

DOCSIS 2.0 AND 3.0



Presented by:



AGENDA



- **CURRENT STATUS**
- **DOCSIS 2.0**
- **M-CMTS**
- **DOCSIS 3.0**
- **Q&A**

CURRENT STATUS



- Majority of MSOs in Caribbean and Latin America have deployed DOCSIS services in some form
- If you are still on DOCSIS 1.0 you are in **SEVERE** risk of theft of service.
- DOCSIS 1.1 is widely deployed but not all advantages used.
 - QoS not being used for other application than voice.
 - Main driver were the security features of Docsis 1.1
- Major MSOs on the region and new deployments already using DOCSIS 2.0.
 - Smaller node sizes
 - High bandwidth services.
- DOCSIS 3.0 services expected to blossom on 2010.

DOCSIS VERSIONS



	Spec	Interop	Certification
DOCSIS 1.0	1997	1998	1999
DOCSIS 1.1	1999	Q3, 2000	Q3, 2001
DOCSIS 2.0	Q4, 2001	Q2, 2002	Q4, 2002

DOCSIS 2.0



DOCSIS 2.0



BENEFITS IN A NUTSHELL

- **Increased return channel capacity**
- **New modulation techniques**
- **Better performance on noisy environments**

Downstream not changed nor improved
MAC layer not changed, only PHY layer.

DOCSIS 2.0



- Higher return path RF Bandwidth

DOCSIS	1.0	1.1	2.0
200 Khz	X	X	X
400 Khz	X	X	X
800 Khz	X	X	X
1600 Khz	X	X	X
3200 Khz	X	X	X
6400 Khz			X

DOCSIS 2.0



IMPROVEMENTS ON SPECTRAL EFFICENCY

	Bits per symbol
1.X	3.2 bits / Hertz QAM16
2.0	4.8 bits /Hertz 64QAM

DOCSIS 2.0



NEW MODULATIONS

- **A-TDMA: Evolution from DOCSIS 1.X TDMA**
 - 8 QAM
 - 32 QAM
 - 64 QAM
- **S-CDMA: New modulation format**

DOCSIS 2.0 ATDMA



Hertz	QPSK	8 QAM	16 QAM	32 QAM	64 QAM	Ksym/Sec
200	320	480	640	800	960	160
400	640	960	1280	1600	1920	320
800	1280	1920	2560	3200	3840	640
1600	2560	3840	5120	6400	7680	1280
3200	5120	7680	10240	12800	15360	2560
6400	10240	15360	20480	25600	30720	5120

DOCSIS 2.0 ATDMA



IMPROVED PERFORMANCE UNDER INTERFERENCE

- **Enhanced Pre-Equalizer from 8 to 24 taps**

DOCSIS 2.0 S-CDMA



SYNCHRONOUS CODE DIVISION MULTIPLE ACCESS

- **Same throughput than ATDMA**
- **Better impulse noise performance under 20 Mhz**
- **Less latency**
- **Only useful on channels > 1 Mhz**
- **Requires 10X better sincronization than ATDMA**

DOCSIS 2.0 MIXED MODE



Logical Channels



ATDMA & TDMA

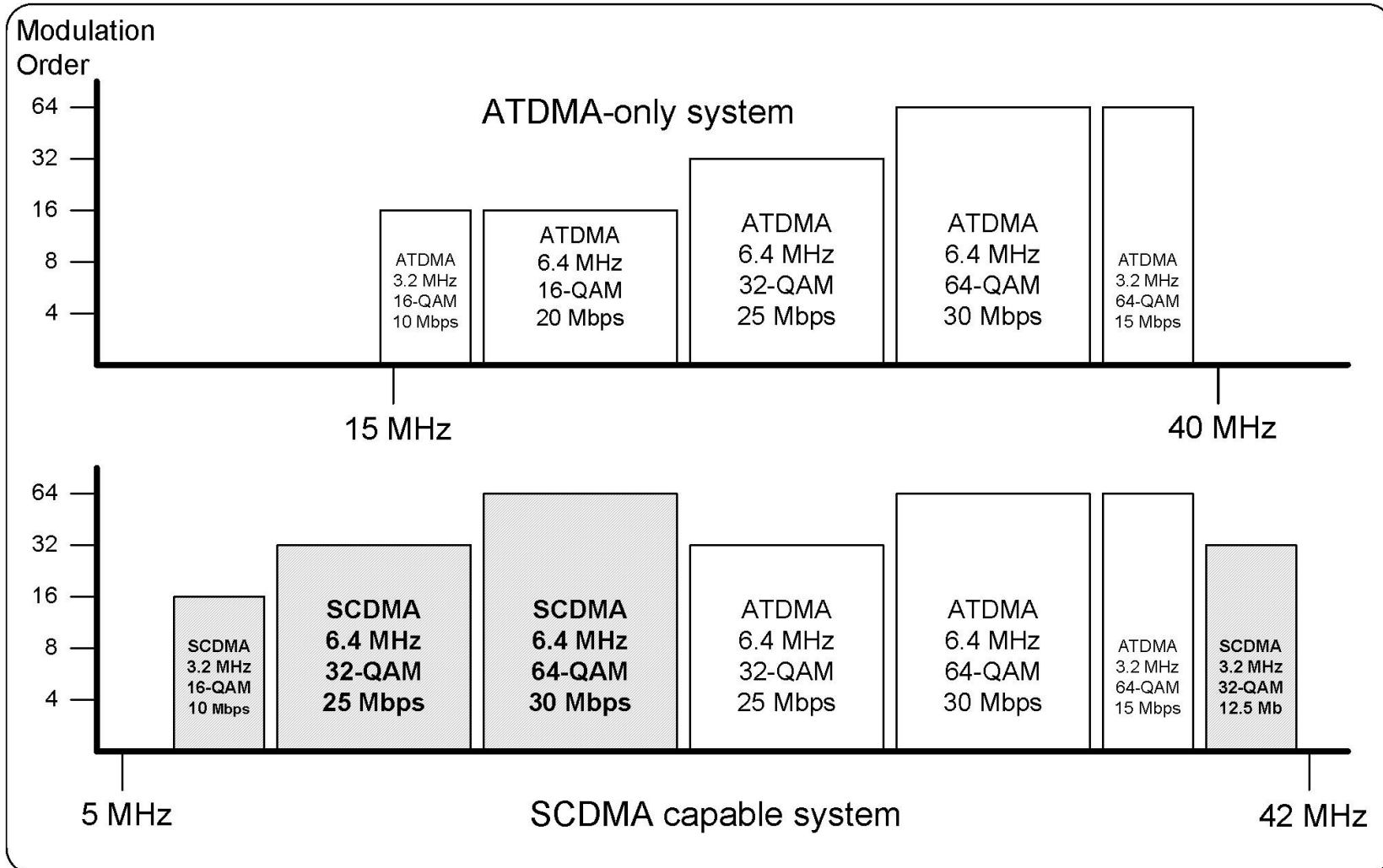


S-CMDA

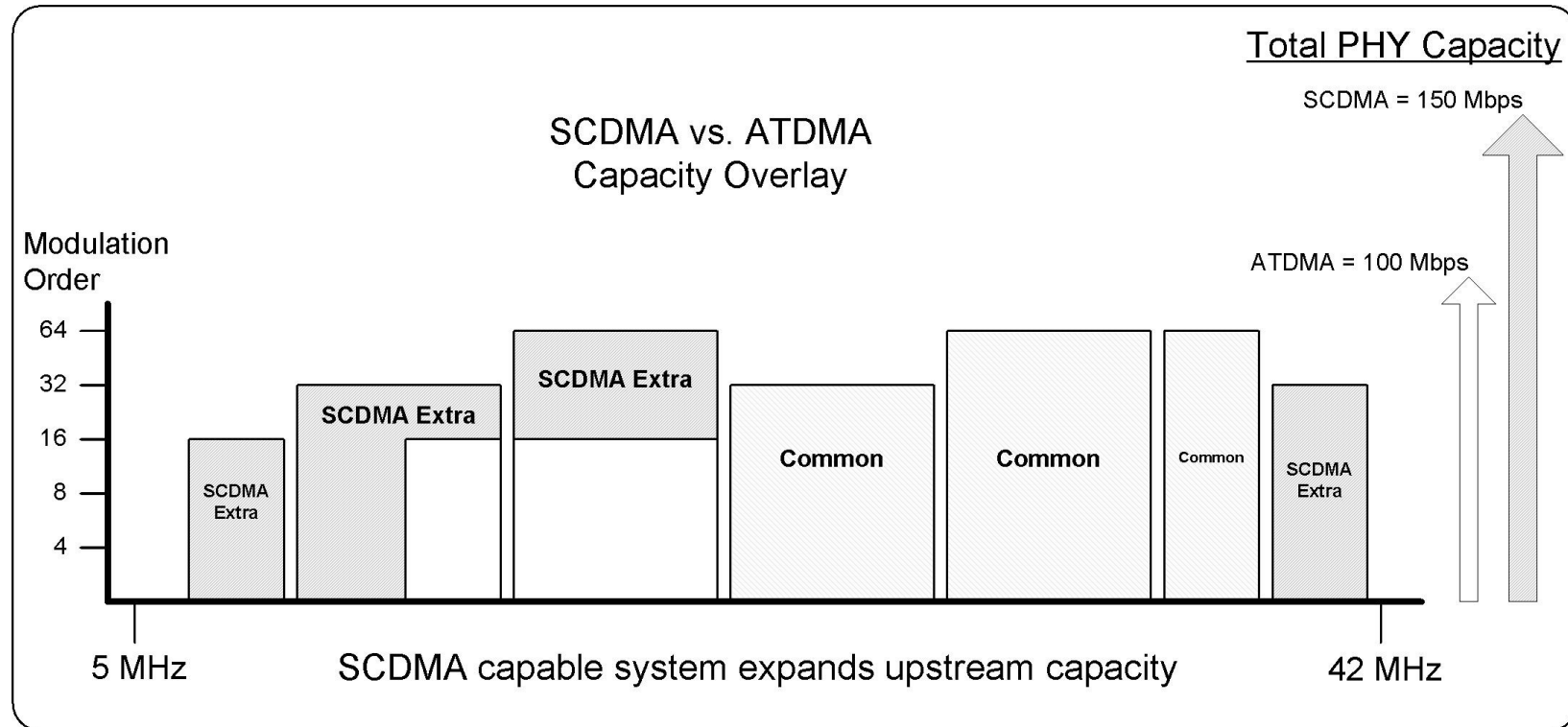
There's a loss of performance close to 25% when mixing ATDMA and SCDMA on the same RF Channel.

There's no loss by mixing ATDMA and TDMA

S-CDMA vs. A-TDMA Capacity Analysis



S-CDMA vs. A-TDMA Capacity Analysis



S-CDMA advantages

S-CDMA increase capacity up to ~50%

Enables 100 Mbps Upstream Service Rates

Defer Node Splits

NETWORK REQUIREMENTS



ATDMA

Channel SNR Required (dB)	Modulation Type
15	QPSK
18	8QAM
21	16QAM
24	32QAM
27	64QAM
30	128QAM
33	256QAM

SCDMA

Channel SNR Required (dB)	Modulation Type
12	QPSK
15	8QAM
18	16QAM
21	32QAM
24	64QAM
27	128QAM
30	256QAM

NETWORK REQUIREMENTS



32QAM and 64QAM usually requires small node sizes.

- **1000 HHPP max**
- **N+1 or N+2 usually**

M-CMTS

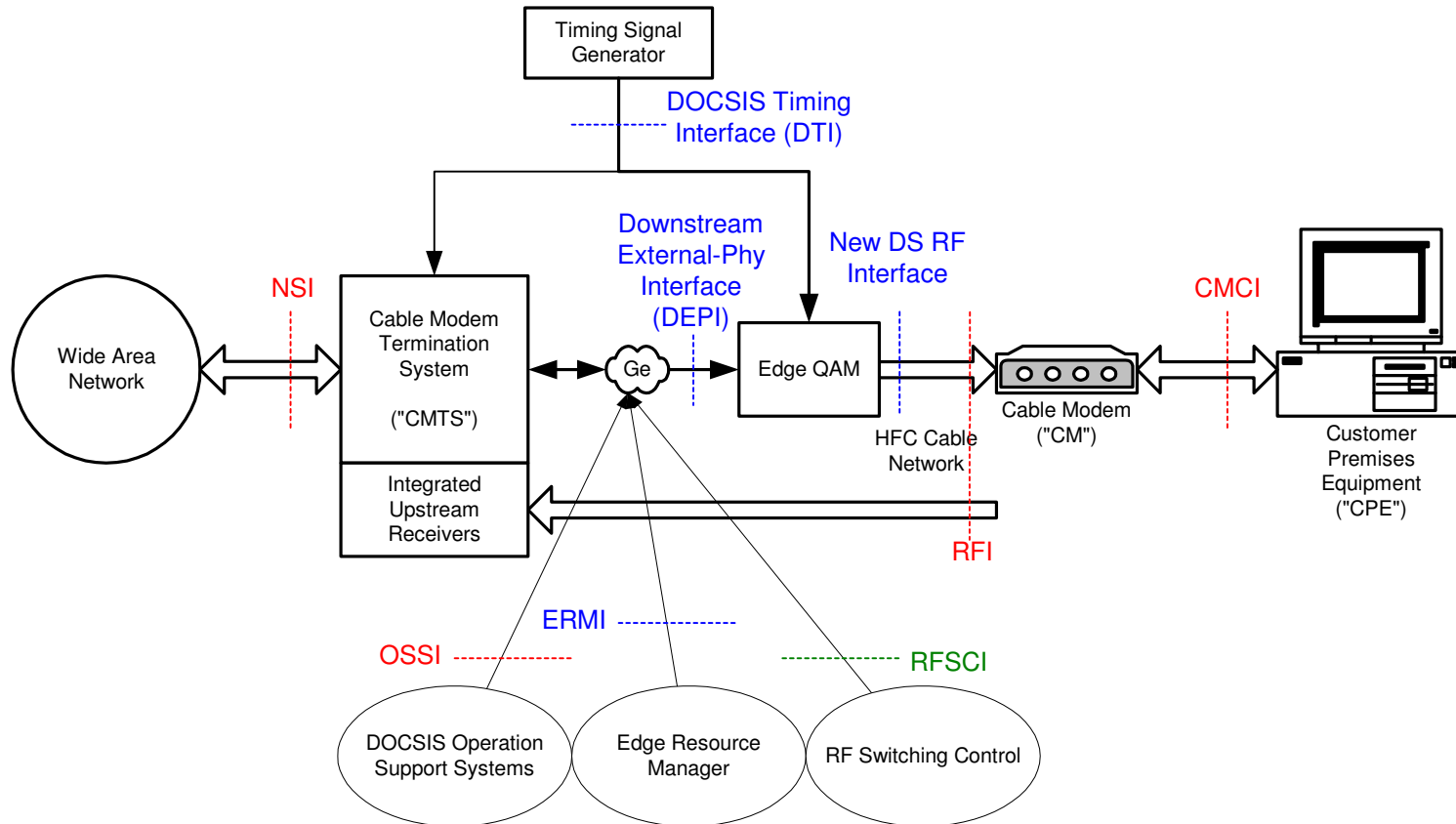


M-CMTS Goals



- **“Independent scalability of CMTS functions from DS PHY”**
 - Means: need to add DS channels without adding US channels
- **“Lower the cost to deliver video over DOCSIS service to be competitive with today’s MPEG VOD”**
- **2005 Incremental DOCSIS DS channel cost: \$24K ASP for 2DS+8US CMTS blade = \$12, 000 per DS channel**
 - **2005 Incremental MPEG VOD channel cost: \$12K for 24-channel MPEG EQAM = \$500 per DS channel**
 - But with no rate limiting, scheduling, QOS, encryption, VOIP compression, or RF switching

M-CMTS Interfaces



What's important and not for M-CMTS



- **What's important is that the two M-CMTS goals be met:**
 - **De-coupling downstream and upstream capacity; and**
 - **Lowering the cost of downstream capacity.**
- **What's important is the adoption of the DEPI specification by the EQAM industry.**
 - **Enables a transition to DOCSIS IPTV with DEPI EQAMs.**
- **What's NOT important is the concept of separating the upstream PHY layer:**
 - **Separation into an “upstream shelf” and definition of an “Upstream Edge Physical Interface” (UEPI)**
 - **Independent vendor implementations of “CMTS Core” and “upstream shelf” MAC functions;**



DOCSIS 3.0 – What's New

DOCSIS 3.0



DOCSIS 3.0 Features



- **Channel Bonding**
 - Upstream Channel Bonding
 - Downstream Channel Bonding
- **IP Multicast**
 - Source Specific Multicast
 - QoS Support for Multicast
- **Security**
 - Enhanced Traffic Encryption
 - Enhanced Provisioning Security
 - Certificate Revocation
- **Network Management**
 - CM Diagnostic Log
 - Enhanced Signal Quality Monitoring
 - Service Statistics Reporting
- **IPv6**
 - IPv6 Provisioning & Management of CMs
 - Alternative Provisioning Mode & Dual-stack Management Modes for CMs
 - IPv6 Connectivity for CPEs
- **Physical Layer**
 - Upstream Frequency Range Extension
- **Business Services over DOCSIS**
 - Layer 2 Virtual Private Networks
 - Support for T1/E1 Services



DOCSIS 3.0 Channel Bonding



Channel Bonding



- **Feature Description**
 - **Simultaneous data transmissions on multiple channels**
 - Support of at least 4 upstream & 4 downstream channels is required (can support more)
 - Channels don't have to be adjacent
 - **Legacy CMs can be supported on each channel**
- **Benefits**
 - **Scalable deployment**
 - MSO can choose to bond any number of channels (2,3,4,etc.) to provide adequate bandwidth to their customers
 - **Enables business and backhaul services**
 - **Subscriber gain of ~10%-25% more customers per channel due to greater statistical multiplexing**

High-DS Bandwidth via Channel Bonding

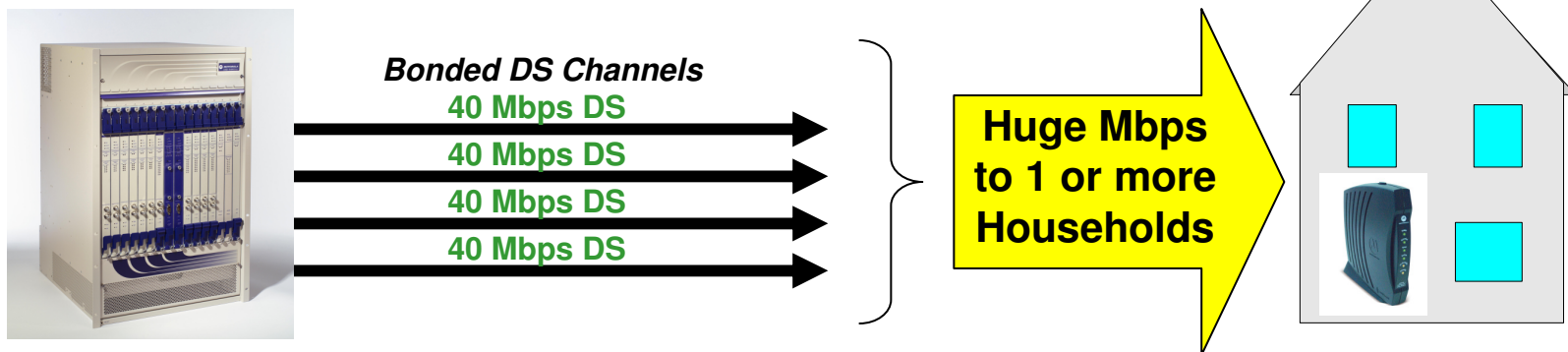


Channel Bonding

Will allow bonding between 4 and up to 16 Adjacent or Non-Adjacent (TBD) RF DS Channels Together

Huge Bandwidth Increases: Assume bonding up to 40 Mbps per DS

Statistical Multiplexing gain over a Single Channel equals more users and bandwidth



Channel Bonding (cont.)



- **Benefits (cont.)**
 - **Higher Data Rates**
 - **Downstream Capacity with 6MHz & 256QAM**
 - Four channels, 160 Mbps
 - Three channels, 120 Mbps
 - Two channels, 80 Mbps
 - **Upstream Capacity with 6.4MHz & 64QAM**
 - Four channels, 120 Mbps
 - Three channels, 90 Mbps
 - Two channels, 60 Mbps
 - **Increased Robustness**
 - **CMs can survive loss of all but one channel**
 - **Flexibility to avoid upstream ingressors**
 - Multiple smaller channels can be bonded
- **Requirements and restrictions for deployment**
 - **Must have available spectrum**



IP Multicast Features



Source Specific Multicast-SSM



- **Feature Description**
 - Delivery of multimedia (audio/video) services from one source to multiple subscribers' CPEs (IPv4 & IPv6) based on customer request
- **Benefits**
 - Enables operators to offer broadcast-like services over DOCSIS based on subscriber demand (e.g. IPTV service)
 - Enables bandwidth efficient on-demand multimedia services as compared with unicast
 - Facilitates offering of interactive video/audio and data services
- **Requirements and restrictions for deployment**
 - Requires DOCSIS 3.0 CMTS & 1.1 or greater CM

QoS Support for Multicast



- **Feature Description**
 - Provides guaranteed bandwidth for multicast sessions
 - Provides ability to control the amount of bandwidth that can be used by multicast traffic that is not part of an MSO service offering
- **Benefits**
 - Enables differentiation of QoS-enabled multicast services
 - Enables service level guarantees to be offered to the end customer
 - Enables offering of QoS-enabled packages to third parties
- **Requirements and restrictions for deployment**
 - Requires 3.0 CMTS & 1.1 or greater CM
 - Cable operator needs to configure QoS parameters for various multicast sessions



IPv6 Features



IPv6 Provisioning & Management of CMs



- **Feature Description**
 - 3.0 CMs can be provisioned with an IPv6 address
- **Benefits**
 - Solves the MSO's address crunch problem without creating isolated networks
- **Requirements and restrictions for deployment**
 - MSO Operations Support Systems need to be upgraded to support IPv6
 - CMTS must be upgraded to support IPv6 based CM provisioning

Alternative Provisioning Mode & Dual-stack Management Modes for CMs



- **Feature Description**
 - When enabled by MSOs, allows for:
 - CMs to failover to IPv4 provisioning when IPv6 provisioning fails & vice-versa
 - MSOs to manage CMs via IPv4 & IPv6 addresses concurrently
- **Why was it incorporated?**
 - Enables phased migration strategy
 - Provides an optional fall-back mode when migrating to IPv6 from IPv4
- **Benefits**
 - Allows MSOs to begin using IPv6 for provisioning and management without doing a hard cut-over
 - Will allow MSOs to communicate with CMs when there are IPv4 or IPv6 specific network outages
- **Requirements and restrictions for deployment**
 - CM consumes both an IPv4 and an IPv6 address. (Does not benefit MSOs who are running out of IPv4 address space.)

IPv6 Connectivity for CPEs



- **Feature Description**
 - CMTS enables IPv6 address configuration and connectivity to the customer devices
- **Why was it incorporated?**
 - Other CableLabs specified devices need to be capable of being provisioned and managed via IPv6 due to IPv4 address space constraints
 - In the future, customer devices will look for IPv6 addressing by default
- **Benefits**
 - Allows MSOs to rollout new IP based services that would not be possible because of the lack of IPv4 address space
- **Requirements and restrictions for deployment**
 - MSO CMTS and management systems need to be upgraded to support IPv6
 - CableLabs specs need to be updated with IPv6 capabilities and devices need to be procured against these specs.



Security Features



Enhanced Traffic Encryption



- **Feature Description**
 - Provides stronger traffic encryption, 128 bit Advanced Encryption Standard (AES) for user's data
- **Why was this incorporated?**
 - National Institute of Standards and Technology (NIST) has declared single DES as not acceptable for government applications.
 - Industry was concerned about public perception.
- **Benefits**
 - Maintains privacy of customer traffic.
 - Avoids negative public perception possible with continued use of existing encryption algorithm.
- **Requirements and restrictions for deployment**
 - Enhanced traffic encryption is only possible between a CMTS and CM that are DOCSIS 3.0 compliant.

Enhanced Provisioning Security



- **Feature Description**
 - **Increases security of the CM provisioning process**
 - Applies authentication before CM accesses MSO's operation support systems
 - Configuration file transfers encrypted
- **Why was this incorporated?**
 - **MSO's have experienced:**
 - Denial-of-service attacks on MSO's operation support systems
 - Hacked modems were requesting unauthorized services
- **Benefits**
 - **Reduces operational complexity while enhancing network security**
- **Requirements and restrictions for deployment**
 - **No special requirements or restrictions for deployment**

Certificate Revocation



- **Feature Description**
 - A more efficient method for the CMTS to check up-to-date certificate revocation status each time a CM attempts to authenticate
- **Why was this incorporated?**
 - Current certificate revocation method is cumbersome
- **Benefits**
 - Reduces operational complexity in managing un-trusted certificates across CMTSs
 - Facilitates sharing certificate revocation data across multiple MSOs
- **Requirements and restrictions for deployment**
 - Requires the operator have a security policy in place that governs the distribution and storage of certificate data



Physical Layer Feature



Upstream Frequency Range Extension



- **Feature Description**
 - Optional feature to extend upstream operation from 5-42 MHz to 5-85 MHz
- **Why was this incorporated?**
 - Provides a mechanism to obtain more upstream bandwidth
- **Benefits**
 - Adds 200 Mbps of potential capacity
 - Switchable feature allows MSO to enable it when plant is ready
 - New downstream/upstream symmetry ratio enables business services.
- **Requirements and restrictions for deployment**
 - Have to move lower analog channels or go all digital
 - Legacy conditional access has to be moved
 - Have to upgrade fiber nodes and amplifiers
 - Have to use filters to protect customers' legacy CPE devices



Network Management Features



CM Diagnostic Log



- **Feature Description**
 - CMTS reports CMs with connectivity problems
- **Why was this incorporated?**
 - Vendors implemented proprietary mechanisms
 - MSOs wanted a standardized approach
- **Benefits**
 - Enables adoption of common mechanisms for troubleshooting CM connectivity
 - Enables proactive maintenance
- **Requirements and restrictions for deployment**
 - Operation systems require updates to make use of this information

Service Statistics Reporting



- **Feature Description**
 - Streaming mechanism to report service statistics from CMTS. e.g. subscriber usage, CM status and traffic statistics
- **Why was this incorporated?**
 - Current mechanisms for collection of CMTS service statistics do not scale well
 - Current approaches do not provide sufficient information for traffic modeling
- **Benefits**
 - Access to more statistics while consuming less network capacity
 - Continuous and concise transmission of statistics reduces CMTS resources allocated to network management operations (do more statistics collection with less memory and processing power)
- **Requirements and restrictions for deployment**
 - MSOs need to interface operation support systems with streaming data systems



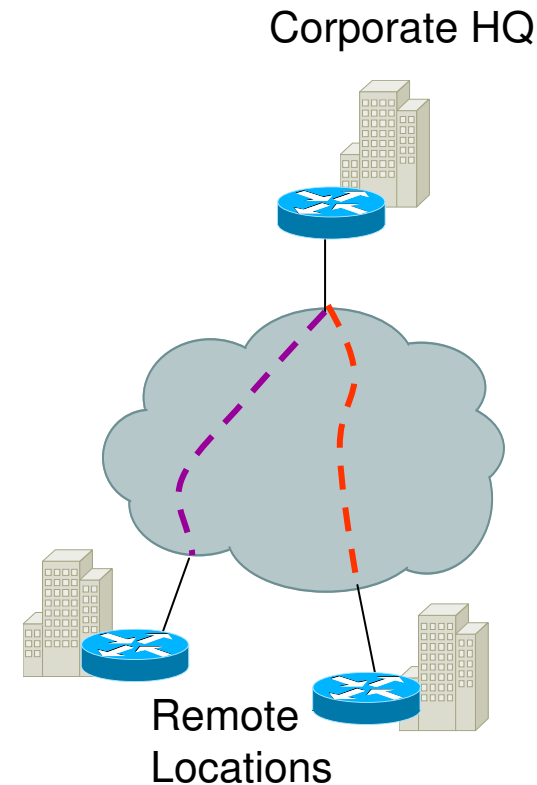
Business Services over DOCSIS (BSoD)



BSoD Layer 2 Virtual Private Networks (L2VPN)



- **Feature Description**
 - Creates transparent, private and dedicated connections between cable modems at multiple business sites
- **Why was this incorporated?**
 - Cable operators asked for a non-proprietary L2VPN gateway solution
- **Benefits**
 - More flexible alternative to Frame Relay service for business customers
 - Does not require special VPN equipment or client software at the customer's site
- **Requirements and restrictions for deployment**
 - Requires enabling DOCSIS BPI+ security feature
 - Requires L2VPN-capable CM & CMTS



Support for T1/E1 Services



- **Feature Description**
 - Business Services over DOCSIS-TDM Emulation service (BSoD-TE) is a method for cable operators to deliver T1, E1 and NxDS0 emulation services
- **Why was this incorporated?**
 - MSO members in the Business Service Roundtable expressed an interest in offering T1/E1 services over DOCSIS in a standard way
- **Benefits**
 - MSOs can now offer a competitive service to that offered by telcos
- **Requirements and restrictions for deployment**
 - **CMTS**
 - A supporting CMTS will require a GPS, BITS, or DTI master clock
 - DOCSIS 1.1 & 2.0 CMTS - May need hardware addition to CMTSs without clock interfaces (DOCSIS 3.0 CMTS will have the needed timing interface)
 - **CMs**
 - Requires specialized CMs with T1/E1 interfaces (per spec).
 - **Operations**
 - May need to be tightened to guarantee service availability