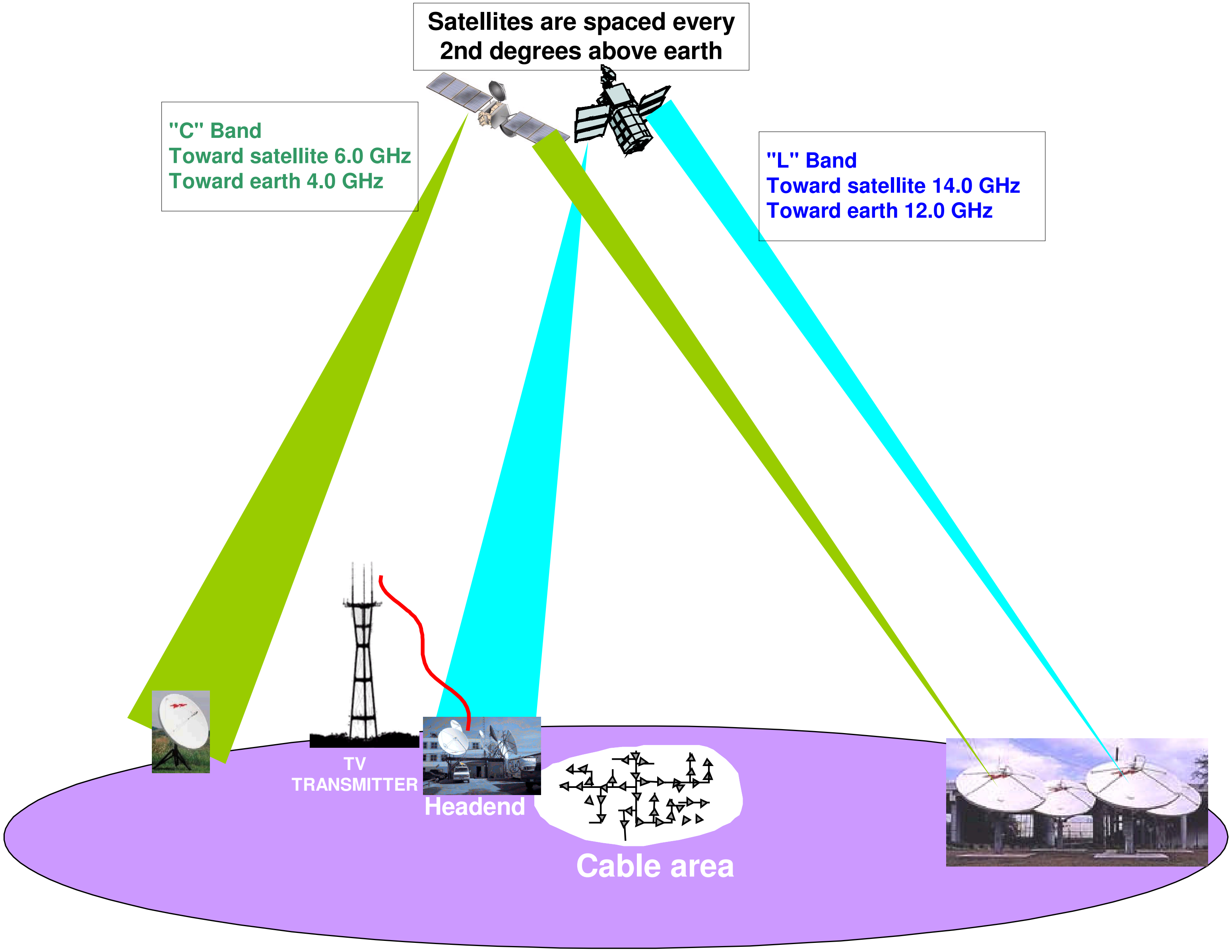
Broadband System - Q



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DOCSIS simplify.

DOCSIS Simplified

Data Over Cable Service Interface Specification (DOCSIS) is an international standard DOCSIS which defines the communications and operation support interface requirements for data over cable system. It permits the addition of high-speed data transfer to an existing cable TV (CATV) system. It is employed by many cable television operator to provide Internet access over their existing hybrid fibre coaxial (HFC) structure. The first DOCSIS specification was version 1.0 issue in March 1997, with revision 1.1 following in April of 1999. Because of increased demand for symmetric, real-time service such as IP telephony, DOCSIS was again revised to enhance upstream transmission speed and (QoS)Quality of Service; this revision - DOCSIS 2.0 was released in January 2002.

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As frequency allocation band plans differ between US and European CATV system, DOCSIS standard have been modified for uses in Europe. These changes were published under the name “EuroDOCSIS”. The main difference account for differing TV channel bandwidths; European cable channels conform to PAL TV standard and are 8 MHz wide, whereas in North-America cable channels conform NTSC standards which are 6 MHz. The wider bandwidth in EuroDOCSIS architectures permits more bandwidth to be allocated to the downstream data path (taken from a user’s point of view, “downstream” is used to download date, while “upstream” is used to upload data)

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DOCSIS 1.0

High Speed Internet Access. Key features: Downstream transfer rates between 27 and 36 Mbps over a radio frequency path between 88 and 870 MHz in a 6.0 MHz spacing, depending if you use 64 or 256 QAM. Upstream traffic transfer rate up to 10 Mbps over a RF path using 200 kHz and 3.2 MHz in the frequency range of 5 to 42 MHz.

But, because data over cable travels on a shared loop, individuals will see transfer rates drop has more users gain access.

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DOCSIS 1.1

The types of services afforded by DOCSIS 1.1 differ from DOCSIS 1.0 technology, by;

•QoS (Quality of Service) was also added.

•Data fragmentation which permit voice services where latency matters more than sheer bandwidth.

•Security upgrade

•The ability to pre-equalize upstream traffic, thus doubling reverse path throughput (10 Mbps per 3.2 MHz spacing, versus 5 Mbps for DOCSIS 1.0)

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DOCSIS 2.0

Added capacity for symmetric services by operating at 64 QAM and having new 6.4 MHz wide return channel. It increased bandwidth for IP traffic by using enhanced modulation and improved error correction. The result for upstream transmission is 30.72 Mbps using 64 QAM, which is 3 times better than DOCSIS 1.1 and 6 times than DOCSIS 1.0. DOCSIS 2.0 is interoperable and compatible with DOCSIS 1.x

The latest DOCSIS specification eDOCSIS has been published to the industry. eDOCSIS stands for embedded DOCSIS, which would provide a subordinate function at the core chip level to the host device. And, rather than leveraging a home networking protocol, an eDOCSIS device would feed directly into a cable network's DOCSIS channel. eDOCSIS is intended to solve end device (and traffic) management, configuration and security issues to significantly reduce cost in the service operation and to improve speed and quality of end customer services.

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MAC layer:

DOCSIS employs a mixture of deterministic access method, specifically TDMA for DOCSIS 1.0/1.1 and both TDMA and S-CDMA for DOCSIS 2.0, with a limited use of contention for bandwidth request. In contrast to pure contention-based MAC CSMA/CD employed in Ethernet systems, DOCSIS systems experience few collisions. For DOCSIS 1.1 and above, the MAC layer also includes extensive Quality of Service (QoS) features that help to efficiently support applications, for example Voice over IP, that have specific traffic requirements, such as low latency.

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DOCSIS 3.0

The new DOCSIS 3.0 standard that features IPv6 and channel bonding which enables multiple downstream and upstream channels to be used together at the same time by a single subscriber.

DOCSIS 3.0 Downstream speed is 160 Mbps and 120 Mbps Upstream.

Channel bonding in computer is an arrangement in which two or more NETWORK INTERFACE on a host computer are combined for redundancy or increased throughput.

Internet Protocol Version 6 (IPv6) is a network layer IP standard used by electronic devices to exchange data across a packet-switched internet work. It follows IPv4 as the second version of the Internet Protocol to be formally adopted for general use..

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Throughput:

All of these features combined enable a total upstream throughput of 30.72 Mbit/s per channel (although the upstream speed DOCSIS 1.0 and 1.1 is limited to 10 Mbit/s). All three versions of the DOCSIS standard support a downstream throughput of up to 38 Mbit/s per channel with 256 QAM (owning to 8 MHz channel width, the EuroDOCSIS standard supports downstream throughput of up to 51 Mbit/s per channel)

DOCSIS 3.0 feature IPv6 and channel bounding, which enable multiple downstream and upstream channels to be used together at the same time by a single subscriber.

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DOCSIS	Downstream	Upstream
1.0	38 Mbps	10 Mbps
2.0	40 Mbps	30 Mbps
3.0	160 Mbps	120 Mbps

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The DNA of DOCSIS 3.0

DOCSIS 3.0 a strategically important set of specification for the cable industry, will provide operators with a rich set of features and service-enablers. While only scratching the surface when compared to detail provided by the full set of specifications, this seminar offers a distilled and more distinct view of DOCSIS 3.0 primary features.

CHANNEL BONDING

This key feature enables simultaneous data transmission on multiple channels. Current requirements call for equipment to support bonding at least four upstream and four downstream channels, although the platform gives operators the flexibility to bond as few as two channels to meet market needs and competition. Channels used for bonding need not to be adjacent. Beyond increasing the peak data rate that can be offered to the subscribers, channels bonding can support an estimated 10-25 percent more customers per channel due to statistical multiplexing gains as compared to node splitting.

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Examples of shared data rates supported by DOCSIS 3.0 channel bonding

Downstream capacity (6 MHz & 256 QAM)		Upstream capacity (6.4 MHz & 64 QAM)	
FOUR channels,	160 Mbps	FOUR channels,	120 Mbps
THREE channels,	120 Mbps	THREE channels,	90 Mbps
TWO channels,	80 Mbps	TW) channels,	60 Mbps

IPV6

To help operators remedy a shrinking (or already exhausted) pool of private IPv4 addresses, DOCSIS 3.0 support IPv6, whose main feature is a much larger address space – 128 bits long compared to IPv4's 32 bits. It is expected that operators will support both IPv4 and IPv6 simultaneously for the foreseeable future. This concurrent support will allow a transition to IPv6 without creating isolated IPv6-only networks or enlisting a hard cut-over to IPv6. This new specs enable IPv6 provisioning and management of cable modems and other DOCSIS 3.0 based consumer premises devices with embedded modems (gateways, multimedia terminal adapters, etc)

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DOCSIS 3.0 Security

Enhanced Traffic Encryption:

DOCSIS 3.0 supports the 128 bits Advanced Encryption Standard (AES), a stronger traffic encryption feature versus the existing DES encryption algorithm.

Enhanced Provisioning Security:

Additional security features such as early authentication & inscription, configuration file enforcement, IP address verification, and certificate revocation help to increase security of the provisioning servers, disrupting the network and stealing services.

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DOCSIS 3.0 Physical Layer Enhancements

Upstream Frequency Range Extension:

Enables operators to extend the upstream from 5 – 40 MHz to 5 – 85 MHz, adding 200 Mbps of potential upstream capacity. That extra upstream bandwidth could be leveraged to support symmetrical business services. To enable this feature, however operators must move lower analog channels or go to a all-digital. Additionally, the operators will have to move to more legacy conditional access system, upgrade amplifiers and fibre nodes, and use filters to protect legacy CPE devices on the network.

- *Last 4 slides from Michelle Kuska, Cablelabs vice-president*

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Services offered by major Canadian Providers:

Provider	Basic	Standard	Faster	Fastest	
Videotron	600 Kbps	7.0 Mbps	10.0 Mbps	20.0 Mbps	Download
	128 Kbps	820 Kbps	900 Kbps	1.0 Mbps	Upload
Cogeco	640 Kbps	10.0 Mbps	16.0 Mbps	N/A	Download
	150 Kbps	640 Kbps	1.0 Mbps	N/A	Upload
Rogers	1.0 Mbps	5.0 Mbps	6.0 Mbps	N/A	Download
	128 Kbps	384 Kbps	800 Kbps	N/A	Upload
Shaw	256 Kbps	5.0 Mbps	10.0 Mbps	25.0 Mbps	Download
	128 Kbps	512 Kbps	1.0 Mbps	1.0 Mbps	Upload
EastLink	256 Kbps	5.0 Mbps	10.0 Mbps	N/A	Download
	128 Kbps	1.0 Mbps	1.0 Mbps	N/A	Upload

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Transfer rate:

Most DOCSIS cable modems have caps (restrictions) on upload and download rates. These are set by transferring a configuration file to the modem, via TFTP, when the modem first establishes a connection to the provider's equipment.
One downstream channel can handle hundreds of cable modems. As the system grows, the CMTS can be upgraded with more downstream and upstream ports. If the HFC network is vast, the CMTS can be grouped into hubs for efficient management.
Some users have attempted to override the bandwidth cap and gain access to the full bandwidth of the system (often as much as 30 Mbps), by uploading their own configuration file to the cable modem - a process called uncapping. Uncapping is almost always a violation of the Terms of Service agreement and the law

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Trivial File Transfer Protocol (TFTP):

Is a very simple file transfer protocol, with the functionality of a very basic form of FTP; it was first defined in 1980.
Since it is so simple, it is easy to implement in a very small amount of memory, an important consideration at that time. TFTP was therefore useful for booting computers such as routers which did not have any mass storage devices. It is still used to transfer small files between hosts on a network, such as when a remote X Windows System terminal or any other thin client boots from a network host or server.
TFTP is based in part on the earlier protocol EFTP, which was part of the PUP protocol suite. In the early days of work on the TCP/IP protocol suite, TFTP was often the first protocol implemented on a new host type, because it was so simple.
The original versions of TFTP, prior to RFC 1350, displayed a particularly bad protocol flaw, which was named Sorcerer's Apprentice Syndrome (after the *Sorcerer's Apprentice* segment of Fantasia) when it was discovered.
Recently, TFTP has been used by computer worms, such as Blaster, as a method of spreading and infecting new hosts.

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Current and New Offerings:

With a typical rate of 3 Mbps Download per user, only 12 subs would be able to share a 256 QAM signal simultaneously. Some systems may allows an over subscription of 100:1 on the DS leading to 1200 subs per subs per DS. Over subscription is very dependant on the demographics; college town or suburb?

Increasing a customer's "cap" to 5 Mbps and using the same model would produce only 800 subs, but changing the "cap" may not have a linear affect as predicted or assumed. On one hand, average usage may be less than extrapolated, but on the other hand, customer that use a lot of P2P services may look more appealing to others outside the network. For example, offering a tier service with 15 Mbps per DS would only allow 2*100= 200 subs per DS and hard to justify a business case. Allowing much more over subscription may be fine. But need to be observed over time.

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Current and New Offerings: (suite)

Customer that actually pay for higher tier service could feel compelled to get their moneys worth and use more than previous. Also, as customers become more computer savvy or other applications become prolific, usage could increase exponentially. This equates to an over subscription calculation that must be re-evaluate and probably decreased. Now the over subscription of 100:1 may need to be 75:1.

Some cable system have different offering in different part of north America. One system has 2 tiers with one providing all basic subs with 10 Mbps DS by 1 Mbps US and tier 2 providing high-end customers with 15 Mbps DS and 2 US. Some other cable system also has a 64 QAM trial going on. Advanced Time Division Multiple Access (ATDMA) as provided by DOCSIS 2.0 allows higher modulation schemes and channels widths and has been deployed in some other par of the world for over a year, but just being deployed in North America.

In all the case above, customer are working toward 600-1000 subscribers on a single DS.

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New Technology Cornerstones:

New technologies are being pursued to address the DS bottleneck conundrum. DOCSIS 3.0 uses a channel bonding technique to achieve higher capacity link, enable faster high speed data (HSD) service, and provide M x N MAC domain to enable Video over IP solutions.
The modular CMTS (M0CMTS) architecture is promoted to achieve better DOCSIS economics, lower cost DS PHY, and de-couple DS and US ports.
One day we may see fibre optic node with DOCSIS physical layer chips embedded so we can use INGRESS cancellation at the node, digital links from the node back to the headend without the need to amplify, and no more laser clipping.
Of course, this mean all traffic needs to be DOCSIS-based in North America.

End of this presentation.

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