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## **OpenCable Specifications**

### **OpenCable Host Device 2.1 Core Functional Requirements**

**OC-SP-HOST2.1-CFR-I06-081114**

**ISSUED**

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## Document Status Sheet

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Work in Progress	An incomplete document, designed to guide discussion and generate feedback that may include several alternative requirements for consideration.
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# 1 INTRODUCTION (INFORMATIVE)

## 1.1 OpenCable Overview

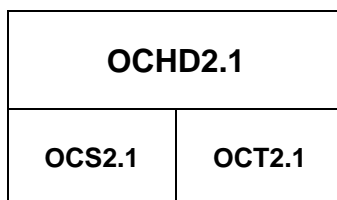
The goal of the OpenCable specifications is to help the cable industry deploy interactive services in North America. Information is presented in this document that defines the range of minimum capabilities to be supported by Bidirectional digital set-top boxes (OCS2.1) and integrated terminal devices (OCT2.1). OpenCable Project information including Unidirectional specifications and other OpenCable Project information is available on the OpenCable website <http://www.opencable.com/>.

The OpenCable specifications:

1. Provide integrated environments for broadcast services (analog and digital) and real-time interactive multimedia services.
2. Require standards and interoperability. OpenCable takes advantage of standard computing and network architectures, wherever possible, to minimize costs and maximize inclusion of emerging technologies. Standards may include international standards, North American standards, or published *de facto* industry standards. In all cases, the acquisition of the necessary software, hardware, and intellectual properties will be achievable at fair and reasonable costs. All standard interfaces will be in the public domain or will be available for license at a fair and reasonable cost. Closed proprietary systems are to be avoided.
3. Require portability. FCC regulations adopted under the "retail availability" provisions of the Communications Act provide for retail cable navigation devices to operate with CableCARD™ modules. The OpenCable system permits "point-of-deployment decisions" for network, security and operator-programmed user interfaces to enable the anticipated variety of retail devices and promotes the portability of such devices.
4. Define a renewable and replaceable core encryption system called the CableCARD device.
5. Provide cable Multiple System Operators (MSOs) the ability to inform the navigation device (Host) of the offered services and the Host device with the tools to display the cable services as intended by the MSO.
6. Co-exist with the embedded base of existing set-top devices.

## 1.2 OpenCable Host Device 2.1 Overview

This document describes the requirements for the OpenCable Host Device 2.1. These devices include OpenCable Set-top 2 (OCS2.1) and OpenCable Terminal 2 (OCT2.1) devices.



**Figure 1.2–1 - OpenCable Host Device 2.1 Types**

The goals and objectives of the OpenCable Host Device 2.1 are:

- To support non-scrambled analog services as well as new scrambled or in-the-clear digital services.
- To receive digital premium (scrambled) cable services via an interface with a CableLabs-Qualified CableCARD Device.

- To support interactive and two-way services through standardized Out-Of-Band (OOB) and DOCSIS® data channels and direct connection to the cable plant.

Information on the OpenCable Project can be obtained from the OpenCable website at <http://www.opencable.com/>, and information on the DOCSIS specifications (including DSG) can be found at the DOCSIS web site at <http://www.cablemodem.com/>.

Below is more detail on the basic functionality of the OpenCable Host Device 2.1 types.

### **OpenCable Set-top 2.1 (OCS2.1)**

- Two-way connectivity support via both ANSI/SCTE 55-1,-2 OOB and DOCSIS with DSG functionality;
- OpenCable Application Platform (OCAP) 1.0 support;
- MPEG2 Main Profile @ Main Level (MP@ML) Standard Definition and Main Profile @ High Level (MP@HL) High-Definition decoding;
- AVC Main and High Profile @Level 3.0 and 4.0 that cover Standard and High Definition decoding as specified in [SCTE 128];
- MPEG-1 audio (Layer I, II & III);
- MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC-v2 audio;
- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) output (source) with HDCP encryption;
- IEEE-1394 output (source) with DTCP encryption;
- Optional MPEG encoding of received analog channels for transport on the IEEE-1394 output;
- Multi-Stream or Single-Stream CableCARD interface support.

### **OpenCable Terminal 2.1 (OCT2.1)**

- Two-way connectivity support via both ANSI/SCTE 55-1,-2 OOB and DOCSIS with DSG functionality;
- OpenCable Application Platform (OCAP) 1.0 support;
- MPEG2 Main Profile @ Main Level (MP@ML) Standard Definition and Main Profile @ High Level (MP@HL) High-Definition decoding and display;
- AVC Main and High Profile @Level 3.0 and 4.0 that cover Standard and High Definition decoding as specified in [SCTE 128];
- MPEG-1 Audio (Layer I, II & III);
- MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC-v2 Audio;
- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) input (sink) with HDCP encryption; DVI or HDMI output (source) optional;
- IEEE-1394 input (sink) with DTCP encryption including the capability to switch between analog and digital inputs as in [CEA-775-B];
- Multi-Stream or Single-Stream CableCARD interface support.



## 1.3 Compliance Notation

Throughout this document, the words used to provide normative statements are capitalized as shown below:

"SHALL"	This word means that the item is an absolute requirement of this specification.
"SHALL 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.

## 1.4 Glossary of Terms

This document uses the following terms:

<b>CableCARD™ Device</b>	A CableCARD device is a detachable device distributed by cable providers that connects to the Host Device. The interface between the CableCARD device and the Host Device is specified by the OpenCable CableCARD Interface 2.0 Specification or OpenCable CableCARD Interface Specification [CCIF2.0]. CableCARD functionality includes copy protection and private CA functions beyond the scope of this specification.
<b>Card</b>	CableCARD Device
<b>Controlled Content</b>	Content that has been transmitted from the CableCARD Device with the encryption mode indicator (EMI) bits set to a value other than zero.
<b>Embedded Cable Modem (eCM)</b>	A Cable Modem that is integrated into an OCHD2.1 for Out-Of-Band signaling, implemented according to the DOCSIS 2.0 spec [RFIv2.0], [eDOCSIS] and supports [DSG].
<b>Network Controller</b>	This is the computer system responsible for managing the CableCARD devices within a cable system. It manages CableCARD devices through control and information messages sent via a dedicated Out-Of-Band channel or DSG channel.

<b>Non-volatile Memory</b>	<p>Memory that retains its contents after any of the following conditions occur:</p> <ul style="list-style-type: none"> <li>Power is removed from the OCHD2.1</li> <li>OCHD2.1 is reset</li> <li>New firmware image is downloaded</li> </ul> <p>Examples of non-volatile memory are flash, battery-backed RAM, and hard disk drive, but this definition does not limit non-volatile memory to these three types.</p>
<b>OC Signaling</b>	<p>OC_Signaling is a term used to defined types of download triggering message, such as the Common Download CVT or OCAP XAITs.</p>
<b>OpenCable Host Device 2.1</b>	<p>A cable receiver that is compliant with one of the hardware profiles defined by this specification. The OCHD2.1 profiles include:</p> <ul style="list-style-type: none"> <li>• OpenCable Set-top 2.1 (OCS2.1)</li> <li>• OpenCable Terminal 2.1 (OCT2.1)</li> </ul>
<b>OpenCable Set-top 2.1</b>	<p>A cable receiver that has no integrated display and is compliant with the OCS2.1 profile defined by this specification.</p>
<b>OpenCable Terminal 2.1</b>	<p>A cable receiver that includes an integrated display and is compliant with the OCT2.1 profile defined by this specification.</p>
<b>Out-Of-Band Messaging</b>	<p>The control and information messages sent from the Network Controller via the Host to the CableCARD requiring a dedicated QPSK channel or DSG channel that may contain the following types of messages:</p> <ul style="list-style-type: none"> <li>• Conditional Access (CA) messages including entitlements</li> <li>• System Information (SI) messages</li> <li>• Electronic Program Guide (EPG) messages</li> <li>• Emergency Alert System (EAS) messages</li> <li>• Other generic messages</li> </ul>

## 1.5 Abbreviations and acronyms

<b>AC-3</b>	Audio Codec 3 (ATSC A/52B or Dolby Digital™)
<b>AVC</b>	Advanced Video Coding (MPEG-4 Part 10/ H.264)
<b>CA</b>	Conditional Access
<b>CM</b>	Cable Modem
<b>CMTS</b>	Cable Modem Termination System
<b>CVCT</b>	Cable Virtual Channel Table
<b>DOCSIS®</b>	Data-Over-Cable Service Interface Specifications

<b>DPB</b>	Decoded Picture Buffer
<b>DSG</b>	DOCSIS Set-top Gateway
<b>DSGCC</b>	DOCSIS Set-top Gateway Client Controller
<b>DTCP</b>	Digital Transmission Content Protection
<b>DTLA</b>	Digital Transmission Licensing Administrator
<b>DVI</b>	Digital Video Interface
<b>DVS</b>	Digital Video Subcommittee
<b>E-AC-3</b>	Enhanced Audio Codec 3 (ATSC A52B or Dolby Digital Plus™)
<b>EAS</b>	Emergency Alert System
<b>eCM</b>	Embedded Cable Modem
<b>EPG</b>	Electronic Program Guide
<b>FAT Channel</b>	Forward Application Transport Channel
<b>FDC</b>	Forward Data Channel
<b>HD</b>	High Definition
<b>HDCP</b>	High-Bandwidth Digital Content Protection
<b>HDMI</b>	High-Definition Multimedia Interface
<b>HDTV</b>	High Definition Television
<b>HFC</b>	Hybrid Fiber/Coax
<b>IP</b>	Internet Protocol
<b>MAC</b>	Media Access Control
<b>MIB</b>	Management Information Base
<b>MMI</b>	Man Machine Interface
<b>MPEG</b>	Moving Picture Experts Group
<b>MPEG-1 AUDIO</b>	MPEG-1 Audio (layer I, II & III) (ISO/IEC 11172-3)
<b>MPEG-4 AUDIO</b>	MPEG-4 AAC, MPEG-4 HE-AAC and MPEG-4 HE-AAC v2 Audio (ISO/IEC 14496-3)
<b>MSO</b>	Multiple System Operator

<b>MTA</b>	Media Terminal Adaptor
<b>NAL</b>	Network Abstraction Layer
<b>NMS</b>	Network Management System
<b>OCAP</b>	OpenCable Application Platform
<b>OCHD2.1</b>	OpenCable Host Device 2.1 (includes OCS2.1 and OCT2.1 profiles)
<b>OCS2.1</b>	OpenCable Set-top 2.1
<b>OCT2.1</b>	OpenCable Terminal 2.1
<b>OOB</b>	Out-Of-Band
<b>OSD</b>	On-screen Display
<b>POD Module</b>	Point Of Deployment Module (also known as CableCARD Device)
<b>RDC</b>	Reverse Data Channel
<b>SCTE</b>	Society of Cable Telecommunications Engineers
<b>SD</b>	Standard Definition
<b>SI</b>	System Information
<b>SNMP</b>	Simple Network Management Protocol
<b>SPS</b>	Sequence Parameter Set
<b>SPTS</b>	Single Program Transport Stream
<b>SRAP</b>	SCTE Random Access Point
<b>TCP</b>	Transmission Control Protocol
<b>TVCT</b>	Terrestrial Virtual Channel Table
<b>UDP</b>	User Datagram Protocol

## 2 REFERENCES

### 2.1 Normative References

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

All references are subject to revision, and parties to agreement based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

[47CFR15]	47CFR15: Radio Frequency Devices, Class B, FCC.
[47CFR76]	47CFR76: Cable Television Service, FCC.
[A/52B]	ATSC A/52B: Digital Audio Compression Standard (AC-3, E-AC-3) 2005.
[A/53]	ATSC A/53: ATSC Digital Television Standard; Part 1:2007 Digital Television System.
[A/65C]	ATSC A/65C: Program and System Information Protocol for Terrestrial Broadcast and Cable (Revision C, with Amendment No. 1).
[AV/C]	AV/C: Digital Interface Command Set General Specification, Version 4.2.
[BPI+]	CM-SP-BPI+-C01-081104, Data-Over-Cable Service Interface Specifications, Baseline Privacy Plus Interface Specification, November 4, 2008, Cable Television Laboratories, Inc.
[CANN-DHCP]	CL-SP-CANN-DHCP-Reg-I02-080306, CableLabs DHCP Options Registry Specification, March 6, 2008, Cable Television Laboratories, Inc.
[CCCP2.0]	OC-SP-CCCP2.0-I08-071113, OpenCable CableCARD Copy Protection 2.0 Specification, November 13, 2007, Cable Television Laboratories, Inc.
[CCIF2.0]	OC-SP-CCIF2.0-I16-081114, OpenCable CableCARD Interface 2.0 Specification, November 14, 2008, Cable Television Laboratories, Inc.
[CEA 708C]	CEA 708C: Digital Television (DTV) Closed Captioning, July 30, 2006.
[CEA-23-A]	CEA-23-A: RF Interface Specification for Television Receiving and Cable Television Systems, December 2004.
[CEA-542-B]	EIA/CEA-542-B: Cable Television Channel Identification Plan.
[CEA-608-D]	CEA-608-D: Recommended Practice for Line 21 Data Service, August 1, 2005.
[CEA-766-B]	CEA-766-B: U.S. Regional Rating Table (RRT) and Content Advisory Descriptor for Transport of Content Advisory Information Using ATSC A/65 Program and System Information Protocol (PSIP).
[CEA-770.3-C]	CEA-770.3-C: High Definition TV Analog Component Video Interface.
[CEA-775-B]	CEA-775-B, 2004: DTV 1394 Interface Specification.
[CEA-861-D]	CEA-861-D: A DTV Profile for Uncompressed High Speed Digital Interfaces, July 18, 2006.
[CEA-931-B]	CEA-931-B: Remote Control Command Pass-through Standard for Home Networking.
[CHILA]	CableLabs Card-Host Interface License Agreement.
[DSG]	CM-SP-DSG-I12-080626, DOCSIS Set-top Gateway (DSG) Interface Specification, June 26, 2008, Cable Television Laboratories, Inc.
[DTCP]	5C Digital Transmission Content Protection Specification and License.
[DVI]	Digital Visual Interface, Digital Display Working Group, Revision 1.0, April 2, 1999.

[DVS 714]	SCTE DVS 714, Constraints on AVC Video Coding for Digital Program Insertion.
[SCTE 128]	ANSI/SCTE 128, 2007: AVC Video Systems and Transport Constraints for Cable Television.
[eDOCSIS]	CM-SP-eDOCSIS-I16-080930, Data-Over-Cable Service Interface Specifications, eDOCSIS Specification, September 30, 2008, Cable Television Laboratories, Inc.
[EIA-679-B]	EIA-679-B (Part B): National Renewable Security Standard, March 2000.
[ETSI TS 101 154 v1.8.1]	Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream.
[HDCP]	High-bandwidth Digital Content Protection System, Digital Content Protection LLC, Revision 1.1, 9 June, 2003.
[HDMI]	High-Definition Multimedia Interface, Specification Version 1.0, December 9, 2002.
[IEC 60958-1]	IEC 60958 (2004-03): Digital Audio Interface: Part 1: General.
[IEC 60958-3]	IEC 60958 (2006-05): Digital Audio Interface: Part 3: Consumer applications.
[IEC 61937]	IEC 61937 (2000-04): Digital audio - Interface for non-linear PCM encoded audio bitstreams applying IEC 60958.
[IEC 61937-3]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 3: Non-linear PCM bitstreams according to the AC-3 audio formats.
[IEC 61937-4]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 4: Non-linear PCM bitstreams according to the MPEG audio formats.
[IEC 61937-6]	IEC 61937 (2003-05): Digital audio - Interface for non-linear PCM encoded audio bitstreams- Part 6: Non-linear PCM bitstreams according to the MPEG-2 AAC and MPEG-4 AAC audio formats.
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[ISO 13818-1/Amd 3]	ISO/IEC 13818-1:2000/Amendment 3, 2004: Transport of AVC video data over ITU-T Rec. H.222.0   ISO/IEC 13818-1 streams.
[ISO 13818-1]	ISO/IEC 13818-1, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Systems.
[ISO 13818-2]	ISO/IEC 13818-2, 2000: Information technology—Generic coding of moving pictures and associated audio (MPEG): Video.
[ISO 14496-10]	ISO/IEC 14496-10:2005: Information technology - Coding of audio-visual objects - Part 10: Advanced Video Coding.
[ISO 14496-3]	ISO/IEC 14496-3, 2005: Information technology - Coding of audio-visual objects – Part 3 Audio including amendment 1: "Bandwidth Extension" and amendment 2 "Parametric coding for High Quality Audio".
[ITU-R-BT.709-2]	ITU-R-BT.709-2: Parameter Values for the HDTV Standard for Production and International Program Exchange.
[Macrovision]	Specifications of the Macrovision Copy Protection Process for STB/IRD Products Revision 7.1.S1, (October 1, 1999).
[MIB-HOST]	OpenCable Host Device 2.X MIB Specification, OC-SP-MIB-HOST2.X-I05-081114, November 14, 2008, Cable Television Laboratories, Inc.
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[OC-FPEXT]	OC-SP-OCAP-FPEXT-I02-071220, OCAP Front Panel Extension, December 20, 2007, Cable Television Laboratories, Inc.
[OC-SEC]	OC-SP-SEC-I07-061031, OpenCable System Security Specification, October 31, 2006, Cable Television Laboratories, Inc.
[OSSIV2.0]	SP-OSSIV2.0-C01-081104, Data-Over-Cable Service Interface Specifications, Operations Support System Interface Specification, November 4, 2008, Cable Television Laboratories, Inc.
[RFC 1112]	Host Extensions for IP Multicasting.
[RFC 1157]	A Simple Network Management Protocol (SNMP).
[RFC 1901]	Introduction to Community-based SNMPv2.
[RFC 1902]	Structure of Management Information for Version 2 of the Simple Network Management Protocol (SNMPv2).
[RFC 2131]	Dynamic Host Configuration Protocol.
[RFC 2132]	DHCP Options and BOOTP Vendor Extensions.
[RFC 2669]	DOCSIS Cable Device MIB Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems.
[RFC 2790]	Host Resources MIB.
[RFC 2863]	The Interfaces Group MIB.
[RFC 3315]	Dynamic Host Configuration Protocol for IPv6.
[RFC 3396]	Encoding Long Options in the Dynamic Host Configuration Protocol (DHCPv4).
[RFC 3411]	An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks.
[RFC 3412]	Message Processing and Dispatching for the Simple Network Management Protocol (SNMP).
[RFC 3413]	Simple Network Management Protocol (SNMP) Applications.
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[SCTE 07]	ANSI/SCTE 07, 2006: Digital Transmission Standard for Cable Television.
[SCTE 127]	ANSI/SCTE 127, 2007: Carriage of Vertical Blanking Interval (VBI) Data in North American Digital Television Bitstreams.
[SCTE 18]	SCTE 18, 2007 (ANSI-J-STD-042-2007): Emergency Alert Message for Cable.
[SCTE 20]	ANSI/SCTE 20, 2004: Method for Carriage of Closed Captions and Non-Real Time Sampled Video. Note: Non-Real Time Sampled Video support is "optional" for Host Devices.
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[SCTE 26]	ANSI/SCTE 26, 2004: Home Digital Network Interface Specification with Copy Protection.
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[SCTE 43]	ANSI/SCTE 43, 2005: Digital Video Systems Characteristics Standard for Cable Television.
[SCTE 54]	ANSI/SCTE 54, 2006: Digital Video Service Multiplex and Transport System Standard for Cable Television.
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[SCTE 55-2]	ANSI/SCTE 55-2, 2002: March 10, 2002, Digital Broadband Delivery System: Out-of-Band Transport Part 2: Mode B.
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## 2.2 Informative References

[CEA-516]	CEA-516, 1998: Joint EIA/CVCC Recommended Practice for Teletext: North American Basic Teletext Specification (NABTS)
[CEA-2020]	CEA-2020, 2006: Other VBI Waveforms
[IEC 61880]	IEC 61880: Video Systems (525/60) - Video and Accompanied Data using the Vertical Blanking Interval - Analogue Interface
[MIL-C-39012]	MIL-C-39012: General Specifications for Connectors, Coaxial, Radio Frequency.
[SMPTE 12M]	SMPTE 12M, 2002: Television, Audio and Film - Time and Control Code
[TIA-250-C]	EIA/TIA-250-C: Electrical Performance Standards for Television Relay Facilities.

## 2.3 Reference Acquisition

### CableLabs Specifications:

Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;  
Phone: 303-661-9100; Fax 303-661-9199; <http://www.cablelabs.com/>



**SCTE/DVS Standards:**

SCTE - Society of Cable Telecommunications Engineers Inc., 140 Philips Road, Exton, PA 19341  
Phone: 610-363-6888 / 800-542-5040; Fax: 610-363-5898; <http://www.scte.org/>

**ISO/IEC Standards:**

ISO Central Secretariat: International Organization for Standardization (ISO), 1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland; Internet: <http://www.iso.ch/>

**HDCP Specifications and License**

Digital Content Protection, LLC, C/O Intel Corporation, Stephen Balogh, JF2-55, 2111 NE 25<sup>th</sup> Ave  
Hillsboro, OR 97124; <http://www.digital-cp.com/>

**HDMI Specifications**

HDMI Licensing, LLC, 1060 E. Arques Avenue, Suite 100, Sunnyvale, CA 94085, USA; <http://www.hdmi.org/>

**DTCP Specifications and License**

Digital Transmission Licensing Administrator, LLC, 225 B Cochrane Circle, Morgan Hill, California 95037  
USA; <http://www.dtcp.com/>

**DDWG Specifications:**

Digital Display Working Group (DDWG), M/S JF3-361; 2111 NE 25<sup>th</sup> Avenue, Hillsboro, OR 97124-5961,  
USA. Fax +1-503-264-5959; Email: [ddwg.if@intel.com](mailto:ddwg.if@intel.com); Internet: [www.ddwg.org](http://www.ddwg.org)

**FCC Specifications:**

<http://wireless.fcc.gov/rules.html>

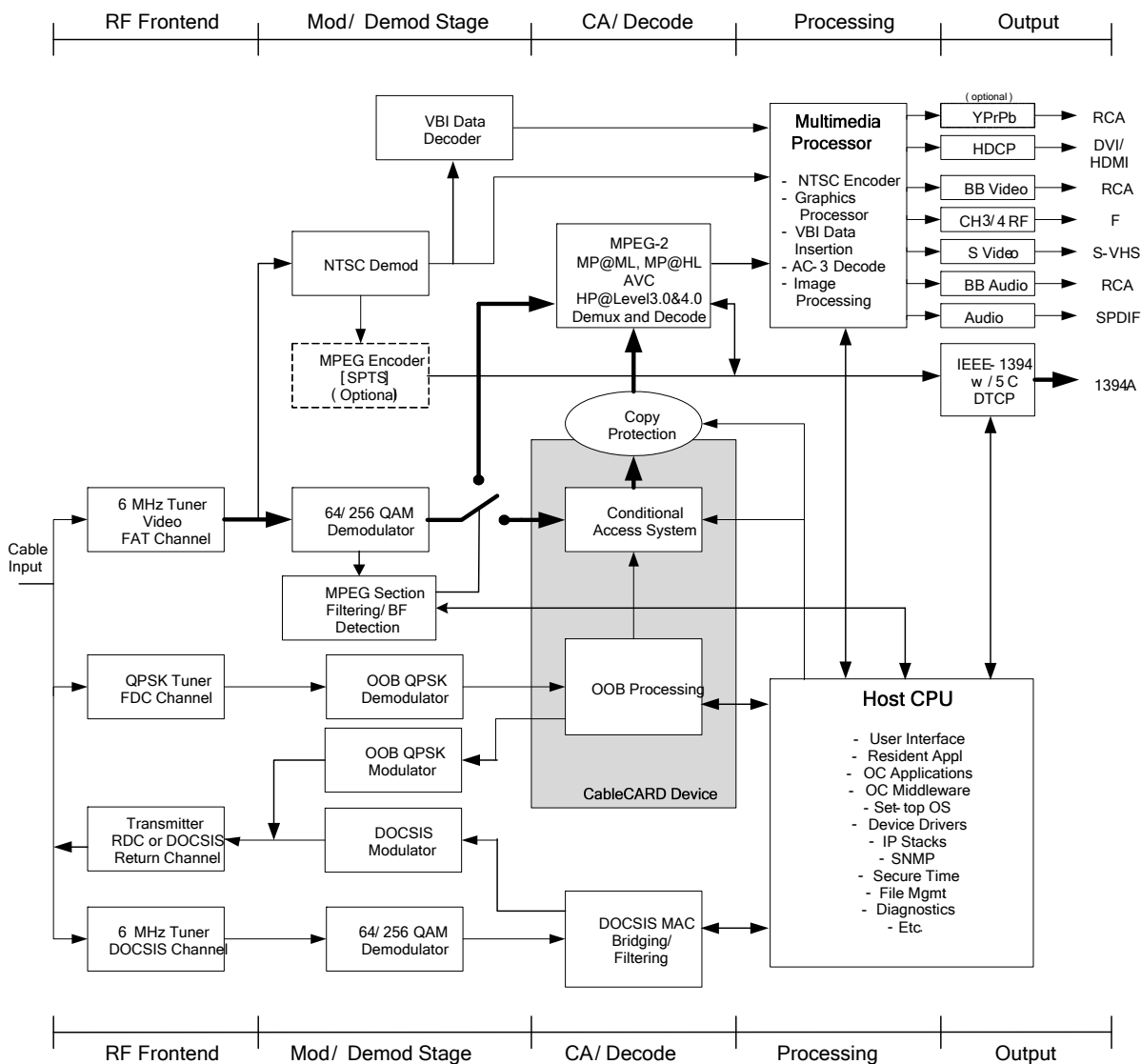
**DVB/ETSI Specifications:**

[www.dvb.org](http://www.dvb.org); [www.etsi.org](http://www.etsi.org)

### 3 OVERVIEW OF CORE SERVICES AND FUNCTIONALITIES

#### 3.1 OpenCable Host Device 2.1 components

This section describes the core services that OCHD2.1s support, as well as the core functions required to implement those services. A block diagram of the OpenCable Set-top Device components is shown below.



**Figure 3.1–1 - Block Diagram of the OpenCable Set-top 2.1 (Informative)**

The OCHD2.1 receives multimedia information by tuning to one of many 6 MHz input channels available via a bi-directional or uni-directional cable connection. When the input channel is an analog channel, the signal is processed via the NTSC decoder and the VBI data decoder. When the input channel is a digital channel, it is processed via the QAM demodulator and then passed to the CableCARD Device where secure and scrambled information is processed. Unscrambled information is passed through the CableCARD Device to the MPEG-2 Transport Demultiplexer. When the CableCARD Device is not inserted, the output of the QAM demodulator is routed directly

to the MPEG-2 Transport Demultiplexer. The multi-media processor handles the synchronization and display of audio-visual material.

Based on the network configuration, the OCHD2.1 receives control information and other data by either tuning to an Out-Of-Band (OOB) Forward Data Channel (FDC) channel or via the DSG channel. The Out-Of-Band mode is communicated by the CableCARD Device to the Host via the CableCARD Interface [CCIF2.0]. The transport of the OOB (FDC / RDC) messaging is detailed in [SCTE 55-2] and [SCTE 55-1]. The transport of the DSG messaging is detailed in [DSG]. The Host cannot assume which mode is supported on the network; therefore both modes must be available within the Host.

### 3.1.1 Core Services (Informative)

The following services are provided by the Core Requirements for OCHD2.1s:

- Analog NTSC audio-visual programming: (unscrambled).
- Digital audio-visual programming utilizing MPEG-2 main profile @ main level and main profile @ high level video and Dolby AC-3 audio including broadcast (unscrambled), subscription-based (scrambled), music channels, Impulse Pay-Per-View (scrambled), VOD and Subscription VOD (scrambled), Switched digital broadcast and other interactive services.
- Digital audio-visual programming utilizing AVC Main and High profile @Level 3.0 and 4.0 video (as specified in [SCTE 128]) and Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO (referred in this document) including broadcast (unscrambled), subscription-based (scrambled), music channels, Impulse Pay-Per-View (scrambled), VOD and Subscription VOD (scrambled), Switched digital broadcast and other interactive services.
- [OCAP] based interactive applications.

### 3.1.2 Core Functions and Features (Informative)

The following features and functions are necessary to support the core services:

- Input range of 54-864 MHz or greater, analog and digital (64/256 QAM) tuning and demodulation
- Closed Caption pass-through (line 21, fields 1 and 2) output for analog video input (OCS2.1)
- Closed Caption reinsertion into the VBI of reconstructed analog video output when input is digital video
- Copy protection on analog and digital outputs including the ability to disable outputs under OCAP control
- Emergency Alert System signaling (compliant with [SCTE 18])
- QPSK Out-Of-Band receiver compliant with [SCTE 55-2] and [SCTE 55-1]
- QPSK Out-Of-Band transmitter compliant with [SCTE 55-2] and [SCTE 55-1]
- Analog NTSC RF Channel  $\frac{3}{4}$  output (OCS2.1)
- Baseband Video output (OCS2.1)
- L&R Baseband Audio outputs (OCS2.1)
- SP/DIF Digital Audio output (OCS2.1)
- High speed IEEE-1394 digital interface (see [SCTE 26]) with [DTCP]
- CableCARD digital interface (see OpenCable CableCARD™ Interface 2.0 Specification [CCIF2.0])
- OpenCable CableCARD Copy Protection 2.0 Specification [CCCP2.0]
- Out-Of-Band messaging via [DSG]

- An embedded cable modem with DSG functionality compliant with [RFIv2.0]
- Optional High-definition analog output ([CEA-770.3-C] Analog Component Video specification)
- Digital Visual Interface (DVI) or High-Definition Multimedia Interface (HDMI) for uncompressed digital video with [HDCP]
- Implementation of [OCAP] middleware including processing of interactive services

### **3.2 General Compliance (Normative)**

Any features of an OCHD2.1 mandated by law or FCC regulation (e.g., Emergency Alert System, V-Chip) will be supported in the Core Requirements for all OCHD2.1s.

REQ3268 The OCHD2.1 manufacturer SHALL confirm compliance with all applicable FCC rules and regulations.

REQ3269 The OCHD2.1 manufacturer SHALL confirm compliance with all applicable UL rules and regulations.

## 4 SECURITY

This section describes requirements for copy protection of video programs, security of video streams, conditional access to video streams, and security of transmitted data.

### 4.1 Conditional Access

REQ3270 The OCHD2.1 SHALL utilize the Card to perform the following Conditional Access functions as defined in [CCCP2.0]: CA descrambling, authorization, entitlement, and Copy Protection encryption.

REQ3271 The OCHD2.1 SHALL NOT implement the following Conditional Access functions: CA descrambling, authorization, entitlement, and Copy Protection encryption.

### 4.2 Partitioning of Memory

REQ3272 Memory in the OCHD2.1 SHALL be partitioned such that separate partitions are maintained solely for the operation of CableLabs certified software, which is not to be overwritten by any mechanism other than those specified in [OC-CD] and [OC-SEC].

REQ3273 The CableLabs certified software in OCHD2.1 memory partitions SHALL have sole access to the Out of Band channels.

### 4.3 Certificate Storage and Management

REQ3274 The OCHD2.1 SHALL store the various certificates and any associated private/public keys as defined in [OC-SEC].

### 4.4 Analog Program Copy Protection

REQ3275 The OCS2.1 SHALL be capable of adding copy protection to NTSC analog video outputs derived from digital programs in accordance with the [Macrovision] standard.

REQ3275.1 The control of Macrovision mode SHALL be dictated by the APS bits of the CCI byte as defined in [CCCP2.0].

REQ3276 If the OCT2.1 includes analog video outputs, it SHALL be capable of adding copy protection to NTSC analog video outputs derived from digital programs in accordance with the [Macrovision] standard.

REQ3276.1 The control of Macrovision mode SHALL be dictated by the APS bits of the CCI byte as defined in [CCCP2.0].

### 4.5 Digital Program Copy Protection

REQ3277 The [IEEE-1394] digital interface on the OCHD2.1 SHALL support both Full Authentication and Restricted Authentication copy protection requirements as defined by [DTCP].

REQ3278 The OCHD2.1 SHALL implement M-Mode copy protection as defined in [CCCP2.0].

REQ3280 The OCHD2.1 SHALL ignore any OCAP commands that would change the effect of CCI received from the Card.

REQ3281 The OCHD2.1 SHALL include CA descriptors, in the ca\_pmt() APDU, associated with the CA\_system\_id passed by the Card, in the ca\_info() APDU, omitting CA descriptors associated with other CA system IDs.

REQ3282 The OCHD2.1 SHALL acquire the association between MPEG program number, ECM-PID and elementary stream PIDs, for the purposes of CP-encryption and CCI authentication, either before sending the transport stream to the Card or after receiving it back from the Card.

REQ3283 The OCHD2.1 SHALL acquire MPEG program number, ECM-PID, and elementary stream packet ID for all content by filtering the MPEG transport stream, either before output to or after reception from the Card interface, but not both.

## 4.6 HD Copy Control

The following describe the requirements of the OCHD2.1 to ensure protection of HD content when required.

Control of copy control mechanisms on HD outputs is determined by the status of CCI bits. The cable operator determines the control policy through agreements between the operator and the content provider and asserts that policy with the CCI bits.

REQ3284 The OCHD2.1 SHALL provide output control for Controlled Content [CCCP2.0] on all outputs in accordance with specific instructions provided by the Monitor Application as defined in [OCAP].

REQ3285 The OCHD2.1 SHALL have the functionality to allow the Monitor Application the ability to enable or disable the program content stream out the following outputs under OCAP software control [OCAP]:

REQ3285.1 IEEE 1394

REQ3285.2 Analog Component Video (Y,Pb,Pr)

REQ3285.3 DVI

REQ3285.4 HDMI

REQ3285.5 any other outputs defined by OCAP specifications.

REQ3286 When an output port is disabled under OCAP software control, the OCHD2.1 SHALL provide a method to display a user message over this same port at the time the port is disabled for program content. The format and content of this message is unspecified.

REQ3287 If the IEEE 1394 output is disabled under OCAP software control, then the OCHD2.1 SHALL display a user message over all analog outputs and signal to the connected device via the External Jack Selection, as defined in [SCTE 26], that the analog port should be utilized.

REQ3287.1 If the connected device does not support External Jack Selection, then the OCHD2.1 SHALL display the user message on all analog output ports.

REQ3287.2 The user message SHALL be displayed for a period that does not exceed 30 seconds.

REQ3288 If analog component video outputs are present, the OCHD2.1 SHALL provide a "Constrained Image" when the Constrained Image Trigger (CIT) bit in the CCI byte has a value equal to "1".

REQ3288.1 A Constrained Image as defined by the [CHILA] license agreement SHALL have the visual equivalent of not more than 520,000 pixels per frame; for example, an image of 960 (h) by 540 (v) pixels for a 16x9 aspect ratio.

REQ3288.2 If a Constrained Image is created by the OCHD2.1, it SHALL be sent to the analog component video interface with one of the scanning formats described in Table 1 of [CEA-770.3-C].

**NOTE:** This may require up-converting the Constrained Image via interpolation or line doubling in order to match one of the output scanning formats.

REQ3289 The OCHD2.1 SHALL provide a method for software, in particular the OCAP Monitor Application, to determine the status of copy control mechanisms (enabled/disabled) on digital output ports, including the [DTCP] status of the IEEE-1394 port and the [HDCP] status of the DVI or HDMI port.

## 5 BI-DIRECTIONAL PHYSICAL LAYER CHARACTERISTICS

### 5.1 RF Interface

REQ3290 The OCHD2.1 SHALL comply with the mechanical and electrical interface requirements as defined in section 3 of [CEA-23-A].

#### 5.1.1 Maximum Individual Carrier Amplitude

REQ3291 The OCHD2.1 SHALL be capable of meeting the FAT and FDC channel performance requirements in the presence of interfering signals, where the maximum RMS value of any individual interfering signal does not exceed the following limits (measured across 75 Ohms):

REQ3291.1 0.5 MHz to 42 MHz +42 dBmV

REQ3291.2 42 MHz to 52 MHz 0 dBmV

REQ3291.3 52 MHz to 54 MHz -17 dBmV

The maximum rms value of any individual signal whose frequency exceeds 54 MHz is less than +20 dBmV across a 75 ohm terminating impedance measured at the input to the Host Device.

### 5.2 Communication Channels

REQ3292 The OCHD2.1 SHALL have the following communication channels:

REQ3292.1 Forward Application Transport (FAT) channels which carry MPEG-2 Program Streams or NTSC analog signals

REQ3292.2 Forward Data Channel (OOB FDC)

REQ3292.3 Reverse Data Channel (OOB RDC)

REQ3292.4 DOCSIS downstream and upstream channels

REQ3292.5 DSG tunnels using DOCSIS downstream channels

**Note:** The frequency range for each downstream tuner or upstream transmitter is:

- 54 to 864 MHz (FAT channel and DOCSIS downstream)
- 70 to 130 MHz (OOB FDC channel)
- 5 to 42 MHz (OOB RDC channel and DOCSIS upstream).



### 5.2.1 Forward Application Transport (FAT) Channel

The forward application transport channel is a 64 or 256 Quadrature Amplitude Modulation (QAM) channel, according to [SCTE 07], that transports approximately 27 or 39 megabits/second, respectively. The OCHD2.1 is instructed to tune to a particular FAT channel when a subscriber requests a service that requires transport on a FAT channel. FAT channels that are present on the cable plant will adhere to the STD, HRC or IRC frequency plans of [CEA-542-B] and can be located anywhere in the 54 to 864 MHz range.

REQ3293 The OCHD2.1 SHALL be capable of receiving and demodulating a Forward Application Transport channel with either 64 or 256 QAM modulation.

REQ3294 The OCHD2.1 SHALL be compliant with [SCTE 07] for the transmission physical layer modulation and coding.

### 5.2.2 NTSC Analog Channels

REQ3295 The OCHD2.1 SHALL receive all existing unscrambled analog channels that are NTSC RF AM-VSB modulated in accordance with applicable FCC rules.

NTSC analog channels will adhere to the STD, HRC or IRC frequency plans of [CEA-542-B] and can be located anywhere in the 54 to 864 MHz range.

#### 5.2.2.1 Vertical Blanking Interval

The Vertical Blanking Interval (VBI) contains data on line 21 of an NTSC analog television signal. During this period, the headend can insert VBI data signals on line 21 for closed captioning. VBI data can be inserted within field 1, field 2 or both, on any analog channel operating in the 54 to 864 MHz range.

REQ3296 The OCS2.1 SHALL include the capability to pass through VBI closed caption information, text mode data services, and extended data services data present on line 21 (field 1 and 2) for all NTSC analog signals. The format of this data is defined in [CEA-608-D].

REQ3297 If analog video outputs are present, the OCT2.1 SHALL include the capability to pass through VBI closed caption information, text mode data services, and extended data services data present on line 21 (field 1 and 2) for all NTSC received analog signals. The format of this data is defined in [CEA-608-D].

### 5.2.3 Out-Of-Band Signaling

#### 5.2.3.1 OOB-FDC and OOB-RDC

The RF front end provides the generic QPSK physical layer common to the OpenCable choices. These have the following characteristics:

Forward receiver: 1.544/3.088 Mbps and 2.048 Mbps

Reverse transmitter: 1.544/3.088 Mbps and 256 Kbps

Based on the network configuration, the Out-Of-Band Messaging for the OpenCable Host Device is implemented over the OOB-FDC / OOB-RDC communication channels or the DSG communication channel. The Out-Of-Band mode is communicated by the Card to the Host via the CableCARD Interface.

REQ3298 The OCHD2.1 SHALL be capable of receiving an Out-Of-Band Forward Data channel and passing the demodulated signal to the Card per [CCIF2.0].

REQ3299 The OCHD2.1 SHALL be compliant with [SCTE 55-2] and [SCTE 55-1] for the OOB FDC and OOB RDC transmission physical layer modulation.

REQ3300 The OCHD2.1 SHALL have an Out-Of-Band Reverse Data Channel QPSK transmitter used only under control of the Card as specified in [CCIF2.0].

## 5.3 Physical Layer Specifications

### 5.3.1 FAT Channel, FDC Characteristics and RF Performance

REQ3301 The OCHD2.1 SHALL decode the Forward Application Transport channel over the range of input parameters as defined in Table 5.3-1 while operating with the downstream transmission characteristics defined by [SCTE 40].

REQ3302 The OCHD2.1 SHALL tune and receive digital signals that fall within the ranges specified in Table 5.3-1 (QAM signals).

**Table 5.3-1 - Analog and FAT Channel: RF Performance Parameters (0° - 40° C)**

	Parameter	Requirement
1.	RF Input Channel Bandwidth	6 MHz
2.	RF Input Tuning Range	54 MHz to 864 MHz IRC/HRC/STD Channel Plans
3.	RF Input Return Loss	6 dB minimum over full tuning range
4.	RF Input Impedance	75 ohm unbalanced
5.	RF Input Level Range	Analog visual carrier@ from 0 dBmV minimum to +15 dBmV maximum; Analog aural carrier from -10 to -17 dBc; Digital QAM 64 signal from -15 dBmV to +15 dBmV; Digital QAM 256 signal from -12 dBmV to +15 dBmV
6.	AGC Range	NTSC baseband video output level variation of not more than $\pm 1$ dB with the analog visual carrier or digital QAM signal input level ranges stated above. (See Note 1)
7.	AFC Range	Better than $\pm 125$ kHz or nominal tuning resolution of 62.5 kHz
8.	LO Leakage (Input EMC)	-37 dBmV over 54 MHz to 864 MHz
9.	Conversion Isolation: RF Input to Converted RF Output	65 dB minimum; where isolation is defined here as the ratio between the converted signal and the unconverted signal present at the channel $\frac{3}{4}$ RF output. This parameter SHALL be met with the output measured on the same frequency as the input of the converter, and applies to all assigned input carrier frequencies over the input level range defined in 5 above. (See Note 2)
10.	RF Bypass Isolation	60 dB minimum over the input tuning range (54-864 MHz) when internal RF bypass option is installed. (See Note 2)
11.	CTB	Not worse than -63 dBc  Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. (See Note 2)
12.	X-Mod.	Not worse than -57 dBc  Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. (See Note 2)

	Parameter	Requirement
13.	CSO	Not worse than -60 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. (See Note 2)
14.	Spurious Emissions within the output channel (channel $\frac{3}{4}$ ) bandwidth	Not worse than -60 dBc Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV. (See Note 2)
15.	Spurious Emissions outside the output channel (other than channel $\frac{3}{4}$ )	Not worse than -10 dBc (See Note 2)
16.	Signal Leakage/RFI	Per [47CFR15]
17.	AM Hum Modulation	Not greater than 3% p-p (See Note 2)
18.	Adjacent Channel Rejection	60 dB min (See Note 2)
19.	Group Delay Variation Tolerance	$\leq 0.25 \mu\text{sec/MHz}$ across the 6-MHz channel
20.	Phase Noise Tolerance	$\leq -88 \text{ dB/Hz}$ @ 10 kHz offset (relative to the center of QAM signal spectrum)
21.	Amplitude Ripple Tolerance Digital channels Analog channels	$\leq 5 \text{ dB p-p}$ within the 6 MHz channel $\leq 4 \text{ dB p-p}$ within the 6 MHz channel
22.	Micro-reflection Tolerance (assumes one dominant echo with max. specified amplitude in dB relative to the primary QAM signal)	-10 dB at $< 0.5 \mu\text{sec}$ -15 dB at $< 1 \mu\text{sec}$ -20 dB at $< 1.5 \mu\text{sec}$ -30 dB at $< 4.5 \mu\text{sec}$ Echoes $> 4.5 \mu\text{sec}$ (see Note 3)
23.	Burst Noise Tolerance	Not longer than 25 $\mu\text{sec}$ at 10 Hz repetition rate
24.	Image Rejection (See Note 2)	Image response less than 60 dBc at final IF or baseband video output, 54 to 714 MHz Image response less than 50 dBc at final IF or baseband video output, 714 to 860 MHz 60dB standard to apply at 714 MHz Two equal power CW signals, +15 dBmV $F_{\text{image}} = F_{\text{desired}} + 90 \text{ MHz}$
25.	Spurious Emissions, 5 – 864 MHz	$< -37 \text{ dBmV}$

*Table Notes:*

1. Applicable only when analog video outputs are provided.
2. Applicable only when converted RF outputs are provided.
3. Micro-reflection longer than 4.5 microseconds rarely occur in conventional cable television systems. Moreover, very low-level micro-reflections (e.g., -40dB) longer than 4.5 microseconds cannot be measured reliably with readily available instruments. Studies on the subject of long Micro-reflections are continuing, which may result in quantifying this parameter at a future date.

REQ3303 The OCHD2.1 SHALL meet all FDC performance parameters specified in Table 5.3-2 while operating with the downstream transmission characteristics defined by [SCTE 40].

REQ3304 The OCHD2.1 SHALL tune and receive digital signals that fall within the ranges specified in Table 5.3-2 (QPSK FDC signals).

**Table 5.3-2 - FDC Channel: RF Performance Parameters (0° - 40° C )**

	Parameter	Requirement
1.	Transmission Rate	1.544/3.088 Mbps [SCTE 55-2] 2.048 Mbps [SCTE 55-1]
2.	RF Input Channel Spacing	1.0/2.0 MHz [SCTE 55-2] 1.8 MHz [SCTE 55-1]
3.	RF Input Tuning Range	70 MHz to 130 MHz
4.	Nominal carrier frequency	Any integer multiple of 250 kHz between the minimum and maximum carrier frequencies, inclusive and the specific fixed frequency of 104.200 MHz.
5.	Frequency acquisition range	+/- 50 ppm
6.	RF Input level range	-15 to +15 dBmV rms (75 ohms) (See Note 1)
7.	Differential Encoding	The differential encoder SHALL accept bits (A, B) in sequence and generate phase changes as follows:  <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">A</div> <div style="text-align: center;">B</div> <div style="text-align: center;">Phase Change</div> </div> <div style="display: flex; justify-content: space-around; margin-top: 5px;"> <div style="text-align: center;">default</div> <div style="text-align: center;">alternative</div> </div> <div style="margin-top: 5px;"> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">0</div> <div style="text-align: center;">0</div> <div style="text-align: center;">none</div> <div style="text-align: center;">none</div> </div> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">0</div> <div style="text-align: center;">1</div> <div style="text-align: center;">+90 deg</div> <div style="text-align: center;">-90 deg</div> </div> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">1</div> <div style="text-align: center;">0</div> <div style="text-align: center;">-90 deg</div> <div style="text-align: center;">+90 deg</div> </div> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">1</div> <div style="text-align: center;">1</div> <div style="text-align: center;">180 deg</div> <div style="text-align: center;">180 deg</div> </div> </div>
8.	Group Delay variation tolerance	200 ns max in channel, measured over Nyquist bandwidth
9.	Channel Tune / Carrier acquisition time	< 500ms
<b>Table Notes:</b> 1. See Section 5.3.1.2 for the variation in level between adjacent channels		

REQ3305 The OCHD2.1 SHALL use a female "F" connector meeting [SCTE 02] for the RF input.

REQ3306 The "F" connector for RF input on the OCHD2.1 SHALL be labeled "Cable In."

### 5.3.1.1 DOCSIS Downstream Channel

The downstream RF performance parameters for the eCM of the OpenCable Host Device are detailed in [RFIv2.0].

### 5.3.1.2 RF Signal Levels and Adjacent Channel Characteristics

#### 5.3.1.2.1 RF Signal Levels

REQ3307 The OCHD2.1 SHALL be capable of receiving an analog signal with a visual signal level that is within  $\pm 3$  dB of the visual signal level of any adjacent analog channel (within a 6 MHz nominal frequency separation) as specified in [47CFR76].

To determine the adjacent channel characteristics between digital and analog signals, the following information is provided. The nominal relative carrier power levels for analog and digital signals are given by:

Analog channel:	0 dBc (reference level)
256 QAM FAT:	$-5 \pm 2$ dBc
QPSK FDC:	$-8 \pm 5$ dBc
64 QAM FAT:	$-10 \pm 2$ dBc

REQ3308 The OCHD2.1 SHALL be capable of receiving a digital signal with an average RMS signal power that is within  $\pm 6$  dB of its nominal level with respect to the nominal level of the adjacent channel digital or analog signal.

It is noted that the nominal carrier power levels provided above fall within the absolute power range for digital signals, -15 dBmV to +15 dBmV. The nominal analog signal power is measured as the peak envelope power (PEP), which is the average of all the analog RMS carrier power levels measured during horizontal sync level. The nominal digital signal power is measured as the average of all the digital RMS signal power levels.

#### 5.3.1.2.2 Adjacent Channel Characteristics

REQ3309 The OCHD2.1 SHALL be capable of receiving digital and analog signals with Adjacent Channel performance as characterized in Table 5.3-3.

**Table 5.3-3 - Adjacent Channel Characteristics**

	Desired (D) Channel Modulation	Undesired (U) Adjacent Channel Modulation	Worst Case D/U Ratio
1.	Analog NTSC	64-QAM	-1 dB
2.	Analog NTSC	256-QAM	-6 dB
3.	Analog NTSC	QPSK FDC	-6 dB
4.	64-QAM	Analog NTSC	-21 dB
5.	64-QAM	256-QAM	-21 dB
6.	64-QAM	QPSK FDC	-21 dB
7.	256-QAM	Analog NTSC	-16 dB
8.	256-QAM	64-QAM	-11 dB
9.	256-QAM	QPSK FDC	-16 dB
10.	QPSK FDC	Analog NTSC	-22 dB
11.	QPSK FDC	64-QAM	-17 dB
12.	QPSK FDC	256-QAM	-22 dB

#### 5.3.1.3 Combined Distortion Characteristics

REQ3310 The OCHD2.1 SHALL be capable of receiving digital 64 QAM with characteristics:

REQ3310.1 Level = -10 dBmV on channel 82

REQ3310.2 Interleaver depth of greater than or equal to I=64 (J=2)

REQ3310.3 33 dB C/N

REQ3310.4 -18 dB ghost at 0.5 us

REQ3310.5 25 us burst noise not greater than -15 dBmV at 10 Hz rep rate

REQ3311 The OCHD2.1 SHALL be capable of receiving digital 256 QAM with characteristics:

REQ3311.1 Level = -7 dBmV on channel 82

REQ3311.2 Interleaver depth of greater than or equal to I=64 (J=2)

REQ3311.3 36 dB C/N

REQ3311.4 -18 dB ghost at 0.5 us

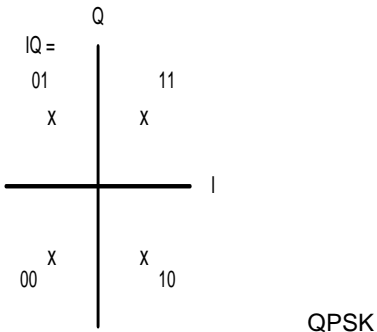
REQ3311.5 16 us burst noise not greater than -12 dBmV at 10 Hz rep rate

### 5.3.2 Upstream Transmission Characteristics

REQ3312 The upstream transmitter of the OCHD2.1 SHALL meet the performance requirements from the combined OpenCable RDC specifications, as specified in Table 5.3-4, and the DOCSIS return channel specifications as specified in [RFIv2.0].

**Table 5.3-4 - Reverse Data Channel RF & Modulation Performance Parameters (0° - 40° C)**

	Parameter	Values for OOB-RDC
1.	Transmission Rate	1.544/3.088 Mbps [SCTE 55-2] 256 Kbps [SCTE 55-1]
2.	Output Channel Spacing	1.0/2.0 MHz [SCTE 55-2] 192 KHz [SCTE 55-1]
3.	Modulation type	Differentially-Encoded QPSK only
4.	RF Output Frequency Range	5 MHz to 42 MHz edge-to-edge
5.	Frequency Step Size Granularity (Note 1)	2 KHz
6.	Frequency Accuracy	+/- 50 ppm
7.	Differential Encoding	The differential encoder SHALL accept bits (A, B) in sequence and generate phase changes as follows:  A   B   Phase Change default    alternative  0   0   none        none  0   1   +90 deg    -90 deg  1   0   -90 deg    +90 deg  1   1   180 deg    180 deg

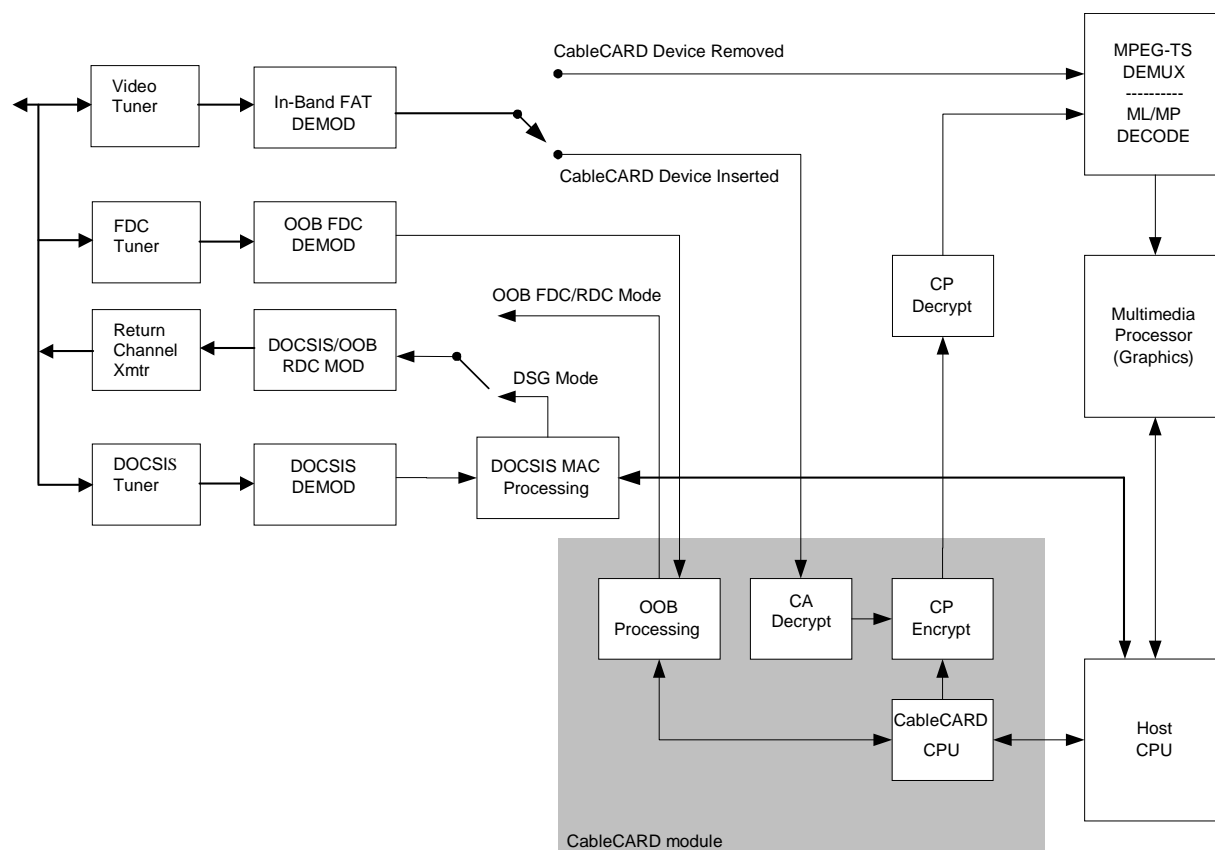
	Parameter	Values for OOB-RDC
8.	Quadrant Mapping	
13.	I/Q amplitude imbalance	< 1 dB
14.	I/Q phase imbalance	< 2 degree
15.	Transmit level range at Host RF connector.	8 to 57 dBmV
16.	Level step size	< 2 dB
17.	Level absolute accuracy	< +/- 2 dB
18.	Level flatness, 5 - 42MHz	< 2 dB
19.	Spurious outputs, 5 - 42 MHz	< -45 dBc
20.	Harmonic outputs, 10 - 42MHz	< -45 dBc
21.	Out-of-band spurious and harmonics, 54 – 864 MHz	< -37 dBmV
22.	Noise Power Density, as measured +/- $f_w/2$ from center channel frequency, where $f_w$ is the channel spacing. Carrier level > 35 dBmV	> 113 dBc in 1 Hz
23.	Noise Power Density, 5 to 42 MHz when transmitter is idle	< - 105 dBmV (1 Hz) 75 ohms
24.	Return Loss, 75 ohms, 5 to 14 MHz 14 to 26 MHz 26 to 42MHz	> 9 dB > 11 dB > 6 dB

## 6 CABLECARD INTERFACE

The OCHD2.1 provides an interface to the CableCARD Device to facilitate the processing of digital information received over the forward application transport (FAT) channel and the OOB forward data channel (FDC) or the OOB channel using the DOCSIS DSG tunnels [DSG]. The interface between the OCHD2.1 and the Card is described in [CCIF2.0].

REQ3313 The OCHD2.1 SHALL only implement the Host side of the Multi-Stream (M-Mode) CableCARD Interface according to [CCIF2.0].

REQ3836 The OCHD2.1 SHALL be constructed to accommodate CableCARD devices having a physical length that may vary from 85 mm up to and including 102 mm.



**Figure 6–1 - Block Diagram of the OpenCable CableCARD Interface (Informative)**

### 6.1 OpenCable Host Device Functionality without a CableCARD Device

The OCHD2.1 will function without a CableCARD Device and process the analog or digital signals received via the FAT channels directly. The Host will have the following minimum functional characteristics without the CableCARD Device:

REQ3316 When the OCS2.1 is operating without a Card, it SHALL demodulate and output unscrambled analog NTSC audio-visual programming transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].



REQ3317 When the OCT2.1 is operating without a Card, it SHALL demodulate and display unscrambled analog NTSC audio-visual programming transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

REQ3318 When the OCS2.1 is operating without a Card, it SHALL discover, decode and output unscrambled digital standard definition and high definition audio-visual programming conforming to MPEG-2 Main Profile @ Main Level or Main Profile @ High Level and Dolby AC-3 audio as specified in Table 3 of [SCTE 43] and transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

REQ3319 When the OCT2.1 is operating without a Card, it SHALL discover, decode and display unscrambled digital standard definition and high definition audio-visual programming conforming to MPEG-2 Main Profile @ Main Level or Main Profile @ High Level and Dolby AC-3 audio as specified in Table 3 of [SCTE 43] and transported according to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

REQ3320 When the OCS2.1 is operating without a Card, it SHALL discover, decode and output unscrambled digital standard definition and high definition audio-visual programming conforming to AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [SCTE 128] with Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO as referred in this document and transported in adherence to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

REQ3321 When the OCT2.1 is operating without a Card, it SHALL discover, decode and display unscrambled digital standard definition and high definition audio-visual programming conforming to AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [SCTE 128] with Dolby AC-3, E-AC-3, MPEG-1 AUDIO and MPEG-4 AUDIO as referred in this document and transported in adherence to STD, HRC or IRC frequency plans as specified in [CEA-542-B].

REQ3322 When the OCHD2.1 is operating without a Card and is tuned to a digital transport stream containing multiple programs, it SHALL identify each program by the one-part channel number specified in the CVCT delivered in the in-band PSIP [A/65C] stream, if such data is present.

REQ3322.1 Each program SHALL be identified by the two-part channel number if the one-part channel number is not specified in the CVCT.

REQ3323 When the OCHD2.1 is operating without a Card and is tuned to a digital transport stream containing multiple programs, it SHALL identify each program by the two-part channel number specified in the TVCT, in the absence of the CVCT delivered in the in-band PSIP [A/65C] stream, if such data is present.

REQ3324 When the OCHD2.1 is operating without a Card, it SHALL process in-band System and Service Information, for programs that are transported unscrambled, in accordance with section 5.5 of [SCTE 54].

REQ3325 When the OCHD2.1 is operating without a Card, it SHALL NOT use any channel map previously created from OOB data while operating with a Card.

REQ3326 When the OCHD2.1 is operating without a CableCARD Device, it SHALL disable the Reverse Data Channel (RDC) transmit function.

## 6.2 Man Machine Interface (MMI) Support

The OCHD2.1 will be capable of operating in a unidirectional system and will support copy protection in this operational case. As defined in the OpenCable Copy Protection 2.0 Specification [CCCP2.0] for a unidirectional system, the copy protection system performs authorization utilizing the MMI resource.

REQ3327 The OCHD2.1 SHALL support a navigation method to allow user navigation with the MMI resource defined in [CCIF2.0].

## 6.3 Software

### 6.3.1 Middleware

REQ3328 The OCHD2.1 SHALL contain a certified implementation of [OCAP].

### 6.3.2 Software Download

REQ3329 The OCHD2.1 SHALL support the download of a Monolithic Firmware Image [eDOCSIS] according to the transmission and security protocols specified in [OC-CD].

REQ3330 The OCHD2.1 SHALL support upgrade of the following functional components by mechanisms specified in [OC-CD] in a manner that does not compromise the integrity of the separate components:

REQ3330.1 embedded Cable Modem (eCM) code including DSG functionality

REQ3330.2 OCAP implementation including any underlying Operating System (OS)

REQ3330.3 Persistent applications such as the Navigation system

For example, an upgrade to DSG functionality must not effect the behavior of the OCAP environment or persistent applications.

## 6.4 Host MAC Address

The OCHD2.1 is required to have a unique MAC address. The MAC address will be utilized by the headend as a means to associate a requested IP address with the OCHD2.1.

REQ3331 The OCHD2.1 SHALL have a unique 48-bit MAC address.

REQ3331.1 The first 24 bits of the MAC address SHALL consist of an Organizationally Unique Identifier (OUI) assigned to an OCHD2.1 vendor by the IEEE.

REQ3331.2 The remaining 24 bits of the MAC address SHALL consist of a unique 24-bit value that is generated by the OCHD2.1 vendor.

REQ3332 The OCHD2.1 SHALL NOT utilize the MAC address of the IEEE-1394 interface for the MAC address used for IP Unicast support.

## 6.5 Support for Local Time Calculation

REQ3333 The OCHD2.1 SHALL implement calculation of local time by using the following parameters:

REQ3333.1 system\_time with GPS\_UTC\_offset as defined in [SCTE 65]

REQ3333.2 time\_zone\_offset from the Generic Feature Control time\_zone() message

REQ3333.3 daylight\_savings\_control, daylight\_savings\_delta, daylight\_savings\_entry\_time, and daylight\_savings\_exit\_time from the Generic Feature Control daylight\_savings() message

**NOTE:** Similar information may be present in the SCTE 65 daylight\_savings\_time\_descriptor(). Currently SCTE 65 Profile 1 and 2 don't allow daylight\_savings\_time\_descriptor() for this descriptor to be present in the system\_time\_table\_section() message.

REQ3334 The OCHD2.1 SHALL NOT use the daylight\_savings\_time\_descriptor() if received in the system time table as defined in [SCTE 65].

## 6.6 Generic Feature Control Resource Requirements

REQ3908 The OCHD2.1 SHALL include every non-reserved feature ID in table 9.15-2 of [CCIF2.0] each time it sends the feature\_list() APDU to the Card.

REQ3909 The OCHD2.1 SHALL store the generic features listed in Table 6.6-1 in such a way that the OCHD2.1 does not have to query the Card each time the OCHD2.1 needs to know the value of one of the generic features.

REQ3910 If the Card supports a generic feature that is not in Table 6.6-1, the OCHD2.1 SHALL accept the generic feature when sent from the Card in the feature\_parameters() APDU, but is not required to store the value.

**Table 6.6-1 - Generic Features Stored in the Host**

Generic Feature
RF Output Channel
Purchase PIN
Parental Control PIN
Timezone
Daylight Savings Control
AC Outlet
Language
Rating Region
EAS Location Code
VCT_ID
Turn On Channel
Terminal Association
Common Download Group ID
Zip Code
RF Output Channel

REQ3911 The OCHD2.1 SHALL set aside a minimum of 256 bytes to store the terminal association generic feature. REQ3911.1 If the terminal association generic feature is longer than 256 bytes, the OCHD2.1 MAY truncate its value.

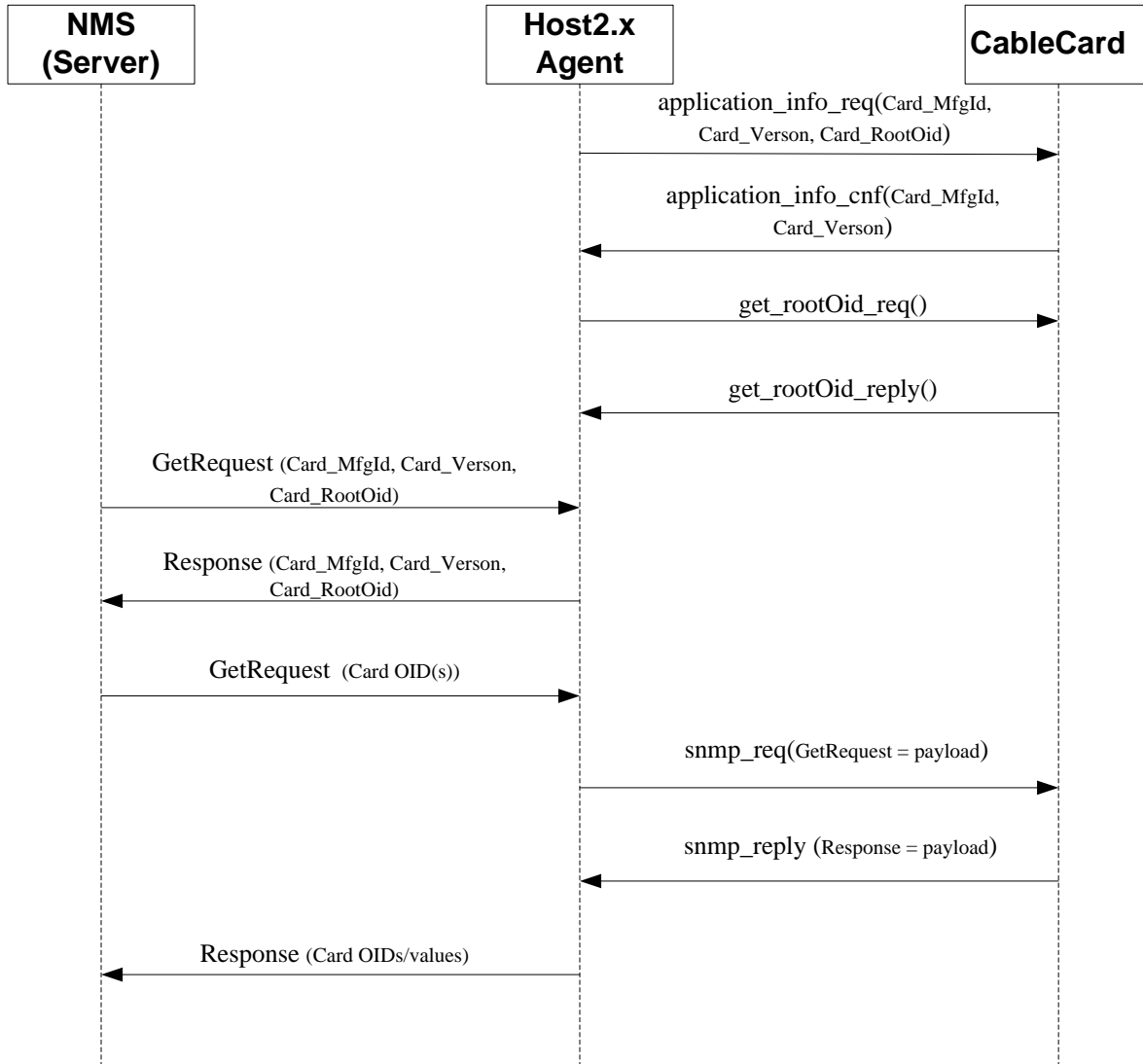
REQ3912 The OCHD2.1 SHALL set aside a minimum of 10 bytes to store the zip code generic feature. REQ3912.1 If the zip code generic feature is longer than 10 bytes, the OCHD2.1 MAY truncate its value.

## 6.7 Card SNMP Message Support

### 6.7.1 Support Functionality (Informative)

The OCHD2.1 provides a limited form of SNMP communication by proxy support (i.e., queries and sets) for Cards. This enables the Card to utilize the OCHD2.1 SNMP agent's communication capabilities with the Network Management System (NMS) to transport vendor-specific diagnostic information to network managers.

Figure 6.7–1 presents the initial flow of a single query, an SNMP GetRequest.



**Figure 6.7–1 - Initial Flow of an SNMP GetRequest**

The data exchange overview follows.

1. During initialization, the Card may open a session to the Card Access MIB resource (not shown here).
2. The Host collects the Card manufacturer/vendor Identifier, version, MAC address, serial number, and manufacturer/vendor private MIB root object identification (OID) for the Card. Note that in some cases the CA

system identifier may be required to resolve the exact Card root OID. This can be found in the Host2.x MIB object, `ocStbHostCASystemIdentifier`.

3. The Host stores the information in the Host2.x MIB. It may be transferred later to the headend via standard SNMP GetRequests.
4. The Headend NMS uses the private Card MIB to form the SNMP queries (GetRequests and GetNextRequests). Note that the Host 2.1 IP address is the PDU destination--not the Card.
5. The Host 2.1 examines the variable-binding list and determines which entries are 1) invalid, 2) objects managed by the Host SNMP Agent, and 3) prefixed by the Card root OID. In this diagram, one or more VARBIND OIDs that match the Card root OID are extracted from the original GetRequest and transferred in the *snmp\_req()* APDU.
6. The Card will build a properly formatted SNMP Response PDU and send it to the Host 2.1 in the *snmp\_reply()* APDU.
7. The Host 2.1 will extract the OID and its value from the Response PDU and add it to the SNMP response that will be sent to the NMS at the headend.

**Note that the Card MIB is not part of the OCHD2.1 Host MIB. Therefore, an SNMP walk of the Host MIB will not include any of the Card MIB OIDs.**

### 6.7.2 Mixed Object Identifier Processing (Informative)

Mixed Object Identifiers<sup>1</sup>, or mixed OIDs, may be contained in a variable-binding list sent to a Host in SNMP queries or modifications. The NMS may send such an SNMP request to the Host and it will expect a single response from the agent regardless of the number of bindings in the request. The agent will examine the variable-binding list and will process each binding as follows.

1. Each object managed directly by the Host agent will be paired with its current value and added to the variable-binding list that will be sent to the NMS in the Response-PDU
2. All objects managed by the Card (i.e., an object in the Card MIB subtree), will be sent in one or more SNMP messages, each encapsulated in the payload of a *snmp\_req()* APDU.
3. The Host will wait a finite period of time for the Card to return the completed variable-binding list in an *snmp\_reply()* APDU.
4. After receiving a reply, the Host adds the Card variable-binding list to the Response-PDU and then sends the Response PDU to the NMS.

An example of a GetNextRequest with mixed OIDs follows.

For the purposes of this example, assume the following MIB objects exist for the Host and the Card.

- Host managed objects: `sysUpTime`, `ocStbCardBindingStatus`
- Card managed objects: `cardStatus`, `cardChannelMap` (note that these are fictitious for demonstrative purposes only)

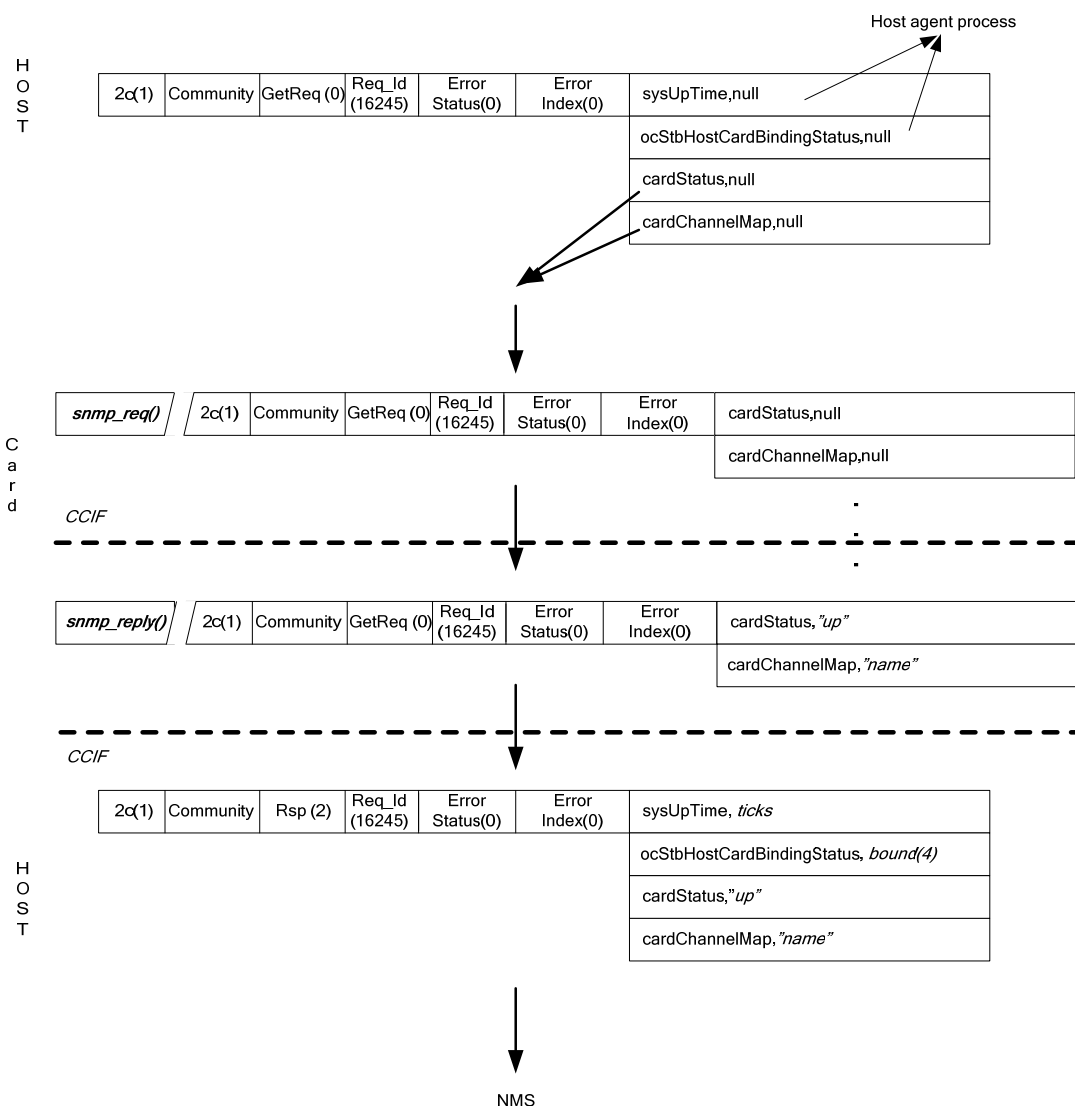
The OID names will be used instead of the ASN.1 encoded values. The SNMP request PDU format is included here to clarify the terms and phrases used throughout this section.

Version	Community	PDU-type	Req_Id	Error Status	Error Index	Variable-Binding List
---------	-----------	----------	--------	--------------	-------------	-----------------------

**Figure 6.7-2 - SNMP Request PDU format**

<sup>1</sup> The Host may receive SNMP messages containing mixed OID requests, which are defined as messages specifying some OIDs destined for the Host and other OIDs destined for the Card.

The NMS sends a GetRequest-PDU to the host for the objects listed above. Figure 6.7–3 represents the three steps required to build and return a Response-PDU.



**Figure 6.7–3 - Example Response-PDU**

- In this example, the Host agent processes the MIB objects it manages.
- The agent identifies the two card objects as part of the Card subtree by comparing the OID prefixes to the ocStbHostCardRootOid. The Host modifies the variable-binding list by reducing it to those OIDs managed by the Card. It encapsulates the GetRequest in the *snmp\_req()* and forwards it to the Card for processing. The Host will wait for the Card's response or a timeout.
- The Card retrieves the values for the OIDs in the GetRequest and returns the completed variable-binding list to the Host in the *snmp\_reply()* APDU.
- The Host combines the variable-bindings from the Card with those it processed for the objects it manages into a single SNMP Response-PDU.

### 6.7.3 GetBulkRequest Processing (Informative)

GetBulkRequest PDUs require more processing by the Host agent on behalf of the Card. Specifically, the agent will convert the GetBulkRequests into GetNextRequests to be sent to the Card. The number of GetNextRequests to be formed and transmitted to the Card is dependent on the GetBulkRequest-PDU fields, *non-repeaters* and *max-repetitions*. Notice in the PDU format in Figure 6.7–4 that the error indicators of the SNMP request/response PDUs have been replaced.

Version	Community	PDU-type	Req_Id	Non Repeaters	Max Repetitions	Variable-Binding List
---------	-----------	----------	--------	---------------	-----------------	-----------------------

**Figure 6.7–4 - GetBulkRequest PDU format**

See [RFC 3416] for the explanation of these fields during normal GetBulkRequest processing by an agent. This proxied GetBulkRequest example demonstrates how these fields will inform the GetNextRequest creation and transmission by the Host agent.

Assume the following in this example.

- The GetBulkRequest variable-binding list is restricted to Card OIDs, although this is not a restriction.
- No errors are encountered by the Host agent or the Card.
- Four Card OIDs in the GetBulkRequest in the variable-binding list. Two OIDs are non-repeaters and two OIDs are subject to max-repetitions (i.e., two "repeaters").
- All Card OIDs in Table 6.7-1 below are demonstrative only and do not reflect any Card manufacturer's implementation.
- Each Table in the example has only one conceptual row instantiated; thus, each GetNextRequest will generate a columnar value instead of multiple instantiations of a single "column".

**Table 6.7-1 - GetBulkRequest example**

Object Name	OID	Value
cardVersion	1.3.6.1.4.1.9876.2.3.1	"1.2.3.a"
cardStatus	1.3.6.1.4.1.9876.2.3.2	"operational"
cardPgmStatusTable	1.3.6.1.4.1.9876.2.3.1.4.6	
cardPgmStatusTableEntry	1.3.6.1.4.1.9876.2.3.1.4.6.1	
cardPgmStatusTableIndex	1.3.6.1.4.1.9876.2.3.1.4.6.1.1	1 (not accessible)
cardPgmStatusProgramNumber	1.3.6.1.4.1.9876.2.3.1.4.6.1.2	33
cardPgmStatusCCI	1.3.6.1.4.1.9876.2.3.1.4.6.1.3	0x00
cardAppTable	1.3.6.1.4.1.9876.2.3.1.4.7	
cardAppTableEntry	1.3.6.1.4.1.9876.2.3.1.4.7.1	
cardAppTableIndex	1.3.6.1.4.1.9876.2.3.1.4.7.1.1	1 (not accessible)
cardAppName	1.3.6.1.4.1.9876.2.3.1.4.7.1.2	"sample"
cardAppStatus	1.3.6.1.4.1.9876.2.3.1.4.7.1.3	"not responding"

Figure 6.7–5 offers a graphic representation of the GetBulkRequest sent by the NMS to the Host.

2c(1)	Community	GetBulk (5)	Req_Id (1673)	Non Repeaters(2)	Max Repetitions (2)	cardVersion,null ▼
						cardStatus,null
						cardPgmStatusTable,null
						cardAppName,null

**Figure 6.7-5 - GetBulkRequest**

The number of GetNextRequests the Host must generate and send to the card is six, based on the following calculation:

Total GetNextRequests =  $N + (M * R)$ , where

N is the minimum of

- the value of the Non-Repeaters field in the request
- the number of variable bindings in the request

M is the Max-Repetitions field of the request.

R is the maximum of

- the total number of variable bindings in the request – N
- zero

The Repeaters count, R, is typically derived by subtracting the number of Non-Repeaters from the total number of OIDs in the GetBulkRequest variable-binding list (i.e., Repeaters = Total # OIDs - Non-Repeaters).

In other words, the Host performs a simple GetNextRequest for the first N variable-bindings in the request and performs M GetNextRequests for each of the remaining R variable-bindings in the request list.

Table 6.7-2 depicts the flow of GetNextRequests that the Host generates and sends to the Card in response to the GetBulkRequest. The message sequence begins *after* receiving the GetBulkRequest from the NMS and ends immediately prior to sending the Response-PDU.

**Table 6.7-2 - Flow of GetNextRequests**

Message	Direction Host--Card	OID	VARBIND Value
GetNext	→	1.3.6.1.4.1.9876.2.3.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.0	"1.2.3.a"
GetNext	→	1.3.6.1.4.1.9876.2.3.2	--
Response	←	1.3.6.1.4.1.9876.2.3.2.0	"operational"
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.1.1	1
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6.1.1.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1	33
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.7.1.2	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1.1	"sample"



Message	Direction Host--Card	OID	VARBIND Value
GetNext	→	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.1.1	--
Response	←	1.3.6.1.4.1.9876.2.3.1.4.6.1.2.2.1	"not responding"

The GetBulkRequest Response-PDU is graphically presented below.

Version 2c(1)	Community	Response (2)	Req_Id (1673)	Error Status (0)	Error Index (0)	cardVersion,"1.2.3.a"
						cardStatus,"up"
						cardPgmStatusProgramNumber,33
						cardPgmStatusCCI,0x00
						cardAppName,"sample"
						cardAppName,"not responding"

**Figure 6.7-6 - GetBulkRequest Response-PDU**

The Response-PDU uses the same Request ID as that contained in the original GetBulkRequest. In addition, the six variable-bindings are returned instead of the four originally received.

#### 6.7.4 Support Requirements (Normative)

**NOTE:** For the purposes of this section, the term "SNMP queries" is interchangeable with SNMP GetRequest and GetNextRequest PDUs. GetBulkRequests require special processing by the OCHD2.1 agent.

REQ3941 The OCHD2.1 SHALL discard any SNMP packet targeted for the Card other than GetRequest, GetNextRequest, GetBulkRequest, and SetRequest PDUs.

REQ3942 The OCHD2.1 agent SHALL format and send GetRequest, GetNextRequest, and SetRequest PDUs to the Card using the *snmp\_req()* APDU as defined in [CCIF2.0].

REQ3943 The OCHD2.1 agent SHALL accept Response-PDUs from the Card using the *snmp\_reply()* APDU.

REQ3944 The OCHD2.1 SHALL determine that the Card supports SNMP message processing if the Card requests that a session be opened to the Card Access MIB resource.

REQ3944.1 The OCHD2.1 SHALL send a *get\_rootOid\_req()* APDU to request the root OID of the Card MIB after the Card has opened a session to the MIB resource. The Card MIB is expected to be defined in the private namespace of the Card manufacturer's MIB.

REQ3944.2 The OCHD2.1 SHALL store the Card root OID in the Host2.x MIB [MIB-HOST].

REQ3944.3 The OCHD2.1 SHALL store a 0.0 for the Card root OID object in the Host2.x MIB [MIB-HOST] until the Card opens a session to the Card Access MIB resource.

SNMP message processing support requires the NMS send all SNMP "queries" and "sets" for either the OCHD2.1 or Card to the OCHD2.1 IP address. Upon receiving each message, the OCHD2.1 determines the final destination(s) of the message by examining the OID(s) in the embedded VARBIND list.

REQ3945 The OCHD2.1 SHALL support SNMPv2c GetRequest, GetNextRequest, GetBulkRequest, and SetRequest PDUs on behalf of the Card.

REQ3946 The OCHD2.1 SHALL send a modified SNMP GetRequest, GetNextRequest, and SetRequest PDUs to the Card on behalf of the NMS if the original message contains mixed OIDs.

REQ3946.1 The OCHD2.1 SHALL send SNMP GetRequest, GetNextRequest, and SetRequest PDUs to the Card encapsulated in an *snmp\_req()* APDU containing only OIDs in the Card's MIB subtree.

REQ3946.2 The OCHD2.1 SHALL combine the VARBIND lists from the OCHD2.1 agent and the *snmp\_reply()* APDU from the Card to create a single SNMP Response-PDU with the same Request ID carried in the original GetRequest, GetNextRequest, or SetRequest PDU. This Response-PDU will be forwarded to the SNMP NMS.

REQ3946.3 The OCHD2.1 SHALL set a response timeout value of five seconds that will be used to determine that a response is not forthcoming from the Card. If a response is not received after sending the request in a period less than this value, the Host will discard the original request.

REQ3947 The OCHD2.1 SHALL process GetBulkRequests on behalf of the Card as follows:

REQ3947.1 The OCHD2.1 SHALL use GetNextRequests to acquire the variable-bindings from the Card.

REQ3947.2 The OCHD2.1 SHALL send a single GetNextRequest to the Card for each Card OID contained in the first N variable-bindings in the GetBulkRequest variable-binding list, where N is defined in Section 6.7.3.

REQ3947.3 The OCHD2.1 SHALL send a sequence of M GetNextRequests for each of the remaining R variable-bindings that contain a Card OID, where M and R are defined in Section 6.7.3.

REQ3947.4 If the Card responds to a GetNextRequest with an "EndofMIBView", the OCHD2.1 SHALL terminate further GetNextRequests for the current repeating sequence.

REQ3947.5 If the Card responds to a GetNextRequest with an error, the OCHD2.1 SHALL send a Response-PDU to the NMS with this error and terminate the GetBulkRequest processing.

REQ3947.6 The OCHD2.1 SHALL combine the GetNext Responses from the Card with any variable-bindings generated by the host SNMP agent as a result of the same GetBulkRequest (e.g., Host2.x MIB objects). The combined variable-bindings list will be sent to the NMS in a single Response-PDU subject to limitations specified in [RFC 3416].

## 7 MULTI-MEDIA INTERFACES

### 7.1 OpenCable Host Device Outputs

The required outputs from the OCS2 are shown schematically in Figure 3.1–1 and detailed below. Some of the outputs shown Figure 3.1–1 are optional for the OCT2.1. Copy protection will be applied as defined in Sections 4.4, 4.5, and 4.6 above. Copy protection signaling is described in the [CCCP2.0].

REQ3335 If the OCS2.1 includes an RF-modulated output, it SHALL be compliant with the following tables: Table 7.3-1, Table 8.3-1, Table 8.3-2, and Table 9.2–1.

REQ3335.1 The default channel setting for the RF-modulated output, if present, SHALL be configurable by the cable operator using the Generic Feature resource defined in [CCIF2.0].

REQ3336 If the OCT2.1 includes a RF-modulated output, it SHALL be compliant with the following tables: Table 7.3-1, Table 8.3-1, Table 8.3-2, and Table 9.2–1.

REQ3336.1 The default channel setting for the RF-modulated output, if present, SHALL be configurable by the cable operator using the Generic Feature resource defined in [CCIF2.0].

REQ3337 If the OCS2.1 includes an RF-modulated output, the output SHALL use a female "F" connector in compliance with [SCTE 02].

REQ3337.1 The connector SHALL be labeled "To TV / VCR".

REQ3338 If the OCT2.1 includes a RF-modulated output, the output SHALL use a female "F" connector in compliance with [SCTE 02].

REQ3338.1 The connector SHALL be labeled "To TV / VCR".

REQ3339 The OCS2.1 SHALL provide composite baseband video compliant with the following tables: Table 8.3-1, Table 8.3-2.

REQ3340 The OCS2.1 SHALL provide L&R baseband audio outputs compliant with the following tables: Table 9.2-2, Table 9.2-3.

REQ3341 If the OCT2.1 includes composite baseband video outputs, it SHALL be compliant with the following tables: Table 8.3-1, Table 8.3-2.

REQ3342 If the OCT2.1 includes L&R baseband audio outputs, it SHALL be compliant with the following tables: Table 9.2-2, Table 9.2-3.

REQ3343 The OCS2.1 SHALL use a female RCA phono connector for composite baseband video output.

REQ3343.1 The RCA phono connector SHALL have a yellow dielectric.

REQ3343.2 The RCA phono connector SHALL be labeled "Video" or "Video Out".

REQ3344 If the OCT2.1 includes a composite baseband video output, it SHALL use a female RCA phono connector.

REQ3344.1 The RCA phono connector SHALL have a yellow dielectric.

REQ3344.2 The RCA phono connector SHALL be labeled "Video" or "Video Out".

REQ3345 The OCS2.1 SHALL include an S-Video output that uses a female 4-pin Mini DIN connector.

REQ3345.1 The 4-pin Mini DIN connector for S-Video output SHALL be labeled "S-Video".

REQ3346 If the OCT2.1 includes an S-Video output, it SHALL use a female 4-pin Mini DIN connector.

REQ3346.1 The 4-pin Mini DIN connector for S-Video output SHALL be labeled "S-Video".

REQ3347 The OCS2.1 SHALL use female RCA phono connectors for L & R audio outputs.

REQ3347.1 The RCA phono connector for the right audio output SHALL have a red dielectric.

REQ3347.2 The RCA phono connector SHALL be labeled to indicate the function of right audio output, for example: "R", "Right" or "Right Audio".

REQ3347.3 The RCA phono connector for the left audio output SHALL have a white dielectric.

REQ3347.4 The RCA phono connector SHALL be labeled to indicate the function of left audio output, for example: "L", "Left" or "Left Audio".

REQ3348 If the OCT2.1 includes L & R audio outputs, it SHALL use female RCA phono connectors.

REQ3348.1 The RCA phono connector for the right audio output SHALL have a white dielectric.

REQ3348.2 The RCA phono connector SHALL be labeled to indicate the function of right audio output, for example: "R", "Right" or "Right Audio".

REQ3348.3 The RCA phono connector for the left audio output SHALL have a white dielectric.

REQ3348.4 The RCA phono connector SHALL be labeled to indicate the function of left audio output, for example: "L", "Left" or "Left Audio".

REQ3349 The OCS2.1 SHALL use a female RCA phono connector, [IEC 61937] optical connector or both, for the S/P DIF audio output.

REQ3349.1 The connector for the S/P DIF audio output SHALL be labeled to indicate the function; for example "Digital Audio Output".

REQ3350 If the OCT2.1 includes a S/P DIF audio output, it SHALL use a female RCA phono connector, an [IEC 61937] optical connector or both.

REQ3350.1 The connector for the S/P DIF audio output SHALL be labeled to indicate the function; for example "Digital Audio Output".

REQ3351 The OCS2.1 SHALL provide at least one 4-pin or 6-pin standard IEEE-1394 connector operated as a source device.

REQ3352 The OCT2.1 SHALL provide at least one 4-pin or 6-pin standard IEEE-1394 connector operated as a sink device.

REQ3837 If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-48 PES data as defined in [SCTE 127] is included in the PES data field.

REQ3838 If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-96 PES data as defined in [SCTE 127] is included in the PES data field.

REQ3839 If the OCS2.1 includes the ability to generate VBI lines as per [CEA-516], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the NABTS PES data as defined in [SCTE 127] is included in the PES data field.

REQ3840 If the OCS2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the TVG2X PES data as defined in [SCTE 127] is included in the PES data field.

REQ3841 If the OCS2.1 includes the ability to generate VBI lines as per [SMPTE 12M], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the VITC PES data as defined in [SCTE 127] is included in the PES data field.

REQ3842 If the OCS2.1 includes the ability to generate VBI lines as per [IEC 61880], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the Copy Protection data as defined in [SCTE 127] is included in the PES data field.

REQ3843 If the OCS2.1 generates VBI lines as per [IEC 61880] resulting from the presence of [SCTE 127] Copy Protection data, it SHALL include the 2-bit aspect ratio and display format as per [IEC 61880].

REQ3844 If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-48 PES data as defined in [SCTE 127] is included in the PES data field.

REQ3845 If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the AMOL-96 PES data as defined in [SCTE 127] is included in the PES data field.

REQ3846 If the OCT2.1 includes the ability to generate VBI lines as per [CEA-516], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the NABTS PES data as defined in [SCTE 127] is included in the PES data field.

REQ3847 If the OCT2.1 includes the ability to generate VBI lines as per [CEA-2020], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the TVG2X PES data as defined in [SCTE 127] is included in the PES data field.

REQ3848 If the OCT2.1 includes the ability to generate VBI lines as per [SMPTE 12M], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the VITC PES data as defined in [SCTE 127] is included in the PES data field.

REQ3849 If the OCT2.1 includes the ability to generate VBI lines as per [IEC 61880], it SHALL generate said VBI lines on the NTSC outputs when [SCTE 127] is present and the Copy Protection data as defined in [SCTE 127] is included in the PES data field.

REQ3850 If the OCT2.1 generates VBI lines as per [IEC 61880] resulting from the presence of [SCTE 127] Copy Protection data, it SHALL include the 2-bit aspect ratio and display format as per [IEC 61880].

## 7.2 OpenCable Host Input Devices

REQ3353 The OCHD2.1 SHALL be supplied with at least one input device with the following characteristics:

REQ3353.1 The input device SHALL support all of the required keys identified in [OCAP] Table 25-5.

REQ3353.2 The four required function keys SHALL be identified as shown in Table 7.2-1.

REQ3353.3 The keys corresponding to certain KeyEvents SHALL be labeled as shown in Table 7.2-2.

**Table 7.2-1 - Function Key Shapes and Colors**

Function Key	Shape	Color
Function Key 0	Circle	Red: Pantone 200
Function Key 1	Diamond	Green: Pantone 355
Function Key 2	Square	Blue: Pantone 300
Function Key 3	Triangle	Yellow: Pantone 803

**Table 7.2-2 - Key Event Labels**

KeyEvent	Key Label
VK_ENTER	Select
VK_GUIDE	Guide
VK_MENU	Menu
VK_INFO	Info
VK_EXIT	Exit
VK_LAST	Last
VK_NEXT_FAVORITE_CHANNEL	Favorite
VK_ON_DEMAND	On Demand

REQ3354 The OCHD2.1 SHALL provide support for a wireless keyboard using one of the following options:

REQ3354.1 Option 1: Supply a wireless keyboard that meets all the requirements specified in REQ3353 and supports all the keys identified in [OCAP] Table 25-6.

REQ3354.2 Option 2: Do not supply a keyboard and provide details on either: a) The exact codes and protocol that are used by the wireless receiver in the Host device, with a release that allows 3rd party vendors to build a compatible keyboard that supports all the keys identified in [OCAP] Table 25-6, or b) Identify the licensable wireless protocol that 3rd party vendors can implement (with or without disclosing the details of the codes and protocols) that supports all the keys identified in [OCAP] Table 25-6.

REQ3940 If the wireless keyboard is the only input device supplied with the OCHD2.1, then it SHALL meet all the requirements specified in REQ3353.

**NOTE:** Regardless of which option is chosen, at least one functional wireless keyboard must be provided with the OCHD2.1 at the time of submission for certification testing.

### 7.3 RF Output Requirements (Channel 3/4 RF Output)

REQ3355 The OCS2.1 SHALL be compliant with the Channel 3/4 RF Performance Parameters in Table 7.3-1.

**Table 7.3-1 - Channel 3/4 RF Output Performance Parameters (0° - 40° C)**

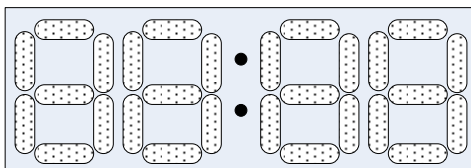
	Parameter	Requirement
1.	RF Output Carrier Frequencies	Channels 3 & 4 STD
2.	RF Output Impedance	75 ohm, unbalanced
3.	RF Output Return Loss	Ch ¾ RF output: 10 dB minimum for either channel
4.	Ch ¾ RF Output Level	+4.5 dBmV to +15 dBmV
5.	Ch ¾ RF Output Level Stability	Not vary more than ±1.5 dB
6.	Output Visual Carrier Frequency Accuracy	Within ±80 kHz or better
7.	Output Video Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-2 to +2 dB, -500 kHz to 3.75 MHz
8.	Terminal Contribution to Output Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-1 to +1 dB, -500 kHz to 3.75 MHz
9.	Output Visual/Aural Carrier Level Difference	Aural carrier is -10 to -17 dB relative to visual carrier level
10.	Output Visual/Aural Carrier Frequency Separation	4.5 MHz, ±5 kHz
11.	Output Depth of Modulation	85%, with variation not more than +5% to -2.5%
12.	Modulation Variation with APL	Not more than ±5%, relative to 50% APL over 10 % to 90% APL range
13.	Conversion Isolation: RF Input to Converted RF Output	65 dB minimum; where isolation is defined here as the ratio between the converted signal and the unconverted signal present at the channel ¾ RF output. This parameter SHALL be met with the output measured on the same frequency as the input of the converter, and applies to all assigned input carrier frequencies over the input level range defined in 5 above.
14.	RF Bypass Isolation	60 dB minimum over the input tuning range (54-864 MHz) when internal RF bypass option is installed
15.	Spurious Emissions within the output channel (channel ¾) bandwidth	Not worse than -60 dBc  Channel loading assumptions: At least 110 AM-VSB channels at input level of +15 dBmV, at least 20 QAM channels at RF input level of +5 dBmV.
16.	Spurious Emissions outside the output channel (other than channel ¾)	Not worse than -10 dBc
17.	AM Hum Modulation	Not greater than 3% p-p

### 7.4 OpenCable Host Front Panel

REQ3356 The OCHD2.1 MAY incorporate a front panel display that is separate from a main video display.

REQ3357 If the OCHD2.1 incorporates a front panel display to support the OCAP Front Panel Extension API, as specified in Annex A of [OC-FPEXT], it SHALL incorporate at least a POWER Display and MESSAGE Display, and at least 4-digit 7-segment display in a format such that time may be displayed and include a colon in the middle of the display.

The following is an example of a 4-digit 7-segment display:



REQ3358 If the OCHD2.1 is designed with a front panel display to support the OCAP Front Panel Extension API and includes RF Bypass functionality, it SHALL incorporate an RF BYPASS display that is active when the RF Bypass is active.

REQ3359 If the OCHD2.1 is designed with a front panel display, the MonitorAppPermission javadoc SHALL contain an additional row in the permissions table as defined in [OC-FPEXT].

frontpanel	Allows use of the front panel API.	Allows an application to get the front panel manager singleton and use the front panel API to modify the front panel display.
------------	------------------------------------	---

REQ3360 If the OCHD2.1 implements the OCAP Front Panel Extension API, the Document Type Definition of the Permission Request File SHALL contain a “frontpanel” entry in the OCAP:MonitorAppPermission element as defined in [OC-FPEXT].



## 8 VIDEO

### 8.1 Analog Video

The OCHD2.1 will be introduced into an environment containing many existing analog set-top devices. The OCHD2.1 will be able to receive analog services that are unscrambled. Analog video and audio will be NTSC-decoded in accordance with current cable-system practice and applicable FCC rules.

#### 8.1.1 Analog Tuning

REQ3361 The OCHD2.1 SHALL have the capability to tune and demodulate NTSC analog channels from 54 to 864 MHz according to the STD, IRC, and HRC channel plans as defined in [CEA-542-B].

REQ3361.1 When switched from one analog channel to another analog channel, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 1.0 second (sec).<sup>2</sup>

REQ3361.2 When switched from one analog channel to another analog channel, the OCHD2.1 SHALL have no interruption lasting longer than 1.0 second (sec) on any analog output.<sup>3</sup>

### 8.2 Digital Video

The OCHD2.1 is required to handle digital transport streams according to the following requirements.

#### 8.2.1 MPEG-2 Transport

REQ3362 The OCHD2.1 SHALL be able to demultiplex and decode a MPEG-2 video (stream type 0x02 or 0x80) within a MPEG-2 transport multiplex compliant to [SCTE 54] containing both MPEG-2 video (stream type 0x02 or 0x80) [SCTE 43] and AVC video (stream type 0x1B) [SCTE 128].

REQ3363 The OCHD2.1 SHALL be able to demultiplex and decode an AVC video (stream type 0x1B) within a MPEG-2 transport multiplex compliant to [SCTE 54] containing both MPEG-2 video (stream type 0x02 or 0x80) [SCTE 43] and AVC video (stream type 0x1B) [SCTE 128].

REQ3364 The OCHD2.1 SHOULD use audio muting and black frames to mask the effect of disruptions and interruptions during all channel changes.

REQ3365 When switched from one analog channel to a reference<sup>4</sup> digital channel, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).<sup>2</sup>

REQ3366 When switched from one analog channel to a reference<sup>4</sup> digital channel, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).<sup>3</sup>

---

<sup>2</sup> With respect to channel changes, the term “disruptions” includes: black frames, picture instability, macroblocking, freeze-frames, audible artifacts including muting.

<sup>3</sup> With respect to channel changes, the term “interruption” includes: loss-of-signal, black-frames, freeze-frames, discontinuities, macroblocking, audible artifacts including muting.

<sup>4</sup> For this requirement a reference signal with a MPEG2 video with GOP structure = 30 frames or a reference signal with an AVC video stream having a SRAP at 1 second intervals will be used. The reference stream will ensure the difference between PTS and PCR for SRAP is less than or equal to 500ms.

REQ3367 When switched between two reference<sup>4</sup> digital channels with same picture resolution within the same multiplex and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.0 seconds (secs).<sup>2</sup>

REQ3368 When switched between two reference<sup>4</sup> digital channels with same picture resolution within the same multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.0 seconds (secs).<sup>3</sup>

REQ3369 When switched between two reference<sup>4</sup> digital channels with different picture resolutions in the same multiplex and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.0 seconds (secs).<sup>2</sup>

REQ3370 When switched between two reference<sup>4</sup> digital channels with different picture resolutions in the same multiplex and same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.0 seconds (secs).<sup>3</sup>

REQ3371 When switched between two reference<sup>4</sup> digital channels with different picture resolutions in different multiplexes and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).<sup>2</sup>

REQ3372 When switched between two reference<sup>4</sup> digital channels with different picture resolutions in different multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).<sup>3</sup>

REQ3373 When switched between two reference<sup>4</sup> digital channels with same picture resolutions in different multiplexes and the same video coding standard, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).<sup>2</sup>

REQ3374 When switched between two reference<sup>4</sup> digital channels with same picture resolutions in different multiplex and the same video coding standard, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).<sup>3</sup>

REQ3375 When switched between two reference<sup>4</sup> digital channels with different video coding standards, the OCT2.1 SHALL be capable of acquiring and displaying signals with no disruption lasting longer than 2.5 seconds (secs).<sup>2</sup>

REQ3376 When switched between two reference<sup>4</sup> digital channels with different video coding standards, the outputs of any OCHD2.1 SHALL have no interruption lasting longer than 2.5 seconds (secs).<sup>3</sup>

REQ3377 The OCHD2.1 SHALL store System Information tables (e.g., NTT, NIT and VCT) required to build the video channel map in non-volatile memory with a minimum storage size of 20 Kbytes.

REQ3851 The OCHD2.1 SHALL store the XAIT table, as defined in [OCAP], in non-volatile memory with a minimum storage size of 16 Kbytes.

### 8.2.2 Digital Video Decoding

REQ3378 The OCHD2.1 AVC decoder SHALL be able to parse and decode the normative elements from [ISO 14496-10] that are specified with constraints in [SCTE 128].

REQ3379 The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional and informative elements from [ISO 14496-10].

REQ3380 The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional and informative elements specified in [SCTE 128].

REQ3381 The OCHD2.1 AVC decoder SHALL be able to parse and process all the 'in-band' normative elements from [ISO 14496-10] Annex D (SEI messages) and Annex E (VUI syntax elements) that are specified with constraints in [SCTE 128].

**Note:** Even though these are optional elements in the AVC specification, which allows applications to convey these elements either in-band or out-of-band, [SCTE 128] mandates transmission of some of these elements in-band.

REQ3382 The OCHD2.1 AVC decoder SHALL be able to parse and process all the normative elements from [ISO 13818-1/Amd 3] that are specified with constraints in [SCTE 128].

REQ3383 The OCHD2.1 AVC decoder SHALL NOT be adversely affected by the presence or absence of optional elements from [ISO 13818-1] (such as data in adaptation headers) that are specified with constraints in [SCTE 128]. These optional elements or information specified in [SCTE 128] may be present for the benefit of AVC receivers that support dedicated applications such as PVR, DPI, VOD, etc.

REQ3384 The OCHD2.1 AVC decoder SHALL be capable of processing AVC bitstreams that have profile\_idc = 100 and the constraints on SPS/VUI/PPS parameters specified in [SCTE 128].

REQ3385 The OCHD2.1 AVC decoder SHALL be capable of processing AVC bitstreams that have profile\_idc(s) = 77 and the constraints on SPS/VUI/PPS parameters specified in [SCTE 128].

REQ3386 The OCHD2.1 SHALL be able to process all of the VUI syntax elements specified in Table 4 of [SCTE 128].

REQ3387 The OCHD2.1 SHALL process AVC streams with the constraints specified in Table 9 of [SCTE 128] and correctly process the no\_output\_of\_prior\_pics\_flag in the IDR picture of sequence after the transition in horizontal resolution only.

REQ3387.1 In all other cases the OCHD2.1 can infer no\_output\_of\_prior\_pics\_flag = 1 and clear the DPB buffer.

REQ3388 The OCHD2.1 AVC decoder SHALL discard any unrecognized SEI payloads encountered in the video bit stream.

REQ3389 The OCHD2.1 SHALL be able to decode all MPEG-2 formats in Table 3 of [SCTE 43].

REQ3390 The OCHD2.1 AVC decoder SHALL be able to decode all AVC formats in Table 9 of [SCTE 128].

REQ3391 The OCHD2.1 SHALL be able to convert the decoded picture to the selected resolution of any supported output interface.

REQ3392 The OCHD2.1 SHALL decode MPEG-2 Main Profile @ Main Level and Main Profile @ High Level per [ISO 13818-2] with the constraints and extensions that apply to video as specified in [A/53].

REQ3393 The OCHD2.1 SHALL decode AVC Main and High Profile @ Level 3.0 and 4.0 as specified in [SCTE 128] with the constraints and extensions that apply to video as specified in Table 9 of [SCTE 128].

REQ3394 The OCS2.1 SHALL decode MPEG-2 video with resolutions shown in Table 3 of [SCTE 43].

REQ3395 The OCS2.1 SHALL decode AVC video with resolutions shown in Table 9 in [SCTE 128].

REQ3396 The OCT2.1 SHALL decode MPEG-2 video with resolutions shown in Table 3 of [SCTE 43] with the following condition: The resolution of the displayed image will be at the option of the OCT2.1 manufacturer.

REQ3397 The OCT2.1 SHALL decode AVC video with resolutions shown in Table 9 of [SCTE 128] with the following condition: The resolution of the displayed image will be at the option of the OCT2.1 manufacturer.

REQ3398 The OCS2.1 SHALL decode MPEG-2 video with aspect ratios listed in Table 3 of [SCTE 43].

REQ3399 The OCS2.1 SHALL decode AVC video with aspect ratios listed in Table 9 of [SCTE 128].

REQ3400 The OCT2.1 SHALL decode MPEG-2 video with aspect ratios as shown in Table 3 of [SCTE 43] with the following conditions:

REQ3400.1 The aspect ratio of the displayed image will be at the option of the OCT2 manufacturer. As a minimum, user options to select letterbox and cropping of pictures that do not match the aspect ratio of the display device SHALL be provided.

REQ3401 The OCT2.1 SHALL decode AVC video with aspect ratios as shown in Table 9 of [SCTE 128] with the following conditions:

REQ3401.1 The aspect ratio of the displayed image will be at the option of the OCT2.1 manufacturer. As a minimum, user options to select letterbox and cropping of pictures that do not match the aspect ratio of the display device SHALL be provided.

REQ3402 The OCHD2.1 MPEG-2 decoder SHALL support decoding of an MPEG-2 Main Profile @ High Level Single Program Transport Stream encoded at a constant bit rate (CBR) of 38.81070 Mbps or variable bit rate (VBR), with peak rates up to 38.81070 Mbps, the maximum payload rate for a 256QAM channel.

REQ3403 The OCHD2.1 AVC decoder SHALL be capable of decoding an AVC Main and High Profile @ Level 3.0 and 4.0 video elementary stream encoded at a maximum bit rate as specified in Annex A of [ISO 14496-10].

**Note:** The bit rate value for the AVC Bitstream is application-dependent and limited by the contiguous bandwidth of the transmission channel. In the application of AVC transmission over a 64-QAM channel, bit rate value, in combination with other components in the MPEG-2 Transport multiplex, conforms to a channel bit-rate of less than or equal to 27.0 Mbps; in transmissions over 256-QAM channels to less than or equal to 38.8107 Mbps.

REQ3404 The OCHD2.1 MPEG-2 decoder SHALL support error concealment to minimize macroblock and stream synchronization errors.

REQ3405 The OCHD2.1 AVC decoder SHALL support error concealment to minimize macroblock and stream synchronization errors.

**Note:** Standard test streams for MPEG-2 and AVC with known errors will be used to evaluate error concealment implementations.

REQ3948 The OCHD2.1 AVC decoder SHALL process `end_of_stream_rbsp()` syntax elements required by applications, such as DPI, where another bitstream follows the `end_of_stream` NAL unit.

REQ3949 The OCHD2.1 AVC decoder SHALL process the bitstream following an `end_of_stream_rbsp()` syntax element. The bitstream following the `end_of_stream` NAL unit will start with an IDR picture in accordance with [SCTE 128], may signal an SRAP (in accordance with [DVS 714]) and may be accompanied by a time base discontinuity.

REQ3950 If the first picture output from the DPB for the following bitstream does not immediately follow the last output picture from the DPB for the stream with `end_of_stream_rbsp()` syntax element, then the OCHD2.1 AVC decoder SHALL repeat the last output picture from the DPB until the first picture from the following bitstream is output from the DPB.

REQ3951 For streams that conform to [SCTE 128]/[DVS 714] where only the horizontal resolution changes in SPS, the OCHD2.1 AVC decoder SHALL NOT infer the `no_output_of_prior_pics_flag` to be '1' when it is set to '0' in the IDR access unit.

REQ3952 The OCHD2.1 AVC decoder SHALL correctly process the `no_output_of_prior_pics_flag` in the IDR access unit that follows the access unit with an `end_of_stream_rbsp()`.

REQ3952.1 If the `no_output_of_prior_pics_flag` is set to '0', then the OCHD2.1 AVC decoder SHALL output all of the decoded pictures in the DPB.

REQ3952.2 If the `no_output_of_prior_pics_flag` is set to '1', then the OCHD2.1 AVC decoder SHALL NOT output and SHALL clear the pictures in the DPB.

In all other cases (such as vertical resolution or frame rate changes in SPS), the OCHD2.1 AVC decoder can infer the `no_output_of_prior_pics_flag` to be '1' even though it is set to '0'.

### 8.2.3 Digital Television (DTV) Out-of-Band Service/System Information

REQ3406 The OCHD2.1 SHALL process out-of-band System and Service Information [SCTE 65] that is sent across the CableCARD interface in Extended Channel data flows, using `Service_type = MPEG_section`, as defined in [CCIF2.0], or sent in a DSG broadcast tunnel that is terminated directly.

REQ3407 The OCHD2.1 SHALL be able to extract the channel map used for program navigation from the System Information tables for all profiles specified in [SCTE 65].

### 8.2.4 Digital Television (DTV) Closed Captioning

REQ3408 The OCS2.1 SHALL extract NTSC closed captioning information when present in the MPEG-2 Picture Level `user_data` as specified in section 4 of [CEA 708C] or as specified in [CEA-608-D] and transported according to [SCTE 21] or [SCTE 20]. This will include all data of `cc_type` 00 and 01, as defined in [CEA 708C].

REQ3408.1 The OCS2.1 SHALL reconstruct the MPEG-2 Picture Level `user_data` on line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

**NOTE:** There may be other closed captioning and extended data structures present in the MPEG-2 Picture Level `user_data`.

REQ3409 The OCS2.1 SHALL extract NTSC closed captioning information when present in AVC stream as specified in [CEA-608-D] and transported according to [SCTE 128].

REQ3409.1 The OCS2.1 SHALL reconstruct line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

REQ3410 If the OCT2.1 includes NTSC analog video outputs, it SHALL extract NTSC closed captioning information, when present in the MPEG-2 Picture Level `user_data`, as specified in section 4 of [CEA 708C], or as specified [CEA-608-D] and transported according to [SCTE 21] or [SCTE 20]. This will include all data of `cc_type` 00 and 01, as defined in [CEA 708C].

REQ3410.1 The OCT2.1 SHALL reconstruct the MPEG-2 Picture Level `user_data` on line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

REQ3411 If the OCT2.1 includes NTSC analog video outputs, it SHALL extract NTSC closed captioning information, when present in the AVC video stream, as specified in [CEA-608-D] and transported according to [SCTE 128].

REQ3411.1 The OCT2.1 SHALL reconstruct line 21 VBI (both field 1 and field 2) according to [CEA-608-D] on all NTSC analog video outputs.

REQ3412 If the OCS2.1 provides analog component video outputs, decoding of NTSC closed captioning data SHALL be provided.

REQ3413 The OCS2.1 SHALL provide decoding of NTSC closed captioning data on uncompressed digital video outputs.

REQ3414 If the OCT2.1 provides analog component video outputs, decoding and display of NTSC closed captioning data SHALL be provided.

REQ3415 The OCT2.1 SHALL provide decoding of NTSC closed captioning data on uncompressed digital video outputs, if present.

REQ3416 The OCS2.1 SHALL extract the Digital Television closed captioning (DTVCC) information when present in the MPEG-2 Picture Level user\_data, as specified in section 9 of [CEA 708C] and delivered according to [SCTE 21] using an extension to the Picture Level user\_data defined in [A/53] (with cc\_type set to '10' or '11').

REQ3417 The OCHD2.1 SHALL pass-through all DTVCC, when present in the MPEG-2 Picture Level user\_data, to the IEEE-1394 interface.

REQ3418 The OCS2.1 SHALL extract the Digital Television closed captioning (DTVCC) information when present in the AVC video stream as specified in [CEA 708C] and delivered according to [SCTE 128].

REQ3419 The OCS2.1 SHALL pass-through to the IEEE-1394 interface any Digital Television closed captioning (DTVCC) information when present in the AVC video stream as specified in [CEA 708C] and delivered according to [SCTE 128].

REQ3420 In the case where an MPEG Picture Level user\_data is transported according to [SCTE 21] or [SCTE 20], the OCHD2.1 MAY use closed captioning data recovered from either standard.

REQ3421 The OCHD2.1 SHALL process the caption\_service\_descriptor, when present, as defined in [A/65C] and carried in either the PMT of the in-band MPEG-2 transport stream or passed across the CableCARD Interface Extended Channel when receiving profile 4, 5 or 6 of [SCTE 65].

### 8.2.5 Digital Television (DTV) Content Advisory Information

To support the interoperable availability of content advisory information for Host Devices and/or CableCARD Devices, OpenCable specifies the use of MPEG-2 Picture Level user\_data found in [SCTE 21], the content\_advisory\_descriptor passed across the CableCARD Interface Extended Channel, or the content\_advisory\_descriptor found in section 6.9.3 of [A/65C]. The syntax follows Table 6.27 in that reference. This descriptor is placed in the Program Map Table (PMT) as permitted in accordance with the standard descriptor mapping for the TS\_program\_map\_section() found in [ISO 13818-1].

The only rating region currently defined for OpenCable use is Region One (value 0x01 for the rating\_region field). Semantics for the coding of the fields found in the PSIP Content Advisory Descriptor follow the rules given in section 6.9.3 of [A/65C].

REQ3422 The OCS2.1 SHALL extract content advisory information formatted as defined in [CEA-608-D] when such information is transported according to [SCTE 21] or [SCTE 20].

REQ3423 If the OCT2.1 includes NTSC analog video outputs, it SHALL extract content advisory information as defined in [CEA-608-D] when such information is transported according to [SCTE 21] or [SCTE 20].

REQ3424 The OCHD2.1 MAY extract content advisory information from the content\_advisory\_descriptor as defined in [A/65C] and [CEA-766-B] when such information is transported in the PMT of the in-band MPEG-2 transport stream or passed across the CableCARD Interface Extended Channel when receiving profile 3, 4, 5 or 6 of [SCTE 65].

REQ3425 The OCS2.1 SHALL pass-through to the IEEE-1394 interface content advisory information, when such information is present in the received digital video stream.

REQ3426 If the OCT2.1 includes an IEEE-1394 interface operated as a source device, it SHALL pass-through to the interface content advisory information, when such information is present in the received digital video stream.

REQ3427 The OCS2.1 SHALL reconstruct line 21 on the NTSC analog video output using the content advisory XDS packet as specified in [CEA-608-D], when such information is present in the received signal.

REQ3428 If the OCT2.1 includes NTSC analog video outputs, it SHALL reconstruct line 21 on the NTSC analog video output using the content advisory XDS packet as specified in [CEA-608-D], when such information is present in the received signal.

REQ3429 If the OCS2.1 includes analog component video outputs, decoding of content advisory information SHALL be provided as required by [47CFR15].

REQ3430 The OCS2.1 SHALL provide decoding of content advisory information on uncompressed digital video outputs.

REQ3431 If the OCT2.1 provides analog component or uncompressed digital video outputs, decoding and display of content advisory information SHALL be provided.

REQ3432 The OCHD2.1 SHALL have *a priori* knowledge of the U.S. RRT (Region Rating Table for Region One) that is defined in [CEA-766-B] (i.e., the table is stored in the OCHD2.1).

REQ3432.1 The U.S. RRT SHALL be the default RRT. It is noted that this approach is consistent with that specified in Annex C.1 of [SCTE 65].

### 8.2.6 Digital Television (DTV) Emergency Alert Service (EAS)

The OCHD2.1 processes emergency messages that utilize the EAS message syntax, which is compatible with MPEG-2 transport and is defined in [SCTE 18]. For in-band transmission, it appears in the transport packet with the same PID as those used for Service/System Information (SI). The table ID for the EAS message is 0xD8 as defined in [SCTE 18]. For out-of-band (OOB) transmission, the EAS message is transmitted according to [SCTE 18].

REQ3433 The OCHD2.1 SHALL process EAS messages, when received, as defined in [SCTE 18].

## 8.3 Video Performance Specifications

REQ3434 The OCHD2.1 SHALL meet all performance requirements for Composite Analog Video Outputs specified in Table 8.3-1.

REQ3434.1 Each line item parameter in Table 8.3-1 SHALL apply to both baseband and RF-modulated output video unless otherwise stated.

**Table 8.3-1 - Composite Analog Video Output Performance Parameters (0 °- 40° C)**

	Parameter	Requirement
1.	Video Standard	NTSC composite, EIA-563
2.	Signal Level (composite video)	1.0 volt peak-to-peak, sync tip (-40 IRE) to reference white (100 IRE) $\pm 10\%$
3.	Long Time Distortion (Bounce)	$\pm 1\%$ , settle in less than 1 second
4.	Field Time Distortion	$\pm 4\%$
5.	Line Time Distortion	Baseband: $\pm 2\%$ , RF Modulated: $\pm 3$
6.	Short Time Distortion	$\pm 6\%$ (Rising and/or Falling)
7.	Chroma to Luminance Gain Inequality	Not more than $\pm 10\%$ (+30% to -50% for OCT2s)
8.	Chroma to Luminance Delay for Baseband Video Output (box only, not including headend and plant)	$\leq 100$ nsec (AM-VSB analog)
9.	Frequency Response for Baseband Video Output (worst case for analog NTSC or digital MPEG input signals)	-2 to +2 dB, 0 kHz to 3.75 MHz (+2 to -6 dB for OCT2s).
10.	Terminal Contribution to Output Frequency Response for RF Output (worst case for analog NTSC or digital MPEG input signals)	-1 to +1 dB, 0 kHz to 3.75 MHz
11.	Luminance Non-Linearity	5% p-p maximum
12.	Chroma Non-Linear Phase Distortion	$\pm 5^\circ$
13.	Chroma Non-Linear Gain Distortion	$\pm 5\%$
14.	Chroma/Luma Intermod	$\pm 3\%$
15.	Differential Gain (over 10% to 90% APL range)	10% peak to peak max. for RF modulated output; 5% peak to peak max. for baseband video output
16.	Differential Phase (over 10% to 90% APL range)	10° peak to peak max. for RF modulated output; 5° peak to peak max. for baseband video output
17.	920 kHz Beat	-52 dBc
18.	Video Signal-to-Noise Ratio (over the full input tuning range)	For RF Modulated Output: 53 dB with a digital input signal and 48 dB with an analog input signal at 0 dBmV (51 dB and 44 dB, respectively, for Terminal Devices). ( <i>Note 1</i> )  For Baseband Video Output: 57 dB with a digital input signal and 49 dB with an analog input signal at 0 dBmV (55 dB and 45 dB, respectively, for Terminal Devices). ( <i>Note 1</i> )
19.	Baseband Video Output Impedance	75 ohm $\pm 10\%$
20.	Baseband Video Output Return Loss	16 dB minimum across video bandwidth
<p><i>Table Notes:</i></p> <p><i>Annex A      Video SNR measured with Unified Weighting filter.</i></p>		

REQ3435 The OCHD2.1 SHALL meet all performance requirements for Analog Video Outputs when processing a digital video source as specified in Table 8.3-2.



**Table 8.3-2 - Analog Video Output Performance when processing a digital video program source (0°- 40° C)**

	Parameter	Requirement
1.	Bar Level (rel. Back Porch)	100 IRE nominal
2.	Sync Polarity	Negative (normal)
3.	Sync Level (rel. Back Porch)	40 IRE $\pm 4$
4.	Color Burst Amplitude	40 IRE $\pm 4$
5.	Color Burst Duration	2.5 microseconds = 9 cycles $\pm 1$ (EIA RS-170)
6.	Front Porch Duration	1.4 microseconds minimum (+4 IRE to -20 IRE)
7.	Sync to Setup Duration	8.5 microseconds minimum (-20 IRE to +4 IRE)
8.	Horizontal Blanking Duration	10.9 microseconds, $\pm 0.3$ microseconds (+4 IRE to -4 IRE)
9.	Sync Pulse Duration	4.7 microseconds, $\pm 0.2$ microsecond (50% width)
10.	Sync Pulse Rise Time	140 nsec $\pm 30$ nsec (10% to 90% amplitude)
11.	Equalization Pulse	2.3 microseconds $\pm 0.2$ (50% width)
12.	Vertical Pulse	(H/2 - 4.7 microsecond) $\pm 0.2$ (50% width)
13.	Breezeway Duration	0.6 microseconds
14.	Setup	7.5 IRE

## 8.4 HD Physical Interfaces

In addition to the analog audio and video interfaces defined in Section 7, the OCHD2.1 may have the output interface requirements defined in this section.

### 8.4.1 HD Analog Component Video Interface

REQ3436 If analog component video outputs are present, the OCHD2.1 SHALL comply with [CEA-770.3-C] and employ three RCA Phono jack connectors as designated in section 10 of [CEA-770.3-C] and labeled as in Table 8.4-1.

**Table 8.4-1 - Connector Color Code Assignment**

Signal Assignment (Label)	Color Code
Y	Green
Pb	Blue
Pr	Red

REQ3437 If analog component video outputs are present on the OCHD2.1, a user controlled selection switch (hardware or software) SHALL be provided to allow the user to match the HD output format with the chosen display.

### 8.4.2 Uncompressed Digital Video Interface

REQ3438 The OCS2.1 SHALL provide support for an uncompressed digital video interface (output) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

REQ3438.1 If the OCS2.1 includes a DVI output, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

REQ3438.2 If the OCS2.1 includes an HDMI output, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

REQ3439 The OCT2.1 SHALL provide support for an uncompressed digital video interface (input) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

REQ3439.1 If the OCT2.1 includes a DVI input, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

REQ3439.2 If the OCT2.1 includes an HDMI input, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

REQ3440 The OCT2.1 MAY provide support for an uncompressed digital video interface (output) using either Digital Visual Interface [DVI] or High-Definition Multimedia Interface [HDMI].

REQ3440.1 If the OCT2.1 includes a DVI output, it SHALL use a female DVI-D connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [DVI].

REQ3440.2 If the OCT2.1 includes an HDMI output, it SHALL use a female HDMI connector, which at a minimum supports the Single Link Transmission Minimized Differential Signaling as defined in [HDMI].

REQ3441 If the OCT2.1 includes both an input and an output DVI and/or HDMI connector, then each connector SHALL be labeled to indicate whether it is a input or output.

REQ3442 The OCHD2.1 SHALL employ the HDCP encryption system on the DVI or HDMI interface as defined in [HDCP].

REQ3442.1 The OCHD2.1 SHALL enable HDCP encryption at all times when video is transmitted over the DVI or HDMI interface.

REQ3442.2 If HDCP authentication fails, then the OCHD2.1 SHALL NOT transmit video over the DVI or HDMI interface, excluding any alerts generated by the device informing the user of the condition.

**Note:** Continued transmission of a blank video field over the DVI or HDMI interface for the purpose of muting video in this case is acceptable.

### 8.4.3 IEEE-1394 Digital Interface

REQ3443 The IEEE-1394 interface on the OCS2.1 SHALL include:

REQ3443.1 copy protection as defined in Section 4.5

REQ3443.2 compliance with section 4.1, Initialization and Configuration, and section 4.2, AV/C Discovery Process, of [SCTE 26]

REQ3443.3 Analog / Digital source selection function as defined in sections 4.11 and 6.1 of [CEA-775-B], unless the Host Device supports requirement REQ3446

REQ3443.4 support for [CEA-931-B] PASS THROUGH control commands: tune function, mute function, and restore volume function

REQ3443.5 support for the POWER control commands (power on, power off, and status inquiry) defined in [AV/C]

REQ3444 The IEEE-1394 interface on the OCT2.1 SHALL include:

REQ3444.1 copy protection as defined in Section 4.5

REQ3444.2 compliance with section 4.1, Initialization and Configuration, and section 4.2, AV/C Discovery Process, of [SCTE 26]

REQ3444.3 bit-mapped graphics support (profile 0b) as defined in Section 4.3.5 of [SCTE 26]

REQ3444.4 all normative elements of [CEA-775-B]

REQ3444.5 Analog / Digital source selection function as defined in Sections 4.11 and 6.1 of [CEA-775-B]

REQ3445 Any OCHD2.1 that supports IEEE-1394 source functionality but does not include an MPEG-2 encoder with the ability to encode graphics or user interface messages for delivery over the interface, SHALL do a verification of the External Jack Selection function, as defined in [SCTE 26], on any sink device connected to an isochronous output plug of the device.

REQ3445.1 If the connected sink device does not support the External Jack Selection function and it is determined that the sink device is a display device (TV/monitor), the OCHD2.1 SHALL disconnect the isochronous output plug preventing isochronous MPEG-2 streams to that sink device.

REQ3445.2 If the OCHD2.1 disconnects the isochronous output plug to the sink device, it SHALL refuse any further connections to that device and update the status of the IEEE-1394 Port Status - A/D Source Selection status as defined in Section 11.1.10.

REQ3445.3 If the connected sink device supports the External Jack Selection function and either the OCHD2.1 or the sink device does not support On-Screen Display (OSD) over the interface, the OCHD2.1 SHALL utilize the External Jack Selection function to switch the sink device to an analog input port when delivery of user interface messages is required.

**Note:** User interface messages include, at a minimum, Diagnostic Screens, MMI and EAS alerts.

**Note 1:** This requirement regarding digital output to display devices places no restriction on the functionality of the 1394 port for digital output to non-display devices that may be on the same 1394 bus such as a digital VCR.

**Note 2:** Support for OSD over IEEE-1394 is optional. In the event that the source device does support OSD and the source device determines that the sink device also supports OSD, then the use of the External Jack Selection function is not required.

REQ3446 If an OCHD2.1 supports IEEE-1394 source functionality and includes an MPEG-2 encoder, then it SHALL be designed to encode analog services for delivery over the 1394 interface as a single program transport stream.

REQ3447 If an OCHD2.1 supports IEEE-1394 source functionality and includes an MPEG-2 encoder that is designed such that it has the ability to encode graphics, then the device SHALL encode any graphics or user interface messaging for delivery over the interface as a single program transport stream.

**Note:** User interface messages includes, at a minimum, Diagnostic Screens, MMI and EAS alerts.

REQ3448 The IEEE-1394 interface (source or sink) on the OCHD2.1 SHALL support the transfer of MPEG-2 single program transport streams (SPTS) via the Isochronous Data Channel (IDC) as specified in section 11 of [CEA-775-B].

REQ3449 The OCS2.1 SHALL support simultaneous local decoding and pass-through to the IEEE-1394 interface compressed standard and high definition MPEG-2 A/V programming.

REQ3450 The OCS2.1 SHALL have the capability to function as the Isochronous Resource Manager (IRM) as defined in section 8 of [IEEE-1394].

REQ3451 The OCS2.1 SHALL have the capability to function as the Cycle Master as defined in section 8 of [IEEE-1394].

## 8.5 Signal Formats

This subsection lists the requirements on an OCHD2.1 with respect to the scanning formats and colorimetry of the HD interfaces.

### 8.5.1 Scanning Formats for the HD Analog Component Video Interface

REQ3452 If analog component video outputs are present on the OCHD2.1, each of the MPEG formats described in Table 3 of [SCTE 43] and AVC formats described in Table 6 of [SCTE 128] SHALL be converted to the selected HD output format on the interface.

REQ3453 If analog component video outputs are present on the OCHD2.1, it SHALL employ the Y', P<sub>B</sub>', P<sub>R</sub>' component format according to section 8 of [CEA-770.3-C].

### 8.5.2 Colorimetry for the HD Analog Component Video Interface

REQ3454 If analog component video outputs are present on the OCHD2.1, the colorimetry SHALL correspond to the requirements in [ITU-R-BT.709-2] and section 5 of [CEA-770.3-C].

REQ3455 If analog component video outputs are present on the OCHD2.1, the MPEG sequence display extension SHALL be observed (when present in the transport stream) to determine when color matrix conversion is necessary.

REQ3455.1 If the MPEG sequence display extension is not included in the transport stream for any standard definition MPEG formats listed in Table 3 of [SCTE 43], the colorimetry SHALL be converted from [SMPTE-170M] to [ITU-R-BT.709-2].

### 8.5.3 Scanning Formats for the DVI/HDMI Interface

REQ3456 The scanning systems supported on the DVI or HDMI output of the OCS2.1 SHALL include all of those identified as mandatory for a source device in [CEA-861-D], except for the 640x480p format, which is optional.

**Note:** Other formats listed in [CEA-861-D] as optional may also be provided.

REQ3457 The DVI or HDMI input of a OCT2.1 SHALL support the mandatory parts of [CEA-861-D] for a sink device.

**Note:** Other formats listed in [CEA-861-D] as optional may also be supported.

REQ3458 The OCS2.1 SHALL convert each of the MPEG formats described in Table 3 of [SCTE 43] to the user selected or preferred format and aspect ratio of the display device connected to the DVI or HDMI output as discovered via the Enhanced Extended Display Identification Data (E-EDID) Detailed Timing Descriptions or the CEA Timing Extensions structure communicated from the display to the host device, as constrained by [CEA-861-D].

REQ3458.1 In the event that the E-EDID data structure or CEA EDID timing extension does not contain a supported timing format or cannot be read, then the DVI or HDMI output SHALL use 640x480p mode, if available.

REQ3458.2 If the OCS2.1 does not support 640x480p mode, then 720x480p mode MAY be utilized, if available.

REQ3458.3 If the OCS2.1 does not support either mode, then the DVI or HDMI output SHALL be disabled.

#### 8.5.4 Video Transmission Format for the DVI/HDMI Interface

REQ3459 If the OCHD2.1 implements a DVI interface, it SHALL employ the RGB component format according to section 5 of [CEA-861-D].

REQ3460 If the OCHD2.1 implements an HDMI interface, it SHALL employ the RGB component format according to [HDMI].

REQ3461 If the OCHD2.1 implements an HDMI interface and analog component interfaces, it SHALL also support the YCbCr format according to [HDMI].

#### 8.5.5 Colorimetry for the DVI/HDMI Interface

REQ3462 The DVI or HDMI interface on the OCHD2.1 SHALL employ the colorimetry requirements according to section 5 of [CEA-861-D].

REQ3463 The OCHD2.1 SHALL observe the MPEG sequence display extension (when present in the transport stream), to determine when color matrix conversion is necessary.

#### 8.5.6 Simultaneous Outputs

REQ3464 All video and graphics of the OCS2.1 (including on-screen displays and set-up menus) MAY be output simultaneously to the composite baseband video output, an analog component video output (if present), and the DVI or HDMI digital output, subject to copy control restrictions. Note that this may require simultaneous output to interfaces that use different color spaces (RGB for DVI and YPrPb for NTSC and HD analog).

REQ3465 The video format of the OCS2.1 analog component video output MAY match that of the DVI or HDMI output.

REQ3466 Standard Definition video received either as an analog or digital signal by the OCS2.1 SHALL be up-converted to support any active High Definition output.

REQ3467 The OCHD2.1 SHALL present any selected and authorized video simultaneously on the composite baseband, S-video and the modulated RF output.

## 9 AUDIO

REQ3468 The OCHD2.1 SHALL be capable of decoding Dolby AC-3 and E-AC-3 audio in accordance with [A/52B] as constrained per [A/53], with additional data rates up to 448 kbps.

REQ3469 The OCHD2.1 SHALL be capable of decoding MPEG-1 audio [ISO 11172-3] and MPEG-4 audio [ISO 14496-3].

REQ3470 The OCHD2.1 SHALL be capable of decoding MPEG-1 audio and MPEG-4 audio with Sampling Rates of 32 kHz, 44.1 kHz and 48 kHz per decoding constraints specified in Section 6.1.4 of [ETSI TS 101 154 v1.8.1].

REQ3471 The OCHD2.1 SHALL be capable of decoding Dolby AC-3 and E-AC-3 audio with Sampling Rates specified in [A/52B] as constrained per [A/53].

REQ3472 The OCHD2.1 SHALL be capable of decoding MPEG-1 layer I & II audio per decoding constraints specified in sections 6.1.1 – 6.1.6 of [ETSI TS 101 154 v1.8.1].

REQ3473 The OCHD2.1 SHALL be capable of decoding MPEG-1 layer III audio as specified in [ISO 11172-3].

REQ3474 The OCHD2.1 SHALL be capable of decoding MPEG-4 audio per decoding constraints specified in Section 6.4 of [ETSI TS 101 154 v1.8.1].

REQ3475 The OCHD2.1 SHALL present the audio component of selected and authorized digital signals simultaneously on the baseband left and right outputs, the modulated RF output, and the digital outputs for all video compression formats listed in Table 3 of [SCTE 43] and Table 9 of [SCTE 128].

REQ3476 If the OCT2.1 includes audio outputs, it SHALL present the audio component of selected and authorized digital signals simultaneously on the baseband left and right outputs, the modulated RF output, and the digital outputs for all video compression formats listed in Table 3 of [SCTE 43] and Table 9 of [SCTE 128].

REQ3477 The OCS2.1 SHALL present the audio component of selected analog signals on the baseband left and right outputs and the modulated RF output.

REQ3477.1 The audio component MAY be present on the digital outputs.

REQ3478 If the OCT2.1 includes audio outputs, it SHALL present the audio component of selected analog signals simultaneously on the baseband left and right outputs and the modulated RF output, if present.

REQ3478.1 The audio component MAY be present on the digital outputs.

REQ3479 The OCHD2.1 SHALL use the ISO 639 language descriptor, if present in the PMT, as defined in [ISO 13818-1] and constrained by [SCTE 54], to identify the language associated with audio elementary streams.

REQ3480 The OCHD2.1 SHALL be certified by Dolby Laboratories Inc. for Dolby Digital™ decoding.

### 9.1 Audio Performance Specifications

All audio performance requirements are valid over the operational environmental parameters defined in Table 9.2-1, Table 9.2-2, and Table 9.2-3. These parameters apply to all OCHD2.1s with audio outputs.

## 9.2 Music Channel Services

Some music channel services provide both an audio elementary stream and a low frame-rate video elementary stream, typically at the rate of one frame every six seconds with a data rate of 50 kbps. These low frame-rate video elementary streams have the **low\_delay** flag set to "1" in the sequence\_extension(), following the sequence\_header() of the video\_sequence(). The following is from the MPEG-2 Video standard [ISO 13818-2] concerning the use of the **low\_delay** flag.

**"low\_delay** - This flag, when set to "1", indicates that the sequence does not contain any B-pictures, that the frame reordering delay is not present in the VBV description and that the bitstream may contain 'big pictures'.

'Big pictures' are images that may reside in the VBV buffer for longer than two fields. The VBV buffer will be examined periodically before removing the coded picture to prevent buffer underflow. See section C.7 of [ISO 13818-2] for details.

REQ3481 The OCHD2.1 MPEG-2 decoder SHALL be capable of decoding video elementary streams when the low\_delay flag in the video sequence extension is enabled.

REQ3482 The OCHD2.1 AVC decoder SHALL be capable of decoding video elementary streams with the low\_delay flag enabled as referred in [SCTE 128].

REQ3483 The OCS2.1 SHALL meet all audio performance requirements for RF Outputs as specified in Table 9.2-1.

REQ3484 The OCT2.1 SHALL meet all audio performance requirements for RF Output, if present, as specified in Table 9.2-1.

**Table 9.2-1 - RF Output Audio Performance**

	Parameter	Requirement
1.	Modulated Audio Mode	Monophonic or BTSC encoded
2.	Modulation Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	50 kHz peak deviation $\pm 7$ kHz for a digital audio signal of 400Hz at 0dBFS. For analog inputs, the RF output MUST reproduce the original carrier deviation, + or - 10%.
3.	Audio Mute	Minimum 48 dB attenuation

REQ3485 The OCS2.1 SHALL meet all audio performance requirements for Baseband Outputs as specified in Table 9.2-2.

REQ3486 The OCT2.1 SHALL meet all audio performance requirements for Baseband Outputs, if present, as specified in Table 9.2-2.

**Table 9.2-2 - Baseband Audio Output when a Digital Service is Selected**

	Parameter	Requirement
1.	Audio Frequency Response	+/-1 dB from 20 Hz to 20 kHz
2.	Audio Mute	Minimum 60 dB attenuation
3.	Baseband Audio Output Impedance	< 5k ohm for each L&R audio outputs

	Parameter	Requirement
4.	Audio Output Signal Level (as measured into a 100k ohm load)  Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	2.16V p-p to 6.22V p-p with digital levels (0 dBFS), and excluding the effects of dialog normalization and dynamic range compression
5.	Intermodulation Distortion (CCIF method using 4040 Hz and 3960 Hz tones at -14 dBFS input per tone)	0.15% max. referenced to output
6.	Stereo L&R Channel Separation	60 dB min. from 20 Hz to 20 kHz
7.	Stereo L&R Channel Gain Difference	+/- 0.5 dB max. from 20 Hz to 20 kHz, referenced to the left channel response
8.	Stereo L&R Channel Phase Difference	5° max. from 20 Hz to 20 kHz
9.	Total Harmonic Distortion	0.3% max. from 20 Hz to 20 kHz at -10 dB relative to full scale
10.	Audio Signal-to-Noise Ratio  Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	80 dB min., 20 Hz to 20 kHz, with 1 kHz test tone at full scale encoder input, dialog normalization and dynamic range compression disabled, using CCIR- 2k weighting
11.	Audio to Video Transmission Time Difference	± 20 msec max

REQ3487 The OCS2.1 SHALL meet all audio performance requirements for Baseband Outputs as specified in Table 9.2-3.

REQ3488 The OCT2.1 SHALL meet all audio performance requirements for Baseband Outputs, if present, as specified in Table 9.2-3.



**Table 9.2-3 - Baseband Audio Output with Analog Service\***

	Parameter	Requirement
1.	Audio Frequency Response	Mono or BTSC Signal: $\pm 3$ dB from 50 Hz to 13 kHz (50 Hz to 10 kHz for Terminal Devices).
2.	Audio Mute	Minimum 60 dB attenuation.
3.	Baseband Audio Output Impedance	< 5k ohm for each L&R audio outputs.
4.	Audio Output Signal Level (as measured into a 100k ohm load)  Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	Mono Signal: 1.2V p-p, $\pm 10\%$ , with 400 Hz test tone at $\pm 25$ KHz p-p audio subcarrier deviation.  BTSC Signal: 1.2V p-p, $\pm 10\%$ , with 400 Hz test tone at $\pm 12.5$ kHz p-p audio subcarrier deviation for each L&R channel.
5.	Stereo L&R Channel Separation	BTSC Signal: 20 dB min. at 1 kHz.
6.	Stereo L&R Channel Gain Difference	BTSC Signal: $\pm 0.5$ dB maximum from 50 Hz to 13 kHz, referenced to the left channel response.
7.	Stereo L&R Channel Phase Difference	BTSC Signal: $15^\circ$ maximum from 50 Hz to 13 kHz.
8.	Total Harmonic Distortion	Mono and BTSC Signals: 3.5% max. from 50 Hz to 13 kHz.
9.	Audio Signal-to-Noise Ratio  Note: For set-tops with volume control, this spec applies when commanded to "unity" or "nominal" gain	Mono and BTSC: 48 dB min., 50 Hz to 13 kHz, referenced to a 1000 Hz test tone at $\pm 25$ kHz p-p audio subcarrier deviation, CCIR-2k weighting (45 dB min. from 50 Hz to 10kHz for Terminal Devices).
<b>Table Notes:</b>  * Requirements are based on input test signals provided by NTSC and BTSC signal sources RF modulated to Channel 4.		

## 10 OPENCABLE HOST DEVICE POWERING STATES

Once AC power is applied to the OCHD2.1 and the Card is installed and initialized, the OCHD2.1 always has access to network services through the Out-Of-Band channel for network monitoring purposes or for receipt of messages, alarms, or notifications. When the OCHD2.1 is "On" (in a video viewing state), it is fully active and providing services that are displayed on the subscriber's television. When it is in "Standby"(powered on but in a non-viewing state), it still maintains network connectivity and is still consuming power and running the processor, operating system, and navigator shell.

When the OCHD2.1 is disconnected from AC power or from the cable connection, it is not connected to the network. When reconnected, the OCHD2.1 does not have to re-initialize, but will re-establish network connectivity. The AC power up sequence is slightly longer than the "Standby " to "On" sequence.

The operation of the OCHD2.1 in background (Standby) mode is not defined in this document.

### 10.1 CableCARD Background Mode Power Management

REQ3489 The minimum power requirements for OCHD2.1 background (Standby) mode SHALL include the following:

REQ3489.1 The OCHD2.1 OOB receiver (including the embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

REQ3489.2 The OCHD2.1 OOB transmitter (including the embedded cable modem) circuitry SHALL be fully powered when a Card is inserted.

REQ3489.3 The Card SHALL be fully powered when inserted.

## 11 OPENCABLE HOST DEVICE DIAGNOSTICS

REQ3490 The OCS2.1 SHALL be capable of performing self-diagnostics and displaying the following conditions via the LED readout:

REQ3490.1 Power status

REQ3490.2 Boot status

REQ3490.3 Indication of fatal error (e.g., Checksum error)

REQ3491 The OCHD2.1 SHALL be capable of performing self-diagnostics and displaying the following information via the on-screen display (OSD):

REQ3491.1 Power status

REQ3491.2 Boot status

REQ3491.3 Memory Allocation

REQ3491.4 Software Version

REQ3491.5 Firmware Version

REQ3491.6 MAC Addresses

REQ3491.7 Network Addresses

REQ3491.8 Status of FDC

REQ3491.9 Status of FAT

REQ3491.10 Status of RDC

REQ3491.11 Current Channel Status

REQ3491.12 IEEE-1394 Port Status

REQ3491.13 DVI / HDMI Port Status

REQ3491.14 Status of DOCSIS transport channels

REQ3491.15 Home Network Status

REQ3492 The Host SHALL display diagnostics when triggered by the "Exit" key, followed by the "Down" key, followed by a second depression of the "Down" key, followed by the "2" key – that is, "Exit"- "Down"- "Down"- "2".

REQ3492.1 The "Exit" key SHALL be depressed for >2 seconds.

REQ3492.2 The interval between key depressions (e.g., "Down" – "2" ) SHALL NOT exceed two seconds.

REQ3906 The Host SHALL respond to the "Power On/Off" key while displaying diagnostics.

REQ3907 The Host SHALL leave the diagnostics display if there has been no interaction with the display for five minutes.

## 11.1 Diagnostic Parameters

The following subsections describe the self-diagnostic parameters that are displayed via the OSD and reported to the Card.

### 11.1.1 Memory Allocation

REQ3493 The OCHD2.1 SHALL be capable of displaying and reporting the following memory allocation information:

REQ3493.1 Type of memory being reported (as applicable: ROM, DRAM, SRAM, Flash, HDD, DVD, and NVM)

REQ3493.2 Physical size of memory type (in kilobytes, defined to 1024 bytes)

### 11.1.2 Software Version Number

REQ3494 The OCHD2.1 SHALL be capable of displaying and reporting the following software version information for all available applications:

REQ3494.1 Application name string

REQ3494.2 Application version number

REQ3494.3 Software status (active, inactive or downloading)

REQ3494.4 Application signature (If applicable)

### 11.1.3 Firmware Version

REQ3495 The OCHD2.1 SHALL be capable of displaying and reporting the following firmware version information:

REQ3495.1 Firmware version number of entire firmware image

REQ3495.2 Firmware release or installation date of entire firmware image

#### 11.1.3.1 Firmware Download Status

REQ3496 The OCHD2.1 SHALL be capable of displaying the following firmware download status:

REQ3496.1 Download Status – one of “COMPLETE”, “DOWNLOADING”, “FAILED”

REQ3496.2 Download Fail Status – one of the applicable Error Codes defined in Table 11.1-1

**Note:** Display of Error Code may include additional textual description.

**Table 11.1-1 - Download Fail Status Error Codes**

Error Code	Definition
CDL-ERROR-1	No Failure
CDL-ERROR-2	Improper code file controls - CVC subject organizationName for manufacturer does not match the Host device manufacturer name
CDL-ERROR-3	Improper code file controls - CVC subject organizationName for code cosigning agent does not match the Host device current code cosigning agent.
CDL-ERROR-4	Improper code file controls - The manufacturer's PKCS #7 signingTime value is equal-to or less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-5	Improper code file controls - The manufacturer's PKCS #7 validity start time value is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-6	Improper code file controls - The manufacturer's CVC validity start time is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-7	Improper code file controls - The manufacturer's PKCS #7 signingTime value is less-than the CVC validity start time.
CDL-ERROR-8	Improper code file controls - Missing or improper extendedKeyUsage extension in the manufacturer CVC.
CDL-ERROR-9	Improper code file controls - The cosigner's PKCS #7 signingTime value is equal-to or less-than the codeAccessStart value currently held in the Host device.
CDL-ERROR-10	Improper code file controls - The cosigner's PKCS #7 validity start time value is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-11	Improper code file controls - The cosigner's CVC validity start time is less-than the cvcAccessStart value currently held in the Host device.
CDL-ERROR-12	Improper code file controls - The cosigner's PKCS #7 signingTime value is less-than the CVC validity start time.
CDL-ERROR-13	Improper code file controls - Missing or improper extended key-usage extension in the cosigner's CVC.
CDL-ERROR-14	Code file manufacturer CVC validation failure.
CDL-ERROR-15	Code file manufacturer CVS validation failure.
CDL-ERROR-16	Code file cosigner CVC validation failure.
CDL-ERROR-17	Code file cosigner CVS validation failure.
CDL-ERROR-18	Improper eCM configuration file CVC format (e.g., missing or improper key usage attribute).
CDL-ERROR-19	eCM configuration file CVC validation failure.
CDL-ERROR-20	Improper SNMP CVC format.
CDL-ERROR-21	CVC subject organizationName for manufacturer does not match the Host devices manufacturer name.
CDL-ERROR-22	CVC subject organizationName for code cosigning agent does not match the Host devices current code cosigning agent.
CDL-ERROR-23	The CVC validity start time is less-than or equal-to the corresponding subject's cvcAccessStart value currently held in the Host device.
CDL-ERROR-24	Missing or improper key usage attribute.
CDL-ERROR-25	SNMP CVC validation failure.

#### 11.1.4 MAC Addresses

REQ3497 The OCHD2.1 SHALL be capable of displaying and reporting the following media access control (MAC) address information:

REQ3497.1 Type of device (as applicable: Host, Card, IEEE-1394, USB, eCM)

REQ3497.2 MAC address of each reported device

REQ3497.3 If multiple devices of the same type exist, the MAC address for each device.

#### 11.1.5 Network Addresses

REQ3498 The OCHD2.1 SHALL be capable of displaying and reporting the following network address information:

REQ3498.1 Network address of device

REQ3498.2 If multiple network addresses exist, the network address for each device

#### 11.1.6 Status of FDC

REQ3499 The OCHD2.1 SHALL be capable of displaying and reporting the following forward data channel (FDC) information:

REQ3499.1 FDC center frequency, in MHz

REQ3499.2 Carrier lock status (locked/not locked)

#### 11.1.7 Status of FAT

REQ3500 The OCHD2.1 SHALL be capable of displaying and reporting the following forward application transport (FAT) channel information:

REQ3500.1 Modulation mode; (NTSC, 64 QAM, 256 QAM, or other)

REQ3500.2 Carrier lock status if the currently tuned channel is a digital QAM channel

REQ3500.3 PCR lock status if the currently tuned channel is a digital QAM channel

REQ3500.4 Numeric estimate of the channel's signal to noise ratio, accurate to within 3 dB of the actual received level, in tenths of dB if the currently tuned channel is a digital QAM channel, across an SNR range of 22 dB to 32 dB for 64 QAM and 28 dB to 38 dB for 256 QAM

REQ3500.5 Numeric estimate of the signal level, accurate to within 6 dBmV of the actual received level, in tenths of dBmV (peak level for analog, average level for others) across the RF Input Level Range defined in Table 5.3-1

REQ3500.6 A reported power change in the same direction of not less than 0.5 dB and not more than 2.0 dB for any 1 dB change in input level across the RF Input Level Range defined in Table 5.3-1

REQ3500.7 A reported SNR change in the same direction of not less than 0.5 dB and not more than 2.0 dB for any 1 dB change in SNR, across an SNR range of 22 dB to 32 dB for 64 QAM and 28 dB to 38 dB for 256 QAM

### 11.1.8 Status of RDC

REQ3501 If the return data channel (RDC) is established, the OCHD2.1 SHALL be capable of displaying and reporting the following reverse data channel (RDC) information:

REQ3501.1 RDC center frequency, in MHz

REQ3501.2 RDC transmitter power level, in dBmV

REQ3501.3 RDC data rate (256 kbps, 1544 kbps or 3088 kbps)

### 11.1.9 Current Channel Status

REQ3502 The OCHD2.1 SHALL be capable of displaying and reporting the following current channel information:

REQ3502.1 Channel type; analog or digital

REQ3502.2 Authorization status; OCHD2.1 is authorized or not authorized for currently tuned service

REQ3502.3 Purchasable status; currently tuned service may be purchased

REQ3502.4 Purchased status; currently tuned service is/is not purchased

REQ3502.5 Preview status; currently tuned service is/is not in preview mode

REQ3502.6 Parental control status, if utilizing parental control; when currently tuned service is blocked/not blocked via parental control

### 11.1.10 IEEE-1394 Port Status

REQ3503 The OCHD2.1 SHALL be capable of displaying and reporting the following IEEE-1394 Port status information:

REQ3503.1 Loop status (loop/no loop exists)

REQ3503.2 Root status (OCHD2.1 is/is not Root node)

REQ3503.3 Cycle Master status (OCHD2.1 is/is not Cycle Master)

REQ3503.4 A/D Source Selection status (Monitor does/does not support A/D source selection function)

REQ3503.5 Port connection status

Port 1 — connected/not connected

Port 2 — connected/not connected

REQ3503.6 Total number of nodes (devices) connected to IEEE-1394 bus, with the following information for each node: device subunit type, A/D Source Selection Status, and EUI 64.

### 11.1.11 DVI / HDMI Port Status

REQ3504 The OCHD2.1 SHALL be capable of displaying and reporting the following DVI / HDMI Port status information:

REQ3504.1 Connection status (no connection exists, device connected – not repeater, device connected – repeater)

REQ3504.2 Connected device type

REQ3504.3 Connected device color space

REQ3504.4 HDCP status (not enabled/enabled)

REQ3504.5 Host Device HDCP status

non HDCP device

compliant HDCP device

revoked HDCP device

REQ3504.6 Video format

The number of horizontal lines associated with the video format on the DVI / HDMI link

The number of vertical lines associated with the video format on the DVI / HDMI link

The scan rate associated with the video format on the DVI / HDMI link

The aspect ratio associated with the video format on the DVI / HDMI link (4:3, 16:9)

REQ3504.7 Progressive or interlaced video

REQ3504.8 Audio format

Audio format type

Audio sample size

Audio sample frequency

### 11.1.12 Status of DOCSIS transport channels

REQ3505 The OCHD2.1 SHALL be capable of displaying and reporting the following DOCSIS transport channels status information:

REQ3505.1 Downstream center frequency, in MHz

REQ3505.2 Downstream received power level, in dBmV

REQ3505.3 Downstream carrier lock status (locked/not locked)

REQ3505.4 Upstream transmitter center frequency, in MHz



REQ3505.5 Upstream transmitter power level, in dBmV

REQ3505.6 Upstream symbol rate, in Msymbols/sec

REQ3505.7 Upstream modulation type

#### **11.1.13 Home Network Status**

REQ3506 The OCHD2.1 SHALL be capable of displaying and reporting the following Home Network status information, if supported:

REQ3506.1 Maximum number of clients the Host can support

REQ3506.2 Host Digital Rights Management (DRM) capability

REQ3506.3 Number of connected clients

REQ3506.4 Client MAC addresses

REQ3506.5 Client IP addresses

REQ3506.6 Client DRM capability

## 12 MECHANICAL

REQ3507 The OCHD2.1 SHALL be capable of dissipating the heat, while satisfying the requirement of item 15 of Table 12–1, from a Card drawing an average of 2.5 watts across the CableCARD interface if it supports both S-Card and M-Card.

REQ3508 The OCHD2.1 SHALL be capable of dissipating the heat, while satisfying the requirement of item 15 of Table 12–1, from a Card drawing an average of 1.5 watts across the CableCARD interface if it supports M-Card only.

REQ3509 The OCHD2.1 SHALL have a non-removable nameplate(s) or sticker(s) that includes the following information:

REQ3509.1 Vendor ID: 24-bit vendor ID represented as 3 bytes (6 hexadecimal digits)

REQ3509.2 Vendor Name: 40 ASCII characters maximum

REQ3509.3 Serial Number or Serial No: 40 ASCII character maximum

**Note:** Vendor ID should be assigned by CableLabs to ensure uniqueness.

REQ3510 The OCHD2.1 SHALL meet the operational environmental / mechanical requirements as specified in Table 12–1.

**Table 12–1 - Environmental / Mechanical Requirements**

**(Meet all operational specs. without malfunction, or hard or soft failures, under the following)**

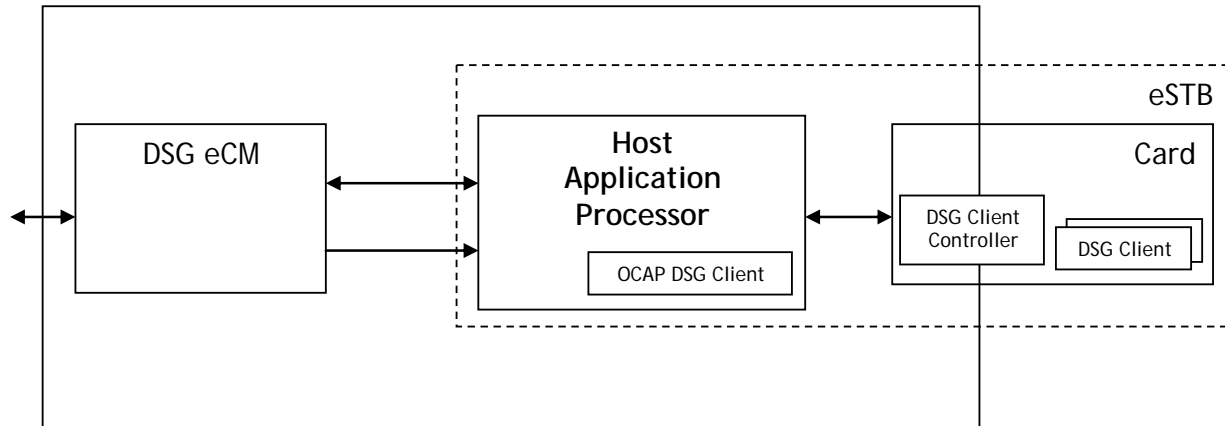
	Parameter	Requirement
1.	Required Compliance	All applicable regulatory requirements including, but not limited to: FCC, UL, CSA, and EIA
2.	Input Line Voltage	95 to 125 volts AC
3.	Input Line Frequency	57 to 63 Hz
4.	Nominal Power Consumption	To be specified in watts by manufacturer
5.	Physical Security/Tampering-Resistance	Secure means of evidencing entry into the security portions of the device
6.	RF Susceptibility	RF field of 2 volts/ meter from 40 MHz to 1 GHz
7.	Radiated RF	[47CFR15] compliant
8.	Conducted	[47CFR15], ANSI C63.4-1992 compliant
9.	Lightning Surge Tolerance	UL 1409 voltage surge test 38.1, UL 1449, IEEE C62.41, IEEE 587 compliant. RF Input: 1.5 kV at 1kV/usec, 60 amp peak; AC line input: 6 kV, oscillatory 0.5 µsec rise time 100 kHz.
10.	Line Surge Test	FCC part 68, UL 1459, CSA compliant. Metallic: 3500 v minimum at 5 µsec max. rise time and 600 µsec min. fall time, 20 joules min. Longitudinal: 6500 v at 5 µsec max. rise time, 600 µsec min. decay time, 30 joules min. Note: Only applies to a Host with a phone return modem.

	Parameter	Requirement
10a.	Line Surge Test	UL 1449 Measured Limiting Voltage test Duty Cycle Test Abnormal Over Voltage Tests.
11.	Power Cross (if Host supports phone modem return)	Metallic: will survive 10 events of 600 v, 10 sec duration and operate. Longitudinal: will survive 10 events of 600 v, 10 sec duration and operate.
12.	Electrostatic Discharge	IEC 801-2, withstand 10 discharges at 15 kV to each corner and center of keypad, through a 150 pf capacitor in series with 150 ohm resistor, with device chassis grounded to ESD generator
13.	Brown Out Effects	No corruption of non-volatile memory due to input voltage fluctuations from nominal to zero volts
14.	Operating Ambient Temperature and Humidity	0° to 40° C and 5% to 95% RH non-condensing humidity (See Note 1)
15.	External Surface Temperature (with 125 vac input applied and device on, 25° C ambient temperature, without internal or external fan)	UL 1409 compliant. No external protruding surface point hotter than 50° C for metallic and 60° C for nonmetallic surfaces. No non-accessible surface point hotter than 65° C.
16.	Storage Temperature (non-powered, non-operating)	-20° to +60° C (See Note 1)
17.	Storage Humidity (non-powered, non-operating)	5% to 95% RH non-condensing at 40° C (See Note 1)
18.	Altitude	Operating: -150 to 10,000 ft. AMSL Storage: -150 to 15,000 ft. AMSL (See Note 1)
19.	Thermal Shock	Device meets all operational specs after subjection to: -40° C. for 30 minutes +25° C. for 10 minute +60° C. for 30 minutes (See Note 1)
20.	Humidity Shock	Mil-std-810d method 507.2 Device meets all operational specs after subjection to: raise temp to +60° C and 95% RH over 26 hrs., maintain for 6 hrs., drop to 85% RH while reducing temp to +30° C over 8 hrs., maintain +30° C and 95% RH for 8 hrs. Repeat for 10 cycles. (See Note 1)
21.	Solvent Resistance	No external surface deformation effect of common household solvents, cleaners, waxes (See Note 1)
22.	Shipping Vibration	Fully operational after subjection to swept frequency vibration test applied in each of x, y, z planes with excursion of 0.3 inches at a frequency varied from 10 to 30 Hz back to 10 Hz done six times within 30 minutes. (See Note 1)
23.	Mounting Feet	No marks or stain to varnished wooden surface after 40° C and 95% RH exposure for 10 days under force of 0.75 kg (See Note 1)
24.	Keypad Keys	Fully operational after subjection to 100,000 cycles of each key through its full travel to closure with a 10- to 12-ounce force applied at 60 times per minute. (See Note 1)

	Parameter	Requirement
25.	Impact Test	Device will not develop any openings creating electrical shock risks after subjection to an impact force of 5 ft. lbs. obtained from a free fall of a 2-inch diameter solid smooth steel sphere weighing 1.18 lbs. (See Note 1)
26.	Static Load on Keypad Keys	No mechanical damages or visible deformation after keypad subjection to a static load of 25 lbs. in the direction of operation of the keys. (See Note 1)
27.	Handling Drop Test	Device fully operational and not develop any openings exposing risk of electrical shock after subjection to one drop on the face of the device from a height of 20 inches onto a 2-inch thick smooth surface concrete floor. (See Note 1)
28.	Strain Relief Test	For permanently attached power supply cords, device will withstand steady pull force of 35 lbs. applied to the cord. (See Note 1)
29.	Non-volatile Memory Battery Life	Batteries used to back up non-volatile memory will have a minimum life of: unplugged: 1.5 yrs storage life @ 60° C or less; powered 8 yrs @ 40° C or less.
30.	Microphonic Shock	Device will remain error- or interference-free (i.e., no audio pops, clicks, no data errors, no video artifacts) when subjected to tapping with a reasonable force by placing device on a hard surface without padding or mats and inducing 20 taps from knuckles, flat hands, fists, finger nails, screwdriver handles, plastic hammers to all external surfaces of the device. (See Note 1)
<p><i>Table Notes:</i></p> <p>1. For OCT2.1s, these parameters are superseded by the manufacturer's specifications.</p>		

## 13 DSG MODE OPERATION

This section details the OpenCable Host 2.1 operation when using the DSG channel for Out-of-Band communication in Advanced DSG mode. There is some overlap between this section and both the DSG and Card interface specifications. This section is not intended to contradict or redefine anything listed in the other specifications.



**Figure 13-1 - Host 2.1 DSG architecture**

In Advanced DSG mode, SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs may be terminated directly in the OCHD2.1 or may be received by the OCHD2.1 via the Extended channel.

REQ3512 In Advanced DSG Mode using Extended Channel resource version 3 or 4, all SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs SHALL be received by the OCHD2.1 via an Extended channel MPEG flow.

In Advanced DSG Mode, the return path is through the DOCSIS upstream channel. In Advanced DSG one-way mode, the DOCSIS return path is not present or has been disabled.

REQ3513 In Advanced DSG Mode using the DSG resource and Extended Channel resource version 5, all SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, and OCAP XAITs SHALL be received directly by the OCHD2.1 directly from the eCM or via an Extended channel MPEG flow as signaled by the Card in the **DSG\_directory()** APDU. In that APDU, `dir_entry_type = 0x01` indicates that the data is provided via DSG directly from the eCM, while `dir_entry_type = 0x02` indicates that the data is provided via an Extended channel MPEG flow.

REQ3514 If the OCHD2.1 receives the `dir_entry_type = 0x01` (ADSG Filter) for SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs in the **DSG\_directory()** APDU, it SHALL use the associated DSG filter to acquire the indicated flow directly from the eCM.

REQ3515 If the OCHD2.1 receives the `dir_entry_type = 0x01` (ADSG Filter) in the **DSG\_directory()** APDU and does not recognize the `dsg_client_id`, it SHALL ignore the ADSG Filter associated with this entry (that is, these parameters are not forwarded to the eCM).

REQ3516 If the OCHD2.1 receives the `dir_entry_type = 0x02` for SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs in the **DSG\_directory()** APDU, it SHALL open an Extended channel MPEG flow for the SI Base PID using the **new\_flow\_req()** APDU to acquire the indicated flow.

REQ3517 If the OCHD2.1 receives SCTE 65 SI messages, SCTE 18 EAS messages, CVTs, or OCAP XAITs over both a DSG Broadcast Tunnel and an Extended channel MPEG flow, the information on the Broadcast Tunnel SHALL take precedence.

On some cable plants, the SCTE 65 Broadcast tunnel might contain more than one Virtual Channel Table designated by different vct\_ids. The Card determines the correct vct\_id and passes this to the OCHD2.1. If the Card does not pass a vct\_id to the OCHD2.1, the device uses a default vct\_id.

REQ3518 The vct\_id sent by the Card in the **DSG\_directory()** APDU SHALL be used by the OCHD2.1 to identify the correct Virtual Channel Table from the SCTE 65 Broadcast tunnel when multiple instances of the VCT are present.

REQ3519 The OCHD2.1 SHALL use the Virtual Channel Table containing the default vct\_id value of zero (0x0000) unless notified by the Card to use a different value.

REQ3520 The OCHD2.1 SHALL use the default vct\_id of zero (0x0000) to identify the Virtual Channel Table after a power cycle or reboot.

In some systems, it might be necessary to use UCID of the DOCSIS upstream channel to facilitate regionalization. The DCD message can contain UCID as a classifier for specific DSG Tunnels.

REQ3521 If a UCID other than 0x00 is included with the **ADSG\_Filter()** table as part of an entry in the **DSG\_directory()** APDU, the OCHD2.1 SHALL use this UCID as a classifier to determine which tunnels to open when the eCM UCID has been acquired.

REQ3521.1 The OCHD2.1 SHALL NOT use UCID as a classifier to determine which tunnels to open when operating in One-Way mode or the eCM UCID is unknown.

REQ3522 If UCID = 0x00 is included with the **ADSG\_Filter()** table as part of an entry in the **DSG\_directory()** APDU, the OCHD2.1 SHALL NOT use UCID as a classifier to determine which tunnels to open.

In Advanced DSG mode, UDP/IP packets delivered directly to DSG clients on the OCHD2.1 may have a multicast IP destination address that does not have the IP multicast address to multicast MAC Address mapping as defined in [RFC 1112]. DSG clients on the OCHD2.1 are expected to disregard any mapping between IP multicast address and Ethernet multicast address and consume all IP packets delivered to the DSG client on the applicable DSG Tunnel(s).

The following messages are used for Advanced DSG mode configuration when a session to the DSG resource has been opened:

- **inquire\_DSG\_mode ()** – The OCHD2.1 can query the Card for the preferred operational mode for the network.
- **set\_DSG\_mode ()** – The Card can inform the OCHD2.1 of the preferred operational mode for the network, either QPSK mode, Advanced DSG mode, or Advanced DSG One-way mode.
- **DSG\_error ()** – The Card can inform the OCHD2.1 of errors that occur while operating in Advanced DSG mode.
- **DSG\_directory ()** – The Card uses the **DSG\_directory()** APDU to pass DSG Advanced Mode configuration parameters.
- **send\_DCD\_info ()** – The Card/OCHD2.1 uses the **send\_DCD\_info()** to pass TLVs contained in the DCD message.
- **DSG\_message ()** – This message is used by the OCHD2.1 to pass the upstream channel ID (UCID) to the Card or to indicate certain eCM operational states.

REQ3523 The eCM in the OCHD2.1 SHALL be implemented according to [RFIv2.0].

REQ3524 The eCM in the OCHD2.1 SHALL comply with the requirements specified in [eDOCSIS].

REQ3525 The OCHD2.1 SHALL implement the eSTB eSAFE (embedded Service/Application Functional Entity) as specified in [eDOCSIS].

REQ3526 The OCHD2.1 SHALL implement the eSTB logical interfaces according to [eDOCSIS].

REQ3527 The OCHD2.1 SHALL NOT implement the DSG Client Controller (DSGCC) function as specified in [DSG].

REQ3528 The eCM in the OCHD2.1 SHALL NOT operate in any DSG mode until the operational mode is established by the DSGCC in the *set\_DSG\_mode()* APDU.

REQ3529 The eCM in the OCHD2.1 SHALL NOT operate in any DSG mode in the absence of a Card, i.e., tunnel packet forwarding disabled.

REQ3530 The eCM in the OCHD2.1 SHALL remain tuned to a valid DSG channel and continue to forward tunnel packets to the eSTB regardless of the state of upstream channel connectivity.

REQ3531 When operating in Advanced DSG Mode, the OCHD2.1 SHALL NOT determine the validity of or make decisions regarding DCD messages received from the eCM except as defined in [DSG].

REQ3534 The OCHD2.1 SHALL support Advanced mode as defined in [DSG].

REQ3535 The OCHD2.1 SHALL provide a packet buffer with a minimum size of 16 kilobytes for receiving DSG tunnel traffic and DCD fragments.

**NOTE:** This buffer is for the temporary storage of packets received by the eCM before they are forwarded across the Card interface. Even though DSG tunnels may be rate-shaped individually to a total of 2.048 Mbps, they are not rate-shaped as an aggregate. This buffer size assumes maximum length packets arriving from eight different tunnels back-to-back plus space for DCD message fragments.

### 13.1 DSG mode selection

1. After initialization, authentication and binding are completed, the OCHD2.1 operates in SCTE 55 mode while the Card downloads a configuration message from the network controller indicating the desired operational mode.
2. The Card prepares for the transfer of DSG tunnel packets over the Extended Channel by issuing the *new\_flow\_req()* APDU to the OCHD2.1 with *service\_type* = 0x03 (DSG). The OCHD2.1 responds with the *new\_flow\_cnf()* APDU with *status\_field* = 0x00 (Request granted) and assigns a unique Flow\_ID regardless of whether the OCHD2.1 is currently operating in the SCTE 55 mode or in any DSG mode and the DSG flow has not been established.
3. If DSG advanced mode is to be established, the Card sends the *set\_DSG\_mode()* APDU to the OCHD2.1 and signals either *Advanced\_DSG\_mode* or *Advanced\_DSG\_One-Way\_mode* depending on whether the upstream transmitter is to be enabled or not.
4. REQ3536 The OCHD2.1 MAY issue the *inquire\_DSG\_mode()* APDU to query the Card as to which operational mode will be used. In either case, eCM initialization will not commence until one of the DSG modes is set by the Card.

REQ3537 Upon receiving the *new\_flow\_req()* APDU with service\_type = 0x03 (DSG), the OCHD2.1 SHALL grant the DSG flow regardless of whether the OCHD2.1 is operating in the SCTE 55 mode or operating in any DSG mode and the DSG flow has not been established.

REQ3538 When the OCHD2.1 sends the *new\_flow\_cnf()* APDU as a response to the *new\_flow\_req()* APDU with service\_type = 0x03 (DSG), the status\_field of the *new\_flow\_cnf()* APDU SHALL only contain the value 0x00 or 0x01.

REQ3539 If the OCHD2.1 receives a *set\_DSG\_mode()* APDU to switch to any DSG mode while operating in the SCTE 55 mode, it SHALL discard any SI data (including the SI tables stored in non-volatile memory acquired when the OCHD2.1 was in SCTE 55 mode), and any EAS data that it received from the Card in the SCTE 55 mode.

REQ3540 If the OCHD2.1 receives a *set\_DSG\_mode()* APDU to switch to SCTE 55 mode or a different DSG mode. while operating in any DSG mode, it SHALL discard any SI data (including the SI tables stored in non-volatile memory), and any EAS data that it received from the Card in the DSG mode.

REQ3541 Upon receipt of a *set\_DSG\_mode()* APDU containing operational\_mode not equal to SCTE 55, the OCHD2.1 SHALL delete any SCTE 55-related Extended channel flows prior to requesting DSG related Extended channel flows.

REQ3542 The OCHD2.1 SHALL terminate the use of the SCTE 55 FDC receiver until a *set\_DSG\_mode()* APDU is received with operational\_mode equal to SCTE\_55.

REQ3543 Upon receipt of a *set\_DSG\_mode()* APDU containing operational\_mode equal to SCTE\_55, the OCHD2.1 SHALL delete any Advanced DSG-related Extended channel flows prior to requesting SCTE\_55 related Extended channel flows.

REQ3544 The OCHD2.1 SHALL terminate the use of the eCM until a *set\_DSG\_mode()* APDU is received with operational\_mode not equal to SCTE\_55.

REQ3545 The OCHD2.1 SHALL verify the IP packet header checksum before sending any DSG packets to the Card over an Extended channel DSG flow.

## 13.2 DSG Advanced Mode Operation

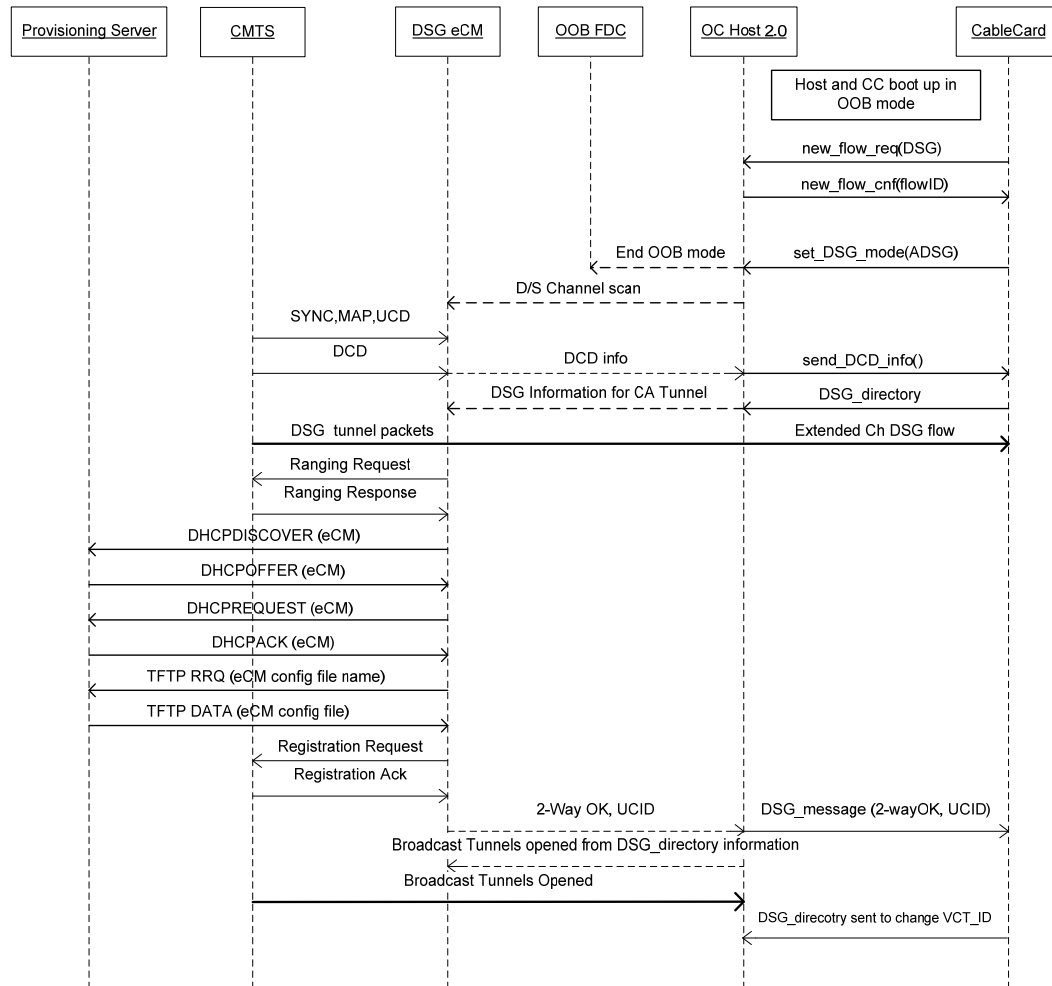
The following steps define the flow of Advanced DSG mode in an OCHD2.1 when using the DSG resource:

1. Once an ADSG operational mode has been established, the OCHD2.1 begins to scan for a valid DSG channel. The DSG eCM downstream scan is identical to the standard DOCSIS scan with the additional requirement that the downstream contain a DCD message.
2. When the eCM finds a DOCSIS channel containing a DCD message, the OCHD2.1 sends the contents of the DCD message to the Card using the *send\_DCD\_info()* APDU. If the Card determines that the downstream channel is valid, it sends the *DSG\_directory()* APDU to the OCHD2.1 containing a list of DSG filters available for OCHD2.1 use, and also a list of DSG filters identifying DSG packets to be forwarded to the Card. The eCM will then remain on the current downstream channel. If the Card determines that the downstream channel is not valid, it sends a *DSG\_error()* APDU to the OCHD2.1 with the error\_status field set to invalid\_dsg\_channel, and the eCM will resume the downstream scan.
3. If the eCM scans the entire downstream spectrum and does not find a DOCSIS channel containing a DCD message, the OCHD2.1 issues the *DSG\_message()* APDU with message\_type 0x03 (Downstream\_Scan\_Completed) to inform the Card that it has done a complete scan. At this point, or at any other time, the Card may switch to another out-of-band mode by issuing a *set\_DSG\_mode()* APDU.



4. As soon as the OCHD2.1 receives the ***DSG\_directory()*** APDU, it can begin forwarding DSG packets to the Card (or terminate DSG packets directly) while the eCM continues the normal DOCSIS initialization sequence.
5. When DOCSIS registration is complete and eCM forwarding is not restricted, the OCHD2.1 indicates to the Card that 2-Way operation is functional by issuing the ***DSG\_message()*** APDU with message\_type 0x01 (2-way OK,UCID).
6. The OCHD2.1 forwards DSG packets requested by the Card across the Extended Channel interface via the DSG flow, if open. If the DSG flow is not open, the packets are to be dropped.
7. REQ3546 After locating a DOCSIS channel containing a DCD message, the OCHD2.1 SHALL pass the initial received DCD message TLVs to the Card using the ***send\_DCD\_info ()*** APDU.
8. REQ3547 After the initial DCD message has been sent using the ***send\_DCD\_info ()*** APDU, the OCHD2.1 SHALL only send the DCD message TLVs when it detects a change in the configuration count change field in the DCD message or detects an eCM MAC layer reinitialization. The DCD message is defined in [DSG].
9. REQ3548 When the UCID has been acquired from the eCM, the OCHD2.1 SHALL use the ***DSG\_message()*** APDU to send the UCID to the Card.
10. OCHD2.1-specific DSG tunnels will be designated in the AD SG\_Filter() table contained in the number\_of\_host\_entries field in the ***DSG\_directory()*** APDU. The Card may send all of the entries defined in the DCD message to the OCHD2.1 or may modify the list it sends.
11. REQ3549 In case of a shortage of network resources, the OCHD2.1 SHALL give priority to the AD SG\_Filters specified as Card entries in the ***DSG\_directory()*** APDU.
12. REQ3550 If the default UCID = 0x00 is included with the AD SG\_Filter() table as part of an entry in the ***DSG\_directory()*** APDU, the OCHD2.1 SHALL open this tunnel if the eCM UCID is not known or the host device is running in Advanced One-Way Mode. If the Host cannot find its UCID in the list of tunnels in the DSG\_directory, the Host is expected to open the default tunnel. When UCID is used as a classifier in a DSG Rule, it is expected that a default rule, with a lower priority that does not use UCID as a classifier, will be present in the DCD message as defined in [DSG].
13. REQ3551 The OCHD2.1 SHALL send a ***DSG\_message ()*** APDU with a message type of eCM Reset whenever the eCM enters the "Continue scanning for DSG Channel" state as shown in Figure 5-4 of [DSG]. This ensures the DSG-CC on the Card will react to a ***send\_DCD\_info ()*** APDU generated by the OCHD2.1 from the DCD of the new downstream, even if the Configuration Change Count (CCC) field happens to contain the same value as the Configuration Change Count (CCC) from the old downstream's DCD.

The following figure is an example of the initial message exchange between the Card and the OCHD2.1 for Advanced Mode Operation:



**Figure 13.2–1 - Sample Advanced Mode Message Flow (Informative)**

### 13.3 Broadcast Tunnels

The OpenCable use of the term "Broadcast Tunnel" describes a DSG Tunnel that is always connected and may be consumed directly by the OCHD2.1, if present. Currently there are three defined types of Broadcast Tunnels; SCTE 65, SCTE 18 and tunnels containing CVTs and/or OCAP XAITs. SCTE 65 Broadcast Tunnels contain data associated with the SCTE 65 specification for Service Information. SCTE 18 Broadcast Tunnels contain data associated with the SCTE 18 specification for Emergency Alert Messages. Other Broadcast Tunnels contain the OCAP XAIT messages that signal unbound applications and Common Download Code Version Tables that signal OCHD2.1 code image upgrade. Each of these tunnel types carries a specific type(s) of industry-standard data and do not contain any other data types. The data in these tunnels are delivered as MPEG sections within a UDP packet and use the BT header as defined in [DSG]. These tunnels may be processed directly by the OCHD2.1.

**NOTE:** [DSG] defines a "Broadcast Client ID" type. The OpenCable "Broadcast Tunnels" are associated with specific DSG Broadcast Client ID values. [DSG] may also define additional Broadcast Client IDs which are not associated with OpenCable "Broadcast Tunnels".

## 13.4 Application tunnels

Application Tunnels are DSG tunnels that carry data flows intended for applications running on the OCHD2.1 or carry operational code file images to upgrade the software of the OCHD2.1. Application Tunnels may contain DSMCC Object or Data Carousels or application specific data formats. If the Application Tunnel contains a Data Carousel (Common Download) or an Object Carousel (OCAP), the stream will use the DSG Carousel Header as part of the MPEG section/UDP structure as defined in [DSG].

One method for OCAP applications to request and receive application tunnels is described below.

1. The OCAP application registers with the OCHD2.1 by providing its textual name (source\_name) through the appropriate OCAP API.
2. Assuming that the OCHD2.1 has already received the SCTE 65 Network Text Table (NTT) delivered directly over a DSG Broadcast tunnel or via the Extended Channel, the source\_name\_subtable (SNS) is parsed for all mappings between source\_name() and application\_id. Using the SNS, the OCHD2.1 makes an association between the textual\_name provided by the OCAP application and an application\_id.
3. The DSGCC parses the DCD message for all DSG Rules and issues the *DSG\_directory()* APDU. The OCHD2.1 will parse the directory for desired application\_ids for the DSG Classifier parameters (MAC address, Source/Dest IP address, TCP/UDP Port address). REQ3552 The OCHD2.1 SHALL ignore any parameters passed in the *DSG\_directory()* APDU associated with application\_ids it does not recognize (i.e., these parameters are not forwarded to the eCM).
4. For application\_ids that the OCHD2.1 recognizes, the device forwards the addresses to the eCM, which begins filtering the desired DSG tunnel packets based on MAC address / DSG Classifier Parameters and passing these packets to the OCHD2.1.
5. The OCHD2.1 forwards the DSG Application tunnel data to the OCAP application associated with the application\_id of the DSG tunnel.

## 13.5 IP Unicast and Multicast Flows

This section describes the interaction between the OCHD2.1 and Card when the Card or OCHD2.1 requires two-way IPv4 communication that utilizes an IP Unicast and/or IP Multicast flow that traverses the Card/Host Interface.

This section does not apply to Socket flows or to OCHD2.1s operating in IPv6 mode.

An IP Unicast or IP Multicast flow is only supported when the device acting as the modem is provisioned with an IPv4 address. IP Unicast and IP Multicast flows are not supported when the modem device is provisioned with an IPv6 address. When IPv6 addressing is utilized, Extended Channel Socket Flows must be used.

The Extended Channel supports delivery of IPv4 packets across the Card interface for OCHD2.1s. Both unicast (point-to-point) and multicast (point-to-multipoint) addressing are supported by this protocol. If the OCHD2.1 is in OOB mode, then the Card is the link device and services the IP flow via utilization of the OCHD2.1's RDC and, if able, supplies the OCHD2.1 with an IPv4 address. On request of a *new\_flow\_req()* APDU from the OCHD2.1, the Card responds to the request to open the flow by obtaining an IPv4 address for use by the OCHD2.1. The IPv4 address is returned in the *new\_flow\_cnf()* APDU message.

**Informative Note:** The Card is not required to grant a request for service type IP Unicast when requested by the OCHD2.1.

When in QPSK mode (Card is the link modem) the Card transmits all unicast IPv4 packets received to the assigned OCHD2.1 IPv4 address to the OCHD2.1 when the OCHD2.1 has successfully opened a unicast IP flow. The Card may drop packets when its buffers become full if the OCHD2.1 is unable to absorb the packets as fast as they are being transmitted.

When in QPSK mode and the Card has opened an IP flow to the OCHD2.1, any IPv4 unicast data received from the OCHD2.1 is transmitted to the network if physically possible.

When in QPSK mode, the Card may send broadcast IPv4 data to the OCHD2.1, and the Card may receive broadcast IPv4 packets from the OCHD2.1.

If the Card supports multicast and is in QPSK mode and has granted the OCHD2.1 a multicast IP flow, all IPv4 data to the multicast IPv4 address is transmitted to the OCHD2.1. The Card may drop packets when its buffers become full if the OCHD2.1 is unable to absorb the packets as fast as they are being transmitted.

REQ3553 In DSG mode, the Card resides at the Network Layer, and the OCHD2.1 SHALL utilize its eCM to provide the Data Link Layer to the underlying DOCSIS network.

When the Card needs to utilize the DOCSIS network to transfer IP packets upstream, it first submits a *new\_flow\_req()* APDU to the OCHD2.1 to establish an IP flow to transfer IPv4 packets between the Card and the OCHD2.1's eCM interface. The Card submits its MAC address in its request to the OCHD2.1 for an IP flow. The Card MAY request a Socket flow if it does require a separate IP address.

If the OCHD2.1 grants the new IP flow request, it utilizes DHCP to acquire an IPv4 address for the Card and sends this information, along with the DOCSIS maximum transmission unit (MTU) (1500 bytes for IP packets) to the Card in a *new\_flow\_cnf()* APDU. The OCHD2.1 now opens an IP flow to the Card over the Extended channel.

REQ3554 When operating in any DSG mode (OCHD2.1 is the link modem), the OCHD2.1 SHALL forward packets received from the eCM interface destined to the Card IP address via the granted IP Unicast flow.

REQ3554.1 The OCHD2.1 MAY drop packets when its buffers become full if the Card is unable to absorb the packets as fast as they are being transmitted.

REQ3554.2 The OCHD2.1 MAY drop packets received from the Card if the buffering for these packets is exceeded.

REQ3555 When operating in any DSG mode, the OCHD2.1 SHALL transmit to the network any IPv4 unicast data received from the Card, if physically possible.

REQ3556 When operating in any DSG mode, the OCHD2.1 MAY send broadcast IPv4 packets to the Card, and the OCHD2.1 MAY receive broadcast IP packets from the Card.

REQ3557 When operating in any DSG mode, the OCHD2.1 SHALL grant a multicast IP flow when requested by the Card and transmit all multicast IPv4 packets from the assigned multicast IPv4 address to the Card, if the host device supports IP multicast.

REQ3557.1 The OCHD2.1 MAY drop packets when its buffers become full if the Card is unable to absorb the packets as fast as they are being transmitted.

The OCHD2.1 utilizes the Extended Channel's IP flow to forward certain IPv4 packets it receives over the eCM interface to the Card. The forwarding rules are described in Section 13.5.1.

REQ3558 When operating in any DSG mode and an established IP flow becomes unavailable for any reason, the OCHD2.1 SHALL report this event to the Card using the *lost\_flow\_ind()* APDU.

One example case where a flow may become unavailable is due to a change in the state of the eCM that may have resulted from a change via SNMP to the eCM's operational state.

When in QPSK mode, the Card is the network interface and modem. If the OCHD2.1 requests an IPv4 address, the Card provides an IPv4 address based on the vendor's proprietary mechanisms. This may be accomplished with DHCP.

When in DSG mode, the OCHD2.1 is the network interface and modem. The Card may request an IP flow (and hence an IPv4 address) from the OCHD2.1 using the *new\_flow\_req()* APDU by requesting a service\_type = 0x01 (IP unicast).

REQ3559 If the OCHD2.1 has received a *new\_flow\_req()* APDU with service\_type = 0x01 (IP unicast) and has not yet completed its network initialization, it SHALL respond with the *new\_flow\_cnf()* APDU with status\_field = 0x03 (Request denied, network unavailable or not responding).

If the OCHD2.1 denies the request for an IP flow, the Card SHOULD periodically attempt to open an IP flow. Once the OCHD2.1 successfully completes its network initialization and receives its IPv4 address, it SHOULD respond to Card requests for an IP flow by acting as a DHCP proxy and attempt to obtain an IPv4 address for the Card. If an IPv4 address is obtained in this manner, the OCHD2.1 will respond to the Card with the *new\_flow\_cnf()* APDU with status\_field = 0x00. If an IP address is not obtained for whatever reason, the OCHD2.1 will respond with the *new\_flow\_cnf()* APDU with status\_field = 0x05, and the IP flow will not be opened. The Card may continue to attempt to open the flow.

When the Card changes the mode from QPSK to DSG, if there is an IP flow open, the Card SHOULD send a *lost\_flow\_ind()* APDU with reason\_field = 0x00 for the flow ID assigned to the OCHD2.1's IP\_U flow. The OCHD2.1 SHOULD respond with the *lost\_flow\_cnf()* APDU with status\_field = 0x00. While it can be assumed that the flow is closed, the OCHD2.1 SHOULD send a *delete\_flow\_req()* APDU to the Card to ensure that the flow is deleted. When a OCHD2.1 receives a *lost\_flow\_ind()* APDU or sends a *delete\_flow\_req()* APDU for the IP\_U flow, it SHOULD discard the previously assigned IP address.

When the Card changes the mode from DSG to QPSK, if there is an IP flow open, the OCHD2.1 SHOULD send a *lost\_flow\_ind()* APDU with reason\_field = 0x00 for the flow ID assigned to the Card's IP\_U flow. The Card SHOULD respond with the *lost\_flow\_cnf()* APDU with status\_field = 0x00. While it can be assumed that the flow is closed, the Card SHOULD send a *delete\_flow\_req()* APDU to the OCHD2.1 to ensure that the flow is deleted. When a Card receives a *lost\_flow\_ind()* APDU or sends a *delete\_flow\_req()* APDU for the IP\_U flow, it SHOULD discard the previously assigned IP address.

### 13.5.1 IPv4 packet Forwarding

The section describes how the OCHD2.1 performs packet handling for IPv4 packets transmitted by or destined to the Card when an IP Unicast flow exists.

The OCHD2.1 forwards IPv4 packets on behalf of the Card by adding Ethernet framing to packets received from the Card and removing Ethernet framing from inbound packets before sending to the Card.

REQ3610 On receipt of an Ethernet frame from the eCM interface targeted to the MAC address of the Card, the OCHD2.1 SHALL extract the embedded IPv4 packet and forward the packet to the Card via the granted IP unicast flow.

REQ3611 The OCHD2.1 SHALL only forward IP packets destined to the Card that have been received via the eCM interface or via applications resident on the Host.

REQ3612 The OCHD2.1 SHALL only forward IPv4 packets received from the Card to the eCM interface or to applications resident on the Host.

REQ3613 The OCHD2.1 SHALL NOT forward to any interface other than the CableCARD interface any Ethernet frames or IP packets destined to the Card that have been received via the eCM interface.

REQ3614 On receipt of an IPv4 packet from the Card via the IP unicast flow, the OCHD2.1 SHALL parse the packet's destination IPv4 address and use the Card's address subnet mask to determine if the destination host is on a connected network.

REQ3615 When performing IPv4 packet forwarding on behalf of the Card, if the OCHD2.1 has determined that the destination host is on a connected network, it SHALL perform ARP to acquire the destination host MAC address.

REQ3615.1 The ARP request payload SHALL contain sender's hardware address equal to the MAC address of the Card and the sender's protocol address equal to the IPv4 address of the Card.

REQ3615.2 The source MAC address of the Ethernet frame containing the ARP request MAY contain either the Host MAC address or the Card MAC address.

REQ3616 When performing IPv4 packet forwarding on behalf of the Card, if the OCHD2.1 has determined that the destination host is not on a connected network, it SHALL perform ARP to acquire the appropriate gateway MAC address.

REQ3616.1 The ARP request payload SHALL contain sender's hardware address, equal to the MAC address of the Card, and the sender's protocol address, equal to the IPv4 address of the Card.

REQ3616.2 The source MAC address of the Ethernet frame containing the ARP request MAY contain either the Host MAC address or the Card MAC address.

REQ3617 When performing IPv4 packet forwarding on behalf of the Card, after the proper destination MAC address has been determined, the OCHD2.1 SHALL encapsulate the IPv4 packet within an Ethernet frame using the acquired destination MAC address as the frame's destination MAC address and the Card's MAC address as the frame's source MAC address.

REQ3617.1 The OCHD2.1 SHALL then forward the Ethernet frame to the eCM interface.

REQ3618 When performing IPv4 packet forwarding on behalf of the Card, if the OCHD2.1 receives an ARP request packet with the target protocol address equal to the IPv4 address of the Card, it SHALL send an ARP reply with sender's hardware address, equal to the MAC address of the Card, and the sender's protocol address, equal to the IPv4 address of the Card.

## 13.6 Socket Flows

If the Card requires two-way communications in DSG mode and decides to open a Socket type connection, the Card can request a new flow using the *new\_flow\_req()* APDU with service\_type = 0x04 (Socket).

REQ3619 The OCHD2.1 SHALL create a socket of the type specified by the protocol\_flag field in a *new\_flow\_req()* APDU sent by the Card with service\_type = 0x04 (Socket).

REQ3620 The OCHD2.1 SHALL bind the socket to the eSTB's IP address and the local port number specified by the local\_port\_number field in a *new\_flow\_req()* APDU sent by the Card with service\_type = 0x04 (Socket).

REQ3621 If the Card has set the local port number field to 0 in a *new\_flow\_req()* APDU with service\_type = 0x04 (Socket), the OCHD2.1 SHALL choose an appropriate local port number for this flow.

**Informative note:** It is expected that applications on the OCHD2.1 will not open ports that will be used by the Card.

REQ3622 If the remote address type = 0x00 (name) in a *new\_flow\_req()* APDU sent by the Card with service\_type = 0x04 (Socket), the OCHD2.1 SHALL use DNS to determine the remote host's IP address using the name\_byte field.

REQ3623 When establishing an IP socket, the OCHD2.1 SHALL connect the local socket to the socket on the remote host using the port number specified in remote\_port\_number specified in the *new\_flow\_req()* APDU.

REQ3624 Once the connection has been established to the remote host specified in a *new\_flow\_req()* APDU with service\_type = 0x04 (Socket), the OCHD2.1 SHALL respond to with the *new\_flow\_conf()* APDU.

REQ3625 If the OCHD2.1 is unable to set up a requested socket flow, it SHALL respond to the Card with the *new\_flow\_cnf()* APDU containing the appropriate error value in the status field.

REQ3626 If the Card requests a socket flow for TCP, the OCHD2.1 SHALL attempt to establish a TCP connection for the number of seconds = connection\_timeout as specified in the *new\_flow\_req()* APDU sent by the Card with service\_type = 0x04 (Socket).

REQ3627 If the OCHD2.1 cannot establish a TCP connection after connection\_timeout number of seconds, it SHALL respond to the Card using the *new\_flow\_cnf()* APDU with the status\_field = 0x09 (Request Denied, could not establish TCP connection).

REQ3628 On receipt of data from the Card over the interface via the Socket Flow, the OCHD2.1 SHALL use the socket that was opened for the flow to send the data to the destination Host using the eCM interface.

REQ3629 When the socket has data ready to be read, the OCHD2.1 SHALL read the data, strip off the Ethernet, IP, TCP and UDP headers, and forward the data to the Card. The data forwarded to the Card will be the exact data that is returned from the OCHD2.1's socket read operation.

REQ3630 When performing socket operations on behalf of the Card, the OCHD2.1 SHALL NOT forward any data destined to the Card to any interface other than the CableCard interface.

REQ3631 When performing socket operations on behalf of the Card, the OCHD2.1 SHALL only forward to the Card data that has been received via the eCM interface, or via applications resident on the OCHD2.1, and which is destined to the Card.

REQ3632 When performing socket operations on behalf of the Card, the OCHD2.1 SHALL NOT forward any data received from the Card over the CableCard interface to any interface other than the eCM interface.

REQ3633 When an established socket flow is no longer needed by the Card, it will send the *delete\_flow\_req()* APDU, at which time the OCHD2.1 SHALL close the socket.

REQ3634 When an established socket has been successfully closed as a result of receiving the *delete\_flow\_req()* APDU, the OCHD2.1 SHALL send the *delete\_flow\_cnf()* APDU to the Card.

REQ3635 If the OCHD2.1 detects that an established socket is no longer valid, it SHALL send the *lost\_flow\_ind()* APDU to the Card with a reason\_field = 0x02 (network down or busy).

## 13.7 IP Address Acquisition

This section describes how the eSTB and Card will acquire and renew their IP addresses. In both IPv4 mode and IPv6 mode, the eSTB will acquire an address. Only in IPv4 mode with an IP Unicast flow will the Card acquire an address.

### 13.7.1 IPv4 Address Acquisition

This section describes how an OCHD2.1 operating in IPv4 acquires and renews its IPv4 addresses.

#### 13.7.1.1 eSTB IPv4 Address Acquisition

This section describes how the eSTB acquires an IP address through DHCP for its own use.

After the eCM has completed the DOCSIS registration process and if eCM forwarding has not been restricted, it will notify the eSTB by issuing the "2-Way OK,UCID" message as defined in [DSG]. This message is forwarded to the DSG Client controller on the Card using the *DSG\_message()* APDU, which indicates that the eCM has established two-way IP connectivity.

REQ3560 After the OCHD2.1 has sent the *DSG\_message()* APDU indicating "2-Way OK,UCID", it SHALL invoke DHCP mechanisms according to [RFC 2131] in order to acquire an IP address for the eSTB and any other parameters needed to establish IP connectivity.

REQ3561 If eCM forwarding is restricted and the eSTB has not been provisioned, then the OCHD2.1 SHALL NOT perform any actions with regard to IP provisioning over the eCM interface.

REQ3562 The OCHD2.1 SHALL deny any request from the Card to open an IP flow until the eSTB has acquired an IP address.

REQ3563 The OCHD2.1 DHCP client behavior during all phases of operation, including initial IP address lease acquisition and lease renewal, SHALL be in accordance with the Client requirements of [RFC 2131] and the DHCP option requirements of [RFC 2132].

REQ3564 The following fields SHALL be present in the DHCPDISCOVER and DHCPREQUEST message from the OCHD2.1 for the eSTB and set as described below.

REQ3564.1 The hardware type (htype) SHALL be set to 1 (Ethernet).

REQ3564.2 The hardware length (hlen) SHALL be set to 6.

REQ3564.3 The client hardware address (chaddr) SHALL be set to the 48-bit MAC address associated with the OCHD2.1.

REQ3564.4 The Client-identifier option (61) SHALL be included with the hardware type set to 1 and the value set to the same 48-bit MAC address as the chaddr field.

REQ3564.5 The "parameter request list" option (55) SHALL be included with the following option codes present in the list:

Option code 1 (Subnet Mask)

Option code 3 (Router Option)

Option code 6 (Domain Name Server)



Option code 15 (Domain Name)

Option code 23 (Default time to live)

Option code 51 (IP address lease time)

Option code 54 (Server Identifier)

REQ3564.6 To enable class identification, DHCP option 60 SHALL be included containing the character string "OpenCable2.1" using characters from the NVT ASCII character set with no terminating NULL.

REQ3564.7 DHCP option 43 and its sub-options 2, 3, 4, 5, 6, 7, 8, 9, 10 and 54 SHALL be included. Details of DHCP option 43 and its sub-options for the eSTB are further defined below.

REQ3564.8 DHCP option 50, Requested IP Address, SHALL only be included in DHCPREQUEST messages.

The following requirements pertain to the option 43 sub-options in the DHCPDISCOVER and DHCPREQUEST messages from the eSTB.

DHCP option 43 in the eSTB is a compound option. The content of option 43 is composed of one or more sub-options. The option begins with a type octet with the value of number 43, followed by a length octet. The length octet is followed by the number of octets of data equal to the value of the length octet. The value of the length octet does not include the two octets specifying the tag and length. Each sub-option begins with a tag octet containing the sub-option code, followed by a length octet that indicates the total number of octets of data. The value of the length octet does not include itself or the tag octet. The length octet is followed by "length" octets of sub-option data. An example of the option 43 suboptions is given in Table 13.7-1.

REQ3565 The definitions of DHCP option 43 sub-options SHALL conform to requirements imposed by [RFC 2132].

An example implementation of the Vendor Specific Information Option (DHCP option 43) is shown in Table 13.7-1.

REQ3566 The OCHD2.1 SHALL encode each of the DHCP option 43 sub-options 2, 3, 4, 5, 6, 7, 8, 9, 10, and 54 as a character string consisting of characters from the NVT ASCII character set with no terminating NULL.

REQ3567 The OCHD2.1 MAY include Option 43 sub-option 1 in DHCPDISCOVER and DHCPREQUEST messages.

REQ3567.1 If DHCP option 43 sub-option 1 is included in DHCP client messages, the OCHD2.1 SHALL encode this sub-option by the number of octets equal to the value of the length octet of this sub-option, with each octet codifying a requested sub-option.

REQ3567.2 If the length octet of sub-option 1 is 0 (because there are no requested sub-options), this sub-option SHOULD be omitted from DHCP option 43.

REQ3568 The OCHD2.1 SHALL include DHCP option 43 sub-option 2 containing the character string "ESTB" (without the quotation marks).

REQ3569 The OCHD2.1 SHALL include DHCP option 43 sub-option 3 containing a colon-separated list of all eSAFE types in the device, including at a minimum the colon-separated character string "ECM:ESTB" (without the quotation marks).

REQ3570 The OCHD2.1 SHALL include DHCP option 43 sub-option 4 containing the device serial number.

REQ3571 The OCHD2.1 SHALL include DHCP option 43 sub-option 5 containing the Hardware version number, identical to the value as reported in the <Hardware version> field in the MIB object sysDescr.

REQ3572 The OCHD2.1 SHALL include DHCP option 43 sub-option 6 containing the Software version number, identical to the value as reported in the <Software version> field in the MIB object sysDescr.

REQ3573 The OCHD2.1 SHALL include DHCP option 43 sub-option 7 containing the Boot ROM version number, identical to the value as reported in the <Boot ROM version> field in the MIB object sysDescr.

REQ3574 The OCHD2.1 SHALL include DHCP option 43 sub-option 8 containing a 6-octet (6 NVT ASCII characters), hexadecimally-encoded, vendor-specific Organization Unique Identifier (OUI) that uniquely identifies the OCHD2.1 manufacturer.

REQ3574.1 A vendor MAY use the same OUI as in the OCHD2.1's MAC address, and MAY use a single OUI to identify all its products.

REQ3575 The OCHD2.1 SHALL include DHCP option 43 sub-option 9 containing the Model number, identical to the value as reported in the <Model number> field in the MIB object sysDescr.

REQ3576 The OCHD2.1 SHALL include DHCP option 43 sub-option 10 containing the Vendor name, identical to the value as reported in the <Vendor name> field in the MIB object sysDescr.

REQ3577 The OCHD2.1 SHALL include DHCP option 43 sub-option 54 containing the 40-bit HOST\_ID, identical to the value in the Host X.509 certificate.

REQ3578 If the total number of octets in all DHCP option 43 sub-options exceeds 255 octets, the OCHD2.1 SHALL follow [RFC 3396] to split the option into multiple smaller options.

An example of DHCP option 60 and the DHCP option 43 suboptions is given in Table 13.7-1.

The following requirements pertain to the DHCPACK message.

REQ3579 The OCHD2.1 SHALL ignore any DHCP options delivered by the DHCP server in the DHCP message that the eSTB does not require or cannot interpret.

REQ3580 The OCHD2.1 SHALL verify the existence of the following DHCP fields within the DHCPPOFFER/DHCPACK message it receives from the DHCP server during initial IP address lease acquisition:

REQ3580.1 The IP address to be used by the eSTB (yiaddr)

REQ3580.2 The subnet mask to be used by the eSTB (Subnet Mask, Option 1)

REQ3580.3 A list of IP addresses of one or more routers to be used for forwarding eSTB-originated IP traffic (Router, Option 3); the eSTB is not required to use more than one router IP address for forwarding but SHALL use at least one.

REQ3580.4 The IP Address Lease Time (Lease Time, Option 51)

REQ3580.5 The Server Identifier of the DHCP server (Server Identifier, Option 54)

REQ3581 If any of the DHCP fields required in REQ3580 are absent from the DHCPACK message, the OCHD2.1 SHALL reject the offered lease and restart its DHCP IP address acquisition process from the INIT state as defined in [RFC 2131].

REQ3582 The OCHD2.1 SHALL disregard any TFTP Server Name (either option 66 or 'siaddr' field of header) and Bootfile Name (either option 67 or 'file' field of header) parameters defined in a DHCPACK/DHCPOFFER message and not download a configuration file using these parameters.

REQ3583 The OCHD2.1 SHALL verify the existence of the DHCP fields required in REQ3580 within the DHCPACK message it receives from the DHCP server during a DHCP Renew or Rebind.

REQ3583.1 If the DHCPACK message does not contain the *yiaddr* field, the OCHD2.1 SHALL restart its DHCP IP acquisition process from the INIT state as defined in [RFC 2131].

REQ3584 If any DHCP field required in REQ3580, other than *yiaddr*, is missing or is invalid in the DHCPACK message during a DHCP Renew or Rebind, the OCHD2.1 SHALL ignore any invalid fields, preserve any field values from its initial IP address acquisition or a previous Renew or Rebind, and continue with normal operation. An example of an invalid field would be an option that is syntactically malformed (e.g., with an incorrect option length).

**Table 13.7-1 - Embedded OpenCable Host 2.1 Device DHCP Request**

DHCP Request Options	Value	Description
CPE Option 60	"OpenCable2.1"	OpenCable Version
CPE Option 43 sub-option 1	"<null>"	The request sub-option vector is a list of sub-options (within option 43) to be returned to client by the server upon reply to the request. None defined.
CPE Option 43 sub-option 2	"ESTB"	Device type of the entity making the DHCP request.
CPE Option 43 sub-option 3	"ECM:ESTB"	List of eSAFEs.
CPE Option 43 sub-option 4	"<device serial number>"	Serial Number of eSTB. If Serial Number is not available, then other unique identifier (other than MAC Address), such as HOST_ID, may be utilized
CPE Option 43 sub-option 5	"<hardware version number>"	Hardware version number of eSTB
CPE Option 43 sub-option 6	"<firmware version number>"	Firmware version number of eSTB
CPE Option 43 sub-option 7	"<boot ROM version number>"	Boot ROM version number of eSTB
CPE Option 43 sub-option 8	e.g., "0204DF"	A 6-octet, hexadecimal-encoded, vendor-specific Organization Unique Identifier (OUI) that may match the OUI in the eSTB's MAC address.
CPE Option 43 sub-option 9	e.g., "Xman200"	Vendor model number of eSTB
CPE Option 43 sub-option 10	e.g., "XYZ Broadband"	Vendor name
CPE Option 43 sub-option 54	e.g., "0A859B428"	40 bit HOST_ID as specified in Host X.509 certificate

### 13.7.1.2 Card IPv4 Address Acquisition

The section describes how the OCHD2.1 acquires an IPv4 address through DHCP on behalf of the Card.

After the eSTB has successfully completed the IP address acquisition, it can grant an IP flow across the extended channel when it receives a *new\_flow\_req()* APDU from the Card with service\_type = 0x01 (IP unicast). This section does not apply if the Card opens an IP socket type flow.

REQ3585 The OCHD2.1 SHALL use the Card's MAC address and options field provided in the *new\_flow\_req()* APDU with service\_type = 0x01 (IP unicast), to obtain an IP address for the Card using DHCP.

REQ3586 The OCHD2.1 SHALL act as a DHCP client for the Card and adhere to all Client requirements specified in [RFC 2131] and the DHCP option requirements of [RFC 2132].

REQ3587 The OCHD2.1 SHALL save the value sent in the MAC\_address field of the *new\_flow\_req()* APDU with service\_type = 0x01(IP unicast), for use in subsequent operations performed on behalf of the Card.

REQ3588 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL confirm that any received DHCP OFFER messages are in response to the initial DHCP DISCOVER message by matching the Transaction ID field (xid), verifying that the *chaddr* field contains the Card MAC address and the destination MAC address is the Card MAC address.

REQ3589 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL confirm that any received DHCP ACK messages are in response to the previous DHCP REQUEST message by matching the Transaction ID field (xid), verifying that the *chaddr* field contains the Card MAC address and the destination MAC address is the Card MAC address.

REQ3590 Once the OCHD2.1 acquires a unique IPv4 address for the Card, it SHALL send the *new\_flow\_cnf()* APDU granting the requested IP Unicast flow and assigning a unique flow\_id. In this confirmation message, the OCHD2.1 includes the IP address assigned to the Card.

REQ3590.1 The OCHD2.1 SHOULD set the option\_field\_length field in the *new\_flow\_cnf()* confirmation message to 0.

REQ3591 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL save the values returned in the *yiaddr* field (IPv4 address assigned to the Card) and option 51 (IP Address Lease Time) of the DHCP ACK message in storage for use in subsequent DHCP operations on behalf of the Card (INIT-REBOOT, RENEW, REBIND).

REQ3592 All OCHD2.1 DHCP transactions associated with acquiring the IP address for the Card SHALL be over the eCM interface and not propagate to any other interface on the OCHD2.1.

REQ3593 The OCHD2.1 SHALL populate Ethernet frames using the Card MAC address as the source MAC address for all DHCP packets initiated on behalf of the Card.

REQ3594 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL populate the source IP address field with "0.0.0.0" in the IP header prior to obtaining an IP address.

REQ3595 The following fields SHALL be present in the DHCP DISCOVER and DHCP REQUEST message sent by the OCHD2.1 on behalf of the Card and set as described below:

REQ3595.1 The hardware type (htype) SHALL be set to 1 (Ethernet).

REQ3595.2 The hardware length (hlen) SHALL be set to 6.

REQ3595.3 The client hardware address (chaddr) SHALL be set to the 48-bit MAC address received in the *new\_flow\_req()* APDU.

REQ3595.4 The Client-identifier option (61) SHALL be included with the hardware type set to 1 and the value set to the same 48-bit MAC address as the *chaddr* field.

REQ3595.5 The "parameter request list" option (55) SHALL be included with the following option codes present in the list:

Option code 1 (Subnet Mask)

Option code 3 (Router Option)

Option code 23 (Default time to live)

Option code 51 (IP address lease time)

Option code 54 (Server Identifier)

REQ3595.6 The OCHD2.1 SHALL NOT reformat option 43 and 60 obtained from the *new\_flow\_req()* APDU.

REQ3595.7 DHCP option 50, Requested IP Address, SHALL only be included in DHCPREQUEST messages.

REQ3596 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL ignore any DHCP options delivered by the DHCP server that the Card does not require.

REQ3597 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL verify the existence of the following DHCP fields within the DHCPACK message it receives from the DHCP server during initial IP address lease acquisition:

REQ3597.1 The IPv4 address to be used by the Card (*yiaddr*)

REQ3597.2 The subnet mask to be used by the OCHD2.1 on behalf of the Card (Subnet Mask, Option 1)

REQ3597.3 A list of IPv4 addresses of one or more routers to be used for forwarding Card-originated IP traffic (Router, Option 3). The OCHD2.1 is not required to use more than one router IPv4 address for forwarding but SHALL use at least one.

REQ3597.4 The IP Address Lease Time (Lease Time, Option 51)

REQ3597.5 The Server Identifier of the DHCP server (Server Identifier, Option 54)

REQ3598 If any of the DHCP fields required in REQ3597 are absent from the DHCPACK message, the OCHD2.1 SHALL reject the offered lease and restart the DHCP Card IP address acquisition process from the INIT state as defined in [RFC 2131].

REQ3599 When performing DHCP operations on behalf of the Card, the OCHD2.1 SHALL verify the existence of any DHCP fields required in REQ3597 within the DHCPACK message it receives from the DHCP server during a DHCP Renew or Rebind.

REQ3600 When performing DHCP operations on behalf of the Card, if the DHCPACK message does not contain the *yiaddr* field, the OCHD2.1 SHALL restart the DHCP IP acquisition process from the INIT state as defined in [RFC 2131].

REQ3601 When performing DHCP operations on behalf of the Card, if any DHCP field required in REQ3597, other than *yiaddr*, is missing or is invalid in the DHCPACK message during a DHCP Renew or Rebind, the OCHD2.1 SHALL ignore any invalid fields, preserve any field values from its initial IP address acquisition or a previous Renew or Rebind and continue with normal operation. An example of an invalid field would be an option that is syntactically malformed (e.g., with an incorrect option length).

### **13.7.1.3 IPv4 Address Lease Renewal**

The OCHD2.1 monitors the operational status of the eCM for changes in state, particularly a re-initialization of the eCM MAC layer, transition to One-Way operation, and changes in eCM forwarding restrictions.

REQ3602 If the OCHD2.1 detects an eCM MAC layer re-initialization, or temporarily added and then removed eCM forwarding restrictions, it SHALL confirm both the eSTB IP address lease and the Card's IP address lease by entering the INIT-REBOOT state for each of these leases as defined in [RFC 2131] after receiving the 2-Way OK indication from the eCM.

REQ3603 In addition to the requirements in REQ3602, all other aspects of eSTB and Card IPv4 address lease expiration SHALL be performed by the OCHD2.1 according to [RFC 2131].

If an IP flow has been established across the CableCARD interface, then the OCHD2.1 indicates to the Card that the flow is lost by sending the *lost\_flow\_ind()* APDU with reason\_field = 0x02 (Network down or busy). The Card responds with the *lost\_flow\_cnf()* APDU acknowledging that the flow has been lost and then requests that the flow be deleted by sending the *delete\_flow\_req()* APDU. The Card expects to receive the *delete\_flow\_cnf()* APDU in reply.

The Card MAY try to re-open lost IP flows by sending the *new\_flow\_req()* APDU.

REQ3604 If the OCHD2.1 does not terminate the IP flow when in the INIT-REBOOT state for the Card's IP address lease, then the OCHD2.1 MAY drop IP packets received from the Card when in this state.

REQ3605 If an IP flow has been established across the CableCARD interface AND the eSTB is forced into the INIT state, then the OCHD2.1 MAY continue to forward IP packets on behalf of the Card.

REQ3606 The OCHD2.1 SHALL monitor the lease expiration time of the Card's IPv4 address and perform lease renewal on behalf of the Card as defined in [RFC 2131].

REQ3606.1 In the event that the renewal process causes the OCHD2.1 to enter the INIT state on behalf of the Card, or upon Card IPv4 address lease expiration, it SHALL terminate any open IP flow by sending the *lost\_flow\_ind()* APDU with reason\_field = 0x02 (Network down or busy).

The Card MAY try to re-open the IP flow by sending the *new\_flow\_req()* APDU.

REQ3607 If the OCHD2.1 detects that the eCM has transitioned from Two-Way operation to One-Way operation, it SHALL notify the Card via the *DSG\_message()* APDU with message\_type = 0x02 (Entering\_one\_way\_mode).

REQ3607.1 If an IP flow has been established across the CableCARD interface AND the OCHD2.1 transitions to One-Way operation or eCM forwarding becomes restricted, the OCHD2.1 SHALL terminate the flow by sending the *lost\_flow\_ind()* APDU with reason\_field = 0x02 (Network down or busy) and not permit any new IP flows until the eCM forwarding restrictions have been removed.

The Card MAY try to re-open the lost IP flow by sending the *new\_flow\_req()* APDU.

REQ3607.2 When the eCM transitions back to Two-way mode, the OCHD2.1 SHALL enter the INIT-REBOOT state as defined in [RFC 2131] both for the eSTB's IP address and the Card's IP address.

REQ3608 If the OCHD2.1 detects that eCM forwarding has been restricted, it SHALL notify the Card via the *DSG\_message()* APDU with message\_type = 0x07 (2-Way OK, but forwarding restricted).

REQ3609 If the OCHD2.1 detects that eCM forwarding restrictions have been removed, it SHALL notify the Card via the *DSG\_message()* APDU with message\_type = 0x01 (2-Way OK, UCID).

### 13.7.2 IPv6 Address Acquisition

This section describes how the OCHD2.1 operating in IPv6 mode will acquire and renew its IPv6 address.

### **13.7.2.1 eSTB IPv6 Address Acquisition**

This section describes how the eSTB is provisioned with an IPv6 address and associated configuration parameters. The requirements in this section apply only to eSTBs that have been instructed to operate in IPv6 mode.

The eSTB's IPv6 address acquisition process includes the assignment of a link-local address, an IPv6 address, and other IPv6 configuration parameters. These steps are described in the following sub-sections.

#### **13.7.2.1.1 Obtain Link-Local Address**

REQ3913 The OCHD2.1 SHALL construct a link-local address for its eSTB according to the procedure in section 5.3 of [RFC 4862].

REQ3913.1 The OCHD2.1 SHALL use the Modified EUI-64 identifier based on its 48-bit MAC address for its eSTB's management interface as described in [RFC 4291].

REQ3914 After constructing the link-local address, the OCHD2.1 SHALL use Duplicate Address Detection (DAD), as described in section 5.4 of [RFC 4862], to confirm that the constructed link-local address is not already in use.

REQ3915 If the OCHD2.1 determines that the constructed link-local address is already in use, the OCHD2.1 SHALL consider that IPv6 address acquisition has failed and follow the procedures in section 5.4.5 of [RFC 4862].

There are security implications if services on the OCHD2.1 are accessible via the Link-Local IPv6 address, as the CMTS may not have the ability to selectively block Link-Local IPv6 traffic that is initiated from the premises of other subscribers.

The Link-Local IPv6 address is only used for IPv6 provisioning traffic to and from the CMTS during acquisition of the routable IPv6 address, and as such the operator will not need to send or receive any application traffic to the OCHD2.1 using its Link-Local IPv6 address. Therefore, this specification restricts the OCHD2.1 to not accept or transmit any IPv6 traffic using its Link-Local IPv6 address for any application other than IPv6 provisioning, Neighbor Discovery and MLDv1/MLDv2.

REQ3916 When the OCHD2.1 has been provisioned using IPv6, it SHALL NOT bind any services or applications to its Link-Local IPv6 address except those that support provisioning of the IPv6 stack, such as DHCPv6.

#### **13.7.2.1.2 Obtain Default Routers**

REQ3917 The OCHD2.1's eSTB SHALL perform router discovery as specified in [RFC 4861]. The eSTB identifies neighboring routers and default routers from the received Router Advertisements (RAs).

#### **13.7.2.1.3 IPv6 Address and Other Configuration Parameters**

REQ3918 The OCHD2.1 SHALL use DHCPv6 [RFC 3315] to acquire an IPv6 address and configuration information for its eSTB.

REQ3919 The OCHD2.1 SHALL support the Reconfigure Key Authentication Protocol as described in [RFC 3315],

The eSTB sends Solicit and Request messages, as described in sections 17.1.1 and 18.1.1, respectively, of [RFC 3315]. REQ3920 The Solicit and Request messages SHALL include the following:

REQ3920.1 A Client Identifier option (OPTION\_CLIENT\_ID) containing the DUID for this eSTB. The DUID SHALL be based on the eSTB's link layer address as described in section 9.4 of [RFC 3315].

REQ3920.2 An IA\_NA option (OPTION\_IA\_NA) to obtain its IPv6 address.

REQ3920.3 A Reconfigure Accept option (OPTION\_RECONF\_ACCEPT) to indicate the eSTB is willing to accept Reconfigure messages.

REQ3920.4 An Options Request option (OPTION\_ORO) requesting the following options:

Domain list option (OPTION\_DOMAIN\_LIST) as defined in [RFC 3646]

DNS Recursive Name Server (OPTION\_DNS\_SERVERS) as defined in [RFC 3646]

REQ3920.5 A Vendor Class option (OPTION\_VENDOR\_CLASS) containing 32-bit number 4491 (the Cable Television Laboratories, Inc. enterprise number) and the string "OpenCable2.1".

REQ3920.6 A Vendor Specific Information option (OPTION\_VENDOR\_OPTS) as defined in section 22.17 of [RFC 3315] containing the options in the following table. The enterprise-number field must be set to CableLabs' enterprise number: 4491. The option codes come from [CANN-DHCP].

**Table 13.7-2 - Vendor Specific Information Options**

Option code	Value	Description
2	"ESTB"	Device Type(CL_OPTION_DEVICE_TYPE)
3	"ECM:ESTB"	"ECM:ESTB" = An Embedded STB(CL_OPTION_EMBEDDED_COMPONENTS_LIST)
4	"<device serial number>"	Device serial number e.g., "123456" (CL_OPTION_DEVICE_SERIAL_NUMBER)
5	"<Hardware version>"	Hardware version number. Identical to value as reported in the <Hardware version> field in the MIB object sysDescr. e.g., "v.3.2.1"(CL_OPTION_HARDWARE_VERSION_NUMBER)
6	"<Software version>"	Software version number. Identical to value as reported in the <Software version> field in the MIB object sysDescr. e.g., "v.1.0.2"(CL_OPTION_SOFTWARE_VERSION_NUMBER)
7	"<Boot ROM version>"	Boot ROM version. Identical to value as reported in the <Boot ROM version> field in the MIB object sysDescr. e.g., "Bv4.5.6"(CL_OPTION_BOOT_ROM_VERSION)
8	"<OUI>"	A 6-octet, hexadecimal-encoded, vendor-specific Organization Unique Identifier (OUI) that may match the OUI in the eCM's MAC address.(CL_OPTION_VENDOR_OUI)
9	"<Model number>"	Device model number. Identical to value as reported in the <Model number> field in MIB object sysDescr. e.g., "T3000"(CL_OPTION_MODEL_NUMBER)
10	"<Vendor name>"	Vendor name or ID. Identical to value as reported in the <Vendor name> field in the MIB object sysDescr. e.g., "XYZ Corp"(CL_OPTION_VENDOR_NAME)
36	"<MAC Address>"	MAC Address(CL_OPTION_DEVICE_ID)

REQ3920.7 A Rapid Commit option (OPTION\_RAPID\_COMMIT) indicating that the eSTB is willing to perform a 2-message DHCPv6 message exchange with the server.

REQ3921 The eSTB SHALL use the following values for retransmission of the Solicit message (see section 14 of [RFC 3315] for details):



REQ3921.1 IRT (Initial Retransmission Time) = SOL\_TIMEOUT

REQ3921.2 MRT (Maximum Retransmission Time) = SOL\_MAX\_RT

REQ3921.3 MRC (Maximum Retransmission Count) = 4

REQ3921.4 MRD (Maximum Retransmission Duration) = 0

REQ3922 If the MRC value is exceeded before the eSTB receives a Reply from a DHCP server, the OCHD2.1 SHALL consider IPv6 provisioning to have failed.

The DHCPv6 server may be configured to use a 2 message Rapid Commit sequence. The DHCP server and eSTB follow [RFC 3315] in the optional use of the Rapid Commit message exchange.

The DHCP server responds to Solicit messages and Request messages with Advertise and Reply messages (depending on the use of Rapid Commit). The Advertise and Reply messages may include other configuration parameters, as requested by the eSTB, or as configured by the administrator to be sent to the eSTB.

### **13.7.3 13.8.2.2 IPv6 Address Lease Renewal**

The OCHD2.1 monitors the operational status of the eCM for changes in state, particularly a re-initialization of the eCM MAC layer, transition to One-Way operation, and changes in eCM forwarding restrictions.

REQ3923 If the OCHD2.1 detects an eCM MAC layer re-initialization, temporarily added and then removed eCM forwarding restrictions or transition from one-way to two-way state, it SHALL confirm the eSTB IPv6 address lease by sending a Confirm message as defined in [RFC 2131] after receiving the 2\_Way OK indication from the eCM.

REQ3923.1 The OCHD2.1 SHALL NOT use its eSTB IPv6 address until it receives a Response message from the DHCP server confirming its address.

REQ3923.2 If the OCHD2.1 does not receive a response to the Confirm message before the message transmission process terminates, the OCHD2.1 SHALL restart its DHCP process by sending a Solicit message.

REQ3923.3 All other aspects of IPv6 address lease expiration SHALL be performed by the OCHD2.1 according to [RFC 2131].

## 14 MANAGEMENT REQUIREMENTS

This section details the OpenCable Host 2.1 device management requirements for SNMP in alignment with section 5.2 of [eDOCSIS]. The Management requirements in this section are divided into three parts: SNMP Protocol requirements covered in Section 14.1, MIB requirements in Section 14.2 (additional details covered in Annex A of [MIB-HOST]), and SNMP Access Control Configuration covered in section 14.4. The OCHD2.1 SNMP Management requirements are primarily defined for diagnostic and status report of the OCHD2.1 core functions and features (Section 3.1.2); therefore, SNMP write access is not commonly specified. In the case of SNMP MIB objects with write access being specified, those definitions should not overlap configuration functions that might be present in other interfaces such as [OCAP].

The configuration of the OCHD2.1 via SNMP is limited to the write access capabilities included in the MIB requirements of this section and [MIB-HOST]. It means that the configuration and provisioning of certain read-only MIB objects are performed by mechanisms such as Out-Of-Band signaling (Section 5.2.3), outside of the scope of this specification. In particular, the configuration of the OCHD2.1 SNMP Access Control mechanisms that provide SNMP access to SNMP entities in the role of managers is defined in Section 14.4 of this specification.

### 14.1 SNMP Protocol requirements

REQ3636 The OCHD2.1 MAY implement the SNMPv3 protocol framework as defined in STD 62 [RFC 3411] through [RFC 3415].

REQ3637 The OCHD2.1 SHALL implement either SNMPv1/v2c Coexistence as defined in [RFC 3584], or SNMPv2 Community-based Access as defined in [RFC 1901].

### 14.2 Requirements for SNMP MIB Modules

REQ3638 The OCHD2.1 SHALL support a minimum of 10 entries for each individual SNMP conceptual table defined in this specification, unless otherwise specified. For example, the mapping of a required number of provisioning parameters may translate to a different number of entries of an SNMP conceptual table, a requirement to map a complete set of MPEG descriptors into SNMP conceptual tables, etc.

#### 14.2.1 Requirements for OC-STB-HOST-MIB MIB Module

This section describes the OCHD2.1 management requirements related to the OCHD2.1 Core Functional Requirements detailed in Section 3.1.2.

REQ3639 The OCHD2.1 SHALL implement the MIB objects of OC-STB-HOST-MIB as described in Annexes A and B of [MIB-HOST].

### 14.3 Additional MIB requirements for OCHD2.1

This section describes the OCHD2.1 management requirements not related to the OCHD2.1 Core Functional Requirements (Section 3.1.2). These requirements include standard IETF networking, interfaces and device parameters, as well as DOCSIS modeled requirements based on [OSSIv2.0] and [eDOCSIS] specifications.

#### 14.3.1 Requirements for SNMPv2-MIB [RFC 3418]

REQ3640 The OCHD2.1 SHALL implement the MIB objects of system group in [RFC 3418].

REQ3640.1 The OCHD2.1 SHALL report the hardware version, Boot ROM image version, vendor name, software version, and model number in the sysDescr object (from [RFC 3418]) as described in Table 14.3-1.

REQ3640.2 The OCHD2.1 SHALL report each type-value pair in Table 14.3-1 separated with a colon and blank space. Each pair is separated by a ";" followed by a blank space. For instance, a sysDescr of an OCHD2.1 of vendor X, hardware version 5.2, Boot ROM version 1.4, SW version 2.2, and model number X will be as follows:

any text<<HW\_REV: 5.2; VENDOR: X; BOOTR: 1.4; SW\_REV 2.2; MODEL: X>>any text

**Table 14.3-1 - [RFC 3418] sysDescr Format**

To report	Format of each field
Hardware Version	HW_REV: <Hardware version>
Vendor Name	VENDOR: <Vendor name>
Boot ROM	BOOTR: <Boot ROM Version>
Software Version	SW_REV: <Software version>
Model Number	MODEL: <Model number>

### 14.3.2 Requirements for IF-MIB [RFC 2863]

REQ3641 The OCHD2.1 SHALL implement the MIB objects of ifGeneralInformationGroup from [RFC 2863] as described in Table 14.3-2 and Annex A of [MIB-HOST].

REQ3642 The OCHD2.1 MAY implement the MIB objects of ifPacketGroup, ifHCPacketGroup or ifVHCPacketGroup and ifCounterDiscontinuityGroup from [RFC 2863] for interfaces with IANA defined ifType as described in Annex A of [MIB-HOST] and Table 14.3-2.

REQ3643 If implemented, the OCHD2.1 SHALL have ifLinkUpDownTrapEnable set by default to 'false' for output interfaces with defined IANA ifType as well as any interface facing the eCM or the HFC network unless defined for this specification.

**Table 14.3-2 - [RFC 2863] ifTable, MIB-Object Details for OCHD2.1 Interfaces**

MIB Object	OCHD2.1	Card
ifIndex	1	2
ifDescr: MUST match the text	"OCHD2.1 Embedded IP 2-way Interface"	"CableCARD Unicast IP Flow"
ifType	Other(1)	Other(1)
ifMtu	0	0
ifSpeed	0	0
ifPhysAddress	OCHD2.1 MAC Address	If the IP_U flow does not exist, then this object should contain an octet string of zero length. Otherwise, this object should contain the Card's MAC address.
ifAdminStatus:	up(1)	up(1), down(2)*
ifOperStatus:	up(1), down(2)	up(1), down(2), notPresent(6)**
ifLastChange	<per RFC2863>	<per RFC2863>
ifInOctets	(n)	(n)

MIB Object	OCHD2.1	Card
ifInUCastPkts	(n)	(n)
ifInDiscards	(0)	(0)
ifInErrors	(0)	(0)
ifUnknownProtos	(0)	(0)
ifOutOctets	(n)	(n)
ifOutUCastPkts	(n)	(n)
ifOutDiscards	(0)	(0)
ifOutErrors	(0)	(0)

Notes:

The SNMP management interface only requires to report the value 'up' for ifAdminStatus in the two-way interface. Other management interfaces may support the reporting of other values.

ifIndex 1 above is the eSTB interface connected to the eCM's interface ifIndex 17 [eDOCSIS]. Packets leaving eCM interface 17 arrive at eSTB interface 1 and vice versa.

ifIndex 2 above is the Card interface connected to the eCM's interface ifIndex 17 [eDOCSIS]. Packets leaving eCM interface 17 arrive at eSTB interface 2 and vice versa. ifIndex 2 is only applicable when the Card has opened a Unicast IP Flow.

\*REQ3644 If the Card has opened a Unicast IP Flow, the OCHD2.1 SHALL set the value of ifAdminStatus for ifIndex 2 to up(1); else down(2).

\*\*REQ3645 If the Card has opened a Socket Flow, the OCHD2.1 SHALL set the value of ifOperStatus for ifIndex 2 to notPresent(6).

### 14.3.3 Requirements for IP-MIB [RFC 4293]

REQ3646 The OCHD2.1 SHALL implement the MIB objects of ipNetToPhysicalGroup from [RFC 4293] to indicate the IP addresses associated to the two-way IP OCHD2.1 interface as defined in Annex A of [MIB-HOST] and Table 14.3-3.

REQ3647 The OCHD2.1 SHALL implement the IP and ICMP objects and statistics according to the [eDOCSIS] requirements.

**Table 14.3-3 - [RFC 4293] ipNetToPhysicalTable, MIB-Object Details for OCHD2.1 Interfaces**

MIB Object	OCHD2.1 IP two-way interface	Card IP Interface
ipNetToPhysicalIfIndex	ifIndex = 1	ifIndex = 2
ipNetToPhysicalNetAddressType	ipv4, ipv6	ipv4, ipv6
ipNetToPhysicalNetAddress	IPv4 or IPv6 Address, if acquired; otherwise 0.0.0.0	IPv4 or IPv6 Address, if acquired; otherwise 0.0.0.0
ipNetToPhysicalPhysAddress	STB Host MAC Address	Card MAC Address
ipNetToPhysicalLastUpdated	sysUptime value from last update	sysUptime value from last update
ipNetToPhysicalType	local(5)	local(5)
ipNetToPhysicalState	For IPv4: unknown(6)	For IPv4: unknown(6)
ipNetToPhysicalRowStatus	active(1)	active(1)

#### 14.3.4 Requirements for DOCS-CABLE-DEVICE-MIB MIB Module

REQ3648 The OCHD2.1 SHALL implement a subset of MIB objects from DOCS-CABLE-DEVICE-MIB [RFC 2669] as described in Annex A of [MIB-HOST].

The OCHD2.1 is required to support the log event model for [OSSIV2.0] defined in [RFC 2669]. This event model consists of a eight Event levels (or priorities) to categorize events by their relevance.

The event levels from high to low priority are: Emergency (priority 1), Alert (priority 2), Critical (priority 3), Error (priority 4), Warning (priority 5), Notice (priority 6), Informational (priority 7), Debug (priority 8).

The control of the logging activities is performed by three modules:

- Local log: A local storage of events in two formats, volatile and a non-volatile. The volatile log clears the entries after the OCHD2.1 reinitializes. The non-volatile log persists its entries after OCHD2.1 reinitialization.
- Event Priority Dispatch: Based on the Event level, the events are sent to combinations of volatile log, non-volatile-log and event collector systems. [RFC 2669] defines the syslog and SNMP notification receivers as collector systems.
- Throttling mechanism: In order to reduce logging activity of events sent to collectors, [RFC 2669] provides mechanisms for controlling the number of events sent to collector systems.

This specification only requires support of local log in volatile and non-volatile formats, as well as the selection of the types of events levels to be logged locally. As an example, an MSO may decide to log only 'Error' and higher event level priorities.

The OCHD2.1 at initialization logs events with priorities 1..6, using the factory default settings as described in the requirements below. After completion of provisioning, the OCHD2.1 could be provisioned to log another set of event priorities.

REQ3649 The OCHD2.1 SHALL support the Event list defined in Annex A and log those events in the SNMP MIB Table docsDevEventTable (see Annex A of [MIB-HOST]).

REQ3650 The OCHD2.1 SHALL support the SNMP MIB object docsDevEvControl from [RFC 2669].

REQ3651 The OCHD2.1 SHALL support the SNMP MIB docsDevEvControlTable from [RFC 2669] to determine the event priority of events to be logged in volatile and non-volatile format.

REQ3652 The OCHD2.1 SHALL support the SNMP MIB docsDevEventTable from [RFC 2669] to report logged in volatile and non-volatile events.

REQ3653 The OCHD2.1 SHALL support only BITS 0 and 3 of the SNMP MIB object docsDevEvReporting, and ignore other BITS.

**Note:** The permissible BIT values for the docsDevEvReporting object [RFC 2669] have been superseded by [OSSIV2.0] as follows:

- local-nonvolatile(0)
- traps(1)
- syslog(2)
- local-volatile(3)

REQ3654 Unless otherwise configured as a factory default, the OCHD2.1 SHALL log in the non-volatile local-log events with priority 'Emergency', 'Alert', 'Critical' and 'Error'.

REQ3655 Unless otherwise configured as a factory default, the OCHD2.1 SHALL log in the volatile local-log events with levels, Warning event (priority 5), Notice event (priority 6).

#### **14.3.5 Requirements for HOST-RESOURCES-MIB [RFC 2790]**

REQ3656 The OCHD2.1 SHALL implement a subset of MIB objects from HOST-RESOURCES-MIB as defined in Annex A of [MIB-HOST].

### **14.4 SNMP Access Control Configuration Requirements**

The OCHD2.1 configures the SNMP Access Control for SNMP entities acting in role of 'managers' by supporting the SNMP Access Control TLVs defined in Section 15.2. The following section indicates the applicability of the SNMP Access Control TLVs for the cases where the OCHD2.1 supports SNMP community-based [RFC 1901] or SNMPv1 and SNMP v2c as specified in [RFC 3584].

This specification refers to "SNMPv1/v2c Coexistence" as the support of SNMPv1 or SNMPv2c messages exchange between the OCHD2.1 and other SNMP entities where the OCHD2.1 implements the SNMPv3 framework ([RFC 3411] through [RFC 3415]). For that purpose, [RFC 3584] defines special mappings of SNMP community names to SNMP security names to community to make use of the access control mechanism defined in [RFC 3415].

REQ3657 The OCHD2.1 SHALL ignore any SNMP request in the absence of SNMP Access Control configuration TLVs received during the OCHD2.1 provisioning process defined in Section 15.1.

#### **14.4.1 SNMP Access Control Configuration for SNMP Community-based Access [RFC 1901]**

REQ3658 If the OCHD2.1 supports SNMP community-based access, it SHALL NOT instantiate any proprietary MIB to report the configuration of the SNMP Access Control TLVs.

REQ3658.1 The OCHD2.1 SHALL NOT report such configuration under the OID sub-tree snmpV2.

The SNMP Access Control TLVs defined in section 15.2 are based on the SNMPv3 framework [RFC 3411]. However, in case the OCHD2.1 supports SNMP community-based access [RFC 1901], the requirements below define the corresponding mapping.

REQ3659 If the OCHD2.1 supports SNMP community-based access, it SHALL ignore the SNMPv3 Access View Configuration TLV.

REQ3852 If the OCHD2.1 supports SNMP community-based access, it SHALL implement Table 14.4-1, which defines the mapping of SNMPv1v2c Coexistence Configuration TLV elements to SNMP community-based parameters.

**Table 14.4-1 - SNMP Community Based Configuration TLV Mapping**

Sub-TLVs	Variable Name	Associated RFC term
SNMPv1v2c Community Name	<i>CommunityName</i>	SNMP community string [RFC 1901]
SNMPv1v2c Transport Address Access:		
SNMPv1v2c Transport Address	<i>TAddress</i>	IP Address bits– ignore TAddress UDP port information. See [RFC 3413]
SNMPv1v2c Transport Address Mask	<i>TMask</i>	IPAddress Mask bits – ignore TMask UDP port information. See [RFC 3584]
SNMPv1v2c Access View Type	<i>AccessViewType</i>	If absent indicates read-only access, <i>AccessViewType</i> = '1' indicates read-only access.  <i>AccessViewType</i> = '2' indicates read-write access
SNMPv1v2c Access View Name	<i>AccessViewName</i>	Ignore this sub-TLV

#### 14.4.2 SNMP Access Control Configuration for SNMPv1v2c Coexistence Mode [RFC 3584]

REQ3660 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL by default add an exclusion rule for access to objects under the OID snmpV2.

REQ3660.1 The OCHD2.1 SHALL provide access to objects under the OID sub-tree snmpV2 in the case the SNMP Configuration TLV 'SNMP Access View Subtree' explicitly includes access to objects under the OID sub-tree snmpV2.

##### 14.4.2.1 SNMPv1v2c Coexistence Configuration TLV

This section specifies the mapping of the SNMPv1v2c Coexistence Configuration TLV (see section 15.2) to SNMPv3 MIB objects. The SNMPv1v2c Coexistence Configuration TLV is used to configure SNMPv3 tables for SNMPv1 and v2c access.

REQ3661 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create entries in the following tables in order to cause the desired SNMP Access: snmpCommunityTable, snmpTargetAddrTable, vacmSecurityToGroupTable, and vacmAccessTable, as described in Table 14.4-2.

**Table 14.4-2 - SNMPv1v2c Coexistence Configuration TLV Mapping**

Sub-TLVs	Variable Name	Associated MIB Object
SNMPv1v2c Community Name	<i>CommunityName</i>	snmpCommunityTable [RFC 3584]
SNMPv1v2c Transport Address Access:		
SNMPv1v2c Transport Address	<i>TAddress</i>	snmpTargetAddrTAddress [RFC 3413]
SNMPv1v2c Transport Address Mask	<i>TMask</i>	snmpTargetAddrTMask [RFC 3584]

Sub-TLVs	Variable Name	Associated MIB Object
SNMPv1v2c Access View Type	<i>AccessViewType</i>	
SNMPv1v2c Access View Name	<i>AccessViewName</i>	Based on value of <i>AccessViewType</i> : vacmAccessReadViewName, vacmAccessWriteViewName [RFC 3415]

The OCHD2.1 is not required to verify the consistency of linkage of tables unless specified in the correspondent RFC's MIB objects the eSTB TLVs are configuring. It is intended that the SNMP agent will handle the corresponding configuration problems as part of the normal SNMP incoming requests (e.g., generating internal abstract data elements like noSuchView [RFC 3415]).

Table 14.4-4 through Table 14.4-9 describe the OCHD2.1 procedures to populate the SNMP Management Framework Message Processing and Access Control Subsystems [RFC 3412].

In configuring entries in these SNMPv3 tables, note the following:

The ReadViewName and WriteViewName may correspond to default entries as defined (if any), or entries created using SNMPv3 Access View Configuration (see Section 15.2).

#### 14.4.2.1.1 *snmpCommunityTable*

The *snmpCommunityTable* is defined in the "SNMP Community MIB Module" section of [RFC 3584].

REQ3662 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in *snmpCommunityTable* for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-3.

REQ3662.1 The OCHD2.1 SHALL set in *snmpCommunityIndex* the keyword @STBconfig\_n where 'n' is a sequential number starting at 0 for each TLV processed (e.g., "@STBconfig\_0", "@STBconfig\_1", etc.).

**Table 14.4-3 - *snmpCommunityTable***

Column Name (* = Part of Index)	Column Value
* <i>snmpCommunityIndex</i>	"@STBconfig_n" where n is 0..m-1 and m is the number of SNMPv1v2c Community Name sub-TLVs
<i>snmpCommunityName</i>	<CommunityName>
<i>snmpCommunitySecurityName</i>	"@STBconfig_n"
<i>snmpCommunityContextEngineID</i>	<the Engine ID of the OCHD2.1 associated SNMP Entity>
<i>snmpCommunityContextName</i>	<Zero-length OCTET STRING> or vendor specific
<i>snmpCommunityTransportTag</i>	"@STBconfigTag_n" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs
<i>snmpCommunityStorageType</i>	volatile (2)
<i>snmpCommunityStatus</i>	active (1)

#### 14.4.2.1.2 *snmpTargetAddrTable*

For *snmpTargetAddrTable*, see "Definitions" section of [RFC 3413].



REQ3663 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in `snmpTargetAddrTable` for each SNMPv1v2c Transport Address Access sub-TLV of the SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-4.

**Table 14.4-4 - `snmpTargetAddrTable`**

Column Name (* = Part of Index)	Column Value
* <code>snmpTargetAddrName</code>	"@STBconfigTag_n_i" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs. i is 0..p-1 and p is the number of SNMPv1v2c Transport Address Access sub-TLV within the SNMPv1v2c Coexistence Configuration TLV n
<code>snmpTargetAddrTDomain</code>	IPv4: <code>snmpUDPDDomain</code> [RFC 3417]
<code>snmpTargetAddrTAddress</code> (IP Address and UDP Port)	IPv4: <code>SnmpUDPAddress</code> [RFC 3417] OCTET STRING (6) Octets 1-4: <TAddress> Octets 5-6: <TAddress>
<code>snmpTargetAddrTimeout</code>	Default from MIB
<code>snmpTargetAddrRetryCount</code>	Default from MIB
<code>snmpTargetAddrTagList</code>	"@STBconfigTag_n" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs.
<code>snmpTargetAddrParams</code>	<null character '00'h> - not used-
<code>snmpTargetAddrStorageType</code>	volatile (2)
<code>snmpTargetAddrRowStatus</code>	active (1)

#### 14.4.2.1.3 `snmpTargetAddrExtTable`

The `snmpTargetAddrExtTable` is defined in the "SNMP Community MIB Module" section of [RFC 3584].

REQ3664 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in `snmpTargetAddrExtTable` for each SNMPv1v2c Transport Address Access sub-TLV of the SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-5.

**Table 14.4-5 - `snmpTargetAddrExtTable`**

Column Name (* = Part of Index)	Column Value
* <code>snmpTargetAddrName</code>	"@STBconfigTag_n_i" where n is 0..m-1 and m is the number of SNMPv1v2c Coexistence Configuration TLVs i is 0..p-1 and p is the number of SNMPv1v2c Transport Address Access sub-TLVs within the SNMPv1v2c Coexistence Configuration element n
<code>snmpTargetAddrTMask</code>	<Zero-length OCTET STRING> when <TMask> is not provided in the i-th sub-TLV IPv4: <code>SnmpUDPAddress</code> [RFC 3417] OCTET STRING (6) Octets 1-4: <TMask> Octets 5-6: <UDP Port>
<code>snmpTargetAddrMMS</code>	Maximum Message Size

#### 14.4.2.1.4 vacmSecurityToGroupTable

The vacmSecurityToGroupTable is defined in the "Definitions" section of [RFC 3415].

REQ3665 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create two rows in vacmSecurityGroupTable for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-6.

REQ3665.1 The OCHD2.1 SHALL set in vacmSecurityName the keyword @STBconfig\_n, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfig\_0", "@STBconfig\_1", etc.).

REQ3665.2 The OCHD2.1 SHALL set in vacmGroupName the keyword @STBconfigV1\_n for the first row and @STBconfigV2\_n for the second row, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfigV1\_0", "@STBconfigV1\_1", etc.).

**Table 14.4-6 - vacmSecurityToGroupTable**

Column Name (* = Part of Index)	First Row Column Value	Second Row Column Value
* vacmSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmSecurityName	"@STBconfig_n"	"@STBconfig_n"
vacmGroupName	"@STBconfigV1_n"	"@STBconfigV2_n"
vacmSecurityToGroupStorageType	volatile (2)	volatile (2)
vacmSecurityToGroupStatus	active (1)	active (1)

#### 14.4.2.1.5 vacmAccessTable

The vacmAccessTable is defined in the "Definitions" section of [RFC 3415].

REQ3666 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create two rows in vacmAccessTable for each SNMPv1v2c Coexistence Configuration TLV as indicated in Table 14.4-7.

REQ3666.1 The OCHD2.1 SHALL set in vacmGroupName the keyword @STBconfigV1\_n for the first row and @STBconfigV2\_n for the second row, where 'n' is a sequential number starting at 0 for each SNMPv1v2c Coexistence Configuration TLV processed (e.g., "@STBconfigV1\_0", "@STBconfigV1\_1", etc.).

**Table 14.4-7 - vacmAccessTable**

Column Name (* = Part of Index)	Column Value	Column Value
* vacmGroupName	"@STBconfigV1_n"	"@STBconfigV2_n"
* vacmAccessContextPrefix	<zero-length string> or vendor specific (see 14.4.2.1.6).	<zero-length string> or vendor specific (see 14.4.2.1.6).
* vacmAccessSecurityModel	SNMPV1 (1)	SNMPV2c (2)
* vacmAccessSecurityLevel	noAuthNoPriv (1)	noAuthNoPriv (1)
vacmAccessContextMatch	exact (1)	exact (1)
vacmAccessReadViewName	When <AccessViewType> == '1'   '2' Set <AccessViewName> Otherwise, set <Zero-length OCTET STRING>	When <AccessViewType> == '1'   '2' Set <AccessViewName> Otherwise, set <Zero-length OCTET STRING>

Column Name (* = Part of Index)	Column Value	Column Value
vacmAccessWriteViewName	When <AccessViewType> == '2' Set <AccessViewName> Otherwise, set <Zero-length OCTET STRING>	When <AccessViewType> == '2' Set <AccessViewName> Otherwise, set <Zero-length OCTET STRING>
vacmAccessNotifyViewName	<Zero-length OCTET STRING>	<Zero-length OCTET STRING>
vacmAccessStorageType	volatile (2)	volatile (2)
vacmAccessStatus	active (1)	active (1)

#### 14.4.2.1.6 vacmContextTable

The vacmContextTable is defined in the "Definitions" section of [RFC 3415].

REQ3667 The OCHD2.1 SHALL populate the vacmContextTable with the context name used by the OCHD2.1 to map the SNMPv1v2c Coexistence Configuration TLV information in the vacmAccessTable as indicated in Table 14.4-8.

**Table 14.4-8 - vacmContextTable**

Column Name (* = Part of Index)	Column Value
* vacmContextName	<zero-length string> or vendor specific (1)

Notes: (1) The OCHD2.1 may use the default Context (zero-length string) or a vendor-specific context to identify the Management Information Base (MIB) for the OCHD2.1 in the case the implementation supports multiple SNMP logical entities within the same SNMP entity (see [eDOCSIS]).

#### 14.4.2.2 SNMPv3 Access View Configuration TLV

This section specifies the mapping of the SNMPv3 Access View configuration TLV (see Section 15.2) to SNMPv3 MIB objects. The SNMPv3 Access View Configuration TLV is used to configure the table vacmViewTreeFamilyTable in a simplified way.

REQ3668 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create entries in vacmViewTreeFamilyTable as indicated in Table 14.4-9.

**Table 14.4-9 - SNMPv3 Access View Configuration TLV Mapping**

Sub-TLVs	Variable Name	Associated MIB Object [RFC 3415]
SNMPv3 Access View Name	<i>AccessViewName</i>	vacmViewTreeFamilyViewName
SNMPv3 Access View Subtree	<i>AccessViewSubTree</i>	vacmViewTreeFamilySubtree
SNMPv3 Access View Mask	<i>AccessViewMask</i>	vacmViewTreeFamilyMask
SNMPv3 Access View Type	<i>AccessViewType</i>	vacmViewTreeFamilyType

Disconnected entries in the OCHD2.1 SNMP access configuration database are not expected to be detected by the OCHD2.1 as part of the configuration. Eventually, the SNMP agent will not grant access to SNMP requests, for example, to disconnected Security Names and View trees as a result of a TLV configuration mistake.

Table 14.4-10 describes the OCHD2.1 procedures to populate the SNMP Management Framework Access Control Subsystem [RFC 3412].

#### 14.4.2.2.1 *vacmViewTreeFamilyTable*

The *vacmViewTreeFamilyTable* is defined in the "Definitions" section of [RFC 3415].

REQ3669 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create one row in *vacmViewTreeFamilyTable* for each SNMPv3 Access View Configuration TLV as indicated in Table 14.4-10.

REQ3670 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL create a log entry with an error code I409.0 when two SNMPv3 Access View Configuration TLVs have identical index components. In such instance, the OCHD2.1 would not be able to create an entry for the second TLV containing the duplicate index.

REQ3671 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object *vacmViewTreeFamilySubtree* to OID 1.3.6 when no sub-TLV SNMPv3 Access View Subtree is defined in the SNMPv3 Access View Configuration TLV.

REQ3672 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object *vacmViewTreeFamilyMask* to the default zero-length string when no sub-TLV SNMPv3 Access View Mask is defined.

REQ3673 If the OCHD2.1 supports SNMPv1v2c Coexistence, it SHALL set the object *vacmViewTreeFamilyType* to the default value 1 (included) when no sub-TLV SNMPv3 Access View Type is defined.

**Table 14.4-10 - *vacmViewTreeFamilyTable***

Column Name (* = Part of Index)	Column Value
* <i>vacmViewTreeFamilyViewName</i>	<AccessViewName>
* <i>vacmViewTreeFamilySubtree</i>	<AccessViewSubTree>
<i>vacmViewTreeFamilyMask</i>	<AccessViewMask>
<i>vacmViewTreeFamilyType</i>	<AccessViewType>
<i>vacmViewTreeFamilyStorageType</i>	volatile (2)
<i>vacmViewTreeFamilyStatus</i>	active (1)

## 15 HOST 2.1 DEVICE OPERATIONAL PARAMETERS CONFIGURATION

This section defines the configuration of management related functions of the OCHD2.1.

### 15.1 Host 2.1 Device configuration

This specification defines a provisioning mechanism that consists of two phases:

- IP acquisition via DHCP (see Section 13.4).
- Proxy of OCHD2.1 configuration parameters in the form of TLVs by the eCM.

The Table 15.1-1 defines the basic provisioning steps for the OCHD2.1. After the OCHD2.1 receives a "2-Way OK UCID" from the eCM, it initiates processing of the eSTB TLVs passed by the eCM and DHCP address acquisition.

**Table 15.1-1 - Provisioning steps of the OCHD2.1**

Flow Step	Operation	Description	Requirement	eSAFE MIB esafeProvisioning StatusProgress
OCHD2.1-Prov-0	"2-Way OK, UCID" (See [DSG])	The eCM signals to the eSTB the message 2-Way OK, UCID	Section 13.7.1.1	(1) notInitiated
OCHD2.1-Prov-1	eSTB TLVs processing	The OCHD2.1 process the eSTB TLVs received from the eCM (1)	See section 15.2 eSTB Configuration TLVs	(2) inProgress
OCHD2.1-Prov-2	IPv4 Address Acquisition	eSTB acquires an IPv4 address	Section 13.7.1	(2) inProgress
OCHD2.1-Prov-3	IPv6 Address Acquisition	eSTB acquires an IPv6 address	Section 13.7.2	(2) inProgress
OCHD2.1-Prov-4	OCHD2.1 provisioning completed	The OCHD2.1 provisioning is completed		(3) finished

REQ3927 If a failure occurs in processing the eSTB TLVs, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL be set to OCHD2.1-Prov-1, and the value of the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

REQ3928 If a failure occurs in acquiring an IPv4 address, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL be set to OCHD2.1-Prov-2, and the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

REQ3929 If a failure occurs in acquiring an IPv6 address, the value of the eSAFE MIB object `esafeProvisioningStatusFailureFlow` SHALL be set to OCHD2.1-Prov-3, and the eSAFE MIB object `esafeProvisioningStatusProgress` SHALL be set to (3) finished.

#### 15.1.1 eCM Proxy mechanism for the configuration of the OCHD2.1

For the purpose of configuring the OCHD2.1 by the means of this specification, the eCM supports the 'eCM Config File Encapsulation' TLV defined in [eDOCSIS]. The eCM passes the content of TLV Type 217 to the OCHD2.1. Such content corresponds to the eSTB configuration TLVs (see Section 15.2).

The OCHD2.1 provisioning process defined above relies on the eCM registration process (see [RFIV2.0]), which supports acceptable security provisions for the OCHD2.1 configuration parameters defined in Section 15.2. An increase of the service sensitivity of new configuration parameters may determine the need of a more robust provisioning mechanism and perhaps independent of the eCM.

REQ3674 When acquiring an IPv4 address, the OCHD2.1 SHALL include in the eCM DHCP option 43 sub-option 15 the text "ESTB" to indicate support of the eCM encapsulation TLV feature by the eSTB.

REQ3930 When acquiring an IPv6 address, the eCM in the OCHD2.1 SHALL include in the [eDOCSIS] eCM DHCP "eCM config file encapsulation" option the text "ESTB" to indicate support of the eCM encapsulation TLV feature by the eSTB.

REQ3675 The OCHD2.1 SHALL pass the content of TLV 217 from the eCM config file to the eSTB. The mechanism to pass such content from the eCM to the eSTB is vendor-specific.

REQ3676 The OCHD2.1 SHALL parse the eSTB TLVs contained in TLV 217 only after receiving the "2-Way OK, UCID" message from the eCM but before beginning its IP address acquisition process.

## 15.2 eSTB Configuration TLVs

This section defines the TLV requirements for the OCHD2.1 when operating in two-way DSG Mode. The OCHD2.1 is required to support the TLVs defined in this section. Some TLVs were initially defined in other specifications such as [RFIPv2.0] and [MULPIv3.0]. The features around those TLVs are maintained. However, the behavior may be different to accommodate the OCHD2.1 provisioning needs.

In case of failure to set one or more configuration parameters, the OCHD2.1 logs the error condition in docsDevEventTable (see Annex A of [MIB-HOST]) and updates the eCM to properly report the status of esafeProvisioningStatusTable [eDOCSIS].

REQ3678 The OCHD2.1 SHALL process the eSTB Configuration TLVs and disregard unrecognized TLVs or sub-TLVs within a TLV.

REQ3679 The OCHD2.1 SHALL create a log entry with an error code I404.0 when unrecognized TLVs or sub-TLVs are present in the configuration process.

REQ3680 The OCHD2.1 SHALL create a log entry with an error code I405.0 in case of duplicated TLVs when not supported.

REQ3681 The OCHD2.1 SHALL create a log entry with an error code I406.0 in case of an invalid TLV Type encoding.

REQ3682 The OCHD2.1 SHALL create a log entry with an error code I408.0 when no resources are available or the limit of configurable elements is reached.

REQ3683 In the case of an error condition while processing configuration parameters, the OCHD2.1 SHALL update the eCM with the Provisioning step (see 15.1.1) and the error condition to be reported by the eCM in the esafeProvisioningStatusTable [eDOCSIS].

### 15.2.1 SNMPv1v2c Coexistence Configuration

This TLV (Type 53) specifies the SNMPv1v2c Coexistence Access Control configuration of the OCHD2.1. This TLV creates entries in SNMPv3 tables as specified in Section 14.4.

REQ3684 The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 53.1 SNMPv1v2c Community Name is not present in a TLV 53.

REQ3685 The OCHD2.1 SHALL create a log entry with an error code I407.0 if the sub-TLV 53.2 SNMPv1v2c Transport Address Access is not present in a TLV 53.

REQ3686 The OCHD2.1 SHALL support multiple instances of sub-TLV 53.2 SNMPv1v2c Transport Address Access within a TLV 53.

REQ3687 The OCHD2.1 SHALL create a log entry with an error code I405.0 for configuration cases that includes repeated sub-TLVs other than sub-TLV 53.2 and preserve the configuration of the first duplicated sub-TLV.

REQ3688 The OCHD2.1 SHALL create a log entry with an error code I406.0 if an OCHD2.1-created entry based on TLV 53 in any SNMP table is rejected due to SNMP syntax conflicts.

REQ3689 The OCHD2.1 SHALL create a log entry with an error code I408.0 if an OCHD2.1-created entry based on TLV 53 in any SNMP table is rejected due to reaching the limit in the number of entries supported for that table.

REQ3690 The OCHD2.1 SHALL create a log entry with an error code I409.0 if an OCHD2.1 created entry based on TLV 53 in any SNMP table already exists.

REQ3691 The OCHD2.1 SHALL support a minimum of five SNMPv1v2c Coexistence Configuration TLVs.

Type	Length	Value
53	N	Composite

**Note:** The number of entries an OCHD2.1 can support in SNMPv3 tables is independent of the number of TLVs the eCM supports.

#### **15.2.1.1 SNMPv1v2c Community Name**

This sub-TLV specifies the Community Name (community string) used in SNMP requests to the OCHD2.1.

Type	Length	Value
53.1	1..32	Text

#### **15.2.1.2 SNMPv1v2c Transport Address Access**

This sub-TLV specifies the Transport Address and Transport Address Mask pair used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1.

REQ3692 The OCHD2.1 SHALL create a log entry with an error code I407.0 if a sub-TLV Transport Address Access (Type 53.2) has more than one sub-TLV 53.2.1 or 53.2.2.

Type	Length	Value
53.2	N	Variable

##### **15.2.1.2.1 SNMPv1v2c Transport Address**

This sub-TLV specifies the Transport Address to use in conjunction with the Transport Address Mask used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1.

REQ3693 The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 53.2.1 is not present in the configuration sub-TLV 53.2.

Type	Length	Value
53.2.1	6 or 18	Transport Address

**Note:** Length is 6 bytes for IPv4 and 18 bytes for IPv6.

The OCHD2.1 is not required to support IPv6 Transport Addresses and ignores TLVs that include those values.

#### 15.2.1.2.2 *SNMPv1v2c Transport Address Mask*

This sub-TLV specifies the Transport Address Mask to use in conjunction with the Transport Address used by the OCHD2.1 to grant access to the SNMP entity querying the OCHD2.1. This sub-TLV is optional.

Type	Length	Value
53.2.2	6 or 18	Transport Address Mask

**Note:** Length is 6 bytes for IPv4 and 18 bytes for IPv6.

The OCHD2.1 is not required to support IPv6 Transport Addresses Masks and ignores TLVs that include those values.

#### 15.2.1.3 *SNMPv1v2c Access View Type*

This sub-TLV specifies the type of access to grant to the community name of this TLV. Sub-TLV Type 53.3 is optional. If sub-TLV 53.3 is not present in TLV-53, the default value of the access type to grant to the community name specified in sub-TLV 53.1 is read-only.

Type	Length	Value
53.3	1	1: Read-only 2: Read-write

#### 15.2.1.4 *SNMPv1v2c Access View Name*

This sub-TLV specifies the name of the view that provides the access indicated in sub-TLV SNMPv1v2c Access View Type.

Type	Length	Value
53.4	1..32	String

### 15.2.2 *SNMPv3 Access View Configuration*

This TLV (Type 54) specifies the SNMPv3 Simplified Access View configuration of the OCHD2.1. This TLV creates entries in SNMPv3 tables as specified in Section 14.4.

REQ3694 The OCHD2.1 SHALL support a minimum of 10 SNMPv3 Access View Configuration TLVs (Type 54).

REQ3695 The OCHD2.1 SHALL create a log entry with an error code I407.0 if the sub-TLV SNMPv3 Access View Name (Type 54.1) is not present in TLV 54.

REQ3696 The OCHD2.1 SHALL support multiple TLVs with same value of SNMPv3 Access View Name sub-TLV (Type 54.1).



REQ3697 The OCHD2.1 SHALL create a log entry with an error code I407.0 if more than one sub-TLV of the same type are included in a TLV 54.4.

REQ3698 The OCHD2.1 SHALL create a log entry with an error code I404.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table is rejected due to syntax conflicts.

REQ3699 The OCHD2.1 SHALL create a log entry with an error code I408.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table is rejected due to reaching the limit in the number of entries supported for that table.

REQ3700 The OCHD2.1 SHALL create a log entry with an error code I409.0 if an OCHD2.1-created entry based on TLV 54 in an SNMP table already exists.

Type	Length	Value
54	N	Composite

**Note:** The number of entries a OCHD2.1 can support in SNMPv3 tables is independent of the number of TLVs the eCM supports for its own management configuration, in the case both CM and OCHD2.1 share the same SNMP entity (see [eDOCSIS] and [RFC 3411]).

#### 15.2.2.1 SNMPv3 Access View Name

This sub-TLV specifies the administrative name of the View defined by this TLV.

REQ3701 The OCHD2.1 SHALL create a log entry with an error code I407.0 if sub-TLV 54.1 is not present within TLV-54.

Type	Length	Value
54.1	1..32	Text

#### 15.2.2.2 SNMPv3 Access View Subtree

This sub-TLV specifies an ASN.1 formatted object Identifier that represents the filter sub-tree included in the Access View TLV.

REQ3702 The OCHD2.1 SHALL accept only encoded values that start with the ASN.1 Universal type 6 (Object Identifier) byte, followed by the ASN.1 length field, and then the ASN.1 encoded object identifier components. For example, the sub-tree 1.3.6 is encoded as 0x06 0x03 0x01 0x03 0x06.

REQ3703 If sub-TLV 54.2 is not included in TLV 54, the OCHD2.1 SHALL use as default the OID sub-tree 1.3.6.

Type	Length	Value
54.2	N	OID

#### 15.2.2.3 SNMPv3 Access View Mask

This sub-TLV specifies the bit mask to apply to the Access View Subtree of the Access View TLV.

Type	Length	Value
54.3	0..16	Bits

REQ3704 The OCHD2.1 SHALL assign a zero-length string to SNMPv3 Access View Mask TLV 54.3 if TLV 54 is present but sub-TLV 54.3 is not included.

#### 15.2.2.4 SNMPv3 Access View Type

This sub-TLV specifies the inclusion or exclusion of the sub-tree indicated by SNMPv3 Access View Subtree sub-TLV 54.2 in the SNMPv3 Access View Configuration TLV 54. The value 1 indicates the sub-tree of SNMPv3 Access View SubTree is included in the Access View. The value 2 indicates the sub-tree of SNMPv3 Access View Sub Tree is excluded from the Access View.

Type	Length	Value
54.4	1	1: included 2: excluded

REQ3705 The OCHD2.1 SHALL assign the value 'included' to SNMPv3 Access View Type sub-TLV 54.4 if TLV 54 is present but sub-TLV 54.4 is not included.

#### 15.2.3 SNMP MIB Object

This TLV specifies the mechanism for setting writable SNMP MIB objects using eSTB TLV constructs.

The value of this TLV Type is one SNMP VarBind as defined in [RFC 1157]. The VarBind is encoded in ASN.1 Basic Encoding Rules, just as it would be if part of an SNMP Set request.

REQ3706 The OCHD2.1 SHALL treat TLV 11 as if it were part of an SNMP Set Request with the following caveats: It treats the request as fully authorized (it cannot refuse the request for lack of access privilege), and no SNMP response is generated by the OCHD2.1.

REQ3707 The OCHD2.1 SHALL process multiple TLV 11 encodings as if simultaneous.

REQ3708 The OCHD2.1 SHALL ignore unsupported SNMP MIB objects in TLV 11 and create a log entry with an error code I401.0 in case of an invalid varbind encoding.

REQ3709 The OCHD2.1 SHALL create a log entry with an error code I402.0 in case of duplicated SNMP MIB OIDs in TLV 11 - setting the same object instance to same or different value.

REQ3710 The OCHD2.1 SHALL create a log entry with an error code I403.0 in case of an invalid varbind encoding in TLV 11.

Type	Length	Value
11	N	SNMP varbind

#### 15.2.4 Vendor ID Encoding

The Vendor ID is defined in [RFIv2.0] and used in this specification for similar purposes. The value field contains the vendor identification specified by the three-byte vendor-specific Organization Unique Identifier of the OCHD2.1 MAC address. This TLV is used in this specification as a sub-tlv of the Vendor Specific Information TLV. Other vendor-specific areas of application are possible. This TLV has no meaning when used as a standalone TLV and is ignored by the OCHD2.1.

When used as a sub-field of the Vendor Specific Information field, this identifies the Vendor ID of the OCHD2.1s that are intended to use this information.

The Vendor ID 0xFFFFFFFF is a reserved value in [RFiv2.0] is not currently used in this specification, but stays reserved.

Type	Length	Value
8	3	OUI

### 15.2.5 Vendor Specific Information

This TLV type is used to extend the capabilities of the OCHD2.1 specification, through the use of vendor-specific features. The Vendor Specific Information TLV comes from [RFiv2.0], where it is defined as part of a multipurpose encapsulation known as DOCSIS Extension Field.

This TLV always includes only one Vendor ID field (see Section 15.2.4) to indicate that the settings apply to a specific vendor device.

REQ3711 The OCHD2.1 SHALL ignore a Vendor Specific Information TLV 43 that includes a Vendor ID different from that of the OCHD2.1.

REQ3712 The OCHD2.1 SHALL create a log entry with an error code I406.0 in the case the Vendor ID TLV 8 does not correspond to the first sub-TLV in a Vendor Specific Information TLV 43.

Type	Length	Value
43	N	

### 15.2.6 IP Mode Control

This TLV (Type 1) is used to inform the OCHD2.1 in which IP mode it should operate.

REQ3931 The eSTB in the OCHD2.1 SHALL acquire an IPv4 address and operate in IPv4 mode when the value of IP Mode Control TLV 1 is set to 0.

REQ3932 The eSTB in the OCHD2.1 SHALL acquire an IPv6 address and operate in IPv6 mode when the value of IP Mode Control TLV 1 is set to 1.

REQ3933 If IP Mode Control TLV 1 is not present, the eSTB in the OCHD2.1 SHALL acquire the same type of address and operate in the same IP mode as the eCM.

Type	Length	Value
1	1	0: IPv4 1: IPv6

## Annex A Format and Content for OCHD2.1 Events (Normative)

This Annex reuses the event framework used in DOCSIS. In particular, only the Local log requirements for [OSSIV2.0] are required for the OCHD2.1.

The format of Table A–1 is slightly different from the one in [OSSIV2.0]. A brief summary of the OCHD2.1 elements is below.

- Each row specifies a possible event that the OCHD2.1 logs to the available mechanisms.
- The first column (Process) indicates the stage where the event would happen. The currently defined processes are: 'Prov' Provisioning of the OCHD2.1, and DHCP renewal of DHCP.
- The second column (SubProcess) indicates a sub-process within the specified Process. For example, for the process 'Prov', the sub-process 'TLV PARSING' and DHCP (initial DHCP provisioning) are defined; the DHCP Process includes the 'Renewal' sub-process.
- The third column (Event Level) indicates the event level of the event (see [OSSIV2.0]). This column value is reported in the MIB object docsDevEvLevel of the docsDevEventTable.
- The fourth column (Event Message) indicates the event text to record. This column value is reported in the MIB object docsDevEvText of the docsDevEventTable.
- The Fifth column (Message Notes and Details) is a placeholder to indicate special interpretation of parameters or indications for the Event Message column.
- The sixth column (Error Code Set) correspond to an Encoding model of the events (originally defined in [OSSIV2.0]). This Error Code set is in the scope of the OCHD2.1 specification. However, some codes have been reused from DOCSIS for consistency. Because DOCSIS may extend this code set independently of the events defined in the Open Cable specification, corresponding Error Code Set would not be always the same for identical error conditions.
- The seventh column (Event ID) is a numeric representation of the Error Code Set. The mapping of Event ID and Error Code Set is defined in [OSSIV2.0], and this specification follows the same methodology. This column value is reported in the MIB object docsDevEvId of the docsDevEventTable.
- The eighth column (Notification Name) indicates the SNMP notification object type that this event would generate. Currently no notifications are defined. This column is left in the table format for future study.
- Additional formatting indications are described as well in [OSSIV2.0].

**Table A–1 - eSTB Event List for the OCHD2.1**

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
<b>TLV-11 Failures</b>						
Prov	TLV-11 PARSING	Notice	TLV-11 - unrecognized OID		I401.0	73040100
Prov	TLV-11 PARSING	Warning	TLV-11 - Illegal Set operation failed		I402.0	73040200
Prov	TLV-11 PARSING	Warning	TLV-11 - Failed to set duplicate elements		I403.0	73040300
<b>TLV Failures</b>						
Prov	TLV PARSING	Notice	TLV - unrecognized Type		I404.0	73040400

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
Prov	TLV PARSING	Warning	TLV - Failed to set duplicate elements		I405.0	73040500
Prov	TLV PARSING	Warning	TLV - illegal encoding failed		I406.0	73040600
Prov	TLV PARSING	Warning	TLV - Invalid element multiplicity		I407.0	73040700
Prov	TLV PARSING	Warning	TLV - Insufficient resources		I408.0	73040800
Prov	TLV PARSING	Warning	TLV- Element Already exist Failed creation		I409.0	73040900
<b>DHCP IP Acquisition</b>						
Prov	DHCP	Critical	DHCP FAILED – Discover sent, no offer received for <P1>	<P1>: 'eSTB' or 'CC'	D01.0	68000100
Prov	DHCP	Critical	DHCP FAILED – Request sent, No response for <P1>	<P1>: 'eSTB' or 'CC'	D02.0	68000200
Prov	DHCP	Critical	DHCP FAILED – Response doesn't contain ALL the valid fields for <P1>	<P1>: 'eSTB' or 'CC'	D03.1	68000301
Prov	DHCP	Critical	DHCP failed – RS sent, no RA received	Only applies to eSTB IPv6 addresses	D12.0	68001200
Prov	DHCP	Critical	DHCP Failed – Invalid RA	Only applies to eSTB IPv6 addresses	D12.1	68001201
Prov	DHCP	Critical	DHCP failed – DHCP Solicit sent, No DHCP Advertise received	Only applies to eSTB IPv6 addresses	D12.2	68001202
Prov	DHCP	Critical	DHCP failed – DHCP Request sent, No DHCP REPLY received	Only applies to eSTB IPv6 addresses	D12.3	68001203
Prov	DHCP	Critical	Link-Local address failed DAD	Only applies to eSTB IPv6 addresses	D13.1	68001301
Prov	DHCP	Critical	DHCP lease address failed DAD	Only applies to eSTB IPv6 addresses	D13.2	68001302

Process	SubProcess	Event Level	Event message	Message Notes And Details	Error Code Set	Event ID
<b>DHCP IP Renewal</b>						
DHCP		Error	DHCP RENEW sent – No response for <P1>	<P1>: 'eSTB' or 'CC'	D101.0	68010100
DHCP		Error	DHCP REBIND sent – No response for <P1>	<P1>: 'eSTB' or 'CC'	D102.0	68010200
DHCP		Error	DHCP RENEW sent – Invalid DHCP option for <P1>	<P1>: 'eSTB' or 'CC'	D103.0	68010300
DHCP		Error	DHCP REBIND sent – Invalid DHCP option for <P1>	<P1>: 'eSTB' or 'CC'	D104.0	68010400

## Appendix I Revision History

The following ECN was incorporated into OC-SP-HOST2.1-CFR-I02-071113:

ECN	Description	Date
HOST2.1-CFR-N-1107-1	MIB sections reorganization	10/23/07

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I03-080118:

ECN	Description	Date
HOST2.1-CFR-N-1086-1	Change to number of required 1394 ports	12/7/07
HOST2.1-CFR-N-1138-1	Changes to sections 13, 14 and 15 for ReqPro compliance	12/21/07
HOST2.1-CFR-N-1145-1	Changes to sections 1 thru 12 for ReqPro compliance	12/21/07

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I04-080404:

ECN	Description	Date
HOST2.1-CFR-N-08.1171-1	Add Host requirement to accommodate Cards of various lengths	2/29/08
HOST2.1-CFR-N-08.1172-1	Support for SCTE-127-2007	2/29/08
HOST2.1-CFR-N-08.1173-1	Minimum Size Limit of SI Data and XAIT Storage in Host and storage of XAIT in Host	2/29/08
HOST2.1-CFR-N-08.1182-1	Define ranges for required SNR & Signal Level accuracy of FAT	2/29/08
HOST2.1-CFR-N-08.1189-3	Change DVS-683 ref in Host 2.1 to SCTE 128	3/14/08
HOST2.1-CFR-N-08.1193-1	Add a requirement for SNMP community-based access support	3/14/08

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I05-080620:

ECN	Description	Date
HOST2.1-CFR-N-08.1170-5	Common Keystroke Diagnostics Entry Sequence	5/30/08
HOST2.1-CFR-N-08.1218-4	Support for IPv6	5/30/08
HOST2.1-CFR-N-08.1219-1	Clarification of allowed values for the docsDevEvReporting object	5/30/08
HOST2.1-CFR-N-08.1233-1	Clarification of required key support for wireless keyboard	5/30/08
HOST2.1-CFR-N-08.1234-1	Change support for Ch 3/4 RF output from mandatory to optional	5/30/08
HOST2.1-CFR-N-08.1239-1	Remove Host Default CCI and Error CCI	5/30/08
HOST2.1-CFR-N-08.1247-2	Generic Feature Control Resource Requirements	5/30/08
HOST2.1-CFR-N-08.1255-2	Specify remote device function key placement	5/30/08

The following ECNs were incorporated into OC-SP-HOST2.1-CFR-I06-081114:

ECN	Description	Date
HOST2.1-CFR-N-08.1123-4	DPI modifications	10/3/08
HOST2.1-CFR-N-08.1269-4	Host2.x-Card SNMP Message Format	10/17/08
HOST2.1-CFR-N-08.1295-2	Deprecate DSG Basic Mode	10/17/08
HOST2.1-CFR-N-08.1304-2	Removal of Option 3 for wireless keyboard implementations	10/17/08
HOST2.1-CFR-N-08.1305-1	Change OCAP reference from 1.0.2 to 1.0.1	10/3/08
HOST2.1-CFR-N-08.1308-1	Remove function key physical layout requirement on OCAP remotes	10/17/08

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