

Cable DOCSIS 2.0 FAQ

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Introduction

This document answers frequently asked questions about Data-over-Cable Service Interface Specifications (DOCSIS) 2.0.

Competition among products gives vendor manufacturers incentive to develop cost effective, high quality products. Likewise, competition among standards gives the developer of a standard the incentive to ensure that they are reasonable and provide more benefit than they cost. Cable Television Laboratories, Inc.

([CableLabs®](#) ) is a consortium that governs the DOCSIS standard and ensures interoperability, competition, and quality. Cable Labs is dedicated to helping cable operators integrate new telecommunications technologies into their business objectives. It might be inevitable that there will be multiple standards that cover the same business objective. Therefore, with regards to the deployment of DOCSIS 2.0, two specifications have emerged: Advanced Time Division Multiplex Access (ATDMA) and Synchronous Code Division Multiple Access (SCDMA). CableLabs has mandated that, for a cable product to be fully DOCSIS 2.0 compliant, it must support both competing protocols. There have been several discussions about migration to DOCSIS 2.0 and about which protocol (ATDMA or SCDMA) is the best fit for any one particular business model. Based on recent surveys, some providers are still very unsure about the migration to DOCSIS 2.0.

This document addresses some initial concerns of those who are considering DOCSIS 2.0 migration and answers some of the questions that they might have.

Q. What is the difference between ATDMA and SCDMA?

A. ATDMA is a direct evolution of DOCSIS 1.x physical layer (PHY), which uses TDMA multiplexing. DOCSIS 1.x upstream PHY uses a frequency division multiple access (FDMA)/TDMA burst multiplexing technique. FDMA accommodates simultaneous operation of multiple radio frequency (RF) channels on different frequencies. TDMA allows multiple

cable modems to share the same individual RF channel, because it allocates each cable modem its own time slot in which to transmit. TDMA is carried over in DOCSIS 2.0, with numerous enhancements. SCDMA is a different approach, in which up to 128 symbols are transmitted simultaneously via 128 orthogonal codes. SCDMA multiplexing allows multiple modems to transmit in the same time slot. Both ATDMA and SCDMA provide the same maximum data throughput, although one may perform better than the other under specific operating conditions.

Q. Does DOCSIS 2.0 have less rigid upstream performance requirements?

A. The upstream performance requirements in the DOCSIS 2.0 Radio Frequency Interface Specification are *not* less rigid than the requirements in DOCSIS 1.0 or 1.1. For maximum reliability and data throughput, cable operators will still need to ensure that their networks comply with the recommended downstream and upstream radio frequency (RF) parameters in the DOCSIS Radio Frequency Interface Specification.

The confusion about this arises from the fact that DOCSIS 2.0 provides for increased upstream throughput—up to a raw data rate of 30.72 Mbps. This is accomplished through the use of higher-order modulation formats, such as 64-QAM. In order for 64-QAM to work in the harsh upstream environment, either the upstream RF performance must be significantly improved, or the data transmission robustness must be improved. DOCSIS 2.0 includes provisions for improved data transmission robustness from several areas:

- DOCSIS 2.0 supports a symbol (T)-spaced adaptive equalizer structure with 24 taps, compared to 8 taps in DOCSIS 1.x. This will allow operation in the presence of more severe multipath and microreflections, and should accommodate operation near band edges where group delay is usually a problem.
- Some cable modem termination system (CMTS) chipset vendors have developed robustness-enhancing features through improved burst acquisition. Carrier and timing lock, power estimates, equalizer training, and constellation phase lock are all done simultaneously. This allows for shorter preambles and reduces implementation loss.
- Forward error correction (FEC) has been improved. DOCSIS 1.x provides for the correction of 10 errored bytes per Reed Solomon block (T=10) with no interleaving, while DOCSIS 2.0 allows correction of 16 bytes per Reed Solomon block (T=16) with programmable interleaving.
- While not specifically a requirement of DOCSIS 2.0, many advanced physical layer (PHY) silicon vendors have incorporated some form of ingress cancellation technology into their upstream receiver chips, which further enhances upstream data transmission robustness. Ingress cancellation is a way to digitally remove in-channel ingress, common path distortion, and certain types of impulse noise.

Q. Is SCDMA better for impulse noise environments while ATDMA better for ingress?

A. SCDMA has a Burst Noise Advantage over ATDMA, because of its capability to spread transmissions out over time. Multiple codewords are sent simultaneously, which effectively interleaves codewords from different cable modems. However, SCDMA uses *longer* symbol times than ATDMA, and this reduces the number of errored symbols created for a given forward error correction (FEC) block, which thus allows those errored symbols to be corrected with the FEC information.

However, these limitations for SCDMA modems must be considered in the real world:

- Must perform periodic ranging for *all* modems every second.
- Only gives throughput benefit when more than 60 percent of upstream traffic is carried in SCDMA mode.
- *Significant* interoperability issues remain in SCDMA mode between different cable modem vendors that have not closely followed the DOCSIS 2.0 specification.

Remember, cable networks are *not* dominated by burst noise in absence of ingress or narrow band interference. These two *always* occur together, but the narrowband interference may come and go, and thus not be apparent in a given 30 minute measurement time. ATDMA uses FEC and byte interleaving to combat impulse and burst noise, while SCDMA uses time spreading and framing:

- Reed-Soloman (RS) FEC encoding involves the transmission of additional data (overhead) that allows for the correction of byte errors.
- Byte interleaving can spread data over the transmission time. If a portion of that data is corrupted by a burst or impulse, then the errors appear spread apart—when de-interleaved at the cable modem termination system (CMTS)—which allows FEC to work more effectively.
- Time spreading allows the reduction of the effective carrier-to-noise ratio (CNR) of noise bursts that are shorter than the spreading interval.
- Framing and subframing spread bytes over multiple RS code words, in a manner similar to byte interleaving in ATDMA.

Q. What is the difference between Processing Gain and Coding Gain?

A. Interference removal technology digitally subtracts the interference signals. The amplitude that can be subtracted is called the Processing Gain. This is separate from the Coding Gain, which shows how much benefit you can get when you trade off throughput for interference or noise rejection. Coding Gain is like adding 3 bytes of forward error correction (FEC) to every 10 bytes of data. If you add another 1 to 3 bytes of FEC to the same amount of data, you have achieved Coding Gain.

Cisco cable modem termination system (CMTS) products can remove between 2 or 3 dB of impairment (worst case, most complex signal possible in an hybrid fiber-coaxial (HFC) network, also known as Common Path Distortion [CPD]) and 25 to 29 dB of impairment (best case, single AM or FM modulated signal). One will typically achieve a 5 to 15 dB Processing Gain on a real HFC network.

In addition, one might see a 1 or 2 dB Processing Gain on some other CMTS, but that is offset by a 3.5 to 4.5 dB Implementation Loss. Be careful that you are not misled by vendors who turn on added Coding Gain, decrease upstream throughput and capacity, and then claim to maintain performance.

Q. If one is mixing ATDMA and S-TDMA, is it necessary to send duplicate maps in the downstream?

A. It depends on whether you wish to run ATDMA at a wider channel width than the TDMA signal. This would have ATDMA modems running at 6.4 MHz and TDMA modems running at 3.2 MHz on the same center frequency: a rather poor use of upstream spectrum, and the throughput is not than advantageous.

If ATDMA and TDMA channels are the same channel width (3.2 MHz), then the A-LONG and A-SHORT grants have their own modulation profiles, and they can run within the *same* maps.

Q. How can one satisfy the high synchronization requirements for SCDMA in a normal cable network?

A. To get high throughput with SCDMA, the modems must all be time aligned within a fraction of the symbol rate. Otherwise, the “S” (synchronous) part of CDMA fails, and the data from one modem corrupts the data from other modems. The result is packet loss. The timing resolution is measured in nanoseconds. There are issues when you measure things in

nanoseconds across a distance of 40 km (a short network) or up to 320 km (a long network):

- minute changes in fiber path distance, caused by temperature (expansion and contraction of the glass itself)
- expansion of the coaxial network (which is why every span has an expansion loop)
- the fact that the speed of light also changes with temperature, in both fiber and coaxial line (Velocity of Propagation as a percentage of speed of light)

Every 1 second, an SCDMA modem *must* be time-aligned, if the modem is more than 20 km from the headend, even if less than half of that network is overhead plant. This represents at least 60 to 80 percent of the cable modems for most multiple service operators (MSOs).

If the hybrid fiber-coaxial (HFC) network is 100 percent underground (including the fiber), the modems are less than 10 km from the headend, and the temperature is very constant for a given day; then the modems can be time-aligned less often.

Apparently, timing alignment had become a major problem with some vendors' modems in general: they are losing synchronization with the downstream and not realizing it, and then transmitting at the wrong time. Thus, the modem transmits at a time that is reserved for another modem and causes packet loss both for itself and for the other modem. The packet loss for all modems vanishes when *only* the bad modems are removed from the network.

Q. Will a DOCSIS 1.1 configuration file work in 2.0 mode?

A. Any DOCSIS 1.1 configuration file will work in 2.0 mode. Even a DOCSIS 1.0 configuration file will work. There is one special type, length, value (TLV) field that prevents the modem from working in a 2.0 mode, even if its capable of doing so. DOCSIS 2.0 has nothing to do with QoS; it is only a new physical layer (PHY) chip. Therefore, the MAC version determines whether the cable modem is capable of doing 1.0/1.1 or 2.0.

At 2.0-capable modem should come up automatically in a 2.0-provisioned environment, because the TLV 39 field must equal 1. If the TLV 39 field is left blank, then it will default to value of 1 and thus register in 2.0 mode. To prevent the 2.0-capable modem from coming up in 2.0 mode, you must set the TLV 39 field to 0; it will then be forced to come up in 1.x mode.


Q. What are some things to check if the Motorola SB5100 fails to come online in 2.0 mode with a Cisco cable modem termination system (CMTS)?

A. Check whether the SB5100 is actually in DOCSIS 2.0 mode. Motorola has a private MIB that can be set so that the modem only broadcasts **docsis1.1...** in the DHCP Option 60. This is the MIB information:

Field	Value
Name	cmDocsis20Capable
Type	OBJECT-TYPE
OID	1.3.6.1.4.1.1166.1.19.3.1.25
Full path	iso(1).org(3).dod(6).internet(1).private(4).enterprises(1).gi(1166).giproducts(1).cm(19).cmConfigPrivateBase(3).cmConfigFreqObjects(1).cmDocsis20Capable(25)
Module	CM-CONFIG-MIB

Parent	cmConfigFreqObjects
Prev sibling	cmUpstreamPower3
Next sibling	cmUpstreamChannelId2
Numerical syntax	Integer (32 bit)
Base syntax	INTEGER
Composed syntax	TruthValue
Status	current
Max access	read-write
Default values	1: false (name)
Description	This object is used to enable DOCSIS 2.0 ATDMA operation mode. Set to true (1), to enable DOCSIS 2.0 ATDMA operation mode. Set to false (2), to disable DOCSIS 2.0 ATDMA operation mode. This object is not accessible before the cable modem (CM) completes registration, except in factory mode.

Related Information

- [DOCSIS 2.0 Interface Specifications](#) 
- [Cable DOCSIS 1.0 FAQ](#)
- [Frequently Asked Questions on DOCSIS 1.0+](#)
- [Cable DOCSIS 1.1 FAQs](#)
- [Broadband Cable Technology Support](#)
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