MICROTUNE®

Bandwidth: Key Weapon in the Cable-Telco Battle for Subscribers

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Cable systems are using leading-edge techniques and next-generation tuners to satisfy consumers' growing hunger for bandwidth.

For years, cable service operators enjoyed excess network capacity and could rest easily. They had ample bandwidth to handle data and video services, and had no need to make serious upgrades to their systems, customer premise equipment (CPE), or plants. Then, telcos upped the ante and made broadband to the home, especially in terms of fiber to the home (FTTH), more competitive. The cable services industry responded by accelerating the advancement of its cornerstone specification, Data-over-Cable-Service-Interface-Specification (DOCSIS®), to deliver a new version, DOCSIS 3.0. This new specification offers a new competitive weapon in the cable arsenal as cable service providers also upgrade their infrastructure, ramp up new services, and expand networks for bandwidth-hungry consumers.

GROWING APPETITE FOR BANDWIDTH

Analysts tracking trends in home entertainment are now talking about networked home entertainment systems. As consumers are told about new opportunities to link their broadband audio, video, and data downloads to electronic devices and gadgets throughout their home, the potential for bandwidth usage grows. In this scenario, cable modems, digital video recorders (DVR), voice over IP (VoIP) systems, personal computers, and TVs will all be linked in a single home network. As each of the latest digital entertainment services come on line, the need for bandwidth increases (see Figure 1).

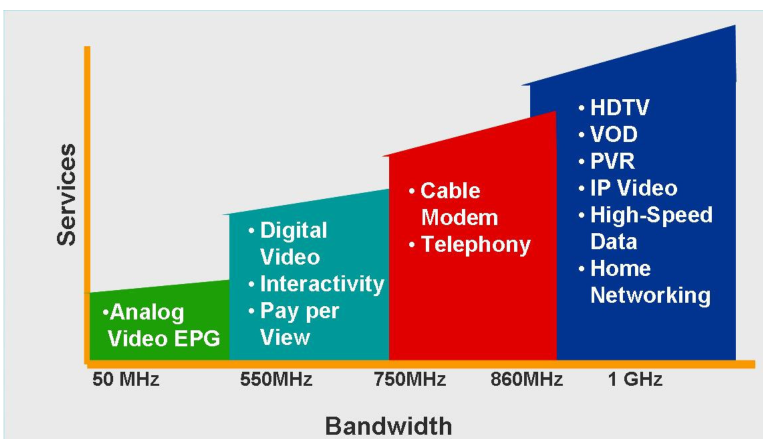

FIGURE 1: NEW APPLICATIONS AND SERVICES CAPTURE NEW REVENUES, POSITION COMPETITIVELY, BUT ARE HUNGRY FOR BANDWIDTH

Cable Feels the Pinch

In many markets, the number of residences moving from cable modem to fiber-optic services from telcos is mounting a significant threat to cable dominance. Fiber-optic services, such as Verizon Communications' heavily-marketed FiOS™, offer complete video suites (including high-definition programming, video-on-demand, uploading, movie downloading, time-shifting, place-shifting, and interactivity), broadband data access, home networking, and commercial business services. FiOS Internet services, for instance, offer advertised connection speeds of up to 50 Mbps or 30 Mbps downstream and 5 Mbps upstream, depending on location[i]. In reality, these fiber-optic systems have the capability to deliver 100 Mbps up and down stream, so there looks to be plenty of headroom for additional services on these networks.

Cable operators have responded with a sound plan to stay in the game. First, they rapidly deployed competitive services to retain subscribers and attract new ones. Then, they adopted and implemented a range of technologies to address near-term service rollouts, including: switched digital video, 1-GHz systems, and node splitting. These technologies allowed them to provide a wider, faster IP pipeline to the home for ultra fast Internet as well as quicker uploads and downloads. Over the long term, cable operators plan to harvest unused analog spectrum to boost capacity.

Cable Service Evolution

Figure 2 represents the progression in the demand for greater capacity in the cable plant.
In the early days of Internet and telephone modems, data speeds advanced rapidly. It seemed that every few months, the top speed of modems doubled, such as from 1200 to 2400 baud. This trend topped out at 56.4 kbps, which was driven by the physical limitation of telephone lines.

Throughout its early history, the cable plant never came near to reaching its physical limit. For many years, capacity outstripped demand. The early DOCSIS standards, for instance, defined in the 1990s, supported a transport limit of 38 Mbps. However, this was essentially dialed down to 10 Mbps in real-world use, and that extra capacity remained for nearly ten years. However, with the rapid increase of video-on-demand programming, additional broadcast channels and new interactive services, that extra capacity disappeared.

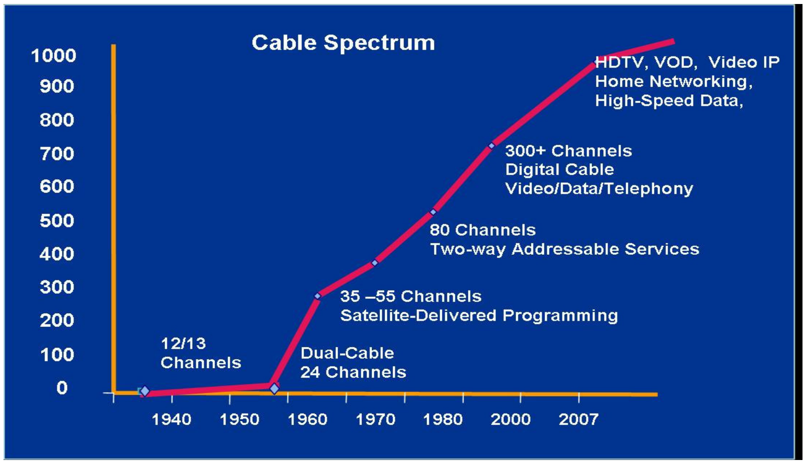

FIGURE 2: CABLE HISTORICALLY CHARACTERIZED BY STEADY GROWTH IN CAPACITY AS CABLE OPERATORS SQUEEZE BANDWIDTH OUT OF EXISTING PLANT

In order to remain competitive, cable operators had to act. Across North America, cable operators are driving fiber deeper into the network and carrying more wavelengths. Most cable plants in the U.S. are hybrid fiber/coax where services are carried digitally on fiber until they reach an optical transition node. Then, the signals are translated back to radio frequency (RF) for transmission over coax to and around the residence or business. Besides these approaches, cable systems operators are also experimenting with higher compression techniques in order to maximize the data on the cable.

Fiber upgrades in the cable plant have been going on for some time in the U.S. It is perhaps the easiest way to increase network capacity, because it does not require extending the RF bandwidth or replacing subscriber equipment.

In order to reach DOCSIS 3.0 data rates of 160 Mbps up and downstream, however, cable operators are expanding the RF bandwidth up to 1 GHz (Figure 2). This adds up to 40 channels to a system. This type of upgrade requires replacement of customer premises equipment (CPE).

Expanding the RF bandwidth is not a new phenomenon (Figure 2). Historically, operators have upgraded approximately every five years. The last upgrade, however, from 750 MHz up to 870 MHz occurred in the late 1990s, so it is not unexpected that a bandwidth upgrade is necessary now.

RF CHALLENGES

The amount of RF bandwidth (MHz) that a network needs is dependent on the amount of capacity (Mbps) required. Upgrading to a higher RF bandwidth (e.g. 1 GHz) allows the operator to utilize the fiber and coaxial cable already in place and frees up an additional 20 or more RF channels per service area – amounting to 800 Mbps additional capacity under existing protocols.

Expanding the RF bandwidth is not without its challenges, however. As more channels are added, this puts additional pressure on the tuner. Over the years, cable set-top box tuner design has become more challenging, because all of the channels hit the front end of the tuner simultaneously, and the tuner must select the desired one. Each of the channels also carries power with it. Expanding from 870 MHz to 1 GHz could increase the amount of power that the tuner must handle by 20% or more.

In order to prepare for the move to 1 GHz, many cable operators are already specifying 1-GHz equipment for the majority of new network builds, upgrades, and set-tops, whether or not they intend to deploy 1 GHz immediately.

ROLE OF THE TUNER

Even if the cable plant is capable of a 1-GHz bandwidth, if the set-top box tuner cannot operate in that frequency range, it makes no difference. The tuner basically has two simultaneous functions. It acts as a frequency translator (takes high frequencies and moves them to lower ones to be processed by the set-top box electronics), and it filters out unwanted channels and signals. While less obvious, the role of frequency translator is paramount, and every time the cable operators upgrade the RF bandwidth, they must ensure that the tuners perform the correct frequency translations.

Microtune began manufacturing 1-GHz tuners before the current trend in network upgrades began. Although most new cable equipment will be designed for 1 GHz, the majority of plants in the U.S. are below 870 MHz. The good news is that 1-GHz tuners must cover the entire frequency range (down to 50 MHz), so they are backward compatible with systems operating below 1 GHz.

Figure 3 shows the design of conventional cable modems operating at 870 MHz or below. This is a DOCSIS 2.0 design with a single tuner that supports capacity of 40 Mbps.

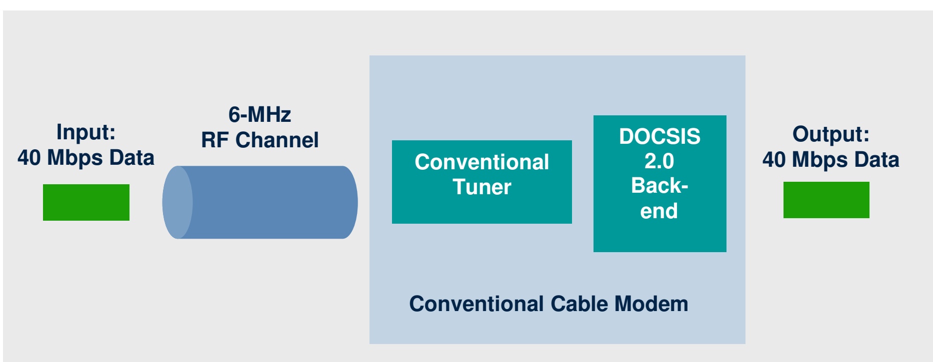

FIGURE 3: A CONVENTIONAL CABLE MODEM DESIGN

To support a 1-GHz bandwidth, the set-top box manufacturer can either use multiple tuners (Figure 4), or select a 1-GHz tuner (Figure 5). For early and pre-DOCSIS 3.0 designs, set-top box manufacturers went with the multi-tuner configuration. However, this was a cost-prohibitive design. Now that 1-GHz tuners are available, the layout in Figure 5 is superior from cost, performance, BOM management, and real estate perspectives.

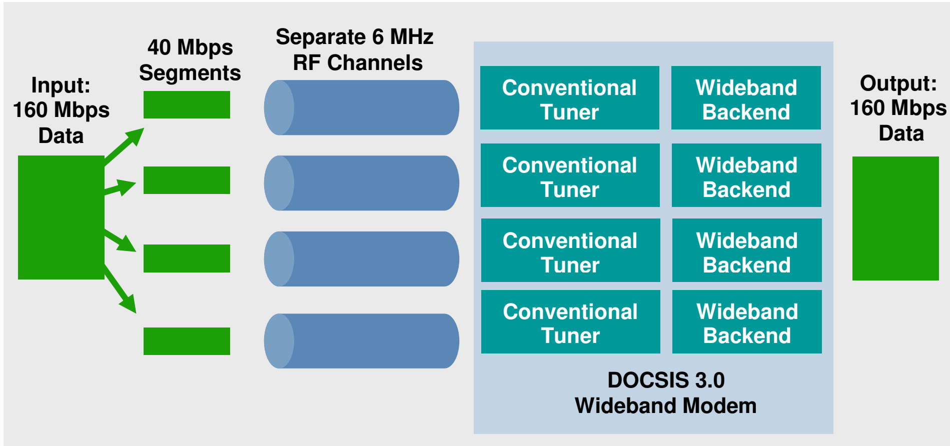

FIGURE 4: AN EARLY DOCSIS 3.0 DESIGN USING MULTIPLE TUNERS TO COVER THE -GHZ BANDWIDTH.

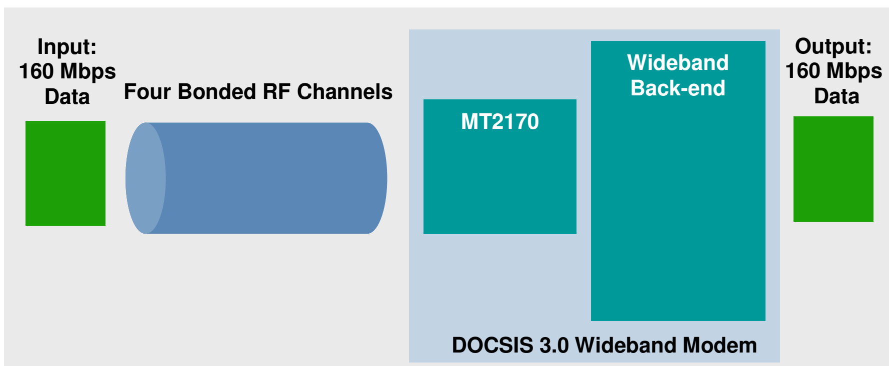

FIGURE 5: A CURRENT DOCSIS 3.0 MODEM DESIGN USING A SINGLE MICROTUNE 1-GHZ TUNER TO COVER THE ENTIRE RF BANDWIDTH, WHICH IS A MORE EFFICIENT WAY TO TRANSMIT DATA

1-GHZ TUNERS

Developing 1-GHz tuners requires a great deal of RF design expertise. First, the single tuner has to handle the additional channels and power at the front end. To achieve the high-frequency design, Microtune turned to silicon germanium (SiGe), a well known silicon process particularly well suited to high-frequency design.

Using SiGe, Microtune developed a proprietary dual-conversion 1-GHz tuner design. By leveraging its patent-pending ClearTune™ proprietary filtering technology, Microtune was also able to satisfy interference issues caused by the additional channels (Figure 6). What makes DOCSIS 3.0 particularly challenging in terms of interference is that cable operators have the flexibility to select non-adjacent channels to make the most use of available spectrum. This adds additional challenges for the tuner, which cannot rely on adjacent "wanted" signals as in conventional or channel-bonded designs.

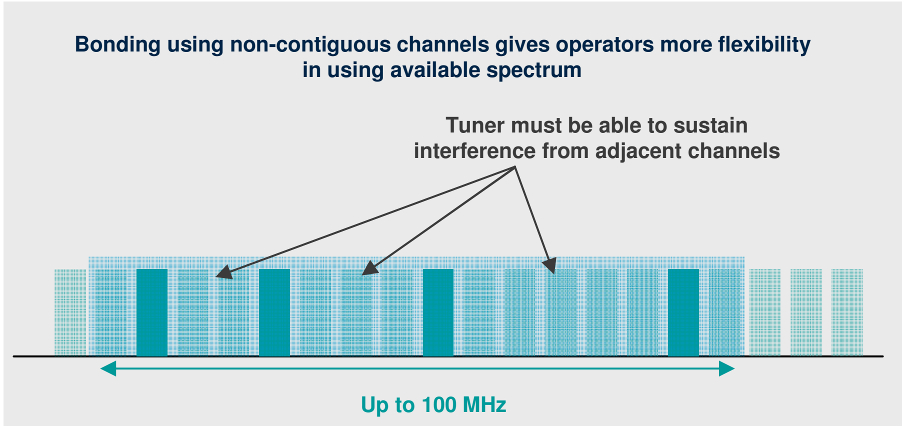

FIGURE 6: A DOCSIS 3.0 TUNER MUST HANDLE INTERFERENCE IN A HOSTILE SIGNAL ENVIRONMENT WITH NON-CONTIGUOUS CHANNELS UP TO 100 MHZ.

The choice of SiGe combined with ClearTune technology also allowed Microtune designers to mitigate the effects of the additional power levels coming into the tuner. The resulting MT2170 offers the equivalent functionality of four tuners. This reduces the RF footprint and power consumption by approximately 75% as compared to multi-tuner designs (Figure 4) and results in a significant reduction in BOM cost.

The MT2170 is capable of channel bandwidths up to 100 MHz, with supporting data transmission speeds up to 160-Mbps. Demonstrating superior technical performance, the MT2170 handles highly compressed digital data in the presence of noise and strong adjacent interferers and maintains low output distortion even with high output levels.

Microtune is not new to cable set-top box tuner design, having shipped more 64 million silicon tuners to worldwide customers. Microtune tuner chips can be found inside of leading cable modem brands today.

The MT2170 joins a family of specialized 1-GHz tuners from Microtune, including the MicroTuner MT2064 designed specifically for low-power VoIP systems. In addition, the MicroTuner MT2022 and MT2122 tuners were optimized for Multimedia over Coax Alliance (MoCA™)[ii]-compatible applications. What makes all of the Microtune 1-GHz tuners unique is that they simultaneously enable 1-GHz bandwidth operation and low power consumption, and enable integrated, high-performance, cost-effective designs. With the 1-GHz tuner, cable operators can realize a competitive advantage in the broadband showdown.

[i] http://www22.verizon.com/content/consumerfios/faqs/faqs.htm
[ii] Reference Moca Paper