSIS data throughput requirements beyond what can be offered under the current standards.

The next-generation IP network architecture allows the convergence of all legacy networks and services into one application-aware and service-aware IP network infrastructure. This type of intelligent network will open up new opportunities for cable operators to offer customers advanced, highly secure, value-added, personalized multimedia services over cable and wireless connections.

Throughput vs. cost

In today's competitive broadband environment, where higher and higher data rates are offered at ever-decreasing prices, operators must differentiate themselves and earn premium margins by increasing the throughput of their high-speed data offerings. Increasing the capacity of their services enables operators to offer new revenue-generating services, such as video over DOCSIS.

While current DOCSIS cable modems offer 10 to 100 times the speeds of dialup modems, their throughput limits are nevertheless becoming an obstacle in today's competitive environment. That competitive environment used to be just basic digital subscriber line (DSL), but is now evolving to include newer and more advanced DSL technologies such as ADSL2+ and VDSL2. There are also two major fiber-to-the-home (FTTH) deployment strategies underway, Verizon's FIOS and AT&T's Lightspeed, that are delivering as much as 50 Mbps speeds and promising 100 Mbps.

Feature set

But help is on the way with the rich set of features that will be available soon to cable operators with the DOCSIS 3.0 specifications. Here are some of the highlights.

DOCSIS 3.0 addresses the bandwidth and speed limitations necessary for triple-play broadband and offers both new features and improved efficiency. One of the most exciting new features is called channel bonding. (See Figure 1.)

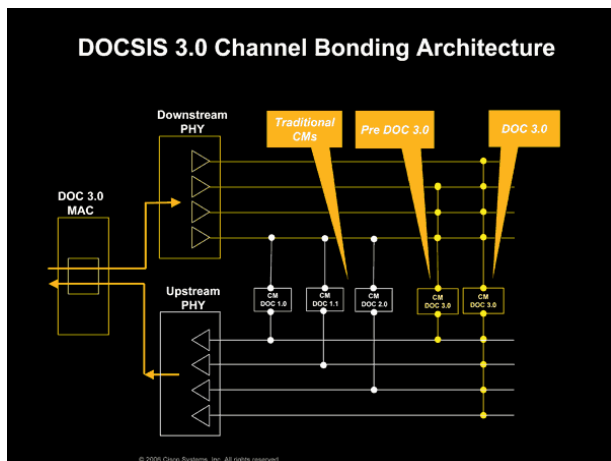


FIGURE 1: DOCSIS 3.0 channel bonding

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Channel bonding is a load-sharing technique for logically combining multiple DOCSIS channels. DOCSIS 3.0 defines channel bonding for both the upstream and downstream directions. For downstream channel bonding, each downstream DOCSIS channel carries a payload of approximately 38 Mbps (50 Mbps with EuroDOCSIS). Load sharing traffic across multiple channels allows a maximum throughput of up to $n \times 38$ Mbps (or $n \times 50$ Mbps), with n representing the number of channels being bonded. A separate 6 MHz or 8 MHz frequency is used for each of the bonded channels. Upstream channel bonding is possible for a minimum of four channels, 10 to 30 Mbps each, for a total of 40 to 120 Mbps of shared throughput.

DOCSIS 3.0 also supports IPv6, which provides expanded IP address space, among other features, to encompass the millions of new network-addressable devices that are being created around the world and have been taxing current IP address limitations. The initial deployment phase allows the cable operator to set up an IPv6 control and management plane for managing the cable modems, set-top boxes, and multimedia terminal adapters (MTAs) with a cost-effective upgrade. In a subsequent deployment phase, cable operators can offer IPv6 directly to the home network. Many new devices are already IPv6 capable, and cable operators could soon be running the largest IPv6 networks in the world.

Enhanced support for multicast is another feature available in DOCSIS 3.0. It enables source-specific multicast (SSM) and Internet group management protocol version 3 (IGMPv3) support, thus allowing for the provisioning and management of multicast sessions with quality of service (QoS) guarantees. A special downstream identifier (DSID) manages multicast over a channel bonding environment, and there is also an IPv6 multicast version. Multicast will enable operators to deliver targeted video to subscribers economically and efficiently.

Other key related DOCSIS 3.0 features, which may be migrated over time, include:

- Enhanced security, including advanced encryption standard (AES), security provisioning and theft of service features;
- An upstream frequency range extension to 85 MHz and a downstream frequency extension to 1 GHz that allows an operator to add existing capacity with plant upgrades at a later date;
- Enhanced plant diagnostic features, including a cable modem diagnostic log, enhanced signal quality monitoring, extension of IP data record (IPDR) usage and capacity management.

Addressing the commercial market, DOCSIS 3.0 specifications define two technologies for business services over DOCSIS: layer 2 virtual private networks (VPNs) and T-1 circuit emulation.

DOCSIS 3.0 specifications provide the intelligent features cable operators will need to become experience providers, providing the services residential and business subscribers are expecting. Business users will be able to videoconference from their PCs and PDAs and tap into corporate networks through VPNs; residential customers will subscribe to video-on-demand (VOD) and IP telephony services with low latency and minimum packet loss; and users everywhere will be able to upload and download files at much greater broadband speeds.

Channel density

The industry consensus is that fully compliant DOCSIS 3.0 CMTS implementations will be available in 2008 to 2009. Many cable operators will require the most critical DOCSIS 3.0 features, such as downstream channel bonding and IPv6, far earlier. To meet this demand, many vendors' CMTS products now include early implementations of such a subset of DOCSIS 3.0 features.

One cost-effective approach to increasing downstream channel density includes the addition of low-cost universal edge quadrature amplitude modulation (QAM) modulators at the network edge through the use of new modular CMTS (M-CMTS) architecture. The universality refers to the edge QAM modulators' ability to be dynamically configured for either

direct video over MPEG-TS or DOCSIS transport. Added to existing infrastructure, these platforms can more than double their number of downstream channels and significantly reduce their costs. Subscriber downstream data rates can be increased to 100 Mbps, which is many times faster than today.

The CMTS component is a router with a DOCSIS media access control (MAC) card that is connected using Gigabit Ethernet (GigE) to an edge QAM modulator, which can support as many as 24 or more QAM channels. Using the channel bonding technique from DOCSIS 3.0, the CMTS can bond up to four, eight or more channels, depending upon the number of RF receivers in a cable modem. To add additional channels to the DOCSIS lineup, operators can start with the same edge QAM modulators many are deploying today for VOD service. RF ports on these QAM modulators cost much less than the price of RF downstream capacity on CMTSs because they are decoupled from the upstreams and are optimized for a specific application.

This modular solution is one cost-effective migration strategy to begin providing the DOCSIS 3.0 feature set.

Shifting ground

Cable operators can see the ground shifting underneath their feet as subscribers' expectations have rapidly evolved. The coming of DOCSIS 3.0 paves the way for the new broadband era and the transformation of operators from providers of connectivity to providers of rich, diverse, high-quality multimedia experiences.

Mindful that to compete and thrive operators need to move as quickly and intelligently as possible in this transformation, equipment vendors are creating many options that will allow incremental upgrades to phase in key DOCSIS 3.0 features even before the entire feature set has been deployed. These features deliver the "connected life" experience to demanding customers, enhancing their satisfaction and loyalty to operators.

For cable operators, DOCSIS 3.0 brings many new efficiencies that allow for better management, smarter use of resources, and potentially a more lucrative return on investment as many new services and features are deployed.

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