

MICROTUNE®

**MAKING DOCSIS® 3.0 A REALITY:
MICROTUNE'S ENABLING DOCSIS 3.0 TUNER TECHNOLOGY**
By Cliff Anderson, Cable Marketing Manager, Microtune®, Inc.

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Competition is heating up to deliver high-definition digital entertainment and telecommunications services, and cable TV is armed with the arsenal of new technologies and services that it needs to compete. For instance, cable multiple systems operators (MSOs) are deploying more efficient digital modulation schemes to reclaim analog bandwidth; expanding network plants up to 1 GHz; implementing switched digital video narrowcast where it makes sense; and integrating multimedia-over-cable (MoCA) in-home networking technology to satisfy today's increased demand for premium service.

A major weapon in the cable TV arsenal is the new CableLabs® DOCSIS 3.0 specification. It is rapidly shaping up to be exactly what the cable industry intended: a cost-effective solution to compete and win against fiber-to-the-home services (FTTH) for ultra high-speed data delivery. The DOCSIS 3.0 specification enables cable modems to achieve unprecedented uplink and downlink data rates, quadrupling current downstream transmission speeds to at least 160 Mbps in data, voice and commercial services.

In order to work, the DOCSIS 3.0 specification requires state-of-the-art broadband foundation technologies, including a new class of wideband tuners. Unlike previous generations of cable tuners, these new tuners handle the wide intermediate frequency (IF) bandwidth employed in DOCSIS 3.0. They also allow multiple channels to be successfully bonded together without a significant increase in solution cost.

THE ROAD TO DOCSIS 3.0

In 1999 CableLabs certified the first cable modems to version 1.0 of the Data-over-Cable-Service-Interface-Specification (DOCSIS). Version 1.1 enabled improved quality-of-service (QoS) for Voice over Internet Protocol (VoIP) telephony with downstream throughput of about 40 Mb/s and upstream throughput of about 10 Mb/s. In 2002, the DOCSIS 2.0 specification boosted the upstream to 30 Mb/s and enabled symmetrical-service for video conferencing, cable telephony, and high-speed data. This important specification was a key driver for the cable industry to deploy digital telephony and other broadband services.

After the release of DOCSIS 2.0, consumers demonstrated a seemingly insatiable demand for more bandwidth. When this demand was combined with the stepped-up competition from telco providers for Internet, voice, and video subscribers, it became imperative for cable operators to upgrade their networks and offer new/improved services for faster video downloading, uploading, file sharing, and other bandwidth-hungry applications.

In August 2006, CableLabs responded to the challenge with the DOCSIS 3.0 specification, which increases downstream speeds to a minimum of 160 Mb/s and upstream to a minimum of 120 Mb/s. DOCSIS 3.0 is a key enabler for popular consumer applications and commercial business offerings, including fast high-definition video downloads, video file exchanges, time-

shifted and place-shifted video, high-bit rate services, Internet-Protocol (IP) services, and interactive on-line gaming. It can be implemented in a variety of end-user equipment, including cable modems, set top boxes, and video phones (see chart).

THE EVOLUTION OF DOCSIS CABLE SERVICES

SERVICES	DOCSIS 1.0	DOCSIS 1.1	DOCSIS 2.0	DOCSIS 3.0
BROADBAND INTERNET	X	X	X	X
VoIP		X	X	X
VIDEO CONFERENCING			X	X
ROAMING SERVICES			X	X
ENTERTAINMENT VIDEO				X
CONSUMER DEVICES				
CABLE MODEM	X	X	X	X
VoIP PHONE (EMTA)		X	X	X
VIDEO PHONE			X	X
WIDEBAND VIDEO				X
NOM DOWNSTREAM MBPS	40	40	40	160
NOM UPSTREAM MBPS	10	10	30	120

As an added advantage, deploying DOCSIS 3.0 allows MSOs to deliver video-over-IP services, such as IPTV, across their upgraded 1GHz systems. This enables a wider, higher-speed IP pipeline for bandwidth-intensive services. Internet service providers are also finding themselves confined by the limited number of IP addresses in current systems (IPv4 supports approximately 16 million IP addresses). DOCSIS 3.0 support for IPv6 (which supports about 3.4×10^{38} addresses) will allow flexibility in allocating addresses and routing, and make for more efficient network management. With all of these features are combined, the advantages of moving to DOCSIS 3.0 are compelling.

DOCSIS 3.0: ROLLOUT BEGINS

By mid-2008, several cable modems were already qualified to the DOCSIS 3.0 specification, an industry pre-condition to rolling out DOCSIS 3.0 consumer equipment in cable systems. These DOCSIS 3.0 certifications were achieved by multiple manufacturers, including the leading worldwide suppliers of premise equipment to the cable industry¹.

The DOCSIS 3.0 specification has the potential to bring rich market and business model opportunities to MSOs worldwide. The infrastructure for DOCSIS 3.0 is already deployed and in service today in a number of countries, including Japan and Korea. Cable operators in Singapore, Brazil, United Kingdom, France and Canada have also unveiled plans for

implementations. According to industry news reports, Comcast in the U.S. announced plans to rollout DOCSIS 3.0 to 20% of its customers by the end of 2008, will full rollout completed by mid 2010.ⁱⁱ

It is important to note that many of the earliest rollouts include downstream channel bonding only. However, upstream channel bonding is expected to take off in late 2008, implemented by operators who intend to work with DOCSIS 3.0 64 QAM upstream channel bonding. While most DOCSIS 3.0 business models currently call for four channels to be bonded, the specification actually allows for a greater number of bonded channels. For instance, six to eight channels could be bonded together for business services, offering data rates of 240 to 320 Mb/s.

Using the DOCSIS 3.0 specification, MSOs have the ability to scale their service offerings while still taking advantage of their existing cable plant. Depending on their needs, they have the opportunity to also transport MPEG video and IP data, all while appearing seamless to the consumer. However, in order to be successful, it requires an efficient, high-performance design with specialized tuner and semiconductor technologies geared specifically for DOCSIS 3.0.

UNDERSTANDING DOCSIS 3.0

To meet demanding performance requirements, DOCSIS 3.0 employs new methodologies. Chief among these is channel bonding, which enables content to be split across multiple radio frequency (RF) channels in order to create more efficient load balancing and improved peak load bandwidth management. The data streams fit into four channels positioned anywhere within a 64 to 96MHz bandwidth. The data is then sent across the cable plant, and it is recombined by the backend processor. This is a similar technology to packet-based IP transmission, except that for DOCSIS 3.0 the data is broken up by frequency. These bonded channels can either be non-contiguous or adjacent.

DOCSIS 3.0 TECHNICAL CHALLENGES

To understand the challenges of DOCSIS 3.0, it is helpful to take a look back at earlier versions of the specification. A conventional DOCSIS 2.0 cable modem, for instance, nominally accepts 40 Mb/s input data in a 6MHz RF channel, passes it through a cable modem, and outputs data at 40 Mb/s of (Figure 1). These systems typically operate at up to 860 MHz and support 128 channels.

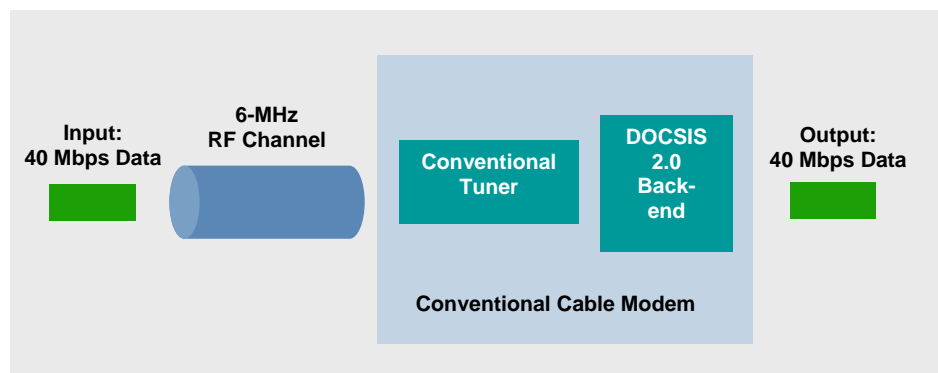


FIGURE 1: DIAGRAM OF A CONVENTIONAL DOCSIS 2.0 CABLE MODEM

In order to make the jump to ultra-high-speed performance, cable modems needed to deploy three to four conventional tuners (Figure 2) in the initial stages of DOCSIS 3.0 rollout. In this configuration, input data is split into four nominal 40 Mb/s segments, simultaneously sent through separate 6MHz RF channels to individual single-channel tuners, and the data is recombined to deliver a 160Mb/s output. While this approach enabled rapid time-to-market for systems with DOCSIS 3.0 throughput, it was not the optimal long-term solution in terms of component cost, footprint, or power consumption.

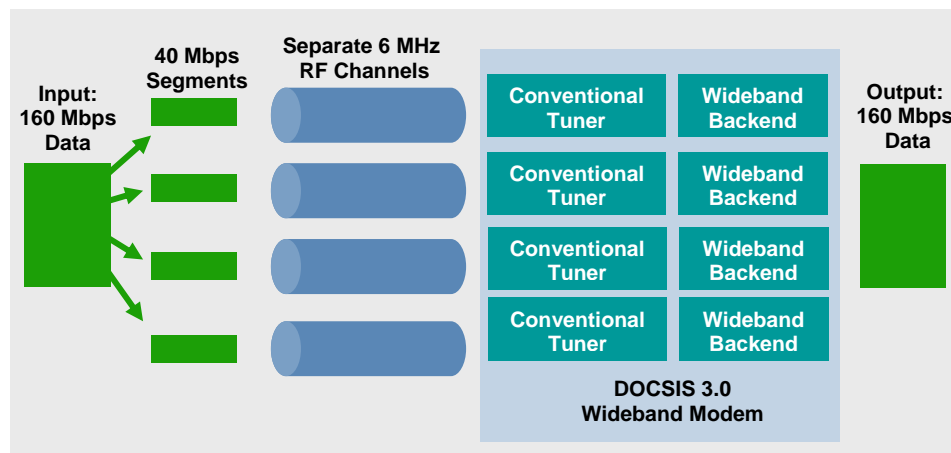


FIGURE 2: DOCSIS 3.0 CABLE MODEM USING CONVENTIONAL DOCSIS 2.0 TUNERS

The better implementation is to use a single wideband tuner, such as the MicroTuner™ MT2170 developed by Microtune, to take advantage of IF channel bandwidths of up to 96 MHz. Figure 3 shows this streamlined approach, where 160 Mb/s input data is sent through four bonded RF channels into a single wideband tuner to deliver 160 Mb/s output. In fact, the MT2170 can pass up to 16 bonded channels for potentially 640 Mb/s downstream throughput.

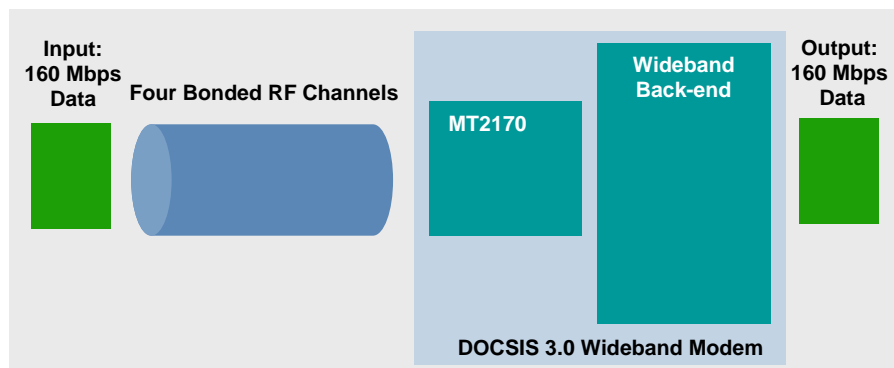


FIGURE 3: DOCSIS 3.0 MODEM WITH A SINGLE-CHIP WIDEBAND TUNER

The MicroTuner MT2170 is a single-chip silicon tuner engineered to deliver the impressive performance and necessary IF bandwidth required to support DOCSIS 3.0 modems. It is rapidly proving to be a key enabler for true DOCSIS 3.0 functionality. For instance, the first wave of DOCSIS 3.0 modems certified in May and August 2008 included the Microtune MT2170 wideband tuner, and this has been the technology approach taken by all of the certified DOCSIS 3.0 modem designs to date.

TECHNICAL CHALLENGES FOR THE TUNER:

Tuners used in DOCSIS 3.0 implementations must address a number of technical challenges, making it necessary for designers to select specialized wideband tuners to ensure optimal designs. For instance, implementing channel bonding with non-contiguous channels can give operators more flexibility in using their available spectrum, but the tuner must be robust enough to withstand adjacent channel interference (Figure 4).

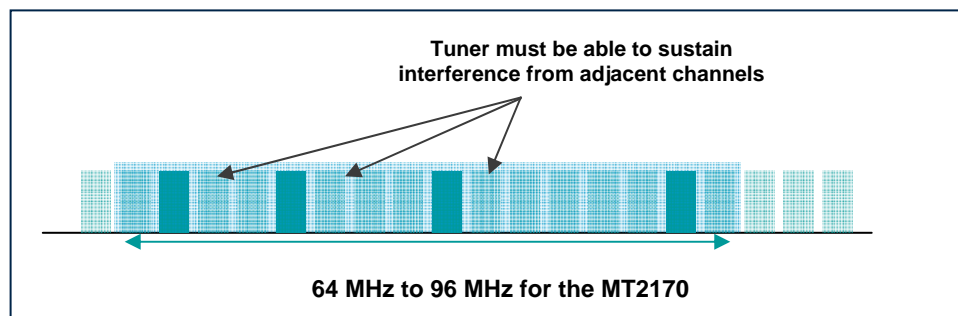


FIGURE 4: TUNER MUST WITHSTAND WIDEBAND INTERFERENCE

A DOCSIS 3.0 tuner must address these technical challenges:

- Extended tuner range: DOCSIS 2.0 initially spanned to 860MHz while DOCSIS 3.0 covers up to 1GHz.
- More channel loading: There will be 155 channels in 1GHz DOCSIS 3.0 systems as compared to 133 channels in previous systems.
- Broader channel bandwidth: 64 to 96 MHz bandwidths in the new systems versus only 6MHz in previous generations.
- Increased downstream throughput: nominally 160 Mb/s as compared to 40Mb/s with DOCSIS 2.0.
- Enable channel bonding: the wideband tuner must withstand the adjacent channel interference in non-contiguous channel bonding.

MICROTUNER MT2170 TUNER

Microtune participated in CableLabs' DOCSIS 3.0 specification development and served on the DOCSIS 3.0 committee to define the specification. Specifically designed for DOCSIS 3.0 applications, the MicroTuner MT2170 is a wideband tuner that supports data and video streams

with downstream rates of 160 Mb/s, offering up to 16 times the bandwidth of today's typical cable pipeline into the home. Operating up to 1GHz, it enables channel bonding technology, accepting four RF channels within any 96MHz bandwidth, and it handles highly compressed digital data in the presence of noise and strong adjacent channel interferers. In addition, it maintains low output distortion even with high output levels.

Significantly reducing the RF footprint in a cable modem design, the single-chip MT2170 tuner is highly integrated. As a result, it offers a considerable reduction in total solution bill of materials (BOM) and decreases power consumption by approximately 75%. It is small enough to be used in multi-tuner configurations, so it provides an avenue to support future configurations.

The MT2170 tuner the first in Microtune's new family of DOCSIS 3.0 tuners, and it is uniquely positioned to enable the next generation of wideband cable modems. Available today, it offers cable modem manufacturers an easy, reliable, and cost-effective way to implement DOCSIS 3.0.

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DOCSIS 3.0 is a series of industry specifications that enable cable operators to offers significantly higher data rates to their broadband customers.
DOCSIS and CableLabs are trademarks of Cable Television Laboratories, Inc.

ⁱ http://www.cablemodem.com/downloads/Certified_Products.pdf. accessed 8/26/08

ⁱⁱ Robuck, Mike, "DOCSIS 3.0 arrives," CED Magazine, May 1, 2008.