PACKET

CISCO SYSTEMS USERS MAGAZINE

SECOND QUARTER 2005

SELF-DEFENDING NETWORKS

CISCO SYSTEMS

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Wideband Protocol for DOCSIS

Cable operators get ten times the bandwidth at one-tenth the cost of today's cable data service—over existing networks.

By Janet Kreiling

How can cable operators leapfrog fiber to the home (FTTH) and deliver 50 or 100 Mbit/s both up and downstream to each residence (or business) on their hybrid fiber-coaxial (HFC) networks? By simply rearranging equipment that's already in place, thanks to *Wideband Protocol for DOCSIS,* a new technology from Cisco that frees up bandwidth already in that fiber and coax.

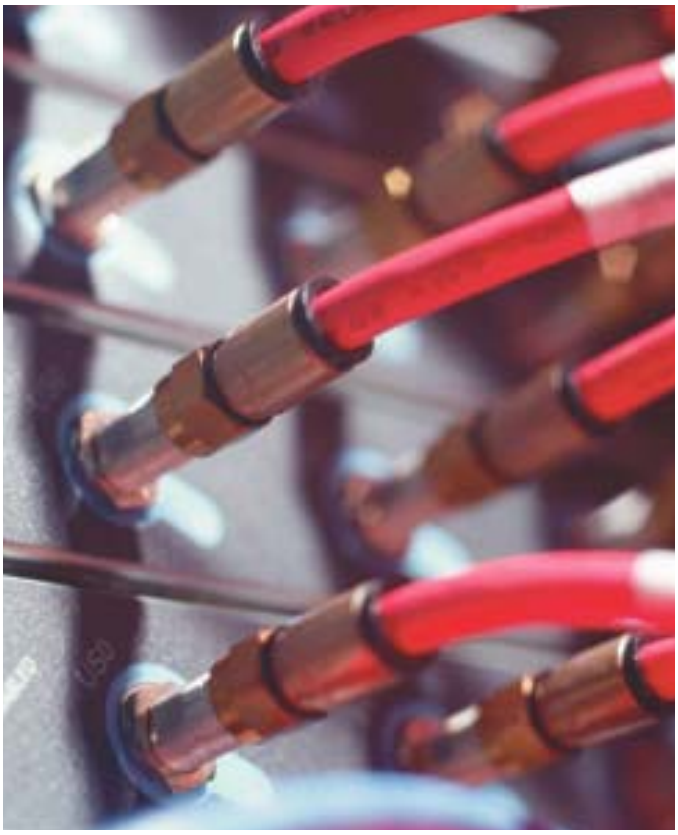
Lindsay Schroth, senior analyst for broadband access technologies at the Yankee Group, calls Wideband Protocol for DOCSIS "absolutely a disruptive technology, especially in Europe and Asia where telcos are competing now with very-high-bandwidth DSL." The technology will become just as important in the US, she adds, but because DSL speeds are currently much lower, most US cable providers will likely wait until the release of the DOCSIS 3.0 standard, which will incorporate it. (DOCSIS—Data over Cable Service Interface Specification—is a set of CableLabs standards that govern delivery of data over cable networks.)

In Europe and Asia, where housing is often very dense, installing FTTH is cost effective, and telcos are delivering 10- or 100-Mbit/s Ethernet in urban areas; several have 1 Gbit/s in sight. In some countries and cities, customer demand is reinforced by governmental mandates requiring telecom carriers to provide very high bandwidth. So, there is already intense interest in the new technology from Asian and European providers. Even in the US, where cable companies serve about two-thirds of broadband homes, there's incentive now. "Users of bandwidth-hungry applications will go with whatever carrier gives them the quality of service they want," says John Mattson, director of marketing for cable products at Cisco. "If interactive gamers, for instance, can't get the bandwidth for good graphic resolution or the low latency they want on their current service, they'll switch to another provider."

One of the next big applications is going to be downloading movies, adds Mattson. "High-definition streaming video can consume 20 Mbit/s, or with compression, perhaps 10 to 12 Mbit/s. Downloading to storage will take a few seconds on a 50-Mbit/s link compared to much longer times on a traditional high-speed Internet connection, or even several hours on a lower speed link. Wideband DOCSIS will let cable companies get in on the ground floor."

Blows Away Speed and Capacity Limitations

Wideband Protocol for DOCSIS offers higher throughput downstream pipes at significantly lower cost, by allowing downstream channels to be added independent of upstream ones, notes John Chapman, the Cisco Distinguished Engineer who created this new wideband technology. "Yet it works with today's DOCSIS



1.x and 2.0 cable modem termination systems, and it takes advantage of the decline in prices for external QAM [quadrature amplitude modulation] devices," he says. There's a terabit of capacity in the HFC serving a typical 100,000-person city, adds Chapman, "and only 1.9 percent of it is being used."

Decoupling downstream and upstream channels gets away from the ratio of one down to four or six up, so cable operators can economically offer whatever bandwidth a subscriber wants by grouping together down or upstream channels as needed to form a larger "wideband" channel. The techniques in Wideband DOCSIS for combining channels up and downstream differ somewhat, but both are consonant with current DOCSIS protocols and very economical.

Downstream wideband channels can use external (edge) QAMs, which, because they have less functionality than a cable modem termination system (CMTS), cost less per port. CMTS handles both DOCSIS (all-digital) and non-DOCSIS (analog) traffic such as video on demand and regular broadcasting. Edge

QAMs couple the downstream digital channel onto the analog HFC network.

The core of Wideband DOCSIS is the formatting of DOCSIS frames into 188-byte MPEG-TS packets; the packets are broken into pieces that are transmitted simultaneously by up to 24 or 48 QAM channels. Chapman calls this technique "striping" the packet across the parallel channels. Transmitting these large packets in multiple chunks simultaneously ensures that wideband doesn't introduce latency. A sequence number embedded in each packet enables the transmit framer to stripe packets on channels as needed, and the receive framer to reassemble them. The QAM channels do not need to be adjacent. If certain QAM channels have already been assigned to non-DOCSIS uses, Wideband DOCSIS uses what's available.

MPEG-TS packets were chosen as the carrier medium rather than bytes or ordinary packets, Chapman says, because they permit bonding of channels at the transmission convergence layer, above the physical layer and below the MAC layer. Because it does not affect either layer, Wideband DOCSIS is transparent to traditional DOCSIS protocols. "This is very powerful as it has the potential to maximize re-use of the existing DOCSIS environment," he points out.

Downstream signaling takes place via the standard DOCSIS downstream signaling channel, so both wideband and present-day cable modems can co-exist in the network.

Upstream and downstream transport are different, because the equipment originating signals is different at each end; the CMTS and edge QAM transmit downstream, and the cable modem upstream. Upstream, data does not travel in MPEG-TS packets. Rather, IP packets are placed into a Packet Streaming Queue service flow, which is then chunked and transmitted to the CMTS over a wideband channel that is dynamically allocated to different upstream QAMs as resources are available.

The Packet Streaming Queue is a construct of the Packet Streaming Protocol, a new concept also introduced by Chapman. Packets may be sorted into queues according to quality of service (QoS) level or other policies and travel on service flows dedicated to the different service requirements; the CMTS manages QoS at the cable modem, as in the current DOCSIS release, and prevents head-of-line blocking (where a higher-priority packet might get stuck behind a lower priority one). This is the major difference between Wideband DOCSIS and the earlier versions of the

standard. Otherwise, transport adheres to DOCSIS practices for signaling between the cable modem and CMTS regarding bandwidth—launching requests from the cable modem to the CMTS and receiving allocation grants—and is compatible with DOCSIS 2.0 concatenation and fragmentation.

Putting Wideband DOCSIS into Your Network

Installing Wideband DOCSIS in your network is largely a matter of installing new WAN interface cards in your CMTS. These cards will implement the MAC and framing tasks, initially managing up to 24 or 48 upstream and downstream QAM carriers. External QAMs couple the signal onto the HFC. In addition to the MPEG-TS packets, they can also support DOCSIS-based IP services. Both upstream and downstream channels are inherently highly available. Downstream, if one of the QAMs in the wideband channel is down, the Wideband DOCSIS protocol simply doesn't stripe across it. If more availability is needed, the protocol can invoke an RF switch and a redundant QAM. Upstream, if one of the line cards bearing a service flow fails, the wideband channel can be dynamically reconfigured around it.

DOCSIS supports a variety of load-balancing features through Dynamic Channel Change (also invented by Chapman), which was devised primarily for voice traffic. But these techniques work best when used with a group of two to four channels. Wideband DOCSIS, which creates one large channel, better serves large numbers of QAMs and bandwidth-hungry traffic such as video and gaming.

Upstream and downstream wideband channels can be dynamically configured, making the new protocol especially responsive to the customers' need for short-term high bandwidth. "Cable operators can offer a 'turbo button' subscribers can use when gaming or doing peer-to-peer file transfers," says Schroth of the Yankee Group.

Wideband DOCSIS is en route to becoming part of DOCSIS 3.0. This is partially in response to the many cable operators who would like to evolve to a wideband service within the DOCSIS framework to reuse their current DOCSIS infrastructure, mix wideband and traditional services on common downstreams during the transition to wideband, and save operating costs by avoiding rewiring and moving customers to new systems.

Moreover, DOCSIS offers very definite benefits, says Andy Page, product manager in Cisco's Broadband Edge and Midrange Routing Business Unit. "Wideband DOCSIS leverages excellent features in provisioning, billing, security, and other areas. For example, the DOCSIS protocol is very hard to hack and makes stealing service very difficult. Cable providers can choose the billing paradigm—flat rate, time-based, or volume-based. Its provisioning is much more streamlined than DSL, and it makes offering different flavors easy, which helps providers differentiate their offerings and tailor them to subscribers."

Says Page, "Cisco plans to offer the technology to the industry via DOCSIS 3.0 rather than locking in the intellectual property, as part of our philosophy of open systems." Wideband DOCSIS, he adds, "is the logical migration path for cable operators to offer all services over a common IP infrastructure." US trials will take place in the second half of this year, and products should be available in the first half of 2006.

Optimizing Revenue per User

Mattson cites a DFC study from July 2005 that projects worldwide gaming revenues will increase from US$1.96 billion in 2003 to $5.2 billion in 2006 to $9.8 billion in 2009. DFC also predicts that customers for on-demand movies over the Internet will increase from under 3 percent of US households in 2005 to upward of 16 percent by 2008. A recent MDR/Instat survey reveals that 64.6 percent of US homes are now sharing files via broadband; 43.9 percent view pictures; 42.1 percent listen to music; 30.6 percent watch videos; and 29.9 percent do some IP telephony. With Wideband DOCSIS, says Mattson, "You can let video-Napster happen without losing sleep, and in fact you can profit handsomely from it."

"The driver for all of this is optimizing the average revenue per user," Chapman notes. "Having a highly adaptive, cost-effective architecture that accommodates changing traffic patterns, services, and customer needs is immensely valuable. The cable industry has an obvious advantage in DOCSIS, which has a historic focus on service bundling and compelling content and which can now standardize a very wide pipe."

He proposes a five-year goal of at least 1-Gbit/s downstream data capacity and 100-Mbit/s upstream capacity. Are you up to the challenge? ■

Cable Operator Trials Wideband Protocol in Japan

Himawari Network, Inc. is testing Wideband Protocol for DOCSIS at the Toyota Dream Home at Aichi prefecture in Japan. Based on the Cisco uBR10012 CMTS platform, the trial showcases the ability to converge video and data traffic onto a single IP-based, high-speed service offering. Himawari will use the technology in parallel with existing modem deployments to provide a migration path to additional high-speed service offerings such as video on demand and online gaming. For more, see cisco.com/packet/172_5c1.