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Digital Video Subcommittee

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SCTE 26 2017 (R2021)

Home Digital Network Interface Specification with Copy Protection

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3 INTRODUCTION

The need for interfaces between cable set top boxes and digital television (DTV) receivers is one element of a general movement to interconnect multiple audio/visual (A/V) devices on a common bus or network. The IEEE 1394 interface has emerged as the preferred tool to accomplish this goal. This specification contains requirements and options for an IEEE 1394 digital interface between a cable TV set top box (called a Host Device in this standard because it "hosts" a removable security module), and a DTV receiver.

IEEE 1394, which covers the physical interface, has been extended by CEA-775, CEA-931 and CEA-799 which cover the command language, remote control commands, and on-screen graphics display respectively. This standard extends these to cover the needs of cable set-top boxes. In addition, the Digital Transmission Content Protection specification governs copy protection of digital content on this interface.

A schematic of the typical architecture expected in the implementation of this specification is shown in below.

The functional partitioning defined in this standard locates the MPEG signal processing into the DTV receiver while service access and content descrambling occurs in the Host device.

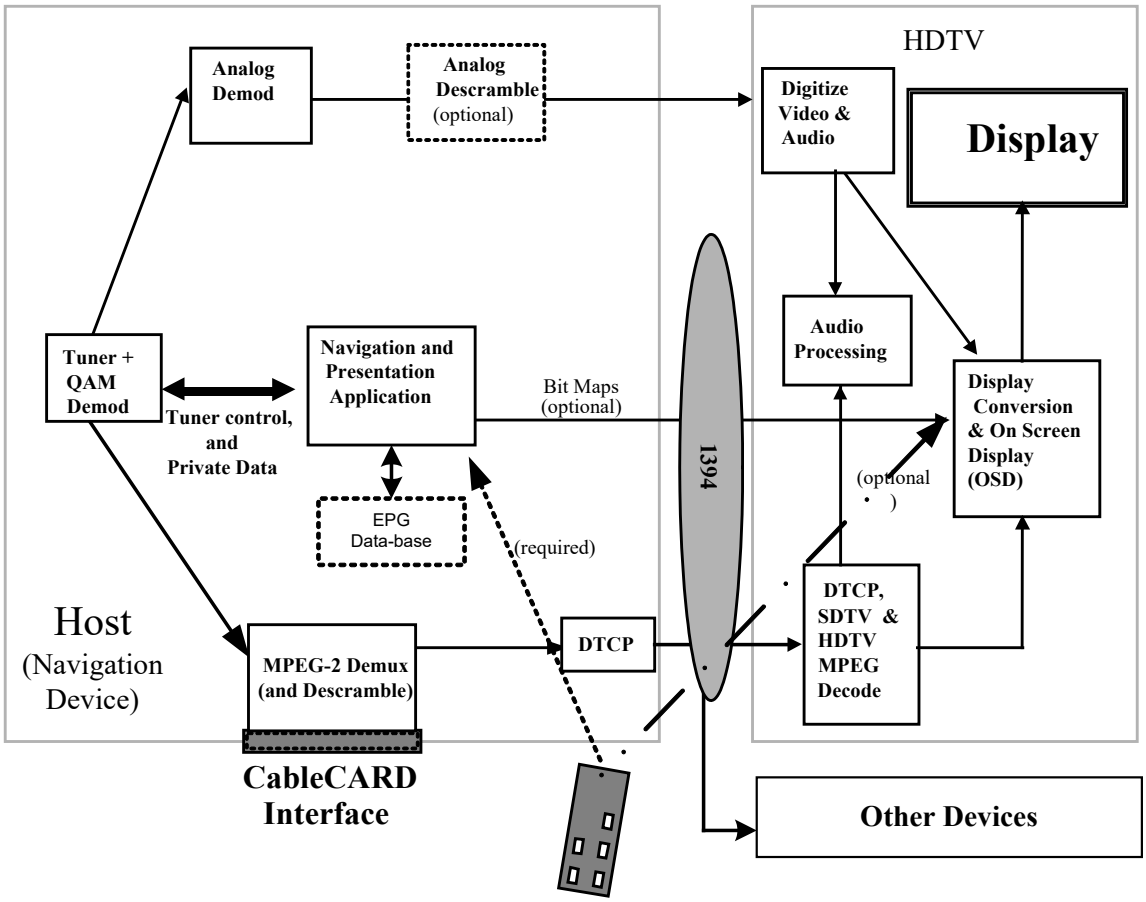

Figure 1 - *Interface Between a Host Device and a DTV Receiver*

To be compatible with Host Devices that comply with this standard, a DTV receiver shall support one or more analog audio/video inputs, and allow an external device such as a set-top box the ability to select either a digital or an analog audio/video source for display.

An external device may optionally supply user interface screens in analog video format instead of bitmap OSD.

4 REFERENCES

4.1 Normative References

The following standards and specifications are normative for devices complying with this interface specification. Where appropriate, this specification incorporates existing standards by reference. This specification also defines additional requirements not found elsewhere.

1. **IEEE 1394-2008 "Standard for a High Performance Serial Bus"**

   IEEE 1394-2008 defines the physical, link, and transaction layers and the bus management protocol for data streams over a high-performance serial bus. It can be ordered from http://shop.ieee.org/store/ and from Global Engineering Documents, http://global.ihs.com/.

2. **Reserved**

3. **IEC 61883 "Digital Interface for Consumer Audio/Video Equipment"**

   IEC 61883-1 defines, among other things, a command/response protocol for delivering commands from a controller to another device over 1394 and connection management protocols for consumer devices.

   IEC 61883-4 defines the digital data transmission format for transmitting MPEG-2 Transport Stream over an isochronous channel on 1394. IEC 61883-1 and -4 are normative and required for devices complying with this standard.

   IEC 61883-2, -3, and -5 define digital data transmission formats for transmitting DVCR format AV data over an isochronous channel on 1394.

   The IEC 61883 standard can be obtained from the IEC National Committees (e.g. ANSI in the US) and other sales outlets. Visit http://www.iec.ch/. Note: The current versions are 61883-1, Edition 2.0, dated 1/2003. Parts 2, 3, 4, and 5 are Edition 2.0 dated 8/2004.

4. **DTCP Digital Transmission Content Protection Specification**

   This is the DTCP copy protection specification which is used to protect designated MPEG content from unauthorized use. An informational version is available from http://www.dtcp.com/. Use of the technology defined in this specification is subject to licensing by Digital Transmission Licensing Administrator, dtla@dtcp.com.

5. **AV/C Digital Interface Command Set, General Specification, 1394 Trade Association, Version 4.2**

   This specification, available from http://www.1394ta.org/, defines a command set (AV/C) that can be used to communicate with a growing family of consumer devices.

6. **Reserved**

7. **ISO/IEC 13818-1:2007, Information Technology - Generic Coding of Moving Pictures and Associated Audio - Part 1:Systems**

This specification defines an MPEG-2 systems standard, including Transport Stream encoding. ISO/IEC 13818-1 is normative and required for devices complying with this standard.

8. ATSC A/53 Digital Television Standard, Parts 1 through 6

ATSC A/53, available from http://www.atsc.org/, is normative and required for devices complying with this standard. A/53 Parts 1, 3, and 4: 2009, Parts 2, 5, and 6: 2007.

9. CEA-775-C, DTV 1394 Interface Specification, September 2008

This is a general specification for a DTV receiver equipped with a 1394 interface. Also, the CEA-775 standard defines a data structure, the EIA Unit Identifier Descriptor, that allows the Host Device to discover the capabilities of the DTV receiver. CEA standards can be purchased from Global Engineering Documents, http://global.ihs.com/.

10. CEA-799-A, On-Screen Display Specification, July 2006

This standard defines a format and method of delivery for on-screen display (OSD) data and the syntax and semantics of the subframes that define the OSD data.

11. ANSI/SCTE 41 2004 POD Copy Protection System

This specifies the copy protection system used on the CableCARD-Host interface.

12. ANSI/SCTE 54 2009, Digital Video Service Multiplex and Transport System Standard for Cable Television

13. ANSI/SCTE 43 2005, Digital Video Systems Characteristics Standard for Cable Television

14. CEA-931-C Remote Control Command Pass-Through Standard for Home Networking, December 2007

4.2 Informative References

The following standards and specifications are informative references.

15. IPv4 over IEEE 1394

This specification, http://www.ietf.org/rfc/rfc2734.txt, describes the mapping of Internet Protocol (IP) to IEEE 1394. Devices use this protocol for IP data transfer, including such applications as e-mail, web browsing, and file transfer.

5 COMPLIANCE WITH CEA-775, CEA-799, CEA-931 AND DIGITAL TRANSMISSION CONTENT PROTECTION SPECIFICATION

Unless otherwise specified, this interface shall require compliance with CEA-775, CEA-799, CEA-931 and applicable portions of the Digital Transmission Content Protection Specification [4]. Whether programming is subject to content protection is beyond the scope of this standard. In the case where content protection is asserted, the DTCP blocks in Figure 1 are active.

6 INTERFACE SPECIFICATIONS

6.1 Initialization and Configuration

On power-up and bus reset, the Host Device shall query all other devices on the 1394 bus to collect the information in the Configuration ROM (as defined in the IEC 61883-1 [3] and IEEE 1394 specifications) of each device. The Host Device shall build a device information table that correlates the node ID and WWUID of every device on the bus. The following standard data structures shall be supported by 1394 nodes:

6.1.1 CSR core registers

CSR core registers shall conform to IEEE 1394-2008. The **STATE_CLEAR.cmstr** bit shall be implemented according to IEC 61883-1 [3].

6.1.2 Serial bus node registers

Serial bus node registers shall be implemented in conformance with IEC 61883-1 [3].

6.1.3 Configuration ROM requirements

The Host Device and DTV shall implement the ROM format as defined in IEC 61883-1 [3]. Implementation requirements for **Bus_info_block**, **Root_directory**, and **Unit_directory** shall conform to IEC 61883-1 [3].

6.1.3.1 Bus_info_block entry

Implementation requirements for **Bus_info_block** in this standard shall conform to IEC 61883-1 [3].

6.1.3.2 Root directory

Implementation requirements for **Root_directory** in this standard shall conform to IEC 61883-1 [3].

6.1.3.3 Unit directory

Implementation requirements for **Unit_directory** in this standard shall conform to IEC 61883-1 [3]. The **Unit_sw_version** shall indicate support for AV/C at minimum (the least significant bit of the third byte of **Unit_sw_version** shall be set to 1).

The EIA **Unit_directory** specified in CEA-775 [9], shall also be present, as required by CEA-775 for source audio/video devices compliant to that standard. The **Unit_SW_Version** shall be set to indicate the version of CEA-775 supported by the Host Device (currently 1.1).

6.2 AV/C Discovery Process

If the Host Device supports OSD, then the Host Device shall query the DTV on bus reset to discover the DTV's OSD-related capabilities. The DTV shall respond to the AV/C SUBUNIT INFO status command and indicate (at minimum) that it has a Monitor Subunit, and it shall indicate its ID (used for later reference).

If the Host Device is discovering the capabilities of the DTV, the Host Device shall use the AV/C OPEN DESCRIPTOR and READ DESCRIPTOR commands to retrieve the Unit Identifier Descriptor, described in Sec. 6.3.3.7.1.

6.3 High-speed Serial Interface

All devices conforming to this specification shall have at least one, and should have at least two 1394 ports.

The user should be made aware when connecting equipment that the best performance will be possible if a direct connection is made between DTV and Host Device, or no devices supporting less than 200 Mbps bus speeds are present on the serial bus between Host Device and display.

6.3.1 Protocol Stack Overview

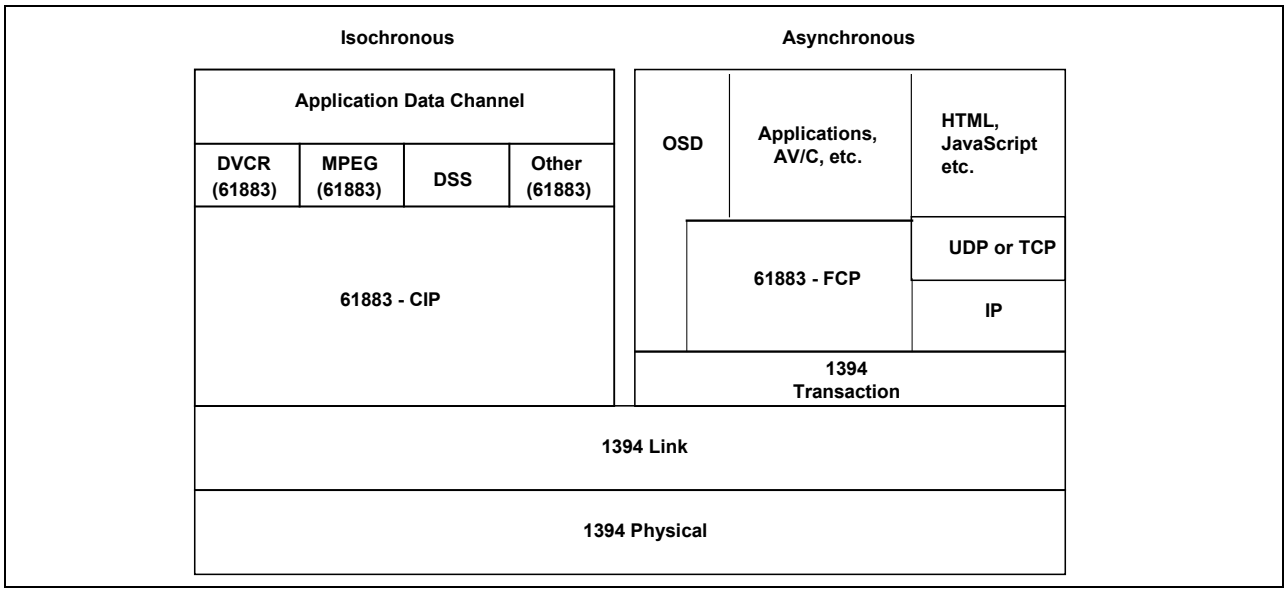

Figure 2 - Protocol Stack for the HDNI serial bus (Informative)

Figure 2 shows the protocol stack defined for the HDNI serial bus. This figure shows the layers in the protocol stack and references the existing standards for 1394 data transport.

6.3.2 A/V Communications Protocols

IEC 61883-1 [3] defines a command/response protocol for delivering commands from a controller to another device over 1394 and connection management protocols for (AV/C) consumer devices plus some other features.

IEC 61883-4 [3] defines the digital data transmission format for transmitting MPEG-2 over an isochronous channel on 1394. IEC 61883-1 and -4 [3] are required for devices complying with this standard. The IEC 61883 [3] Common Isochronous Packet (CIP) shall be used for isochronous data transfer, and IEC 61883 Function Control Protocol (FCP) shall be used for command transfers. The IEC 61883 [3] connection management protocols shall be used.

IEC 61883-2, -3 and -5 [3] define digital data transmission formats for transmitting DVCR format AV data over an isochronous channel on 1394. IEC 61883-2, -3 and -5 [3] are optional for devices complying with this standard.

6.3.3 A/V Service Protocols

6.3.3.1 MPEG TS

When a digital video service is selected, the Host Device shall tune the appropriate MPEG multiplex, and select the appropriate packets corresponding to the video, audio, private data, and control information needed by the display. If access-controlled services are required then the Host Device shall pass the selected streams to the access control circuitry which shall decrypt the streams as applicable. The packets shall be transported over the 1394 interface as an isochronous channel using the IEC 61883-4 [3] standard. This output of the Host Device shall be an MPEG Single Program Transport Stream (SPTS) and as such does not require any generalized System/Service Information such as ATSC A/65 (PSIP). However, the SPTS does require Program Specific Information (PSI), particularly the Program Association Table (PAT) and Program Map Table (PMT).

In the general case, an MPEG-2 Transport Stream may contain multiple services. For the purpose of delivering a selection of services to the DTV for decoding, the source device shall create a Single Program Transport Stream (SPTS). An SPTS is a valid MPEG-2 Transport Stream, but it contains just one MPEG-2 program. CEA-775 [9] specifies the behavior of the DTV when presented with an SPTS.

When processing MPEG programs, all elementary stream references shall be maintained unless a user option has de-selected an elementary stream. This provision ensures that downstream devices that may be present are afforded the option to process any parts of a digital service that have not been processed in the Host Device. Note that selection of an audio language track in the Host Device by the user may be considered to be an implicit de-selection of all other languages, hence they may be removed from the output SPTS. At minimum, “removal” means removal of elementary stream references from the PMT. Deletion of transport packets for the un-referenced streams is permitted.

The Host Device may also support selection of an RF channel and sending the entire transport stream from that channel onto the 1394 interface. See CEA-775 for additional information.

6.3.3.2 Content Advisory (V-chip) Data

The Host Device may process content advisory data when present. However, the Host Device shall not remove content advisory data that may be present in program streams when constructing an output SPTS.

6.3.3.3 Digital Content Copy Protection Specification

Content Copy Protection shall be provided for MPEG TS based on the DTCP Specification [4]. The level of copy protection shall be determined based on the setting in the Copy Control Information (CCI) field, as defined in [11].

6.3.3.4 Digital Interface Command Specification

The primary command interface with the HDTV (or other primary target display) connected to the Host Device shall be through the OSD and Host Device remote control. The Host Device shall support the 1394 Trade Association AV/C Digital Interface Command Set for communicating with other 1394 devices on the network.

The target display shall comply with the AV/C Digital Interface Command Set General Specification [5]. Support for those commands and command forms indicated as "mandatory" in the AV/C Specification shall be required for this specification. Specifically, the Host Device shall respond to the AV/C UNIT INFO and SUBUNIT INFO status commands.

The Host Device shall support the POWER control commands (power on, power off and status inquiry). The Host Device may support other AV/C commands.

6.3.3.5 Unit Info command

The target display shall respond to the AV/C UNIT INFO command, indicating its proper type.

6.3.3.6 Subunit Info command

The target display shall respond to the AV/C SUBUNIT INFO command with, at minimum, indication that a Monitor Subunit is present, and shall return its ID.

6.3.3.7 Open and Read Descriptor commands

If the Host Device supports OSD, then the Host Device shall use the AV/C OPEN DESCRIPTOR and READ DESCRIPTOR control commands to the DTV, in accordance with CEA-775 [9], to learn its capabilities.

The target display shall support the AV/C OPEN DESCRIPTOR and READ DESCRIPTOR commands directed at the DTV unit. The DTV shall return a Unit Identifier Descriptor as described in the following section.

6.3.3.7.1 Host Device Unit Identifier Descriptor

The Host Device shall respond to the unit-directed AV/C OPEN DESCRIPTOR and READ DESCRIPTOR status command with the Unit Identifier Descriptor specified in CEA-775 [9]. The descriptor allows an external device (such as a DTV) to discover the plug IDs of the Host Device's digital, analog, and OSD outputs. The descriptor shall contain information applicable to the Host Device, that is, if the Host Device does not contain OSD functionality, then OSD specific descriptor information is not required to be present.

6.3.3.7.2 DTV Unit Identifier Descriptor

If the Host Device supports OSD, then the Host Device shall query the characteristics of the target display's on-screen display (OSD) using the A/V SUBUNIT INFO and OPEN DESCRIPTOR and READ DESCRIPTOR commands. The Host Device shall process the Unit Identifier Descriptor according to CEA-775 [9] to discover capabilities of the display and the plug ID values used for delivery of digital transport streams and OSD data.

This descriptor indicates the capabilities of the target display with regard to OSD and video handling. The Unit Identifier Descriptor reports capabilities including:

- OSD grid formats supported
- OSD color depths supported
- Whether double buffering is supported
- Video format conversion performed by the DTV for source video formats including 1920 x 1080, 1280 x 720, 704 x 480 (for both 4:3 and 16:9 display aspect ratios), and 640 x 480.
- The OSD vertical on-screen size and pixel aspect ratio for each of these source video formats.

6.3.3.8 External Jack Selection

The Host Device or other devices on the 1394 bus may request display of either a digital or analog input to the target display. For purposes of selection of analog/digital sources (if applicable), the Host Device shall use the AV/C CONNECT command as specified in CEA-775 [9] to control analog/digital input selection in the DTV. In the case that it has multiple baseband analog audio/video inputs, the DTV is responsible for determining the appropriate analog input when asked to select "analog" by the Host Device.

6.3.3.9 Pass Through Control Commands

Host Devices shall support the following list of PASS THROUGH control commands described in CEA-931 [14]: tune function, mute function, and restore volume function. Support for other PASS THROUGH control commands is optional.

6.3.4 Connection Management

The Host Device shall conform to CEA-775 [9] with regard to rules governing the establishment and disconnection of isochronous channels and the asynchronous connections used for delivery of OSD data.

6.3.5 On-Screen Display

A Profile 0 is defined to help set baseline functionality and define future directions for display-device OSD capabilities. Profile 0a or 0b as shown in Table 1 is required for all "cable-ready" displays.

6.3.5.1 Profile 0 (Normative)

Profile 0 is targeted to provide an equivalent level of OSD performance for HDTVs and digital devices when compared to the OpenCable set-tops that are connected to conventional analog TVs. Bit maps shall be used over the 1394 interface in accordance with the following subsections.

Some DTVs compliant with CEA-775 [9] may not support composition of OSD onto analog video. The Host Device should be able to accommodate such DTVs by performing this composition itself.

The OSD bitmap transmission format defined in the following sections supports various OSD modes (horizontal resolution x vertical resolution x bits per OSD pixel), including:

- 640 x 480 x 4 OSD grid, with each OSD pixel a 4-bit index to a color lookup table (CLUT) of 16 entries, each entry containing 16 bit data
- 640 x 480 x 8 OSD grid, with an 8-bit index to a CLUT of 256 entries, each entry containing 16 bit data
- 640 x 480 x 16 OSD grid, each OSD pixel a 16 bit data representing component color or component color and alpha value, (not a reference to a CLUT entry)
- Pixel component coding including:
    - Alpha-Y-Cb-Cr 2:6:4:4, where each pixel is transparent, opaque, or an alpha blend value defined per screen
    - Alpha-Y-Cb-Cr 4:6:3:3, where each pixel is transparent, opaque, or the alpha value given by the pixel's 4-bit alpha value

- Y-Cb-Cr 6:5:5, where all pixels are opaque

Table 1 - Capability Profiles

Capability	Profile 0a	Profile 0b
640 x 480 x 4 OSD grid, 4-bit to 16-bit CLUT format:		
Alpha-YCbCr 2:6:4:4, transparent, opaque or per-screen alpha value	✓	✓
Alpha-YCbCr 4:6:3:3, transparent, opaque or alpha value per pixel		✓
640 x 480 x 8 OSD grid, 8-bit to 16-bit CLUT format:		
Alpha-YCbCr 2:6:4:4, transparent, opaque or per-screen alpha value		✓
Alpha-YCbCr 4:6:3:3, transparent, opaque or alpha value per pixel		✓
YCbCr 6:5:5		✓
640 x 480 x 16 OSD grid, pixel format:		
Alpha-YCbCr 2:6:4:4, transparent, opaque or per-screen alpha value		✓
Alpha-YCbCr 4:6:3:3, transparent, opaque or alpha value per pixel		✓
YCbCr 6:5:5		✓
Video scaling/positioning		✓

Profile 0 is subdivided into two sub-profiles according to Table 1. The Host Device may discover whether a given display supports Profile 0a or 0b upon processing the Unit Identifier Descriptor.

Note that some devices supporting Profile 0a may be able to offer one or more (but not all) advanced features from the Profile 0b list. If the Host Device is able to take advantage of any advanced graphics modes and color depths that are available, it shall use the Unit Identifier Descriptor to discover them.

The video scaling and positioning feature is described in Sec. 6.3.5.2 on page 22.

6.3.5.1.1 OSD Bitmap Pixel Format

The frame buffer shall support OSD bit maps of 640x480 pixels. Each pixel shall be represented by 16 bits of component color (luminance and chrominance) and alpha overlay transparency information. The sampling density and location of each of these pixel components are identical and coincident. Many displays may also be capable of 14:9 or 16:9 resizing of NTSC video stretched to full screen. In a similar manner the display may be capable of scaling the 640x480 bit map into an appropriate 14:9 or 16:9 full screen overlay.

The baseline format for 16 bit pixels shall be 2:6:4:4 (alpha-Y-Cb-Cr). Optional formats for 16 bit pixels shall be 6:5:5 and 4:6:3:3.

6.3.5.1.2 OSD Bitmap Pixel Transport

OSD data shall be delivered via the "asynchronous push" method, with connection management and flow control in accordance with methods defined in the CEA-775 DTV 1394 Interface Standard [9]. Data to be transferred is organized into *frames* and *subframes*. For this application, a number of different subframe types are defined, each functioning to establish OSD format or encoding, or to deliver actual OSD data.

For increased transmission efficiency, a 16- or 256-entry Color Look Up Table (CLUT) that contains 16-bit color pixel data shall be implemented, thereby enabling each pixel in an OSD bit map to be encoded and transmitted by a 4- or 8-bit index operand.

CLUT entries may be transferred from the Host Device to the target display at any time, and at least at every bus reset. The values of the CLUT shall remain valid until overwritten by a changed version of the CLUT. An initial CLUT must be loaded from the Host Device to the target display before any index operands can be transferred to the target display for OSD image conversion and display.

6.3.5.1.3 OSD Pixel Syntax And Semantics

If the Host Device sends OSD data, the OSD data shall conform to CEA-799 [10]. This CEA standard defines the following subframe types:

Set_OSD_pixel_format: Establishes the display mode and format of the basic 16 bit pixels that make up the data definition to follow, and the size and color depth of the OSD grid. When the pixel format is initially defined, or any time it changes, the display initializes the display buffers of the target display and fills them with a constant pixel value defined in the subframe. For OSD grid formats with 4- or 8-bit color depths, the subframe contains a 4- or 8-bit Color Lookup Table (CLUT).

4_bit_OSD_data: Defines 4-bit pixels in a rectangular region. Each 4-bit pixel represents a color/alpha blend value derived by indirection through the 4- bit CLUT.

8_bit_OSD_data: Defines 8-bit pixels in a rectangular region. Each 8-bit pixel represents a color/alpha blend value derived by indirection through the 8- bit CLUT.

Uncompressed_16_bit_data: Defines raw uncompressed 16-bit OSD data in a rectangular region.

Fill_region_with_constant: Defines a rectangular region to fill with a 16 bit constant.

Clear_OSD: Causes the display device to clear the OSD screen.

6.3.5.1.4 Video Frame Buffer

The maximum theoretical data transfer rate for the bit maps is approximately 50 Mbps for 200Mbps interfaces. 640 x 480 x 16 x 60 Hz would require 295 Mbps bandwidth if every frame changed completely. At 50 Mbps, it is possible to change 1/6 of the screen every frame and maintain a 60hz display. This provides a reasonable tradeoff between screen resolution, pixel depth, picture complexity, and frame rate.

The Host Device and display shall support rectangular region based updating.

The DTV display may offer double buffering of OSD. If double buffering is available, OSD data may be directed to the "off screen" buffer by a control bit in the subframe. Another control bit may be used by the Host Device to direct the DTV to swap the off screen with the on-screen buffer following processing the data in the subframe, and time the buffer swap to coincide with vertical retrace on the output scan.

6.3.5.2 Video Scaling and Positioning

The OSD generator may want to place the video inside its graphics rendered content. Examples of this include shrinking the video display into the corner of the display and wrapping the EPG grid around it, or placing video in a web page. The scaling information is derivable from the size. Some devices may or may not support limited resizing, and if they do support limited resizing should do closest larger fit.

According to AV/C design methodology, a DTV unit includes a functional block called the Monitor Subunit. The general Monitor Subunit supports multiple analog or digital audio/video inputs. The Monitor Subunit specification models video processing functions including scaling and positioning, and defines the AV/C commands used to control processing and display functions in the DTV.

The 1394 Trade Association Monitor Subunit specification can be accessed at http://www.1394ta.org/.

Support for the scaling and positioning feature also involves a discovery process. The Monitor Subunit specification describes the Monitor Subunit Identifier Descriptor, which allows an Host Device to discover DTV capabilities and limitations related to the scaling and positioning feature.

6.3.5.3 Wireless Remote Interface

This interface specification assumes that the Host Device will receive commands directly from the user, in response to menus displayed using the OSD. See Section 3.4 of CEA-775.

6.3.6 IP Over 1394

Support for IP over 1394 is optional in this standard, but if supported, implementation shall comply with Ref. [1] or other standards that are compatible with it.

7 PROTOCOL STACK—DETAILED DESCRIPTIONS

This section describes protocol stacks for the interaction between an AV source device (e.g. Digital VCRs, Cable STBs, etc.) and a DTV (Digital TV) over IEEE 1394. These protocol stacks are categorized into the following:

- Initialization
- AV Protocols
- Bitmap OSD Protocols
- Internet Protocol (IP)

7.1 Initialization

7.1.1 Initialization Protocol Stack

The protocol stack for initialization is defined in Figure 3.

The initialization process shall consist of two applications: 1) 1394 node discovery application and 2) Subunit Identifier descriptor discovery application.

The 1394 Node discovery application shall be invoked at IEEE 1394 bus reset. The 1394 Node discovery application shall query all other devices on the 1394 bus to collect the information in the Configuration ROM of each device, as defined in CEA-775. This application shall build a device information table that correlates the node ID and WWUID of every device on the bus.

The Subunit identifier descriptor discovery application shall be invoked at IEEE 1394 bus reset for all DTVs and for all Host Devices that support OSD. The Subunit identifier descriptor discovery application shall query the current configuration of the target display's capabilities, including target display's OSD (On-Screen-Display), using the AV/C READ DESCRIPTOR Command. In future profiles, Subunit identifier descriptor discovery application can query the Host Device's capabilities using the AV/C READ DESCRIPTOR Command.

<table>
<tr><td rowspan="3">1394 Node Discovery
Application</td><td colspan="2">Subunit Identifier Descriptor Discovery Application</td></tr>
<tr><td colspan="2">Command & Control
(AV/C READ DESCRIPTOR Command)</td></tr>
<tr><td colspan="2">Function Control Protocol – FCP
(IEC 61883-1)</td></tr>
<tr><td rowspan="3">1394 Serial Bus Management
(Configuration ROM, CSR)</td><td colspan="2">1394 Transaction Layer</td></tr>
<tr><td colspan="2">1394 Link Layer</td></tr>
<tr><td colspan="2">1394 Physical Layer</td></tr>
</table>

Figure 3 - Protocol Stack for Initialization

7.1.2 Description of Specific Protocols

This section describes the specific protocols used in the protocol stacks identified in the section above.

7.1.2.1 1394 Physical Layer

Defined in IEEE 1394-2008.

The devices conforming with this specification shall support speeds of S200 (196.608 Mbps) or greater. The choice of using a four (4) pin connector or six (6) pin connector is not specified. Devices conforming with this specification shall have least one, and should have at least two 1394 ports implemented.

7.1.2.2 1394 Link Layer

Defined in IEEE 1394-2008.

The devices conforming with this specification shall support both Asynchronous packet transmission and Isochronous packet transmission. Devices capable of sourcing isochronous data shall be Cycle Master Capable.

7.1.2.3 1394 Transaction Layer

Defined in IEEE 1394-2008.

The devices conforming with this specification shall be Asynchronous transaction capable.

7.1.2.4 1394 Serial Bus Management

Defined in IEEE 1394-2008.

Regarding Command and Status Registers (CSRs), the implementation of both CSR Architecture core registers and Serial-Bus-Dependent registers shall conform with IEC 61883-1.

Regarding Configuration ROM, the implementation of **Bus_info_Block**, **root_directory** and **unit_directories** shall conform with IEC 61883-1.

The Host Device shall support isochronous resource manager capability as defined in IEEE 1394-2008 [1] section 8. The support of bus manager capability is optional

7.1.2.5 Function Control Protocol (FCP)

Defined in IEC 61883-1 [3].

The devices conforming with this specification shall implement a Command Register and a Response Register as the target address space of command frame and response frame, respectively. The register address, frame structure and CTS (Command/Transaction Set) value shall conform with IEC 61883-1.

7.1.2.6 Command and Control (AV/C READ DESCRIPTOR Command)

Defined in AV/C Digital Interface Command Set General Specification, version 3.0.

The devices conforming with this specification shall support the AV/C READ DESCRIPTOR command to issue or respond to queries using the Subunit identifier descriptor. The Unit Identifier Descriptor for the display device is defined in CEA-775 [9] and referenced in Sec. 3.3.3.7.2 of this specification.

7.2 AV Protocols

7.2.1 AV Protocol Stacks

This section describes the protocol stacks for AV streams.

7.2.1.1 MPEG TS Content Flow

The protocol stack for MPEG TS Content Flow is defined in Figure 4.

MPEG TS content flow contains the real time MPEG audio and video Elementary Stream, and MPEG-2 Program Specific Information. Single program TS (SPTS) is used.

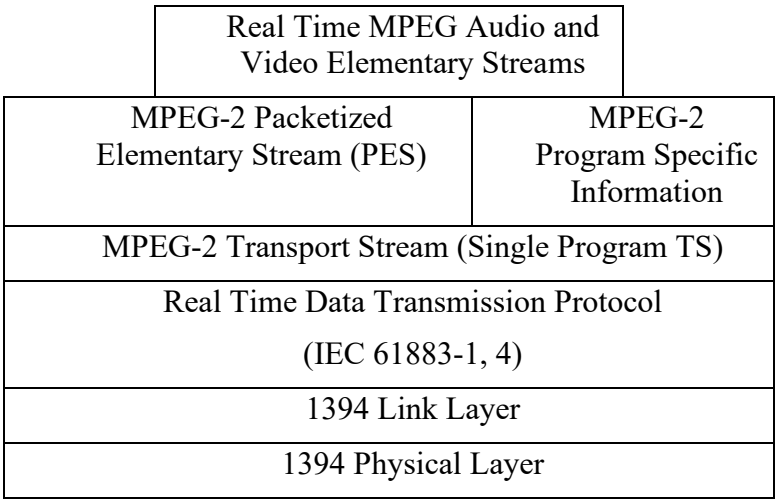

Figure 4 - Protocol Stack for MPEG TS Content Flow

7.2.1.2 AV Stream Control

The protocol stack for AV stream control is defined in Figure 5.

AV Stream Control consists of one application, the Isochronous data flow management application.

Isochronous data flow management application establishes/releases the logical connection called Isochronous Connection between the source device and the destination device of an AV stream.

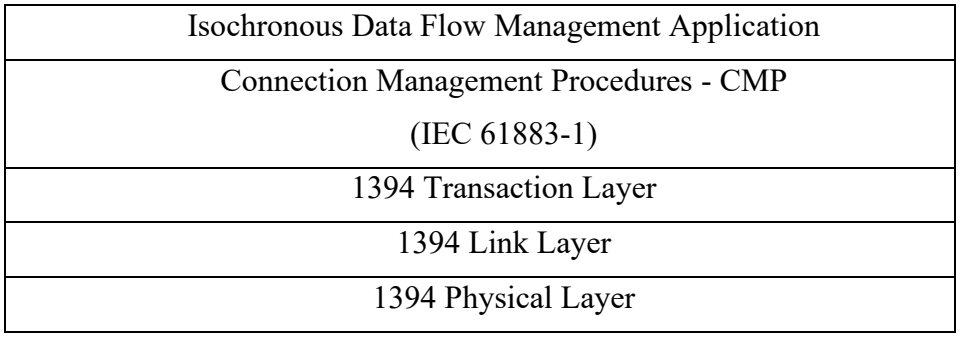

Figure 5 - Protocol Stack for AV Stream Control

7.2.1.3 Channel Change Control

Support for the CEA-931 tune function is mandatory. Other methods to control channel changes are optional.

The protocol stack for channel change control using the tune function is defined in Figure 6.

The assumed situation is that the IR (infra-red) remote is directed at the DTV or other device, and is not directed at the Host Device. This protocol forwards the selected channel information to OC-STU Subunit from the device with IR remote.

Channel Change Control Application
Command and Control (AV/C Panel Subunit Command)
Function Control Protocol – FCP (IEC 61883-1)
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 6 - Protocol Stack for Channel Change Control

A protocol stack for channel change control using other optional methods is defined in Figure 7.

Channel Change Control Application	
Command and Control (AV/C Tuner SubunitCommand)	Universal Remote Command
Function Control Protocol – FCP (IEC 61883-1)	
1394 Transaction Layer	
1394 Link Layer	
1394 Physical Layer	

Figure 7 - Protocol Stack for Alternative Channel Change Control

7.2.1.4 Inter OC-STU Subunit Communication

The protocol stack for inter OC-STU Subunit communication is defined in Figure 8.

Inter OC-STU Subunit communication is optional for future profiles. It is to exchange information among two or more OC-STU Subunits. The assumed information content is the current subscribed program. This is utilized when OC-STU Subunits negotiate to avoid duplicated isochronous streams for a program when multiple DTVs ask to subscribe the same program.

(Optional for future profiles) Inter OC-STU Communication Application
Command and Control (AV/C OC-STU Command; TBD)
Function Control Protocol – FCP (IEC 61883-1)
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 8 - Protocol Stack for Inter OC-STU Subunit Communication

7.2.1.5 OC-STU Subunit and Other Device Communication

The protocol stack for OC-STU Subunit and other device communication is defined in Figure 9.

OC-STU Subunit and other device communication is optional for future profiles. It is to exchange information between an OC-STU Subunit and other devices on the 1394 bus. This protocol stack is employed when some control entity located in a device on the 1394 bus wishes to control the OC-STU Subunit. This entity can be located in a DTV or other device, like a PC.

(Optional for future profiles) OC-STU and Other Device Communication Application
Command and Control (AV/C OC-STU Command; TBD)
Function Control Protocol – FCP (IEC 61883-1)
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 9 - Protocol Stack for OC-STU Subunit and Other Device Communication

7.2.2 Description of Specific Protocols

This section describes the specific protocols used in the protocol stacks identified in the section above.

7.2.2.1 Real-time Data Transmission Protocol

Defined in IEC 61883-1 and -4 [3].

This protocol defines the method to transmit MPEG TS over 1394 using an Isochronous channel.

MPEG TS packets are transmitted within the Common Isochronous Packet (CIP) structure defined in IEC 61883-1 [3].

At the source side, each MPEG TS transport packet is encapsulated in one or more CIPs. The process is as follows:

- Source Packet assembly—A source packet is formed from an MPEG-TS transport packet by adding a 4-byte time-stamp.
- Data Block assembly—A data block is formed by segmenting a the 192-byte source packet into 8 data blocks, each with a length of 6 quadlets.
- CIP assembly—A CIP payload is formed from one or more data blocks, taking account of both the MPEG TS encoding data rate and the bandwidth of 1394. A CIP header is added to the payload.

At the destination side, an MPEG TS is extracted from the received CIP(s).

The Packet format and the header information setting shall conform with IEC 61883-1 and -4 [3].

7.2.2.2 MPEG-2 Transport Stream

Defined in ISO/IEC 13818-1 [7] MPEG-2 *Systems*.

Single program TS (SPTS) shall be supported. Multiple program TS may be used.

7.2.2.3 MPEG-2 Packetized Elementary Stream (PES)

Defined in ISO/IEC 13818-1 [7] MPEG-2 *Systems*.

7.2.2.4 MPEG-2 Program Specific Information (PSI)

Defined in ISO/IEC 13818-1 [7] MPEG-2 *Systems*. PSI includes, at a minimum, the Program Association Table (PAT) and Program Map Table (PMT).

7.2.2.5 Real-time MPEG Audio and Video Elementary Streams

Defined in ATSC A/53 [8] (audio) and ANSI/SCTE 43 [13] (video).

7.2.2.6 Connection Management Procedures (CMP)

Defined in IEC 61883-1 [3].

CMP are used to establish, overlay and break an isochronous connection that is transmitting an AV stream. The connection is from the source device to the destination device. CMP are accomplished by handling the Plug Control Registers located in a source device and a destination device of the connection.

7.2.2.7 Command and Control (AV/C CONNECT Command)

Defined in AV/C Digital Interface Command Set General Specification [5].

AV/C CONNECT command is used to establish connections within a device.

7.3 Bitmap OSD Protocols

7.3.1 OSD Data Transmission

If the Host Device supports OSD bitmaps, OSD data shall be transmitted in accordance with the Asynchronous Connections method and protocol described in Section 5 of CEA-775 DTV Interface Specification [9]. The format of OSD frames and subframes is defined in CEA-799 [10].

The protocol stack for OSD data transmission is defined in Figure 10.

The OSD data transmission realizes the generation and the drawing of graphics data in distributed fashion. The source side feeds bitmapped region data and the destination side draws the received data into its graphics memory.

Graphics Application
Asynchronous Connections per Sec. 5 of [9]
OSD Frames
OSD Subframes
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 10 - Protocol Stack for OSD Data Transmission

7.3.2 OSD Flow Control

The flow of OSD data is managed in accordance with the mechanisms defined in Section 5 of CEA-775 DTV Interface Specification [9].

7.3.3 OSD Connection Management

The protocol stack for the management of the OSD connection for subframe transmission is defined in Figure 10.

OSD connection management realizes the establishment/release of the logical connection for OSD subframe transmission, and the start/stop of OSD subframe transmission. This is realized with the cooperation of the Graphics application. This application is invoked by the IR remote of the Host Device, or the IR remote of the DTV or other devices on the 1394 bus.

The A/VC commands used to establish and disconnect OSD are defined in Section 5 of CEA-775 DTV Interface Specification [9].

OSD Application
ASYNCHRONOUS CONNECTION command sub-functions
Function Control Protocol – FCP (IEC 61883-1) [3]
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 11 - Protocol Stack for OSD Connection Setup

7.4 Internet Protocol (IP)

Support for IP over 1394 is optional in this standard, but if supported, implementation shall comply with Ref. [1] or other standards that are compatible with it.

7.4.1 IP Protocol Stack

The protocol stack for Internet Protocol (IP) is defined in Figure 12.

This protocol stack realizes the terminal or router function for Internet related protocols.

High Layer Protocols (for Terminal, Router)
TCP, UDP
IP
IP over IEEE 1394 (Reference [15])
1394 Transaction Layer
1394 Link Layer
1394 Physical Layer

Figure 12 - Protocol Stack for Internet Protocol

7.4.2 Description of Specific Protocols

This section describes the specific protocols used in the protocol stacks identified in the section above.

7.4.2.1 IP over IEEE 1394

Defined in reference [15].

7.4.2.2 IP, TCP, UDP, and High Layer Protocols

Defined in Reference [15].