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Embedded Cable Modem Devices

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1 INTRODUCTION

Existing DOCSIS specifications were created for stand-alone cable modems that provide high-speed broadband services using the hybrid-fiber-coaxial cable infrastructure. The emergence of a class of devices that embeds additional functionality with a Cable Modem, such as packet-telephony, home networking and video, has necessitated the creation of this specification to define additional requirements such as interfaces, management, and provisioning models. This is necessary to ensure that the Cable Modem will function properly and interact properly with the embedded Service/Application Functional Entities (eSAFEs).

1.1 Scope

This specification defines additional features that must be added to a DOCSIS Cable Modem for implementations that embed the Cable Modem with another application, such as an IPCablecom MTA.

1.2 Goals

The goals for this specification are:

- To preserve functional separation of the DOCSIS cable modem entity from eSAFEs within the eDOCSIS Device, so that existing DOCSIS cable plant integrity, cable modem configuration, management and provisioning security are not compromised.
- To isolate DOCSIS cable modem functionality so that specification compliance can be tested for the eCM component independent of eSAFEs.
- To enable the service provider to enable or disable forwarding traffic between each eSAFE and the eCM within the eDOCSIS Device.
- To maximize compatibility with existing back-office management/provisioning infrastructure so that new services enabled by eDOCSIS devices can be deployed rapidly.
- To architect eDOCSIS devices in such a way as to scale to new services and applications, and to take advantage of technology innovations to achieve low cost and high functionalities.

1.3 Requirements

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

“MUST”	This word 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 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 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.

2 REFERENCES

2.1 Normative References

In order to claim compliance with this standard, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this standard. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

[SCTE 23-2]	ANSI/SCTE 23-2 2007, DOCSIS 1.1 Part 2: Baseline Privacy Plus Interface.
[CANN-DHCP]	CableLabs DHCP Options Registry, CL-SP-CANN-DHCP-Reg-I02-080306, March 6, 2008, Cable Television Laboratories, Inc.
[CCIF 2.0]	CableCARD™ Interface 2.0 Specification, OC-SP-CCIF2.0-I16-081114, November 14, 2008, Cable Television Laboratories, Inc.
[CL BB]	Battery Backup MIB Specification, CL-SP-MIB-BB-I02-070119, January 19, 2007, Cable Television Laboratories, Inc.
[DOCSIS 2.0 + IPv6]	Data-Over-Cable Service Interface Specifications, DOCSIS 2.0 + IPv6 Cable Modem Technical Report, CM-TR-DOCSIS2.0-IPv6-V01-080307, March 7, 2008, Cable Television Laboratories, Inc.
[DOCSIS-CMCI]	DOCSIS Cable Modem to Customer Premise Equipment Interface Specification, CM-SP-CMCI-C01-081104, November 04, 2008, Cable Television Laboratories, Inc.
[DOCSIS OSSI]	Refers to [SCTE 23-3], [SCTE 79-2], and [SCTE 135-4].
[DOCSIS RFI/MULPI]	Refers to [SCTE 23-1], [SCTE 79-1], and [SCTE 135-2].
[SCTE 106]	ANSI/SCTE 106 2007, DOCSIS® Set-Top Gateway (DSG) Specification.
[SCTE 140]	ANSI/SCTE 140 2007, Cable Modem IPv4 and IPv6 eRouter Specification.
[HOST2.1]	OpenCable Host 2.1 Core Functional Requirements, OC-SP-HOST2.1-CFR-I07-090206, February 06, 2009, Cable Television Laboratories, Inc.
[SCTE 135-2]	ANSI/SCTE 135-2 2008, DOCSIS 3.0 Part 2: MAC and Upper Layer Protocols.
[SCTE 22-3]	ANSI/SCTE 22-3 2002R2007, DOCSIS 1.0 Operations Support System Interface (OSSI)
[SCTE 23-3]	ANSI/SCTE 23-3 2005, DOCSIS 1.1 Part 3: Operations Support System Interface.
[SCTE 79-2]	ANSI/SCTE 79-2 2009, DOCSIS 2.0 Operations Support System Interface.
[SCTE 135-4]	ANSI/SCTE 135-4 2008, DOCSIS 3.0 Part 4: Operations Support Systems Interface.
[RFC 768]	IETF STD6, RFC 768, User Datagram Protocol, J. Postel August, 1980.
[RFC 791]	IETF STD5, RFC 791, Internet Protocol, J. Postel, September 1981.
[RFC 1493]	IETF RFC 1493, Definitions of Managed Objects for Bridges, E. Decker, P. Langille, A. Rijsinghani & K. McCloghrie, July 1993.

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- [RFC 2011] IETF RFC 2011, SNMPv2 Management Information Base for the Internet Protocol using SMIPv2, K. McCloghrie, November 1996.
- [RFC 2131] IETF RFC 2131, Dynamic Host Configuration Protocol, Droms, R., March 1997.
- [RFC 2132] IETF RFC 2132, DHCP Options and BOOTP Vendor Extensions, Alexander, S., and R. Droms, March 1997.
- [RFC 2863] IETF RFC 2863, The Interfaces Group MIB, K. McCloghrie, F. Kastenholz, June 2000.
- [RFC 3396] IETF RFC 3396, Encoding Long Options in the Dynamic Host Configuration Protocol (DHCPv4), Lemon, T., and S. Cheshire, November, 2002.
- [RFC 3418] IETF STD62, IETF RFC 3418, Management Information Base (MIB) for the Simple Network Management Protocol (SNMP), R. Presuhn, Ed., December 2002.
- [RFC 4188] IETF RFC 4188, K. Norseth, Ed. and E. Bell, Ed., Definitions of Managed Objects for Bridges, September 2005.
- [RFC 4293] IETF RFC 4293, Management Information Base for the Internet Protocol (IP), S. Routhier, April 2006.
- [SCTE 22-1] ANSI/SCTE 22-1 2002R2007, Data-Over-Cable Service Interface Specification DOCSIS 1.0 Radio Frequency Interface (RFI).
- [SCTE 23-1] ANSI/SCTE 23-1 2005, DOCSIS 1.1 Part 1: Radio Frequency Interface.
- [SCTE 79-1] ANSI/SCTE 79-1 2007, DOCSIS 2.0 Part 1: Radio Frequency Interface.

2.2 Informative References

- [CH1.0] CableHome 1.0 Specification, CH-SP-CH1.0-C01-060728, July 28, 2006, Cable Television Laboratories, Inc.
- [CH1.1] CableHome 1.1 Specification, CH-SP-CH1.1-C01-060728, July 28, 2006, Cable Television Laboratories, Inc.
- [SCTE 136-2] ANSI/SCTE 136-2 2007, Cable Modem TDM Emulation Interface Standard.
- [SCTE 24-5] SCTE 24-5 2009, IPCablecom 1.0 Part 5: Media Terminal Adapter (MTA) Device Provisioning Requirements for the Delivery of Real-Time Services over Cable Television Using Cable Modems.
- [SCTE 24-6] SCTE 24-6 2009, IPCablecom 1.0 Part 6: IPCablecom Management Information Base (MIB) Framework.
- [RST-EDVA] PacketCable Residential SIP Telephony E-DVA Specification, PKT-SP-RST-E-DVA-I04-080710, Cable Television Laboratories, Inc.
- [SMA] PacketCable Security, Monitoring, and Automation Signaling Specification, PKT-SP-SMA-I01-081121, November 21, 2008, Cable Television Laboratories, Inc.
- [RFC 2578] IETF RFC 2578/IETF STD58, Structure of Management Information Version 2 (SMIPv2), K. McCloghrie, D. Perkins, J. Schoenwaelder, April 1999.

2.3 Reference Acquisition

- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027; Phone +1-303-661-9100; Fax +1-303-661-9199; Internet: <http://www.cablelabs.com/>
- SCTE Standards, Society of Cable Telecommunication Engineers, 140 Philips Road, Exton PA 19341-1318, Phone +1-610-524-1725, <http://www.scte.org/>
- IETF Standards, Internet Engineering Task Force (IETF) Secretariat c/o Corporation for National Research Initiatives, 1895 Preston White Drive, Suite 100, Reston, VA 20191-5434, Phone +1-703-620-8990, Fax +1-703-620-9071, Internet: <http://www.ietf.org/>

3 GLOSSARY

This specification uses the following terms.

CableCARD™ Device	A PCMCIA card distributed by cable providers and inserted into a Host device to enable premium services in compliance with the OpenCable specifications; also called "Card" and "Point of Deployment" (POD) module.
CMCI	Cable Modem (CM) to Customer Premise Equipment (CPE) Interface as defined in [DOCSIS-CMCI].
Downstream Service Identifier	A 20-bit value in a DOCSIS extended header that identifies a stream of packets distributed to the same cable modem or group of cable modems. The DSID value is unique within a MAC Domain. For sequenced packets, the DSID identifies the resequencing context for downstream packet bonding in the CM.
eCM	An eCM is an embedded Cable Modem, i.e., one that has been enhanced with the features of this specification.
eDOCSIS	eDOCSIS is the embedded DOCSIS specification that defines the interface between the eCM and an eSAFE.
eDOCSIS Device	An eDOCSIS Device is one that includes an eCM entity, one or more eSAFEs and supports a single software image download that is used for the entire device.
E-DVA	Embedded Digital Voice Adaptor, a type of UE.
eSG	Embedded Security, Monitoring, and Automation Gateway.
Embedded Security eSTB	An eSTB with integrated security functions.
eMTA	Embedded Multimedia Terminal Adaptor. An embedded version of an MTA.
E-MTA	Embedded MTA device. An eDOCSIS device that contains both an eMTA and an eCM.
ePS	Embedded Portal Service Element. A CableHome-compliant eSAFE that provides management and network address translation functions between the DOCSIS network and the home network.
eRouter	DOCSIS Embedded Router: An eSAFE that is compliant with [SCTE 140], providing version 4 and/or version 6 Internet Protocol-formatted data forwarding, address configuration, and Domain Name services to Internet Protocol host devices connected to the cable modem in a customer's premises.
eSAFE (embedded Service/Application Functional Entity)	An embedded version of standardized-specified application, such as an IPCablecom Multimedia Terminal Adapter (MTA), that provides a service using the DOCSIS IP platform, or a function or set of functions, such as the CableHome Portal Services logical element, that supports the delivery of one or more services over an IP platform.
E-SMA	Embedded Subscriber Module Adaptor, a type of UE.
eSTB	Embedded Set-Top Box: An eSAFE that is compliant with [SCTE 106], providing video, audio, and data services. An example OpenCable-compliant eSTB is further specified in [HOST2.1].
eTEA	Embedded TDM Emulator Adapter: An eSAFE that is compliant with [SCTE 136-2], providing T1 and E1 Circuit transport over IP.
LCI	Logical CPE Interface. A bi-directional or uni-directional data-only logical 802.3/Ethernet MAC frame interface between eCM and an eSAFE.

Monolithic Firmware Image	A single firmware image containing one or more code images for the entire eDOCSIS device. For eDOCSIS devices, the Monolithic Firmware Image contains both the eCM code image as well as the applicable eSAFE code image. As an example for an eDOCSIS device containing an eSTB, the Monolithic Firmware Image contains the eCM code image as well as the eSTB code image (which may also be composed from multiple eSTB code images).
Multicast DSID Forwarding	A mechanism by which multicast traffic is forwarded by a CM based on a multicast DSID signaled by the CMTS to the CM. A multicast DSID identifies a subset of CMs intended to receive the same Multicast session and for the CM the DSID is a filtering and forwarding criterion for multicast packets.
MTA	Multimedia Terminal Adapter as defined in [SCTE 24-5]. Contains the interface to a physical voice device, a network interface, CODECs, and all signaling and encapsulation functions required for VoIP transport, class features signaling and QoS signaling.
NVT	The Network Virtual Terminal as defined in the Telnet Protocol. NVT was a bi-directional character device, representing characters as 7-bit ASCII codes, using an 8-bit field.
OpenCable Host eSTB	An eSTB device built to CableLabs OpenCable Host specifications.
Secure Microprocessor	The security element in a device that supports downloadable conditional access.
Set-top Device	An eDOCSIS device that contains an eSTB.
TDM	Time Division Multiplexing: The means by which multiple digital signals can be carried on a single transmission path by interleaving portions of each signal in time.

4 ABBREVIATIONS

This specification uses the following abbreviations:

ASCII	American Standard Code for Information Interchange
BSoD	Business Services over DOCSIS
CATV	Community Access Television, Cable Television
CM	Cable Modem
CMCI	Cable Modem to Customer Premises Equipment Interface
CMTS	Cable Modem Termination System
CVC	Code Verification Certificate
DHCP	Dynamic Host Configuration Protocol
DIX	Digital Intel Xerox
DNS	Domain Name Server
DOCSIS	Data-Over-Cable Service Interface Specifications
DSG	DOCSIS Set-top Gateway
DSID	Downstream Service Identifier
eCM	Embedded Cable Modem
eDOCSIS	Embedded DOCSIS
eDVA	Embedded Digital Voice
eMTA	Embedded Multimedia Terminal Adapter
ePS	Embedded Portal Services Element
eSG	Embedded Security, Monitoring, and Automation Gateway
eSTB	Embedded Set-Top Box
eSAFE	Embedded Service/Application Functional Entity
eSMA	Embedded Subscriber Module Adaptor
eTEA	Embedded T1/E1 TDM Emulation Adapter (TEA)
FCS	Frame Check Sequence
FQDN	Fully Qualified Domain Name
IP	Internet Protocol
LCI	Logical CPE Interface
LLC	Logical Link Control
MAC	Media Access Control
MDF	Multicast DSID Forwarding
MIC	Message Integrity Check
OCAP	Open Cable Application Platform
RF	Radio Frequency
ROM	Read Only Memory
SLED	Software Loopback for eDOCSIS
SMA	Security, Monitoring, and Automation
SNMP	Simple Network Management Protocol

SW	Software
SSD	Secure Software Download
TDM	Time Division Multiplexing
TFTP	Trivial File Transfer Protocol
TLV	Type/Length/Value
UDP	User Datagram Protocol
UPS	Uninterrupted Power Supply
USB	Universal Serial Bus
WAN	Wide Area Network

5 EMBEDDED DOCSIS CABLE MODEM

5.1 Device Interface Reference Model (Informative)

Referring to Figure 5–1, an eDOCSIS device consists of an embedded DOCSIS cable modem (eCM) and one or more embedded Service/Application Functional Entities (eSAFEs). An eDOCSIS device may also have one or more physically exposed interfaces. In addition, only a single secured software image download is used for the entire eDOCSIS device.

eSAFEs include:

- ePS: embedded CableHome Portal Services Logical Element [CH1.0], [CH1.1].
- eDVA: embedded PacketCable 2.0 Digital Voice Adaptor [RST-EDVA].
- eMTA: embedded IPCablecom Multimedia Terminal Adapter [SCTE 24-5], [SCTE 24-6].
- eSG: embedded PacketCable Security, Monitoring, and Automation Gateway [SMA].
- eSTB: embedded Set-Top Box: An eSAFE that is compliant with [SCTE 106], providing video, audio, and data services. An example OpenCable-compliant eSTB is further specified in [HOST2.1].
- eTEA: embedded T1/E1 TDM Emulation Adapter (eTEA) [SCTE 136-2].
- eRouter: An eSAFE that is compliant with [SCTE 140], providing Internet Protocol data forwarding, address configuration, and Domain Name services.

Within an eDOCSIS device, each eSAFE interfaces to the eCM via a point-to-point logical CPE interface.

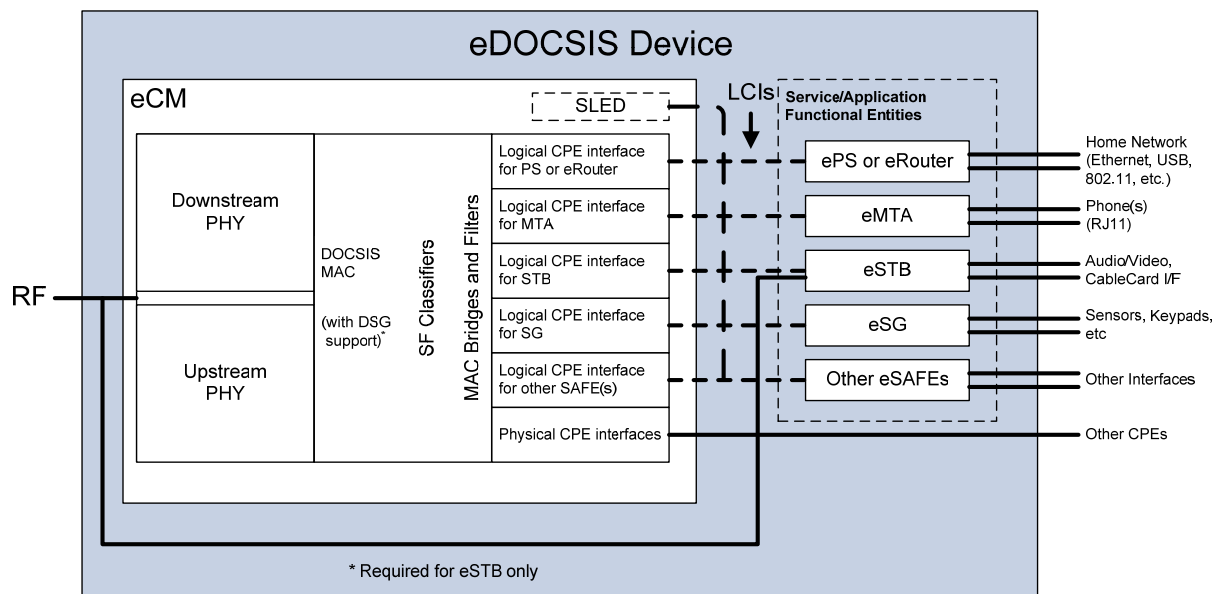


Figure 5–1 - eDOCSIS Reference Model

5.1.1 ePS Reference Model

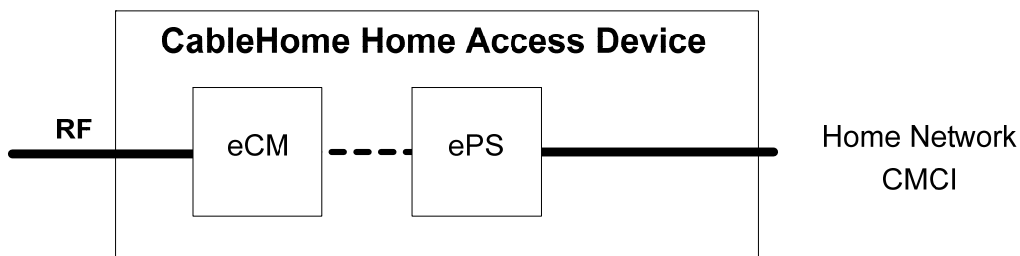


Figure 5–2 presents a typical CableHome Home Access eDOCSIS Device reference model.

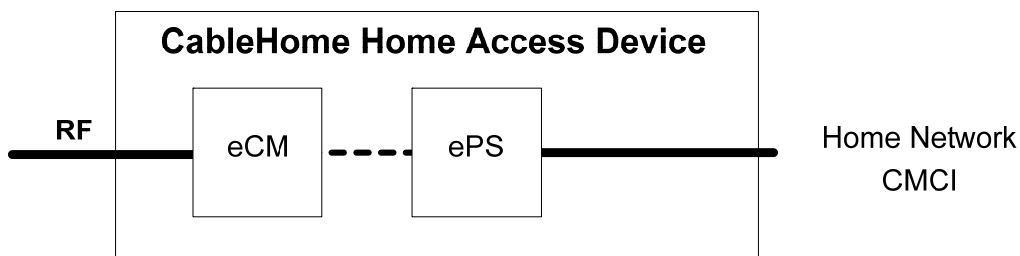


Figure 5–2 - CableHome Home Access eDOCSIS Device Reference Model

Figure 5–3 presents a logical view of protocol stacks for an eCM to ePS interface.

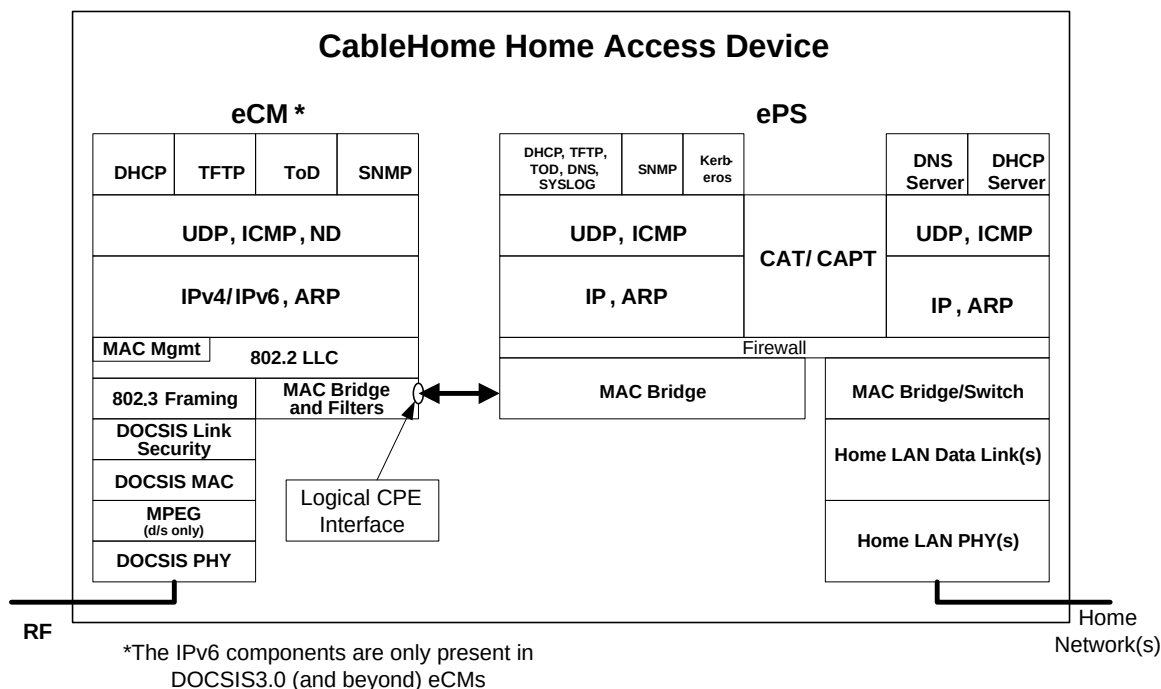


Figure 5–3 - eCM - ePS Protocol Stacks

5.1.2 eMTA Reference Model

Figure 5–4 presents a typical IPCablecom E-MTA (with DOCSIS cable modem) eDOCSIS Device reference model.

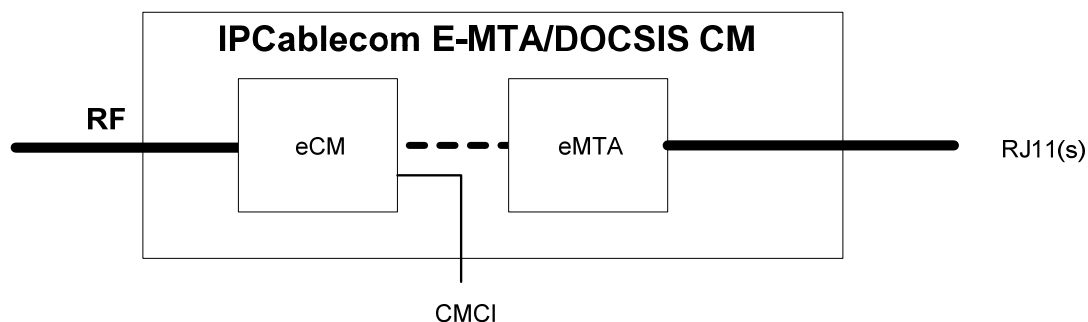


Figure 5–4 - IPCablecom E-MTA (with DOCSIS CM) eDOCSIS Reference Model

Figure 5–5 presents a logical view of protocol stacks for an eCM to eMTA interface.

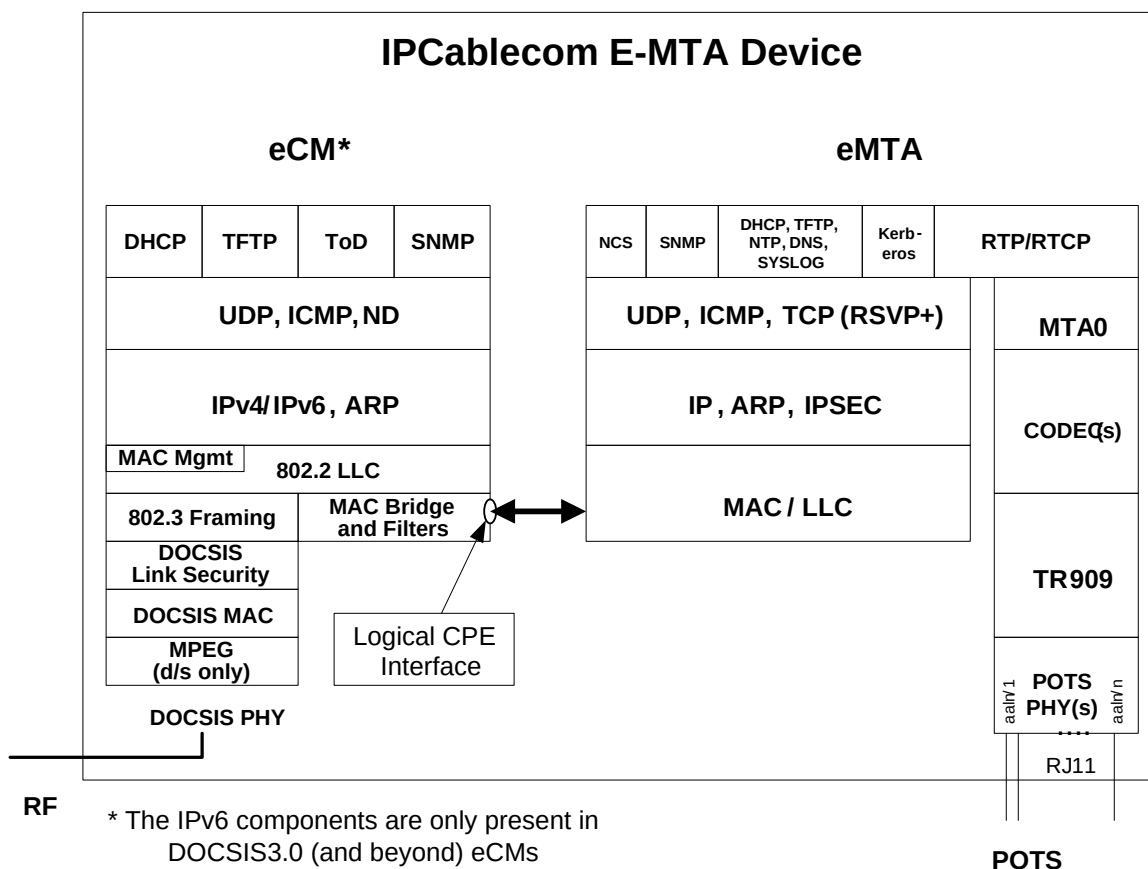


Figure 5–5 - eCM - eMTA Protocol Stacks

5.1.3 eSTB Reference Model

Figure 5–6 presents a typical OpenCable Host 2.1 eDOCSIS Device reference model where the Host provides DSG Flow, Socket Flow, and IP Flow support.

Note: The CableCARD™ may support Socket Flow or IP Flow or both, but neither is supported simultaneously by the Host.

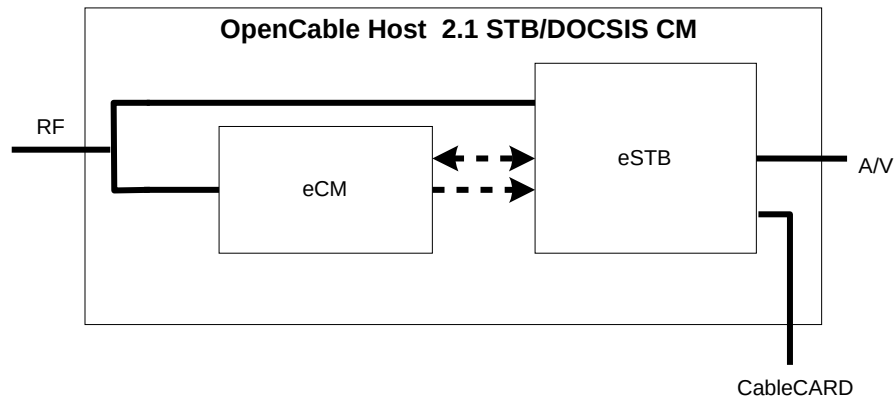


Figure 5–6 - OpenCable Host 2.1 eDOCSIS Reference Model

Figure 5–7 presents a logical view of protocol stacks for an eCM to eSTB to CableCARD interface (OpenCable Host 2.1) where the Host provides DSG Flow, Socket Flow, and IP Flow support.

Note: The CableCARD may support Socket Flow or IP Flow or both, but neither is supported simultaneously by the Host.

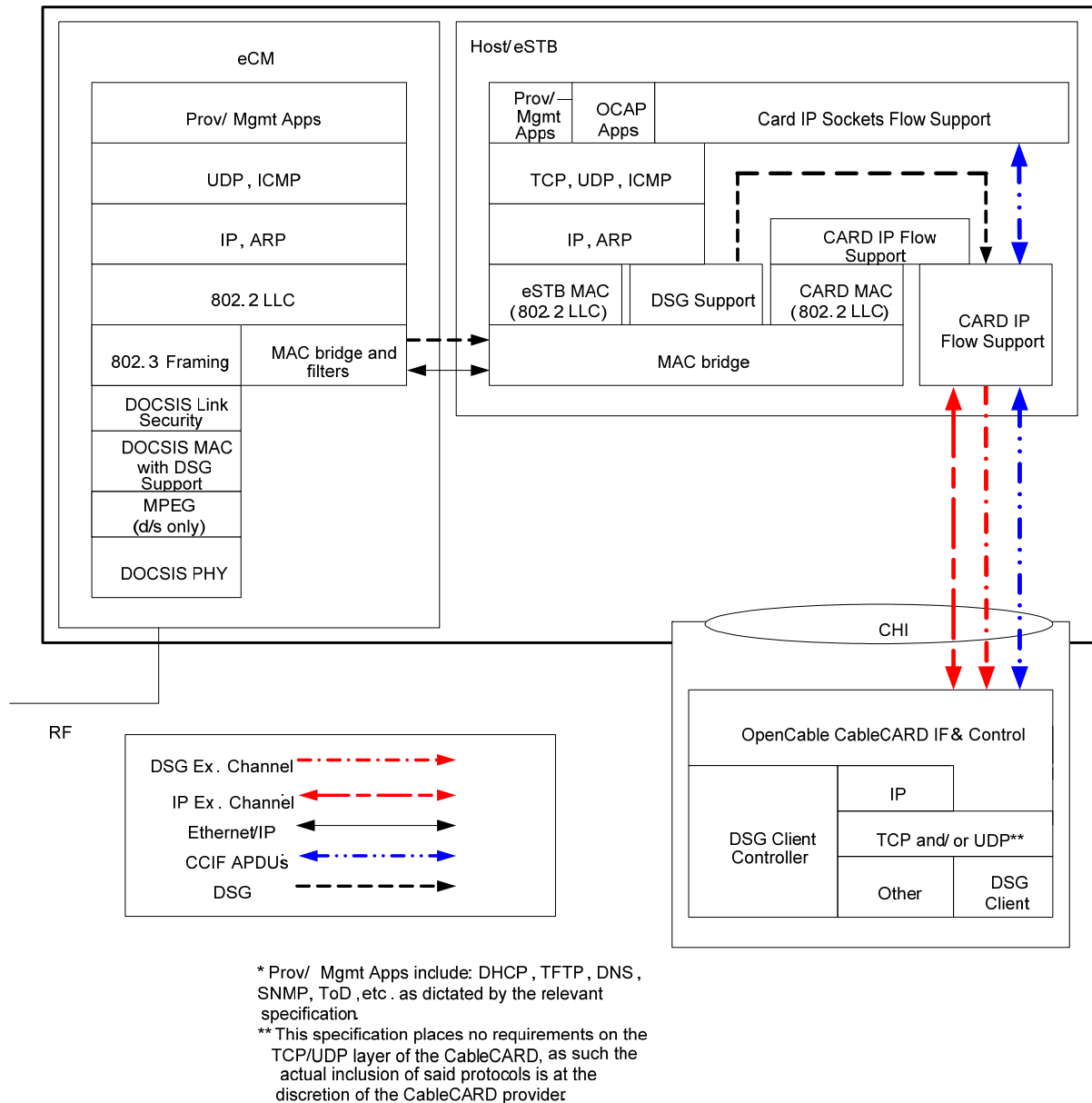


Figure 5-7 - eCM - eSTB Protocol Stacks - OpenCable Host 2.1 - Unicast IP Flow

Figure 5–8 presents a typical embedded security STB eDOCSIS Device reference model.

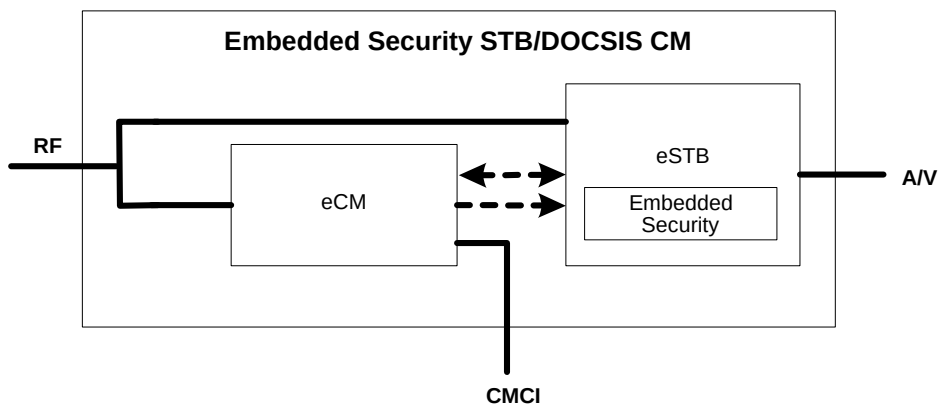
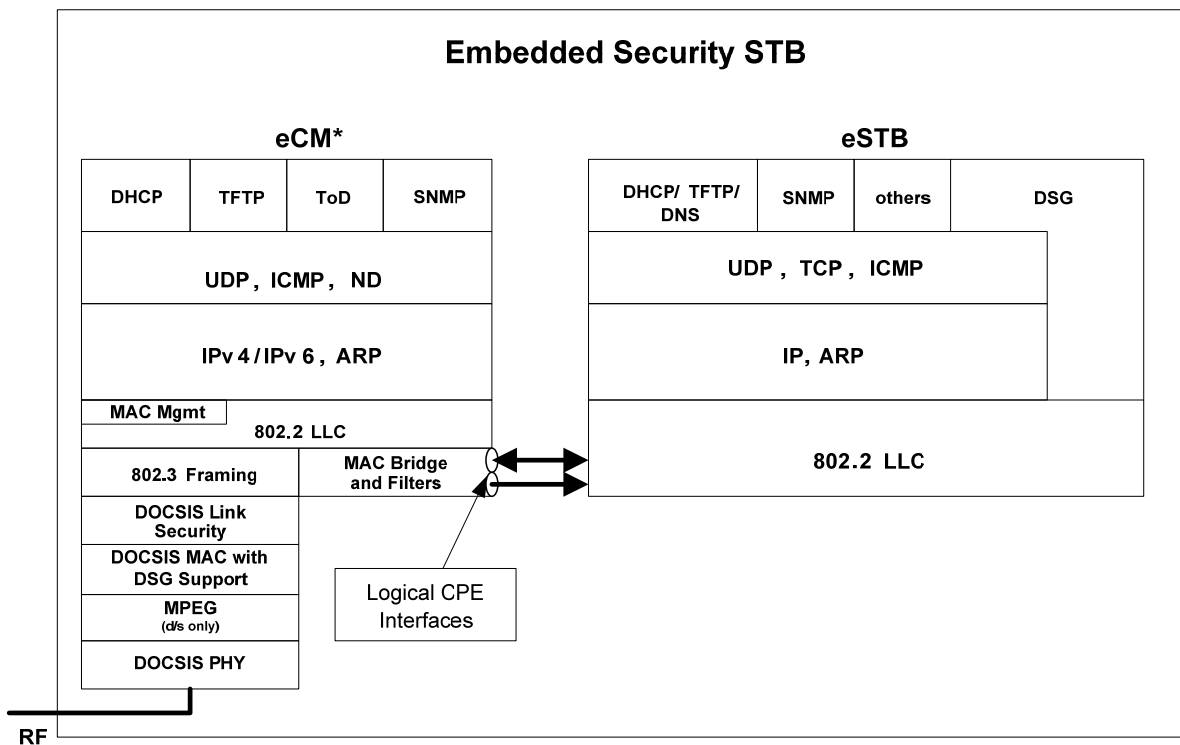


Figure 5–8 - Embedded Security STB eDOCSIS Reference Model

Figure 5–9 presents a logical view of protocol stacks for an eCM to eSTB interface (embedded security STB).



* The IPv6 components are only present in DOCSIS3.0 (and beyond) eCMs

Figure 5–9 - eCM - eSTB Protocol Stacks - Embedded Security STB

5.1.4 eTEA Reference Model

Figure 5–10 presents a typical T1/E1 TDM Emulation Adapter (TEA) eDOCSIS device Reference model.

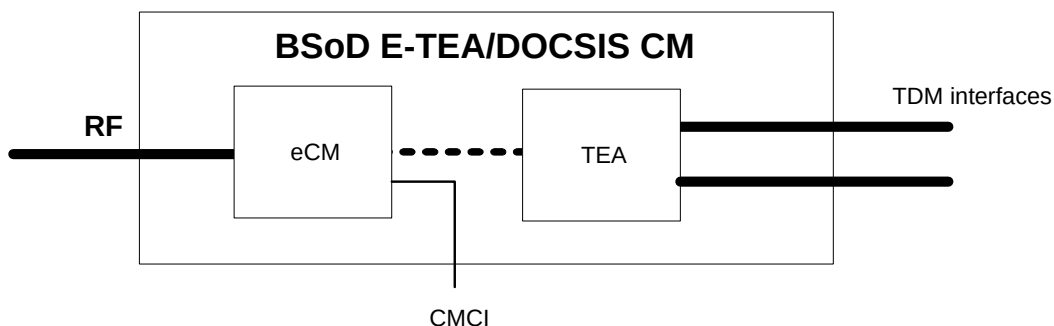


Figure 5–10 - BSoD eTEA (with DOCSIS CM) eDOCSIS Reference Model

Figure 5–11 presents a logical view of protocol stacks for an eCM to eTEA interface (embedded TDM Emulation Adapter).

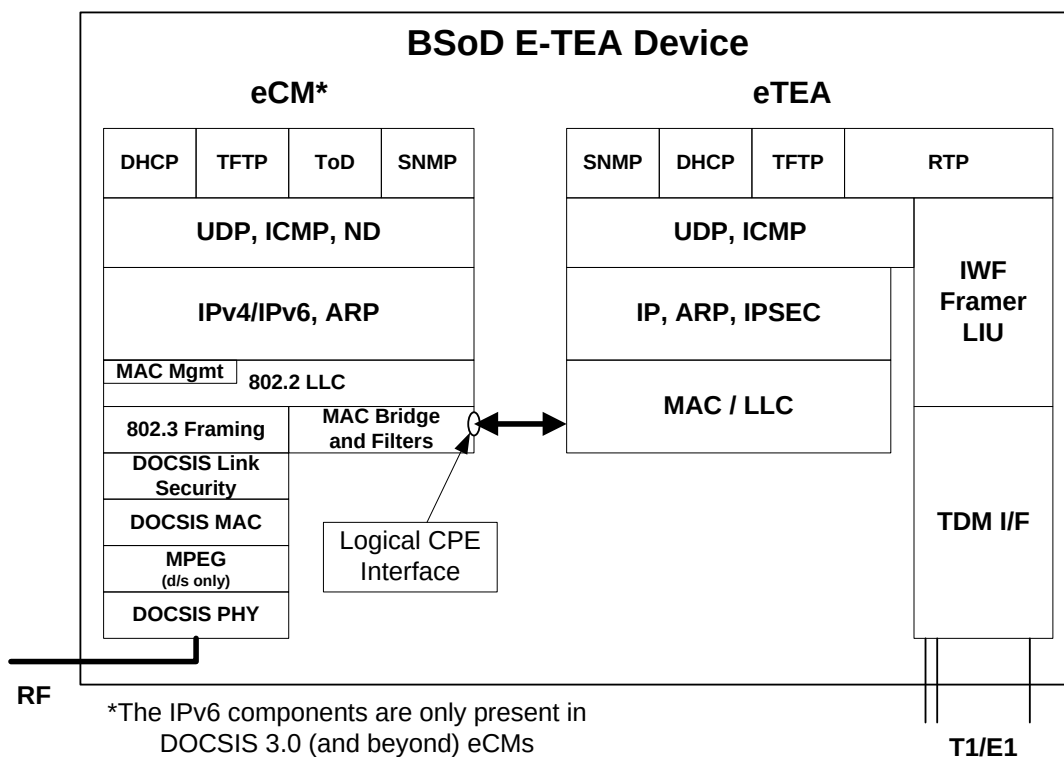


Figure 5–11 - eCM - eTEA Protocol Stacks