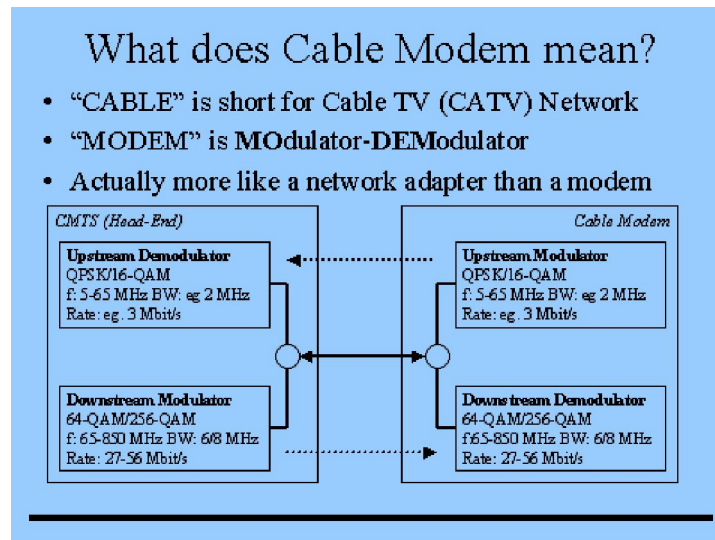


## INTRODUCTION



The term 'Cable Modem' is quite new and refers to a modem that operates over the ordinary cable TV network cables. Basically you just connect the Cable Modem to the TV outlet for your cable TV, and the cable TV operator connects a Cable Modem Termination System (CMTS) in his end (the Head-End).

Actually the term "Cable Modem" is a bit misleading, as a Cable Modem works more like a Local Area Network (LAN) interface than as a modem.

Cable modems allows consumers access to the Internet at higher speeds and at a fraction of the time it takes traditional telephone modems.

This is true for two reasons:

- 1) Broadband networks make the connection up to a hundred times faster
- 2) The service is "always on," meaning customers get the information they want, when they want it.

Unlike telephone modems, cable modems allow consumers to keep their telephone lines open for voice conversations.

## **IMPORTANT TERMS**

A short list of some of the technical terms and acronyms that you may come across in trying to understand the cable modem world.

**CATV:** Community Antenna Television or Cable TV system. Can be all coaxial or HFC (Hybrid Fiber Coax) based.

**Cable modem (CM):** Client device for providing data over a cable TV network. Read all about it here.

**Channel:** A specific frequency and bandwidth combination. Used in this context about TV channels for television services and downstream data for cable modems.

**CMTS:** Cable Modem Termination System. Central device for connecting the cable TV network to a data network like the internet. Normally placed in the headend of the cable TV system.

**CPE:** Customer Premises Equipment. Used to describe the PC and/or other equipment, that the customer may want to connect to the cable modem.

**DHCP:** Dynamic Host Configuration Protocol. This protocol provides a mechanism for allocating IP addresses dynamically so that addresses can be reused. Often used for managing the IP

addresses of all the cable modems in a cable plant and the PC's connected to the cable modems.

**DOCSIS:** Data Over Cable Service Interface Specification. The dominating cable modem standard. Defines technical specifications for both cable modem and CMTS.

**Downstream:** The data flowing from the CMTS to the cable modem.

**Downstream frequency:** The frequency used for transmitting data from the CMTS to the cable modem. Normally in the 42/65-850 MHz range depending on the actual cable plant capabilities.

**Headend:** Central distribution point for a CATV system. Video signals are received here from satellites and maybe other sources, frequency converted to the appropriate channels, combined with locally originated signals, and rebroadcast onto the HFC plant. The headend is where the CMTS is normally located.

**HFC:** Hybrid fiber-coaxial (cable network). Older CATV systems were provisioned using only coaxial cable. Modern systems use fiber transport from the headend to an optical node located in the neighborhood to reduce system noise. Coaxial cable runs from the node to the subscriber. The fiber plant is generally a star configuration with all optical node fibers terminating at a headend. The coaxial cable part of the system is generally a trunk-and-branch configuration.

**MAC layer:** Media Access Control sublayer in the network stack. Read more about that later in this presentation.

**MCNS:** Multimedia Cable Network System Partners Ltd. The consortium behind the DOCSIS standard for cable modems.

**Minislot:** Basic timeslot unit used for upstream data bursts in the DOCSIS standard.

**MSO:** Multiple Service Operator. A cable TV service provider that also provides other services such as data and/or voice telephony.

**QAM:** Quadrature Amplitude Modulation. A method of modulating digital signals using both amplitude and phase coding. Used for downstream and can be used for upstream.

**QPSK:** Quadrature Phase-Shift Keying. A method of modulating digital signals using four phase states to code two digital bits per phase shift.

**Ranging:** The process of automatically adjusting transmit levels and time offsets of individual modems, in order to make sure the bursts coming from different modems line up in the right timeslots and are received at the same power level at the CMTS.

**SID (Service ID):** Used in the DOCSIS standard to defines a particular mapping between a cable modem (CM) and the CMTS. The SID is used for the purpose of upstream bandwidth allocation and class-of-service management.

**Subscriber Unit (SU):** An alternate term for cable modem.

**Upstream:** The data flowing from the CM to the CMTS.

**Upstream frequency:** The frequency used to transmit data from the CM to the CMTS. Normally in the 5-42 MHz range for US systems and 5-65 MHz for European systems.

## CATV NETWORK

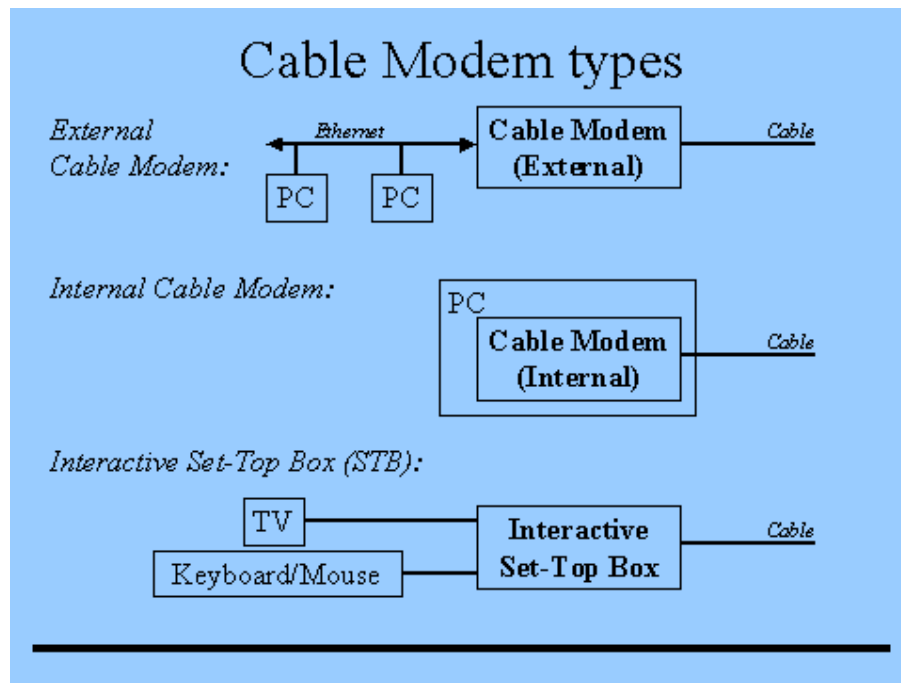
### What's a CATV network?

- Used for TV distribution
- Upgrade to allow return channel signals
- Head-End sends out signals
- HFC means Hybrid Fibre-Coax
- Structure is "tree-like"
- The (single) Head-End is the root
- The (many) Cable Modems are at the leaves
- One Head-End to eg. 1000 Cable Modems

A CATV network is designed and used for cable TV distribution. With an upgrade of the system, it is normally possible to allow signals to flow in both directions. Higher frequencies flow toward the subscriber and the lower frequencies go in the other direction. This is done by upgrades to the amplifiers in the cable distribution network etc.

Most CATV networks are Hybrid Fiber-Coax (HFC) networks. The signals run in fiber-optical cables from the Head-End center to locations near the subscriber. At that point the signal is converted to coaxial cables, that run to the subscriber premises. One CMTS will normally drive about 1-2000 simultaneous Cable Modem users on a single TV channel. If more Cable Modems are required, the number of TV channels are increased by adding more channels to the CMTS.

## TYPES OF CABLE MODEM



A number of different Cable Modem configurations are possible. These three configurations are the main products we see now. Over time more systems will arrive.

## **External Cable Modem**

The external Cable Modem is the small external box that connect to your computer normally through an ordinary Ethernet connection. You will need to add a (cheap) Ethernet card to your computer before you can connect the Cable Modem. A plus is that you can connect more computers to the Ethernet. Also the Cable Modem works with most operating systems and hardware platforms, including Mac, UNIX, laptop computers etc.

Another interface for external Cable Modems is USB, which has the advantage of installing much faster (something that matters, because the cable operators are normally sending technicians out to install each and every Cable Modem). The downside is that you can only connect one PC to a USB based Cable Modem.

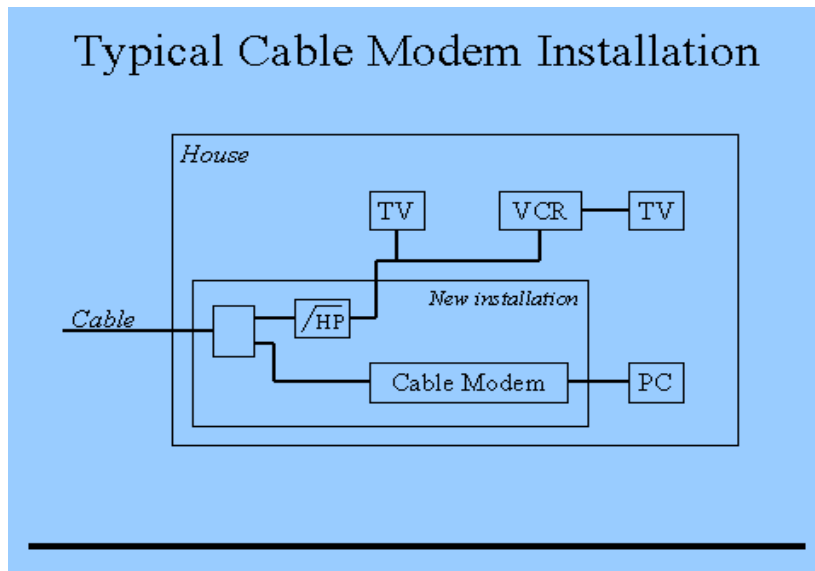
## **Internal Cable Modem**

The internal Cable Modem is typically a PCI bus add-in card for a PC. That might be the cheapest implementation possible, but it has a number of drawbacks. First problem is that it can only be used in desktop PC's. Mac's and laptops are possible, but require a different design. Second problem is that the cable connector is not galvanic isolated from AC mains. This may pose a problem in some CATV networks, requiring a more expensive upgrade of the network installations. Some countries and/or CATV networks may not be able to use internal cable modems at all for technical and/or regulatory reasons.

## Interactive Set-Top Box

The interactive set-top box is really a cable modem in disguise. The primary function of the set-top box is to provide more TV channels on the same limited number of frequencies. This is possible with the use of digital television encoding (DVB). An interactive set-top box provides a return channel - often through the ordinary plain old telephone system (POTS) - that allows the user access to web-browsing, email etc. directly on the TV screen.

## TYPICAL CABLE MODEM INSTALLATION



When installing a Cable Modem, a power splitter and a new cable are usually required. The splitter divides the signal for the "old" installations and the new segment that connects the Cable Modem. No TV-sets are accepted on the new string that goes to the Cable Modem.

The transmitted signal from the Cable Modem can be so strong, that any TV sets connected on the same string might be disturbed. The isolation of the splitter may not be sufficient, so an extra high-pass filter can be needed in the string that goes to the TV-sets. The high-pass filter allows only the TV-channel frequencies to pass, and blocks the upstream frequency band. The other reason for the filter is to block ingress in the low upstream frequency range from the in-house wiring. Noise injected at each individual residence accumulates in the upstream path towards the head-end, so it is essential to keep it at a minimum at every single residence that needs Cable Modem service..

### **Data-interface**

On any kind of external cable modem (the majority of what is in use today), you obviously need some kind of data-interface to connect the computer and the cable modem.

### **Ethernet**

On most external modems, the data-port interface is 10 Mbps Ethernet. Some might argue that you need 100 Mbps Ethernet to keep up with the max. 27-56 Mbps downstream capability of a cable modem, but this is not true. Even in a very good installation, a cable modem can not keep up with a 10 Mbps Ethernet, as the downstream is shared by many users.

The 1st version of the MCNS standard, that dominates the US market, specified 10 Mbps Ethernet as the only allowable data-interface. The DVB/DAVIC standard is totally open, allowing any type of interface. Other types of interfaces are being incorporated

in the MCNS standard to allow for a wider range of cable modem configurations.

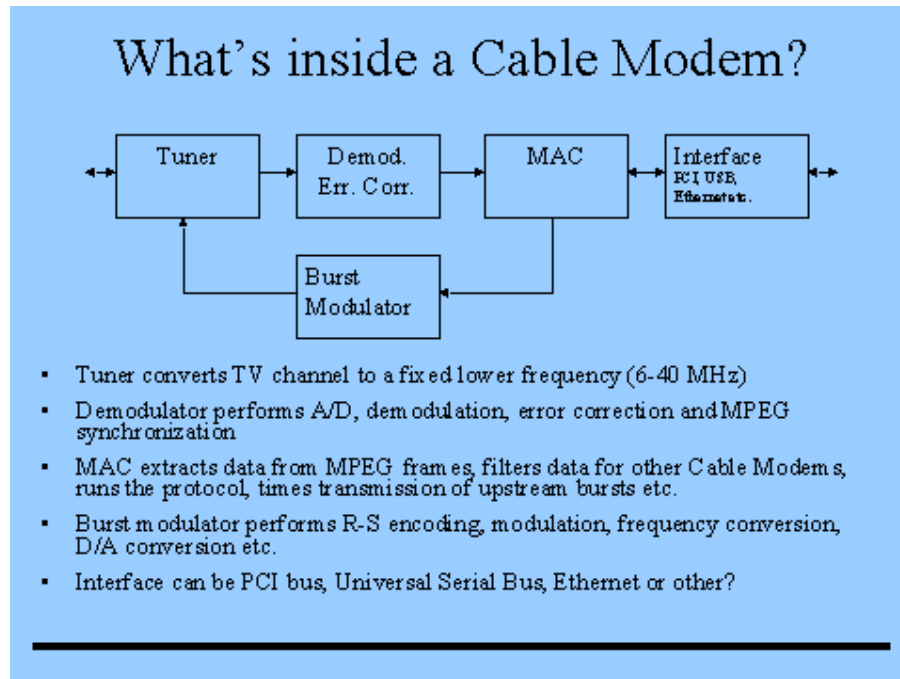
### **USB (Universal Serial Bus)**

Among others, Intel recently announced that they are working with Broadcom on cable modems with USB interface. This is expected to bring down the installation hassle for the many users with less computer skills. Obviously you do not need to open the box to install an Ethernet card, if the computer has an USB interface. If the computer does not have an USB interface, you will need to install that and you are back to about the same hassle-level as with the Ethernet interface.

### **Cost**

The installation cost is a significant issue, as this is something that needs to be done in the house of every subscriber. The CATV operators and equipment manufactures needs to try really hard to push down the installation cost, to keep the whole operation profitable.

## INSIDE A CABLE MODEM



Cable Modems are different, but the basic architecture is more or less the same as shown above. The major components are outlined below, along with an indication of some companies that are known to deliver products to the open market. Many other companies are working in the field, but may not be so well known to me - or may only produce components for their own use.

### Tuner

The tuner connects directly to the CATV outlet. Normally a tuner with build-in diplexer is used, to provide both upstream and downstream signals through the same tuner. The tuner must be of sufficiently good quality to be able to receive the digitally modulated QAM signals. Companies like ALPS, Sharp, Temic and Panasonic are strong suppliers here.

A new concept of a silicon tuner is in the works. This is basically a tuner on a chip, and is expected to cut the cost down quite a bit compared to a more conventional tuner module.

## **Demodulator**

In the receive direction, the IF signal feeds a demodulator. The demodulator normally consists of A/D converter, QAM-64/256 demodulator, MPEG frame synchronization, Reed Solomon error correction.

The clear leader here is Broadcom, with a single chip demodulator. Other companies are Stanford Telecom with a combined demodulator and burst modulator, but also companies like SGS Thomson, VLSI Technologies, LSI Logic and Fujitsu play a role here. The demodulator component is required both in a cable modem and in the more mature product, the digital (receive-only) set-top box, so many companies have developed products for this part of the game.

## **Burst modulator**

In the transmit direction, a burst modulator feeds the tuner. The burst modulator does Reed Solomon encoding of each burst, modulation of the QPSK/QAM-16 on the selected frequency and D/A conversion. The output signal is fed through a driver with variable output level, so the signal level can be adjusted to compensate for the unknown cable loss. The burst modulator is unique to the cable modem (and some two-way set-top boxes), so fewer components are available here. Broadcom leads the pack, with Stanford Telecom, Analog Devices, SGS Thomson and others playing catch-up Combined demodulator and burst modulator

chips are also available as the integration race drives more and more functions into a single chip.

## **MAC**

A Media Access Control mechanism sits between the receive and transmit paths. This can be implemented in hardware or split between hardware and software. The MAC is pretty complex compared to an ethernet MAC, and in reality no MAC's are able to handle all of the MAC layer function without some microprocessor "help". For DOCSIS cable modems, Broadcom and Libit (now Texas Instruments) are known to have MAC ASIC's available as a standard products Connexant is also in the market with a MAC that rely more on software to handle the various functions, supposedly giving more flexibility. Other companies are known to be working on various MAC chips for both DOCSIS and DVB/DAVIC, with different partitions of what goes in software and hardware. Some cable modem manufacturers even develop their own MAC apparently in an attempt to be more competitive or to differentiate their products.

## **Interface**

The data that pass through the MAC goes into the computer interface of the Cable Modem, be it Ethernet, USB, PCI bus or whatever.

## **CPU**

The microprocessor is not explicitly shown on the diagram, but for external cable modems a CPU is required. Some work is being done on host based processing cable modems, that uses the processor in the host (PC or Mac) to do all (or almost all)


processing. Much like how analog telephony modems (WinModem) rely on the PC processor to do the processing.

For external cable modems with Ethernet interface, the Motorola embedded PowerPC series of microprocessors are popular, but other RISC based architectures are also used. Single devices combining MAC, demodulator, burst modulator, processor, ethernet/PCI/USB interfaces and more are emerging, in effect integrating the guts of a cable modem in a single chip. There will still be some additional parts for memory, tuner, analog stuff, power supply etc. so we are still no-where near the true single-chip cable modem - even though that is what the final aim is.

## DOWNSTREAM

**What is Downstream?**

- What the Cable Modem receives
- Frequency 65-850 MHz
- Bandwidth 6 MHz (USA) or 8 MHz (EU)
- Modulation 64-QAM (or 256-QAM)
- Data-rate 27-56 Mbit/s (4-7 Mbyte/s)
- Continuous stream of data
- Received by all modems



The diagram shows a frequency spectrum from 5 MHz to 850 MHz. An upstream channel of 2 MHz is shown between 5 MHz and 65 MHz. A downstream channel of 8 MHz is shown between 65 MHz and 850 MHz.

Downstream is the term used for the signal received by the Cable Modem. The electrical characteristics are outlined in the below table. Notice that most CATV networks in Europe allows 8 MHz bandwidth TV channels, whereas the US CATV networks allows only 6 MHz. Again Europe runs a little faster.

Frequency	42-850 MHz in USA and 65-850 MHz in Europe
Bandwidth	6 MHz in USA and 8 MHz in Europe
Modulation	64-QAM with 6 bits per symbol (normal) 256-QAM with 8 bits per symbol (faster, but more sensitive to noise)

The raw data-rate depends on the modulation and bandwidth as shown below:

64-QAM	256-QAM	
31.2 Mbit/s	41.6 Mbit/s	6 MHz
41.4 Mbit/s	55.2 Mbit/s	8 MHz

Note: A symbol rate of 6.9 Msym/s is used for 8 MHz bandwidth and 5.2 Msym/s is used for 6 MHz bandwidth in the above calculations. Raw bit-rate is somewhat higher than the effective data-rate due to error-correction, framing and other overhead.

Since the downstream data are received by all Cable Modems, the total bandwidth is shared between all active Cable Modems on the system. This is similar to an Ethernet, only the wasted bandwidth on an Ethernet is much higher. Each Cable Modem filters out the data it needs from the stream of data.

## Downstream data format

**Downstream data format**

MPEG Payload	SYNC Byte	MPEG Header	MPEG Payload	SYNC Byte
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- Reed-Solomon error correction
- Corrects 6 errors in 204 bytes
- MPEG-TS (Transport Stream)
- MPEG-PS (Program Stream)
- MAC messages
- ATM cells (DVB/DAVIC)
- Data addressed to one, many or all Cable Modems

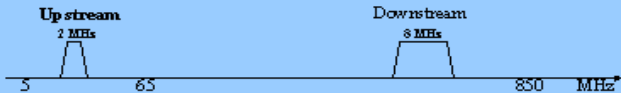
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Downstream data is framed according to the MPEG-TS (transport stream) specification. This is a simple 188/204 byte block format with a single fixed sync byte in front of each block. The Reed-Solomon error correction algorithm reduces the block size from 204 bytes to 188 bytes, leaving 187 for MPEG header and payload. This is where the various standards differ quite a lot. Some standards even allow various formatting of data within the MPEG-TS payload. For the DVB/DAVIC standard, the framing inside the MPEG-TS payload is simply a stream of ATM cells.

## UPSTREAM

**What is Upstream?**

- What the Cable Modem transmits
- Frequency 5-65 MHz (5-42 MHz)
- Bandwidth eg. 2 MHz.
- Modulation QPSK or 16-QAM
- Data-rate eg. 3 Mbit/s (~400 KB/s)
- Transmit bursts of data in timeslots (TDM)
- Reserved and contention timeslots



The diagram shows a frequency spectrum from 5 MHz to 850 MHz. An upstream channel is shown as a trapezoidal shape between 5 MHz and 65 MHz, labeled 'Up stream' and '2 MHz'. A downstream channel is shown as a trapezoidal shape between approximately 54 MHz and 64 MHz, labeled 'Downstream' and '8 MHz'.

Upstream is the term used for the signal transmitted by the Cable Modem. Upstream is always bursts, so many modems can transmit on the same frequency. The frequency range is typically 5-65 MHz or 5-42 MHz. The bandwidth per channel may be e.g. 2 MHz for a 3 MBit/s QPSK channel.

The modulation forms are QPSK (2 bits per symbol) and 16-QAM (4 bits per symbol), with the later being the fastest, but also most sensitive to ingress. One downstream is normally paired with a number of upstream channels to achieve the balance in data bandwidths required. Each modem transmits bursts in time slots that might be either marked as reserved, contention or ranging.

## **Reserved slots**

A reserved slot is a time slot that is reserved to a particular Cable Modem. No other Cable Modem is allowed to transmit in that time slot. The CMTS (Head-End) allocates the time slots to the various Cable Modems through a bandwidth allocation algorithm (notice: this algorithm is vendor specific, and may differentiate vendors considerably). Reserved slots are normally used for longer data transmissions.

## **Contention slots**

Time slots marked as contention slots are open for all Cable Modems to transmit in. If two Cable Modems decide to transmit in the same time slot, the packets collide and the data is lost. The CMTS (Head-End) will then signal that no data was received, to make the Cable Modems try again at some other (random) time. Contention slots are normally used for very short data transmissions (such as a request for a number of reserved slots to transmit more data in).

## **Ranging slots**

Due to the physical distance between the CMTS (Head-End) and the Cable Modem, the time delay vary quite a lot and can be in the milliseconds range. To compensate for this all Cable Modems employ a ranging protocol, that effectively moves the "clock" of the individual Cable Modem forth or back to compensate for the delay.

To do this a number (normally 3) of consecutive time-slots are set aside for ranging every now and then. The Cable Modem is commanded to try transmitting in the 2nd time-slot. The CMTS

(Head-End) measures this, and tells the Cable Modem a small positive or negative correction value for its local clock. The two time slots before and after are the "gap" required to insure that the ranging burst does not collide with other traffic.

The other purpose of the ranging is to make all Cable Modems transmit at a power level that makes all upstream bursts from all Cable Modems arrive at the CMTS at the same level. This is essential for detecting collisions, but also required for optimum performance of the upstream demodulator in the CMTS. The variation in attenuation from the Cable Modem to the CMTS can vary more than 15dB.

## Upstream data format

### Upstream data format

ATM Payload	Gap	U.W. 14bit	ATM Header	ATM Payload	Gap	U.W. 14bit
-------------	-----	---------------	------------	-------------	-----	---------------

- Reed-Solomon error correction
- Prepend unique word
- One ATM cell per burst (DVB/DAVIC)
- MAC message or data as payload
- 18 time-slots per 3 ms (DVB/DAVIC)
- Reserved time-slots for longer data
- Contention time-slot for small data (initiate)
- Ranging time-slots are 3 slots

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Upstream data is arranged in short bursts. The DAVIC/DVB standard requires a fixed length burst, whereas the MCNS standard specifies variable length bursts.

Since the upstream data is just a short burst of data, the demodulator needs something to trigger on. That is the unique word, that is prepended to the data. For DVB/DAVIC the unique word is 32 bit of data that triggers the demodulator to demodulate the burst. Without the unique word, the demodulator could easily start to demodulate various noise signals etc. And then be all busy doing that when the real data arrives. Also the unique word provides resynchronisation at every burst.

## **MEDIA ACCESS CONTROL**

### **What is MAC?**

- **Media Access Control**
  - **Implemented in HW and maybe some SW**
  - **Performs ranging to calibrate TX level**
  - **Performs ranging to calibrate time reference**
  - **Assigns upstream frequency and data-rate**
  - **Allocates time-slots (upstream bandwidth)**
  - **Runs on both Cable Modem and Head-End**
  - **Very similar to satellite protocol**
- 

The Media Access Control mechanism is normally implemented in hardware or in a combination of hardware and software. The primary purpose of the MAC is to share the media in a reasonable way. Both the CMTS and the Cable Modem implements protocols to do the following.

- Ranging to compensate for different cable losses. It is essential that the upstream bursts from all Cable Modems are received in the Head-End at the same level. If two Cable Modems transmit at the same time, but one is much weaker than the other one, the CMTS will only hear the strong signal and assume everything is okay. If the two signals are same strength, the signal will garble and the CMTS will know a collision occurred.
- Ranging to compensate for the different cable delays. The size of a CATV network calls for fairly large delays in the millisecond range.
- Assigns frequencies etc. to the Cable Modems. The Cable Modem first listens to the downstream to collect information about where and how to answer. Then it signs on to the system using the assigned upstream frequency etc.
- Allocate the time-slots for the upstream.

This is one of the areas that are most closely tied to the specific standard. So It is impossible to give more detailed information about the MAC, without going into the specific standards.

## **CABLE DATA SYSTEM FEATURES**

Beyond modulation and demodulation, a cable modem incorporates many features necessary to extend broadband communications to wide-area networks (WANs). The network layer is chosen as Internet protocol (IP) to support the Internet and World Wide Web services. The data link layer is comprised of three sublayers: logical link control sublayer, link security sublayer

conforming to the security requirements, and media access control (MAC) sublayer suitable for cable system operations. Current cable modem systems use Ethernet frame format for data transmission over upstream and downstream data channels. Each of the downstream data channels and the associated upstream data channels on a cable network form an extended Ethernet WAN. As the number of subscribers increases, a cable operator can add more upstream and downstream data channels to support demand for additional bandwidth in the cable data network. From this perspective, growth of new cable data networks can be managed in much the same fashion as the growth of Ethernet LANs within a corporate environment.

The link security sublayer requirements are further defined in three sets of requirements: baseline privacy interface (BPI), security system interface (SSI), and removable security module interface (RSMI). BPI provides cable modem users with data privacy across the cable network by encrypting data traffic between the user's cable modem and CMTS. The operational support provided by the EMS allows a CMTS to map a cable modem identity to paying subscribers and thereby authorize subscriber access to data network services. Thus, the privacy and security requirements protect user data as well as prevent theft of cable data services.

Early discussions in the Institute of Electrical and Electronic Engineers (IEEE) 802.14 Committee referred to the use of asynchronous transfer mode (ATM) over cable data networks to facilitate multiple services including telephone, data, and video, all of which are supported over cable modems. Although current cable modem standards incorporate Ethernet over cable modem,

extensions are provided in the standards for future support of ATM or other protocol data units. IP-telephony support over cable data networks is expected to be a new value-added service in the near term.

## STANDARDS

### What standards?

- Proprietary systems (1st generation systems).
- MCNS (USA mainly). Developed for Cable Modem only. Specifies external Cable Modem only, but may add internal Cable Modem also.
- DAVIC/DVB (Europe mainly). Used for set-top box and now also Cable Modem.
- IEEE 802.14 lost 1st round, but tries to leapfrog and be the standard of the future (3rd generation systems).

Three major standards exist for Cable Modems. First generation Cable Modems uses various proprietary protocols etc. making it impossible for the CATV network operators to use multiple vendors Cable Modems on the same system.

Around 1997 three standards emerged. DAVIC/DVB were first with a European standard, closely followed by MCSN with a US standard (DOCSIS). IEEE came last with 802.14, and clearly lost

the 1st round. IEEE is now trying to leapfrog the two other standards by focusing on the next generation standards.

### **DVB/DAVIC**

This standard is also known as DVB-RCC and as ETS 300 800. Initially run by DAVIC, but now the work has moved to DVB. Very few vendors develop for this standard, but enough that it

does play a role. This standard is fighting the EuroDOCSIS standard for the European market. This standard is based on fixed cell size (ATM) and includes all the standard ways of doing quality of service (QoS) that ATM is known for. In that way, the standard is very well suited to both data i.e. TCP/IP (using AAL5) and telephony as pure ATM. VoIP to the cable modem may not be the best solution, although technically feasible.

Initially the standard lacked security (encryption), but that was added as an option in version 1.4. Open to both internal and external implementations, and also covering Set-Top Box implementations with an additional out-of-band receive data channel. Some of the European cable operators joined forces and made a request for proposals for a EuroModem. The specification is available to the public from [EuroCableLabs](#) for free, and even though it does not seem very big, it does refer to other standards including ETS 300 800 for the details.

### **MCNS/DOCSIS**

DOCSIS (Data-Over-Cable Service Interface Specifications) a manufacturing standard for cable-modem companies established by CableLabs, certifies cable modems and qualifies CMTSs for interoperability. It defines interface requirements for cable modems involved in high-speed data distribution over cable

television system networks. The project also provides cable modem equipment suppliers with a fast, market-oriented method for attaining cable industry acknowledgement of DOCSIS compliance and has resulted in high-speed modems being certified for retail sale.

The dominant US standard-even though it has not gone through any formal/independent standards body yet. This standard is very much driven by the wish of the large cable operators to have cable modems sold through the retail channel. Initially the chip manufacturer Broadcom played an important role, by pushing the standard and the level of chip integration at a very fast pace. As a result, the complexity of the standard is generally agreed to be much higher than what is strictly required, and is even growing.

Initially the standard did not support QoS which is required for telephony applications (VoIP) and other applications as well, but this has been added in version 1.1.

Initially open to only external box solutions with Ethernet interface, but now also allows internal modems and USB modems. Host based processing solutions is still debated (start 1999).

While originally targeted at the US domestic market, an off-spring named EuroDOCSIS is being pushed as the solution to the DVB centric European market. EuroDOCSIS is essentially the same as DOCSIS apart from the physical layer, which is DVB compliant in EuroDOCSIS.

**IEEE**

Lost the 1st round of the Cable Modem standards battle. What happens down the road remains to be seen. It looks like part of the IEEE group is working with Broadcom and Terayon on the next generation physical layer with increased (30 Mbps) upstream bitrate. This has also been termed DOCSIS 1.2, even though that

does not seem to be official, and is certainly not approved by the DOCSIS vendor community yet. The battle for the US domestic market is clearly won by the DOCSIS standard, but the same for the European market is still going on.

## **ADSL Vs CABLE MODEM**

ADSL provides a dedicated service over a single telephone line; cable modems offer a dedicated service over a shared media. While cable modems have greater downstream bandwidth capabilities (up to 30 Mbps), that bandwidth is shared among all users on a line, and will therefore vary, perhaps dramatically, as more users in a neighborhood get online at the same time.

Cable modem upstream traffic will in many cases be slower than ADSL, either because the particular cable modem is inherently slower, or because of rate reductions caused by contention for upstream bandwidth slots.

The big difference between ADSL and cable modems, however, is the number of lines available to each. There are no more than 12 million homes passed today that can support two-way cable

modem transmissions, and while the figure also grows steadily, it will not catch up with telephone lines for many years. Additionally, many of the older cable networks are not capable of offering a return channel; consequently, such networks will need significant upgrading before they can offer high bandwidth services.

**High-Speed:** DSL overtakes cable modems, offering downstream speeds of up to 1.5 Mbps (T1 equivalent), and upstream speeds of up to 768 kbps. Also, each ADSL circuit is separate, performance of your ADSL circuit won't downgrade just because other people are using theirs at the same time.

**Two-Way Connection:** Most cable modems only work in one direction - downstream, and you still have to maintain a dial-up connection to go upstream. With ADSL, you get a high-speed, reliable two-way communications solution.

**More Security:** ADSL provides a permanent, dedicated connection. It's dedicated to the user and no one else whereas cable modems offer access over a shared cable connection.

## ISSUES

**1.Security:** The DOCSIS specifications provide a baseline privacy that guarantees user data privacy (across the cable network) and services protection by encrypting CM/CMTS traffic flows and controlling distribution of encryption keys to CMs. The DOCSIS system architecture includes security components that ensure user data privacy across the shared-medium cable network and

prevents unauthorized access to DOCSIS-based data transport services across the cable network. The DOCSIS architecture also supports the policing (e.g., filtering) functions that can be used to reduce risks from attacks targeted at attached CPE devices. These policing capabilities are comparable to those available within dedicated line network access systems (e.g.; telephone, ISDN, DSL).

**2. Static and dynamic IP addresses:** An IP Address is essential to using the Internet, and since each PC needs one to get on the Internet, having an IP address is a must. Typically, most cable and xDSL ISP's do not want you to host a server. One big issue with hosting on your home cable connection is a Dynamic IP Address. This Dynamic IP may change at any time, and causes problems when people try to connect to your PC. These Dynamic Addresses are given out for two reasons: It makes network administration easier, and it also acts as a deterrent to hosting your own server on your Dynamic IP. A Static IP Address never changes (Not unless you change ISP's usually), and can always be found on the Internet. If you have a static IP address, they typically cost more, or some ISP's won't even allow you to have a static IP Address.

**3. Speed:** Cable modems can provide very high speeds in comparison with other technologies such as dialup, ISDN and even DSL. But an important fact to be considered is that this bandwidth is to be shared among a large number of users. As the users log on to the network, the available downstream bandwidth decreases and the performance may degrade further.

## **CONCLUSION**

Cable modem technology offers high-speed access to the Internet and World Wide Web services. Cable data networks integrate the elements necessary to advance beyond modem technology and provide such measures as privacy, security, data networking, Internet access, and quality-of-service features. The end-to-end network architecture enables a user cable modem to connect to a CMTS which, in turn, connects to a regional data center for access to Internet services. Thus, through a system of network connections, a cable data network is capable of connecting users to other users anywhere in the global network.

Because cable operates at speeds many times faster than a dialup phone line, it is now possible to view streaming video clips real-time, download multi-megabyte software programs in seconds, videoconference with friends and family and play video games on-line. These capabilities were not practical nor, in some cases, even possible with 56K dialup. In addition, cable Internet subscribers can be fully connected, 24 hours a day, to both remote and local services without interfering with their cable television service or tying up a phone line. The requirements for greater bandwidth and speed is on the rise. With the many advantages, Cable Modems with the present technology seem to be a feasible solution.