Data-Over-Cable Service Interface Specifications

Operations Support System Interface Specification
Radio Frequency Interface

SP-OSSI-RFI-I03-990113

INTERIM SPECIFICATION

Notice

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Key to Document Status Codes

Work in Process	An incomplete document, designed to guide discussion and generate feedback, that may include several alternative requirements for consideration.
Draft	A document in specification format considered largely complete, but lacking review by DOCSIS and vendors. Drafts are susceptible to substantial change during the review process.
Interim	A document which has undergone rigorous DOCSIS and vendor review, suitable for use by vendors to design in conformance with, and suitable for field testing.
Released	A stable document, reviewed, tested and validated, suitable to enable cross-vendor interoperability.

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1. Introduction

This document outlines the Radio Frequency (RF) Interface Management Information Bases (MIBs) for high-speed data-over-cable systems developed by the DOCSIS Data Over Cable Services working group.

Two Simple Network Management Protocol (SNMP) MIBs are defined. The first is the DOCSIS Radio Frequency (RFI) Interface MIB and defines objects that enable management of the CATV RF and CATV MAC layer interfaces. The second is the DOCSIS Cable Device (CD) MIB and defines objects that enable management of cable modem and cable modem termination Systems (CMTSs).

This specification is intended to enable prospective vendors of cable modems and other data-over-cable systems to address the operations support requirements in a uniform and consistent manner.

1.2 Requirements

Throughout this document, the words that are used to define the significance of particular requirements are capitalized. These words are:

"MUST"	This word or the adjective "REQUIRED" means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word or the adjective "RECOMMENDED" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word or the adjective "OPTIONAL" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

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2. CM and CMTS Management Requirements

This section describes the CM and CMTS management requirements. The MIBs compliant with these requirements are described in Section 4 and formally defined in Section 5.

2.1 Accounting Management

Although many different types of billing scenarios exist for operators, the only scenarios which require use of CM and CMTS managed objects are those based on metered usage or reserved bandwidth. Common practice by several Internet Service Providers (ISPs) allows usage-based billing based on peak rates. A DOCSIS provider can implement usage-based billing two ways: By polling the CMs or by polling the CMTS.

In the first method, a service provider can poll the ifInOctets and ifOutOctets counters from the MIB-II [RFC-1213] Interfaces group on each CM. This has the advantage of enabling both upstream and downstream traffic metering with the potential disadvantage of affecting network performance.

The second metered billing method involves monitoring the docsIfCmtsServiceTotalDataSlots counter from the docsIfCmtsServiceTable on each CMTS. This has the advantage of avoiding congestion on the RF network; however, it enables upstream traffic metering only. In a typical ISP environment, a BSS polls the appropriate counters on each customer device once every 15 minutes throughout a monthly billing cycle. This data is converted into an average utilization rate for the sample period. Doing so permits the ISP to bill based on peak bandwidth by choosing the sample ranked at the 90-95th percentile. Note that the billing system may also include time-of-day rate variations. The billing of reserved upstream MAC bandwidth is aided by information available from the docsIfQosProfileTable for each CM. These MIB variables report the upstream QOS characteristics, not just the nominal bandwidth, associated with each service ID and enable the service provider to bill for Grade of Service by verifying QOS.

2.2 Configuration Management

2.2.1 Version Control

The CM and CMTS SHOULD support software revision and operational parameter configuration interrogation. In particular, the fields of the sysObjectID Object Identifier (OID) of the CM should successively encode the vendor ID, the hardware platform, the hardware revision, the software/PROM major revision number, the software/PROM minor revision number, and (optionally) the software patch level. Each parameter MUST occupy exactly one field. The fields of the sysObjectID OID of the CMTS SHOULD use the same encoding.

Additionally, the CM MUST (and the CMTS SHOULD) include the same revision information in the vendor defined text of the sysDescr object in the MIB-II System Group [(RFC-1213)].

2.2.2 Software upgrades

The CM software upgrade process is documented in [MCNS7].

The mechanism to upgrade software from an SNMP manager MUST be supported by CMs, and SHOULD be supported by CMTSs. From a network management station, the operator:

- sets `docsDevSwServer` to the address of the TFTP server for software upgrades
- sets `docsDevSwFilename` to the file pathname of the software upgrade image
- sets `docsDevSwAdminStatus` to `upgrade-from-mgt`

One reason for the SNMP-initiated upgrade is to allow loading of a temporary software image (e.g., special diagnostic software) that differs from the software normally used on that modem without changing the provisioning database.

Note that software upgrades should not be accepted blindly by the cable modem. The cable modem may refuse an upgrade if:

- The download is incomplete.
- The file contents are incomplete or damaged.
- The software is not intended for that hardware device (may include the case of a feature set that has not been purchased for this device).

2.2.3 System Initialization and Configuration

Most system configuration of CMs is performed through a combination of CATV MAC, DHCP, and TFTP exchanges. These exchanges are defined in detail in the Radio Frequency Interfaces Specification [MCNS7]. In particular, to enable event logging through SYSLOG, the DHCP server sets the log server option [RFC-2132] to the address of the SYSLOG server.

2.3 Fault Management

2.3.1 SNMP Usage

In the DOCSIS environment, the goals of fault management are the remote detection, diagnosis, and correction of network problems. Therefore, the CM MUST support SNMP management traffic across both the Ethernet and CATV MAC interfaces. Access may be restricted to support policy goals (see the `docsDevNmAccessTable`).

CM installation personnel can use SNMP queries from a station on the Ethernet to perform on-site CM and CATV MAC diagnostics and fault classification (note that this may require temporary provisioning of the CM from an Ethernet DHCP server). Further, future customer applications using SNMP queries can diagnose simple post-installation problems, avoiding visits from service personnel and minimizing help desk telephone queries.

Standard MIB-II support MUST be implemented to instrument interface status, packet corruption, protocol errors, etc. The transmission MIB for Ethernet-like objects [RFC-1643] MUST be implemented on each CM and CMTS Ethernet and Fast Ethernet port. The ifXTable [RFC-1573] SHOULD be implemented to provide discrimination between broadcast and multicast traffic.

The CM and CMTS MUST support managed objects for fault management of the PHY and MAC layers. The MIB includes variables to track PHY state such as codeword collisions and corruption, signal-to-noise ratios, transmit and receive power levels, propagation delays, micro-reflections, in channel response, and Sync loss. The MIB also includes variables to track MAC state such as collisions and excessive retries for requests, immediate data transmits, and initial ranging requests.

For fault management at all layers, the CM/CMTS MUST generate replies to SNMP queries (subject to policy filters) for counters and status, MUST send SNMP traps to one or more trap NMSs (subject to policy), and MUST send event logging to a SYSLOG server (if a log server is defined). The ifTestTable [RFC-1573] SHOULD be implemented for any diagnostic test procedures that can be remotely initiated.

2.3.2 Event Logging

Event logging and history provide vendors an opportunity for product differentiation. The ability to report useful logs may depend on semi-graceful failure modes and on the ability to record such in nonvolatile storage.

Events SHOULD be reported via log entries in a MIB, the SYSLOG facility (as documented in Appendix B), and SNMP traps. Reporting of events SHOULD be fully configurable by priority class. At minimum, it MUST be possible to disable SNMP Trap and SYSLOG transmission.

A local event log that is available via SNMP queries SHOULD be implemented to track events that cannot be reported at the time that they occur. This log SHOULD support a minimum of ten event log entries, and SHOULD persist across device re-boots.

The definition and coding of events is vendor-specific. However, the standard set of error codes and messages listed in Appendix I [MCNS 7] SHOULD be used to textually describe events where applicable.

In deference to the network operator who must troubleshoot multi-vendor networks, the circumstances and meaning of each event are reported as human-readable text. Vendors SHOULD provide time-of-day clocks in CMs to provide useful timestamping of events. Similarly, event logs SHOULD be persistent across device re-boots. The depth of the event log is vendor dependent, with oldest entries discarded as needed.

For each vendor-specific event that is reportable via TRAP, the vendor must create an enterprise-specific trap definition. Trap definitions MUST include `docsDevEvText` and SHOULD be defined according to section 3.2.2. of draft-ietf-ipcdn-cable-device-mib.txt:

The event framework described in this section MUST be implemented in CMs and SHOULD be implemented in CMTSs.

2.3.3 Trap and Syslog Throttling

The CM and CMTS MUST provide support for trap and syslog message throttling as described below. The network operator can employ message rate throttling or trap limiting by manipulating the appropriate MIB variables.

2.3.3.1 Rate Throttling

Network operators may employ either of two rate control methods. In the first method, the device ceases to send traps and SYSLOG messages when the rate exceeds the specified maximum message rate. It resumes sending traps only if reactivated by a network management station request.

In the second method, the device resumes sending traps when the rate falls below the specified maximum message rate. The network operator configures the specified maximum message rate by setting the measurement interval (in seconds), and the maximum number of trap and SYSLOG messages (excluding duplicates) to be transmitted within the measurement interval. The operator can query the operational throttling state (to determine whether traps are enabled or blocked by throttling) of the device, as well as query and set the administrative throttling state (to manage the rate control method) of the device.

2.3.3.2 Trap Limiting

Network operators may wish to limit the number of traps sent by a device over a specified time period. The device ceases to send traps and SYSLOG messages when the number of traps exceeds the specified threshold. It resumes sending traps only when the measurement interval has passed.

The network operator defines the maximum number of traps he is willing to handle and sets the measurement interval to a large number (in hundredths of a second). For this case, the administrative throttling state is set to stop at threshold which is the maximum number of traps.

See "Techniques for Managing Asynchronously Generated Alerts" [RFC-1224] for further information.

2.3.4 Non-SNMP Fault Management protocols

The OSS can use a variety of tools and techniques to examine faults at multiple layers. For the IP layer, useful non-SNMP based tools include ping (ICMP Echo and Echo Reply), traceroute (UDP and various ICMP Destination Unreachable flavors). Pings to a CM from its Ethernet side MUST be supported to enable local connectivity testing from a customer’s PC to the modem. The CM and CMTS MUST support IP end-station generation of ICMP error messages and processing of all ICMP messages.

2.4 Performance Management

At the CATV MAC layer, performance management focuses on the monitoring of the effectiveness of cable plant segmentation and rates of upstream traffic and collisions. Instrumentation is provided in the form of the standard interfaces statistics, as well as the mcnsifCmtsServiceTable and mcnsifCmServiceTable.

It is not anticipated that the CMTS upstream bandwidth allocation function will require active network management intervention and tuning. Nevertheless, management objects are provided in case tuning or direct control is necessary. The three key upstream contention intervals are the request interval, the immediate data interval, and the initial ranging maintenance interval. If the upstream collision rate of requests and immediate data is high relative to the upstream traffic bandwidth, then the network management system (NMS) might increase the size of the request and immediate data intervals, respectively. The NMS might increase the size of the initial ranging maintenance interval when the upstream collision rate of initial ranging messages is relatively high, such as at the conclusion of a wide-spread regional power outage. The NMS might also decrease the size of these contention intervals under low collision rate conditions, since these intervals occupy bandwidth that may be otherwise used for upstream transmission bandwidth. As a last resort, the NMS might change the guaranteed upstream bandwidth for one or more service IDs, to relieve upstream traffic congestion for key subscribers. The CM MUST implement MIB counters that report the number of contention interval collisions (measured as the number of contention interval retries) per service ID, and the CMTS MUST implement read-write MIB objects that control the size of the contention intervals for each upstream channel. The CMTS SHOULD implement a read-write MIB object that controls the guaranteed upstream bandwidth for each service ID.

At the LLC layer, the performance management focus is on bridge traffic management. The CM and CMTS (if the CMTS implements transparent bridging) MUST implement the Bridge MIB [RFC-1493], including the `dot1dBase` and `dot1dTp` groups. The CM and CMTS MUST implement a managed object that controls whether the 802.1d spanning tree protocol (STP) is run and topology update messages are generated; STP is unnecessary in hierarchical, loop-free topologies. If the STP is enabled for the CM/CMTS, then the CM/CMTS MUST implement the `dot1dStp` group. These MIB groups' objects allow the NMS to detect when bridge forwarding tables are full, and enable the NMS to modify aging timers.

A final performance concern is the ability to diagnose unidirectional loss. Both the CM and CMTS MUST implement the MIB-II [RFC-1213] Interfaces group. When there exists more than one upstream or downstream channel, the CM/CMTS MUST implement an instance of IfEntry for each channel. The ifStack MIB [RFC-1573] MUST be used to define the relationships among the CATV MAC interfaces and their channels.

2.5 Protocol Filters

The CM MUST implement LLC and IP protocol filters. The LLC protocol filter entries can be used to limit CM forwarding to a restricted set of network-layer protocols (such as IP, IPX, NetBIOS, and Appletalk). The IP protocol filter entries can be used to restrict upstream or downstream traffic based on source and destination IP addresses, transport-layer protocols (such as TCP, UDP, and ICMP), and source and destination TCP/UDP port numbers. The CM MUST support a minimum of ten LLC protocol filter entries, and ten IP protocol filter entries.

2.6 Common Spectrum Management

The CMTS SHOULD implement the HFC RF Spectrum Management MIB [CSMI-MIB]. The definition of this MIB is likely to evolve, and vendors should anticipate changes in this area.

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3. Areas for Future Consideration

This section outlines some areas for future consideration within this specification.

- As ATM standards develop, this specification will include appropriate standards references.
- Enterprise-specific traps will be defined in the future as dictated by field experience.
- Multicast service provisioning within the cable modem will be clearly defined.
- To support the billing of reserved downstream MAC bandwidth, the CMTS should implement the evolving RSVP/Integrated Services MIB(s). Because of the variety of output queuing mechanisms, comments are solicited for the management mechanisms to support this.
- Comments are solicited as to required and recommended diagnostic test procedures.

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4. Management Information Base (MIB)

This section defines the minimum set of managed objects required to support the CM and CMTS management requirements identified in the previous section. Vendors may augment this MIB with objects from other standard or vendor-specific MIBs where appropriate.

4.1 MIB Organization

There are three parts of the MIB needed for CMs and CMTSs. The first is a set of objects drawn from standard SNMP MIBs that bear on this class of devices. It is not the intention of this specification to duplicate existing specifications. These are available as RFCs from the IETF and are widely available.

The second part is a set of objects for the CATV interfaces of the CM and CMTS. This MIB provides the objects needed to configure, operate, and monitor the physical CATV interfaces. This specification is derived from the MCNS Radio Frequency Specification [MCNS7]. These objects are defined in section 5.0 as the docsIf and docsDev MIB modules.

The third part is a set of objects for management of CM and CMTS devices. These provide system-level functionality that is specific to the business and operational environments of cable data systems. These objects are defined in section 5.0 as the docsDev MIB module.

The latter two parts are presented here as separate MIBs.

The docsIf and docsDev MIB modules are formally defined in section 5.0.

4.2 Managed Objects from Existing Standards

4.2.1 The MIB-II 'system' Group

The System Group from MIB-II [RFC-1213] MUST be implemented. See Section 2.2.1 for sysObjectID requirements.

4.2.2 The MIB-II 'interface' Group

The MIB-II interface group provides essential information about both MAC interfaces and individual channels. The interface extensions (ifXTable) [RFC-1573] SHOULD be supported.

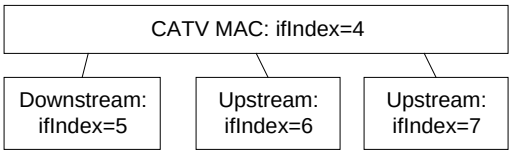
4.2.2.1 Interface Organization and Numbering

An instance of ifEntry MUST exist for each CATV-MAC interface, downstream channel, upstream channel, and LAN interface.

If a MAC interface consists of more than one upstream and downstream channel, then a separate instance of ifEntry MUST also exist for each channel.

The ifStack group ([RFC-1573]) must be implemented to identify relationships amoung sub-interfaces. Note that the CATV-MAC interface must exist, even though it is broken out into sub-interfaces.

The example below illustrates a MAC interface with one downstream and two upstream channels:



Implementation of ifStackTable for this example.

ifStackHigherLayer	ifStackLowerLayer
4	5
4	6
4	7

Figure 4-1. Interface Numbering Example

At the CMTS, interface numbering is at the discretion of the vendor, and should correspond to the physical arrangement of connections. If table entries exist separately for upstream and downstream channels, then the ifStack group ([RFC-1573]) must be implemented to identify relationships among sub-interfaces. Note that the CATV MAC interface(s) must exist, even if further broken out into sub-interfaces.

At the CM, interfaces SHOULD be numbered as:

- Ethernet: 1
- CATV MAC: 2
- all others (individual channels if present, telephony return if present): n+2

Note that network management platforms MUST NOT rely on this numbering scheme, and should use `ifType` and the `ifStack` table to identify interfaces.

4.2.2.2 Specific Interface Attributes

The `ifAdminStatus` object provides administrative control over both MAC interfaces and individual channels.

For CATV MAC interfaces, `ifSpeed` is defined as the bit rate of the highest-speed channel which is attached to this interface.

The `ifSpecific` object must be set to { `docsIfMib` } for CATV MAC interfaces. For upstream channels, it is set to { `docsIfUpstreamChannelTable` }. For downstream channels, it is set to { `docsIfDownstreamChannelTable` }. Note that this object is deprecated in reference [RFC-1573].

The `ifType` object has been assigned the following enumerated values for each instance of a Data Over Cable Service (DOCS) interface:

- CATV MAC interface: docsCableMacLayer (127)
- CATV downstream channel: docsCableDownstream (128)
- CATV upstream channel: docsCableUpstream (129)

4.2.3 The MIB-II 'ip' Group

The IP group is implemented. It does not apply to IP packets forwarded by the device as a link-layer bridge. For the CM, it applies only to the device as an IP host. At the CMTS, it applies to the device as an IP host, and as a router if IP routing is implemented.

4.2.4 Other MIB-II Groups

All devices MUST implement all MIB-II groups which apply to the functionality of the device. At a minimum, this includes the ICMP, UDP, and SNMP groups, all of which apply only to the device's role as an IP host.

4.2.5 The Bridge MIB

In both the CM and the CMTS (if the CMTS implements transparent bridging), the Bridge MIB [RFC-1493] MUST be implemented to represent the bridging process.

In the CMTS that implements transparent bridging, the Bridge MIB SHOULD be used to represent information about the MAC Forwarder state.

4.2.6 The Ethernet-Like MIB

The Ethernet-like MIB ([RFC-1643]) must be implemented if Ethernet or Fast Ethernet interfaces are present.

4.2.7 The FDDI MIB

The FDDI MIB ([RFC-1512]) must be implemented if Fiber Distributed Data Interfaces are present.

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5. Concise MIB Definition

This section provides the MCNS release information for the Data Over Cable Service (DOCS) Radio Frequency (RF) and Cable Device (CD) Management Information Base (MIBs).

The RF (docsIfMib) and CD (docsDev) MIB modules are specified in most recent releases of draft-ietf-ipcdn-rf-interface-mib.txt and draft-ietf-ipcdn-cable-device-mib.txt under the development of the IPCDN work group within the Internet Engineering Task Force. The documents are written in Internet Draft format and contain concise MIB definitions in accordance with SMI version 2.

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Appendix A. Protocol Definition for SYSLOG

This appendix documents the usage of the SYSLOG protocol for the Operations Support System environment. The SYSLOG protocol is a UDP-based protocol that permits remote logging of devices. Messages may be associated with different facilities and multiple priorities.

The basic format of the SYSLOG packet is simple to describe. The UDP source and destination port number is 514. The UDP payload consists of a facility/priority value enclosed in angle brackets, followed by a null-terminated string. The UDP payload string normally includes an optional time-of-day stamp, an identification string, an optional PID (in square brackets), and the actual logging message.

For consistency in a multi-vendor CM environment, this appendix adds further constraints to the SYSLOG packet. The CM uses the "local0" facility in its SYSLOG messages, so that the SYSLOG server can manage CM SYSLOG messages separately from kernel, mail, news, and other generic facilities. This limits the facility/priority values to the range of 128 to 135. The actual facility/priority value depends on the urgency of the message: emergency(128), alert(129), critical(130), error(131), warning(132), notice(133), information(134), and debug(135).

This appendix also constrains the UDP payload string. The time-of-day stamp SHOULD NOT be included, forcing the SYSLOG server to provide its own (consistent) timestamps for all CM SYSLOG messages. The identification string MUST be "Cablemodem", and the "optional PID" MUST be a constant vendor-specific identification label, to assist in SYSLOG server logging management.

An example of a valid SYSLOG UDP payload would be "<132>Cablemodem[VendorX]: Downloading new CM software". This example payload might be recorded on the SYSLOG server as "Jan 12 12:56:03 24.1.1.1 Cablemodem[VendorX]: Downloading new CM software".

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Appendix B. References

[CSMI-MIB] Masuma Ahmed and Mario P. Vecchi . Definitions of Managed Objects for HFC RF Spectrum Management (internet draft draft-ahmed-csmimib-mib-00.txt). June 13,1996

[MCNS1] MCNS Data Over Cable Service Interface Specification Request for Proposals, December 11, 1995 (can be downloaded on the World Wide Web from http://www.cablemodem.com)

[MCNS3] MCNS Cable Modem Termination System - Network-Side Interface Specification SP-CMTS-NSI-I01-960702

[MCNS4] MCNS Cable Modem to Customer Premise Equipment Interface Specification SP-CMCI-I02-980317

[MCNS 5] MCNS Operations Support System Framework TR-OSSF-W08-961016

[MCNS 6] MCNS Data Over Cable Services Cable Modem Telephony Return Interface Specification SP-CMTRI-I01-970804

[MCNS 7] MCNS Data Over Cable Services Cable Modem Radio Frequency Interface Specification SP-RFI-I05-980724

[MCNS 8] MCNS Data Over Cable Services Security Specification SP-SS-I01-970506

[RFC-1157] Schoffstall, M., Fedor, M., Davin, J. and Case, J., A Simple Network Management Protocol (SNMP), IETF RFC-1157, May, 1990

[RFC-1212] K. McCloghrie and M. Rose. Concise MIB Definitions, IETF RFC-1212, March, 1991

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[RFC-2132] S. Alexander, R. Droms. DHCP Options and BOOTP Vendor Extensions. IETF RFC-2132. March, 1997.

[RFC-1573] K. McCloghrie and Kastenholz., Evolution of the Interfaces Group of MIB-II, IETF RFC-1573, January, 1994

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Appendix C. Glossary

Address Resolution Protocol (ARP) – the protocol used for discovery of IP addresses in shared media (particularly IEEE 802-like) networks.

American National Standards Institute (ANSI) – A U.S. standards body.

ANSI – See American National Standards Institute.

ARP – See Address Resolution Protocol.

Asynchronous Transfer Mode (ATM) – A protocol for the transmission of a variety of digital signals using uniform 53-byte cells.

ATM – See Asynchronous Transfer Mode.

Availability – In cable television systems, availability is the long-term ratio of the actual RF channel operation time to scheduled RF channel operation time (expressed as a percent value) and is based on a bit error rate (BER) assumption.

BPDU – See Bridge Protocol Data Unit.

Bridge Protocol Data Unit – any of the messages exchanged between spanning tree bridges used for spanning tree configuration and maintenance.

Broadcast Addresses – A predefined destination address that denotes the set of all data network service access points.

BSS – See Business Support System.

Business Support System (BSS) – a collection of computing equipment maintaining accounting, billing, and access control for a cable modem network.

Cable Modem (CM) – A modulator-demodulator at subscriber locations intended for use in conveying data communications on a cable television system.

Cable Modem Termination System (CMTS) – Cable modem termination system, located at the cable television system headend or distribution hub, which provides complementary functionality to the cable modems to enable data connectivity to a wide-area network.

Cable Modem Termination System - Network Side Interface (CMTS-NSI) – The interface, defined in [MCNS3], between a CMTS and the equipment on its network side.

Cable Modem to CPE Interface (CMCI) – The interface, defined in [MCNS4], between a CM and CPE.

CM – See Cable Modem.

CMCI – See Cable Modem to CPE Interface.

CMTS – See Cable Modem Termination System.

CMTS-NSI – See Cable Modem Termination System - Network Side Interface.

CPE – See Customer Premise Equipment.

Cross-Modulation – A form of television signal distortion where modulation from one or more television channels is imposed on another channel or channels.

Customer – See End User.

Customer Premises Equipment (CPE) – Equipment at the end user's premises; MAY be provided by the end user or the service provider.

Data Link Layer – Layer 2 in the Open System Interconnection (OSI) architecture; the layer that provides services to transfer data over the transmission link between open systems.

DHCP – See Dynamic Host Configuration Protocol.

Distribution Hub – A location in a cable television network which performs the functions of a Headend for customers in its immediate area, and which receives some or all of its television program material from a Master Headend in the same metropolitan or regional area; see, for example, [MCNS1].

Downstream – In cable television, the direction of transmission from the headend to the subscriber.

Drop Cable – Coaxial cable that connects to a residence or service location from a directional coupler (tap) on the nearest coaxial feeder cable.

Dynamic Host Configuration Protocol (DHCP) – An Internet protocol used for assigning network-layer (IP) addresses.

Dynamic Range – The ratio between the greatest signal power that can be transmitted over a multichannel analog transmission system without exceeding distortion or other performance limits, and the least signal power that can be utilized without exceeding noise, error rate or other performance limits.

Electronic Industries Association (EIA) – A voluntary body of manufacturers which, among other activities, prepares and publishes standards.

End User – A human being, organization, or telecommunications system that accesses the network in order to communicate via the services provided by the network.

Feeder Cable – Coaxial cables that run along streets within the served area and connect between the individual taps which serve the customer drops.

Fiber Node – A point of interface between a fiber trunk and the coaxial distribution.

Forward Channel – The direction of RF signal flow away from the headend toward the end user; equivalent to Downstream.

Headend – The central location on the HFC network that is responsible for injecting broadcast video and other signals in the downstream direction. See also Master Headend, Distribution Hub.

Header – Protocol control information located at the beginning of a protocol data unit.

HFC – See Hybrid Fiber/Coax (HFC) System.

High Frequency (HF) – Used in this document to refer to the entire subsplit (5-30 MHz) and extended subsplit (5-42 MHz) band used in reverse channel communications over the cable television network.

High Return – A frequency division scheme that allows bi-directional traffic on a single coaxial cable. Reverse channel signals propagate to the headend above the downstream passband.

Hybrid Fiber/Coax (HFC) System – A broadband bi-directional shared-media transmission system using fiber trunks between the headend and the fiber nodes, and coaxial distribution from the fiber nodes to the customer locations.

ICMP – See Internet Control Message Protocol.

IEEE – See Institute of Electrical and Electronic Engineers.

IETF – See Internet Engineering Task Force.

Internet Control Message Protocol (ICMP) – An Internet network-layer protocol.

International Electrotechnical Commission (IEC) – An international standards body.

Institute of Electrical and Electronic Engineers (IEEE) – A voluntary organization which, among other things, sponsors standards committees and is accredited by the American National Standards Institute.

Internet Engineering Task Force (IETF) – A body responsible, among other things, for developing standards used in the Internet.

Internet Protocol (IP) – An Internet network-layer protocol.

International Organization for Standardization (ISO) – An international standards body, commonly known as the International Standards Organization.

IP – See Internet Protocol.

Latency – The time, expressed in quantity of symbols, taken for a signal element to pass through a device.

Layer – A subdivision of the Open System Interconnection (OSI) architecture, constituted by subsystems of the same rank

LLC – See Logical Link Control (LLC) procedure.

Local Area Network (LAN) – A non-public data network in which serial transmission is used for direct data communication among data stations located on the user's premises.

Logical Link Control (LLC) procedure – In a local area network (LAN) or a Metropolitan Area Network (MAN), that part of the protocol that governs the assembling of data link layer frames and their exchange between data stations, independent of how the transmission medium is shared.

MAC – See Media Access Control (MAC) procedure.

MAC Service Access Point (MSAP) – The conceptual binding of a MAC-layer service provider to the protocol entities (i.e., data link layers) above it.

Master Headend – A headend which collects television program material from various sources by satellite, microwave, fiber and other means, and distributes this material to Distribution Hubs in the same metropolitan or regional area. A Master Headend MAY also perform the functions of a Distribution Hub for customers in its own immediate area; see, for example, [MCNS1].

MCNS – See Multimedia Cable Network System (MCNS) partners.

Mean Time to Repair (MTTR) – In cable television systems, the MTTR is the average elapsed time from the moment a loss of RF channel operation is detected up to the moment the RF channel operation is fully restored.

Media Access Control (MAC) address – The “built-in” hardware address of a device connected to a shared medium.

Media Access Control (MAC) procedure – In a subnetwork, that part of the protocol that governs access to the transmission medium independent of the physical characteristics of the medium, but taking into account the topological aspects of the subnetworks, in order to enable the exchange of data between nodes. MAC procedures include framing, error protection, and acquiring the right to use the underlying transmission medium.

Media Access Control (MAC) sublayer – The part of the data link layer that supports topology-dependent functions and uses the services of the Physical Layer to provide services to the logical link control (LLC) sublayer.

Mini-Slot – The unit of allocation for time-division of the upstream channel. The size of a mini-slot is configurable, but normally it is a time interval corresponding to 16 byte-times (QPSK) or 32 byte-times (QAM16).

MSAP – See MAC Service Access Point.

Multimedia Cable Network System (MCNS) partners – A consortium of Comcast Cable Communications, Inc., Cox Communications, Tele-Communications, Inc., and Time Warner Cable, interested in deploying high-speed data communications systems on cable television systems.

Multipoint Access – User access in which more than one terminal equipment is supported by a single network termination.

Multipoint Connection – A connection among more than two data network terminations.

National Cable Television Association (NCTA) – A voluntary association of cable television operators which, among other things, provides guidance on measurements and objectives for cable television systems in the U.S.A.

Network Layer – Layer 3 in the Open System Interconnection (OSI) architecture; the layer that provides services to establish a path between open systems.

Network Management – The functions related to the management of data link layer and physical layer resources and their stations across the data network supported by the hybrid fiber/coax system.

National Television Systems Committee (NTSC) – Committee which defined the analog color television broadcast standard used today in North America.

Open Systems Interconnection (OSI) – A framework of ISO standards for communication between different systems made by different vendors, in which the communications process is organized into seven different categories that are placed in a layered sequence based on their relationship to the user. Each layer uses the layer immediately below it and provides a service to the layer above. Layers 7 through 4 deal with end-to-end communication between the message source and destination, and layers 3 through 1 deal with network functions.

Operations Support System (OSS) – The backoffice software used for configuration, performance, fault, accounting and security management.

Organization Unique Identifier (OUI) – A 3-octet IEEE assigned identifier that OUI can be used to generate Universal LAN MAC addresses and Protocol Identifiers per ANSI/IEEE Std 802 for use in Local and Metropolitan Area Network applications.

OSI – See Open Systems Interconnection.

OSS – See Operations Support System.

OUI – See Organization Unique Identifier.

PDU – See Protocol Data Unit.

PHY – See Physical (PHY) Layer.

Physical (PHY) Layer – Layer 1 in the Open System Interconnection (OSI) architecture; the layer that provides services to transmit bits or groups of bits over a transmission link between open systems and which entails electrical, mechanical and handshaking procedures.

Protocol – A set of rules and formats that determines the communication behavior of layer entities in the performance of the layer functions.

Protocol Data Unit (PDU) – A discrete piece of information like a frame or a packet in the appropriate format for encapsulation and segmentation in the payload of a cell.

QoS – See Quality of Service.

Quality of Service (QoS) –The accumulation of the cell loss, delay, and delay variation incurred by cells belonging to a particular connection.

Radio Frequency (RF) – In cable television systems, this refers to electromagnetic signals in the range 5 to 1000 MHz.

Return Loss – The parameter describing the attenuation of a guided wave signal (e.g., via a coaxial cable) returned to a source by a device or medium resulting from reflections of the signal generated by the source.

Reverse Channel – The direction of signal flow towards the headend, away from the subscriber; equivalent to Upstream.

Request For Comments (RFC) – A technical policy document of the IETF; these documents can be accessed on the World Wide Web at http://ds.internic.net/ds/rfcindex.html.

RFC – See Request for Comments.

Service Access Point (SAP) – The point at which services are provided by one layer, or sublayer to the layer immediately above it.

Service Data Unit (SDU) – Information that is delivered as a unit between peer service access points

Service Identifier (SID) – An identifier appearing in the MAC allocation map message which identifies the entities which may make use of a particular upstream bandwidth assignment. A cable modem may have one or more unicast service IDs. A group of cable modems may share a multicast service ID.

SID – See Service Identifier.

Simple Network Management Protocol (SNMP) – A network management protocol of the IETF.

SMS – See Spectrum Management System.

SNAP – See Subnetwork Access Protocol.

SNMP – See Simple Network Management Protocol.

Spectrum Management System (SMS) – A system, defined in [SMS], for managing the RF cable spectrum.

Subscriber – See End User.

Sublayer – A subdivision of a layer in the Open System Interconnection (OSI) reference model.

Subnetwork – Subnetworks are physically formed by connecting adjacent nodes with transmission links.

Subnetwork Access Protocol (SNAP) – An IEEE 802 framing convention that allows the link-layer encapsulation of ethernet (DIX) frames on 802 networks.

Subsystem – An element in a hierarchical division of an Open System that interacts directly with elements in the next higher division or the next lower division of that open system.

Systems Management – Functions in the application layer related to the management of various open systems Interconnection (OSI) resources and their status across all layers of the OSI architecture.

Telecommunications Management Network (TMN) – a management concept that defines the relationship between basic network functional building blocks (operations systems, data communications networks, and network elements) in terms of standard interfaces.

TFTP – See Trivial File-Transfer Protocol.

TMN – See Telecommunications Management Network.

Transmission Control Protocol (TCP) – A transport-layer Internet protocol which ensures successful end-to-end delivery of data packets without error.

Trivial File-Transfer Protocol (TFTP) – An Internet protocol for transferring files without the requirement for user names and passwords that is typically used for automatic downloads of data and software.

Transmission Link – The physical unit of a subnetwork that provides the transmission connection between adjacent nodes.

Transmission Medium – The material on which information signals may be carried; e.g., optical fiber, coaxial cable, and twisted-wire pairs.

Transmission System – The interface and transmission medium through which peer physical layer entities transfer bits.

Transmit On/Off Ratio – In multiple-access systems, the ratio between the signal powers sent to line when transmitting and when not transmitting.

Trunk Cable – Cables that carry the signal from the headend to groups of subscribers. The cables can be either coaxial or fiber depending on the design of the system.

Upstream – The direction from the subscriber location toward the headend.