

# ANSI/CEA Standard

## DTV 1394 Interface Specification

ANSI/CEA-775-C R-2013

September 2008



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(Formulated under the cognizance of the CEA **R4.8 DTV Interface Subcommittee.**)

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## FOREWORD

Users of CEA-775-C should be aware that ongoing standardization work in the 1394 Trade Association may have a future impact on CEA-775-C. CEA has stated its intention to harmonize its standard with those developed within the 1394 Trade Association, and likewise the TA has indicated its willingness to coordinate standards development with CEA.

CEA-775-C supersedes EIA-775-A, CEA-775-A, and CEA-775-B.

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## DTV 1394 Interface Specification

### 1 Scope

CEA-775-C defines mechanisms to allow a source of MPEG service, such as a cable or terrestrial set-top box, digital VCR, or DTV to utilize the MPEG decoding and display capabilities in a DTV. A method is included to allow the OSD Producer to supply bitmap graphic overlays for blending and composition in the DTV over decoded video.

CEA-775-C supports an optional baseband analog audio/video connection between an audio/video source device and the DTV. Mechanisms are provided to allow the source device to control the selection of the audio/video source for display in the DTV between an MPEG service decoded in the DTV and incoming analog audio/video supplied to it via an external input.

Nothing in CEA-775-C is intended to constrain the use of other 1394-based protocols.

### 1.1 Background

The currently implemented analog audio/video home entertainment cluster consists of various signal sources and various display devices. Possible audio/video sources in this system include a video cassette recorder, a DVD player, and a DBS or cable set top box. In the analog system the audio/video source can overlay its graphical user interface on its output video as shown in Figure 1. This allows the user to control the source based on information shown on the TV display.

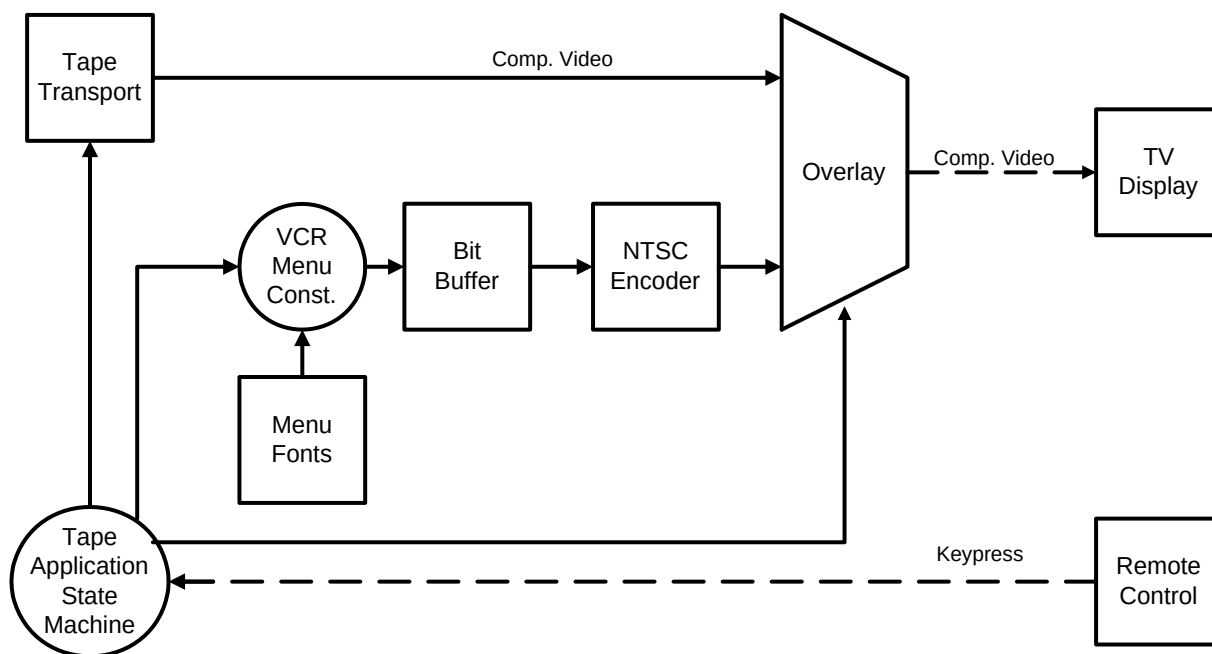


Figure 1 Typical NTSC System

A Digital Television (DTV) system using a similar model is not currently practical. Figure 2 shows an example of what would be required. The process of decoding the original bitstream to include the GUI overlay and then re-encoding for transmission to the DTV adds significant complexity and usually degrades picture quality.

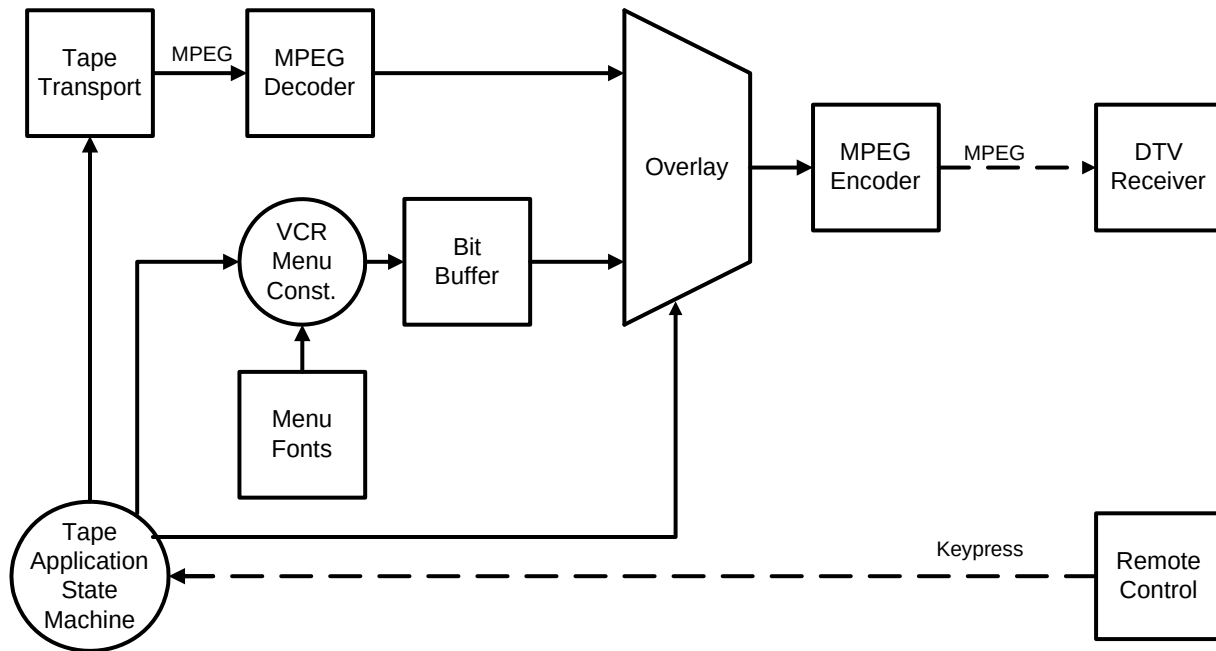


**Figure 2 Equivalent DTV System**

CEA-775-C defines a specification for a compressed audio/video digital interface to a DTV that provides a level of functionality that is similar to an analog audio/video system or an uncompressed digital audio/video system (e.g. HDMI). A representation of a typical system is shown in Figure 3. This diagram shows an A/V Source that is capable of producing analog audio and video and also compressed audio and video delivered as an MPEG Transport Stream. The analog signal is transmitted over a standard coaxial cable and the MPEG Transport Stream is passed over an IEEE 1394 bus. Bitmaps of the source OSD are sent separately over the same IEEE 1394 bus and are mixed with the decoded MPEG video in the DTV prior to being presented on the display. This process removes the need for the A/V Source to perform the additional MPEG video decodes and re-encodes. The IEEE 1394 bus is also used by the source and display to exchange control and status messages.

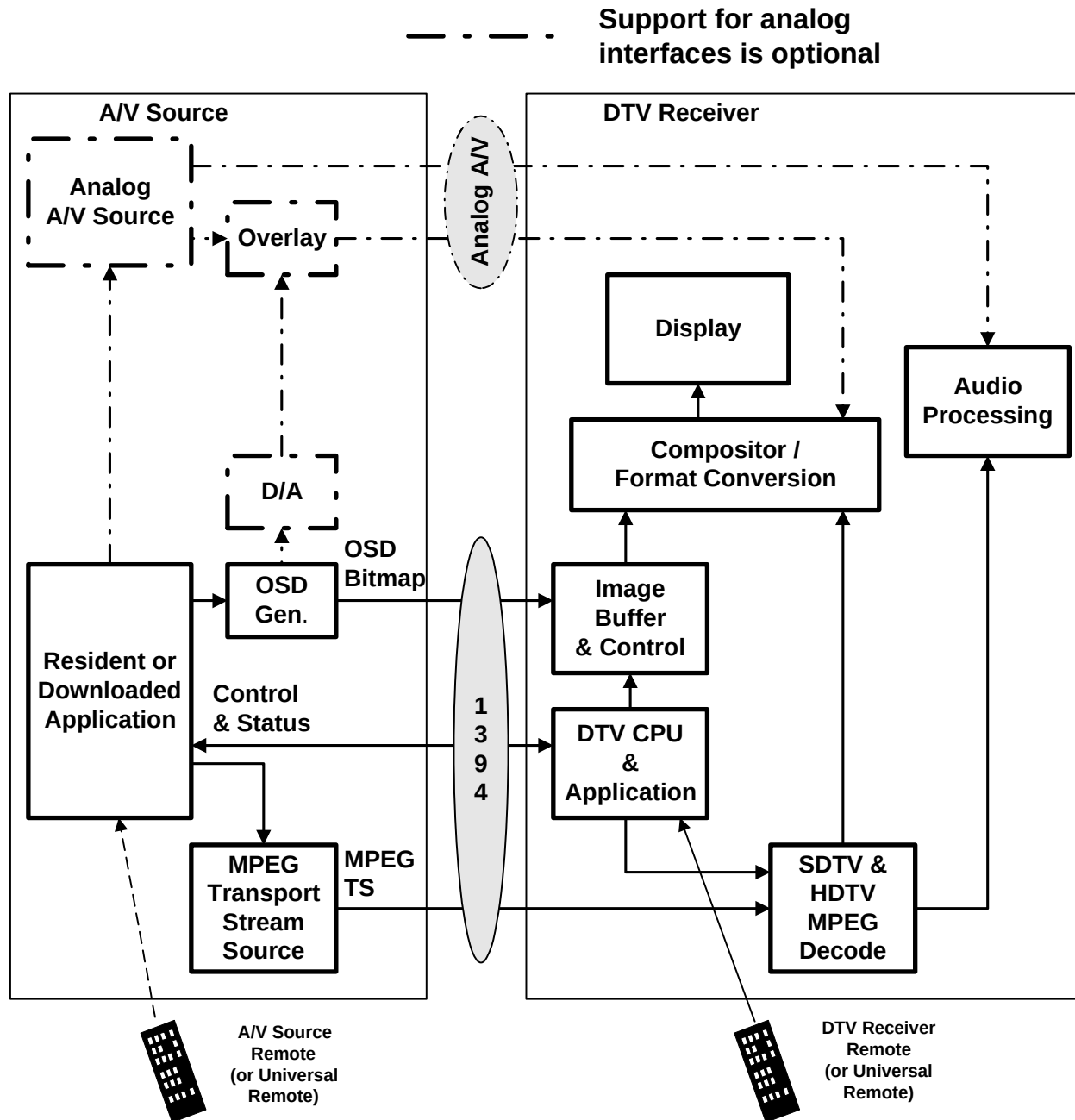


**Figure 3 Typical DTV Implementation**

The digital interface is based on the IEEE 1394 Standard for a High Performance Serial Bus [16], the IEC 61883-1 digital interface standard [10], and on the AV/C Digital Interface Command Set General Specification [6]. The IEEE 1394 Standard originated in Apple Computer as a multi-media interconnect. The standard provides:

- Data transmission at various data rates. CEA-775-C requires support for the s200 or higher level of service defined in IEEE 1394-1995 (s200 has a bit rate of 196.608 megabits per second).
- Inexpensive and physically small interconnection
- Hot pluggable connection

- d) Daisy chained or branched interconnection
- e) Guaranteed bandwidth for isochronous data

CEA-775-C is designed to enable interoperability between a DTV compliant with CEA-775-C and various types of Consumer digital audio/video sources including digital set-top boxes (STBs) and analog/digital hard disk or videocassette recorders (VCRs). CEA-775-C defines a level of functionality that allows compliant systems to:

- a) Discover and adapt to OSD functionality supported in the display device
- b) Pass an MPEG-2 Transport Stream from the bitstream source to the display device
- c) Transmit OSD information from the OSD Producer to the display device or OSD Consumer
- d) Control the selection of different sources to the display device

## 2 References

### 2.1 Normative References

The following standards contain provisions that, through reference in this text, constitute normative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying for the most recent editions of the standards listed in Sec. 2.1.1.

#### 2.1.1 Normative Reference List<sup>1</sup>

1. ATSC Now A/53E parts, ATSC Digital Television Standard with Amendments 1, April 18, 2006
2. ATSC A/65C, Program and System Information Protocol for Terrestrial Broadcast and Cable with Amendment 1, May 9, 2006
3. AV/C Commands for the Management of Asynchronous Serial Bus Connections, Version 1.1, 1394 Trade Association Document 2000006, October 24, 2000
4. 1394 Trade Association 2001009, AV/C Compatible Asynchronous Serial Bus Connections, 2.1, July 23, 2001
5. 1394 Trade Association 1999025, AV/C Descriptor Mechanism 1.2, , July 23, 2002
6. 1394 Trade Association 2001012, AV/C Digital Interface Command Set 4.1, December 11, 2001
7. 1394 Trade Association 1999045, AV/C Information Block Types Specification Version 1.0, July 23, 2001
8. CEA-799-A, On Screen Display Specification, July, 2006
9. CEA-861-D, A DTV Profile for Uncompressed High Speed Digital Interfaces, July, 2006
10. IEC 61883-1, Consumer audio/video equipment—Digital Interface—Part 1: General, Second Edition, January 24, 2003
11. IEC 61883-2, Consumer audio/video equipment—Digital interface—Part 2: SD-DVCR Data Transmission, Second Edition, August, 2004
12. IEC 61883-3, Consumer audio/video equipment—Digital interface—Part 3: HD-DVCR Data Transmission, Second Edition, August, 2004

<sup>1</sup> In some instances, only specified sections of a standard may be normative. References listed below shall take precedence over references within these listed references.

13. IEC 61883-4, Consumer audio/video equipment—Digital interface—Part 4: MPEG-2 Transport Stream Data Transmission, Second Edition, August, 2004
14. IEC 61883-5, Consumer audio/video equipment--Digital interface--Part 5: SDL-DVCR Data Transmission, Second Edition, August, 2004
15. IEEE 1212-2002, IEEE Standard for a Control and Status Registers (CSR) Architecture for Microprocessor Buses, September 6, 2002
16. IEEE 1394-1996, IEEE Standard for a High Performance Serial Bus, August 3, 1996
17. IEEE 1394A-2000, IEEE Standard for a High Performance Serial Bus – Amendment 1, June 30, 2000
18. ISO 639-1: 2002, Codes for the representation of names of languages — Part 1: Alpha-2 code
19. ITU-R BT.601-5, Studio Encoding parameters of digital television for standard 4:3 and wide-screen aspect ratios, October, 1995
20. ITU-R BT.709-5, Parameter values for the HDTV standards for the studio and for international programme exchange, April, 2002
21. ITU-T Rec. H.222.0 | ISO/IEC 13818-1:2000, Information technology — Generic coding of moving pictures and associated audio information—Part 1: systems

### 2.1.2 Normative Reference Acquisition

#### CEA Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email [global@ihs.com](mailto:global@ihs.com)

#### ANSI/CEA Standards: United States of America

- American National Standards Institute, Customer Service, 11 West 42nd Street, New York NY 10036; Phone 212-642 4900; Fax 212-302-1286; Internet <http://www.ansi.org>; Email [sales@ansi.org](mailto:sales@ansi.org)

#### ANSI/IEEE Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email [global@ihs.com](mailto:global@ihs.com)
- American National Standards Institute, Customer Service, 11 West 42nd Street, New York NY 10036; Phone 212-642 4900; Fax 212-302-1286; Internet <http://www.ansi.org>; Email [sales@ansi.org](mailto:sales@ansi.org)

#### ATSC Standards:

- Advanced Television Systems Committee (ATSC), 1750 K Street NW, Suite 1200, Washington, DC 20006; Phone 202-872-9160; Fax 202-872-9161; Internet <http://www.atsc.org>.

#### IEC Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO. USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email [global@ihs.com](mailto:global@ihs.com).

#### ISO Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email [global@ihs.com](mailto:global@ihs.com)
- ISO Central Secretariat, 1, rue de Varembe, Case postale 56, CH-1211 Geneve 20, Switzerland; Phone + 41 22 749 01 11; Fax + 41 22 733 34 30; Internet <http://www.iso.ch>; Email [central@iso.ch](mailto:central@iso.ch)

#### ITU Standards

- ITU Sales and Marketing Service, International Telecommunication Union, Place des Nations CH-1211, Geneva 20, Switzerland; Phone +41 22 730 6141; Fax +41 22 730 5194; Internet <http://www.itu.org>; Email [sales@itu.int](mailto:sales@itu.int)

#### SMPTE Standards

- Society of Motion Picture & Television Engineers (SMPTE), 595 West Hartsdale Avenue, White Plains, NY 10607; Phone 914-761-1100; Fax 914-761-3115; Internet <http://www.smpite.org>; Email [smpite@smpite.org](mailto:smpite@smpite.org)

#### 1394 Trade Association Documents

- 1394 Trade Association, Regency Plaza, Suite 350, 2350 Mission College Blvd. Santa Clara, CA 95054; Phone 408-982-8289; Fax 408-982-8288; Internet <http://www.1394ta.org>

## 2.2 Informative References

The following standards contain provisions that, through reference in this text, constitute informative provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying for the most recent editions of the standards listed in Sec. 2.1.1.

### 2.2.1 Informative Reference List

22. CEA-849-A, Application Profiles for EIA-775-A Compliant DTVs, December, 2001
23. Digital Transmission Content Protection (DTCP) Specification, Revision 1.4, February 28, 2005
24. ANSI/SCTE 54 2004, Digital Video Service Multiplex and Transport System for Cable Television

### 2.2.2 Informative Reference Acquisition

#### CEA Standards:

- Global Engineering Documents, World Headquarters, 15 Inverness Way East, Englewood, CO USA 80112-5776; Phone 800-854-7179; Fax 303-397-2740; Internet <http://global.ihs.com>; Email [global@ihs.com](mailto:global@ihs.com)

#### DTCP Specifications:

- <http://www.dtcp.com> or email [info-request@dtcp.com](mailto:info-request@dtcp.com)

#### SCTE Standards:

- Society of Cable Telecommunications Engineers, 140 Philips Rd., Exton, PA 19341; Phone 800-543-5040; Fax 610-363-5898; Internet <http://www.scte.org>; Email [info@scte.org](mailto:info@scte.org)

## 3 Definitions

For the purposes of CEA-775-C, the following definitions apply:

**Allocate** To acquire the resources, the address and other parameters of a plug for the purpose of establishing an asynchronous connection data transfer capability

|                                 |                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Asynchronous connection</b>  | A point-to-point communication path established between a producer node and a Consumer node, that supports robust high-bandwidth flow-controlled transfers of one or more data frames                                                                                                                                                                          |
| <b>Asynchronous push</b>        | A method of data delivery in which the node producing the data uses 1394 write transactions to deposit data into the address space of a Consumer node                                                                                                                                                                                                          |
| <b>Attach</b>                   | To communicate the address and other parameters of a plug to another plug for the purpose of establishing data transfer capability                                                                                                                                                                                                                             |
| <b>A/V</b>                      | Audio and Video                                                                                                                                                                                                                                                                                                                                                |
| <b>Byte</b>                     | 8 bits of data                                                                                                                                                                                                                                                                                                                                                 |
| <b>Compare_Swap4</b>            | A bus transaction that stores, at the specified address, a provided data value when the contents of the specified address are equal to a provided argument value. This operation is performed indivisibly on the addressed quadlet.                                                                                                                            |
| <b>Consumer</b>                 | A device that accepts OSD data                                                                                                                                                                                                                                                                                                                                 |
| <b>Consumer port</b>            | A port that is the sink of data frames and is flow controlled by updates of its externally visible <b>iAPR</b> control register                                                                                                                                                                                                                                |
| <b>data frame (frame)</b>       | A contiguous group of data bytes sent between producer and Consumer nodes                                                                                                                                                                                                                                                                                      |
| <b>data segment (segment)</b>   | The largest portion of a data frame that can be written into the segment buffer before updating the Consumer's <b>iAPR</b> register                                                                                                                                                                                                                            |
| <b>Detach</b>                   | To remove access to an asynchronous connection plug's address space.                                                                                                                                                                                                                                                                                           |
| <b>Digital Television (DTV)</b> | A device that receives, decodes, and presents audio and video material that has been transmitted in a compressed form. The device can be a single unit or it can be constructed from a number of individual components (e.g. a digital terrestrial set top box and an analog television).                                                                      |
| <b>iAPR</b>                     | A Consumer-resident register affiliated with a Consumer port that is updated by the producer to indicate how much data has been written to the segment buffer. This register also has other bits that are used for demarcation of variable-length frames, and to support the connection disconnection sequence.                                                |
| <b>oAPR</b>                     | A producer-resident register affiliated with a producer port on a plug that is updated by the Consumer to indicate how much data can be safely written by the producer. This register also has other bits that are used for demarcation of variable-length frames, and to support the connection disconnection sequence.                                       |
| <b>oAPR.count</b>               | An internal Consumer-local register affiliated with a segment buffer that indicates how much data can be written by the producer.                                                                                                                                                                                                                              |
| <b>OSD Producer</b>             | A device that is the source of an OSD bitmap                                                                                                                                                                                                                                                                                                                   |
| <b>OSD Consumer</b>             | A device that receives an OSD bitmap for the purpose of presenting the information on a display device or storing the information for future use.                                                                                                                                                                                                              |
| <b>passive</b>                  | The Consumer plug is in this state when it accepts transactions directed at the plug's address space but does not respond with updates to the producer's registers.                                                                                                                                                                                            |
| <b>plug</b>                     | A collection of externally visible components (called ports) that can be connected to a sub-unit for the purposes of sending sequences of variable-length frames. There are three types of plugs, those associated with Asynchronous Connections, those associated with AV/C Isochronous Channels, and those associated with IEC 61883-1 Isochronous Channels. |
| <b>port</b>                     | A sub-component of an asynchronous connection plug that supports unidirectional asynchronous connection data transfers                                                                                                                                                                                                                                         |
| <b>program</b>                  | In MPEG-2 terminology, a collection of related elementary stream components making up a television service                                                                                                                                                                                                                                                     |

|                       |                                                                                                                                              |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------|
| <b>quadlet</b>        | Four bytes of data                                                                                                                           |
| <b>Segment buffer</b> | An externally visible address space on a Consumer into which data is written by the connected producer                                       |
| <b>Source</b>         | A device that produces or passes on OSD data                                                                                                 |
| <b>sub-unit</b>       | A uniquely identifiable and addressable entity contained within a unit                                                                       |
| <b>unit</b>           | The instantiation of an AV/C device. A unit is addressable in a specific way using AV/C commands. A unit may contain zero or more sub-units. |

#### 4 Symbols and Abbreviations

|       |                                                   |
|-------|---------------------------------------------------|
| 0x    | Hexadecimal                                       |
| ATSC  | Advanced Television Systems Committee             |
| ANSI  | American National Standards Institute             |
| A/V   | Audio/Video                                       |
| AV/C  | Audio/Video Control                               |
| CEA   | Consumer Electronics Association                  |
| CLUT  | Color Look-up Table                               |
| CIP   | Common Isochronous Packet                         |
| CMP   | Connection Management Procedures                  |
| CPTWG | Copy Protection Technical Working Group           |
| CPU   | Central Processing Unit                           |
| CSR   | Control Status Register                           |
| CVCT  | Cable Virtual Channel Table                       |
| DBS   | Direct Broadcast Satellite                        |
| DTCP  | Digital Transmission Content Protection           |
| DTV   | Digital Television                                |
| DVD   | Digital Versatile Disk                            |
| EUI   | Extended Unique Identifier                        |
| EIA   | Electronic Industries Alliance                    |
| HDMI  | High Definition Multimedia Interface              |
| IEC   | International Electrotechnical Commission         |
| IEEE  | Institute of Electrical and Electronics Engineers |
| ISO   | International Organization for Standardization    |
| LAN   | Local Area Network                                |
| lsb   | least significant bit                             |
| MPEG  | Moving Picture Experts Group                      |
| msb   | most significant bit                              |
| OSD   | On-Screen Display                                 |
| OUI   | Organization Unique Identifier                    |
| PAT   | Program Association Table                         |
| PMT   | Program Map Table                                 |
| PCR   | Plug Control Register                             |
| PID   | Program Identifier                                |
| PIP   | Picture-In-Picture                                |
| PSIP  | Program and System Information Protocol           |
| SMPTE | Society for Motion Picture & Television Engineers |
| SPTS  | Single Program Transport Stream                   |
| STB   | Set-Top Box                                       |
| TSID  | Transport Stream ID                               |
| TVCT  | Terrestrial Virtual Channel Table                 |

#### 5 Compliance Notation

As used in this document, “*shall*” and “*must*” denote a mandatory provisions of the standard. “*Should*” denotes a provision that is recommended but not mandatory. “*May*” denotes a feature, whose presence does not preclude compliance, that may or may not be present at the option of the implementer. “*Optional*” denotes items that may or may not be present in a compliant DTV.

## 6 System Overview

A simple system implementation has already been shown in Figure 3. In this simple system there is one source of A/V signals and one DTV display. CEA-775-C supports more complicated systems having multiple sources and multiple DTV displays.

In the simple implementation there are four separate conduits for the exchange of data between the source and display.

- a) Analog Audio and Video
- b) Digital Audio and Video
- c) Control and Status
- d) OSD

Each one of these can initially be considered separately but will affect each other in the display.

### 6.1 Digital TV Video Processing

The application running on the A/V Source shall control the output of data from the MPEG Transport Stream Source, as shown in Figure 3. The data out of the A/V Source must reach the decoder in the DTV Display consistent with its originators requirements. The link between the A/V Source and the DTV is accomplished using an isochronous channel on the IEEE 1394 bus. This provides the guaranteed bit rate required for the transmission of MPEG data.

The data passes to the DTV MPEG Decoder, where the Transport Stream is parsed into video, audio, and data streams. The video stream is decoded under the control of the DTV's local application. The Decoder selects the video and audio to be decoded based on Section 11.2.

The baseband video is then sent on to the Compositor/Format Conversion block where the OSD is mixed with the video and the video may be reformatted to accommodate the limitations of the display. The order of compositor and format conversion processes is a matter of implementation and is not specified in CEA-775-C.

### 6.2 On-Screen Display

#### 6.2.1 Analog OSD

Support for analog—uncompressed digital systems is optional. The application running on the A/V Source may use its analog video output (e.g. component) or its uncompressed digital video output (e.g. HDMI) as a display method for GUIs. It may overlay its own OSD onto the analog signal before delivery to the display.

#### 6.2.2 Digital OSD

The application in the A/V Source generates a bitmap to be transmitted to the DTV. The use of bitmaps means that the look and feel of the OSD is under the control of the A/V Source. The DTV shall support at least one graphics plane. Support of bitmaps over an analog input or an uncompressed digital input is optional.

NOTE—Implementers should be aware that on-screen text and graphics generated within the display device may obscure video and graphics provided by the source device. Examples include screens generated for the control over video display characteristics (contrast and brightness, etc.) and graphic overlays associated with volume control.

#### 6.2.2.1 OSD Delivery

The delivery mechanism described in CEA-775-C and the OSD defined in CEA-799 [8] taken together provide the following features:

- a) 4- and 8-bit Color Look-up Tables (CLUTs)
- b) Various defined pixel formats
- c) Source can specify colorimetry preference
- d) Global writes to load the OSD with a constant value

- e) 0Global clear
- f) A data block write to any arbitrary rectangular region of the OSD

### 6.2.2.2 OSD Transmission

The OSD is transmitted to the DTV via an “asynchronous push” connection on the IEEE 1394 link. Protocols used to set up this connection are defined in Section 8.

### 6.2.2.3 DTV OSD Processing

The DTV shall assemble the OSD bitmap using information transmitted over the IEEE 1394 link and shall mix the bitmap with the digital video delivered via IEEE 1394, and optionally the analog video or uncompressed digital video delivered via an external jack.

## 6.3 Discovery of Capability

IEEE 1394 asynchronous transactions shall be used by the A/V Source to obtain information on the capabilities of the DTV. This discovery process is defined in Section 12.

## 6.4 User-Machine Control

The user controls the DTV or A/V Source using the Remote Control or front panel controls for that particular unit. Feedback to the user can be provided via the bitmap graphics transmitted over the IEEE 1394 link to be rendered by the DTV.

An illustration of the user-machine control is shown in Figure 4.

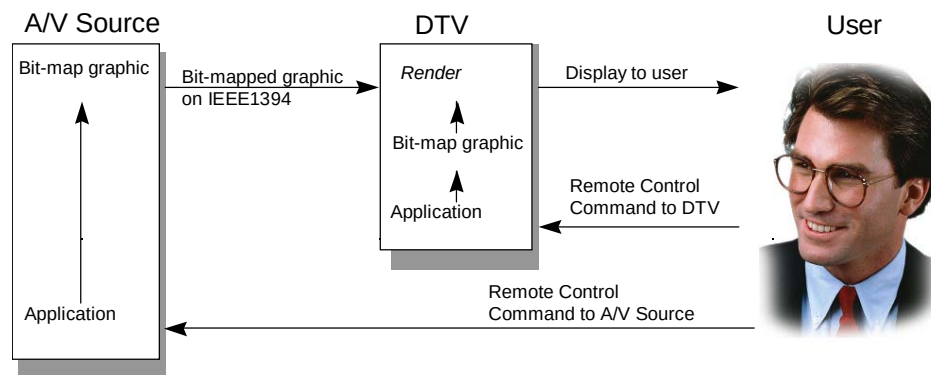


**Figure 4 User-Machine Control Loop**

## 7 Miscellaneous Requirements

NOTE—In CEA-775-C, field names CEA\_XXX replaced field names EIA\_XXX. CEA\_XXX field names are semantically equivalent to EIA\_XXX field names, which appeared in predecessors of CEA-775-C.

### 7.1 Digital Interface Physical layer

The DTV shall support IEEE 1394 at s200 clock rate. At least one IEEE 1394 connector shall be present on the DTV. The connectors may be 4- or 6-pin. All 4-pin connectors shall conform to the connector specification given in IEEE 1394A [17]. All 6-pin connectors shall conform to the connector specification given in IEEE 1394-1995 [16]. Support for two or more IEEE 1394 connectors on each device is recommended. The provision of multiple connectors facilitates bus interconnections in the A/V cluster and supports home networking.

### 7.2 Digital Interface Link layer

Link layer implementations conforming to CEA-775-C shall conform to IEEE 1394-1995 [16], Chapter 6.

### 7.3 Digital Interface Transaction layer

Transaction layer implementations conforming to CEA-775-C shall conform to IEEE 1394-1995 [16], Chapter 7.

## 7.4 Serial Bus Management

Serial bus management implementations conforming to CEA-775-C shall conform to IEEE 1394-1995 [16], Chapter 8.

## 7.5 Command and Status Registers

### 7.5.1 CSR Core Registers

CSR core registers shall conform to IEEE 1394-1995 [16]. The **STATE\_CLEAR.cmstr** bit shall be implemented according to IEC 61883-1 [10].

### 7.5.2 Serial Bus Node Registers

Serial bus node registers shall be implemented in conformance with IEC 61883-1 [10].

### 7.5.3 Configuration ROM Requirements

The DTV shall implement the ROM format as defined in IEC 61883-1 [10]. Implementation requirements for **bus information block**, **Root** Directory, and 61883 **Unit** Directory shall conform to IEC 61883-1 [10]. A more detailed description of the Configuration ROM is discussed in Section 9.1, which deals with discovery information.

#### 7.5.3.1 IEC 61883 Unit directory

Implementation requirements for the IEC 61883 **Unit** Directory in CEA-775-C shall conform to IEC 61883-1 [10]. The **Version** shall indicate support for CTS (the least significant bit of the first byte of **Version** shall be set to 1) and show AV/C compliance (the least significant bit of the third byte of **Version** shall be set to 1). This subject is also covered in Section 9.1.6.1.

#### 7.5.3.2 CEA-775 Unit Directory

The CEA-775 Unit Directory is defined in Section 12.2.3.

## 7.6 Real Time Transmission of MPEG-2 Transport Streams

Transmission of MPEG-2 Transport Stream packets over the IEEE 1394 serial bus shall be in accordance with IEC 61883-4 [13].

## 7.7 Isochronous Data Flow Management

Isochronous data connections shall be managed via the plug control register (PCR) mechanism defined in IEC 61883-1 [10].

## 7.8 Connection Management Procedures (CMP)

Establishing connections between input and output plugs on the 1394 bus, breaking connections on the 1394 bus, and managing of connections after a bus reset shall be handled in accordance with IEC 61883-1 [10].

The DTV shall supply a minimum of one input PCR for delivery of digital Transport Streams.

In general, destination devices should set up isochronous channels to source devices. The isochronous channel shall accommodate a 40 Megabits per second bitstream.

### 7.8.1 Isochronous Connection Procedures

The location of **oMPR** and **oPCRs** on a source node are determined by Section 7.11 (Figure 14) of IEC 61883-1. Figure 14 of IEC 61883-1 specifies the location of Plug Control Registers and is shown in Table 1.

|                  |                 |
|------------------|-----------------|
| 0xFFFF F000 0900 | <b>oMPR</b>     |
| 0xFFFF F000 0904 | <b>oPCR[0]</b>  |
| ...              | ...             |
| 0xFFFF F000 097C | <b>oPCR[30]</b> |

**Table 1 Plug Control Register Location**

The number of implemented **oPCRs** is contained in the **#oPCR** field (bits 0-4) of the **oMPR**. **#oPCR** can be a number from 0-31 (Section 7.2 of IEC 61883). **oPCR[0]** through **oPCR[#oPCR-1]** are the implemented **oPCRs** (Section 7.2 of IEC 61883).

To make a connection from a Video Source to a Video Destination with the Video Destination Device as the controller, the following procedures can be followed:

- a) The Destination Device uses the AV/C OPEN DESCRIPTOR and READ DESCRIPTOR commands to read the Source Device's Unit Descriptor and determine the output plug.
- b) The Destination Device reads the **oPCR** associated with the proper output plug to determine the proper bandwidth. Bus Bandwidth Units (BWU) can be calculated from three parameters (data rate, overhead ID, and payload) using the procedure described in Section 7.7 of IEC 61883-1 [10].
- c) The Destination Device uses the procedure described in Section 8.2 IEC 61883-1 to establish the connection.

### 7.9 Asynchronous Connection Management

The following rules shall apply to setting up Asynchronous Connections:

- a) An OSD connection shall only be broken by the node that established it. Asynchronous connections are analogous to isochronous connections in this way.
- b) The OSD Consumer (the DTV) shall play the "controller" role (see Section 8) in connecting and disconnecting asynchronous plugs.

### 7.10 Function Control Protocol (FCP)

Commands carried on the 1394 bus in conformance with CEA-775-C shall be carried within the Function Control Protocol defined in IEC 61883-1 [10].

### 7.11 External Jack Selection

The specifications in this section apply to DTVs that feature one or more external analog A/V inputs in addition to the IEEE 1394 port.

A DTV that has one or more external A/V inputs in addition to the IEEE 1394 port shall support the CONNECT command for the purpose of allowing a source device that has other external A/V outputs in addition to the IEEE 1394 port to signal which of the two it wishes the DTV to process for display, that is, to use the IEEE 1394 port or another external A/V port.

If the DTV has selected a particular A/V source, it shall accept a CONNECT command from that source indicating:

- a) **source\_subunit\_type** = 0x1F, indicating AV unit
- b) **source\_subunit\_ID** = 0x7, used when subunit type is AV unit
- c) **source\_plug** indicating either (a) the serial bus **iPCR** plug of the DTV; or (b) the external jack input plug of the DTV (both of these plug values are provided in the DTV's Unit Identifier Descriptor - CEA\_775\_plug\_info data structure).
- d) **destination\_subunit\_type** = 0, indicating video monitor
- e) **destination\_subunit\_ID** indicating the ID of the Monitor Subunit (discovered through the SUBUNIT INFO command)
- f) **destination\_plug** = 0, indicating the Monitor Subunit's main display input.

The DTV shall indicate support for external jack selection by defining a Monitor Subunit and by setting the value of the **external\_jack\_input\_plug\_ID**, contained within the **CEA\_775\_plug\_info** data structure defined in Section 12.3.4, to a single value within the range of 0x80 through 0x9E (inclusive).

It is the responsibility of the DTV to form the proper association between a physical analog input plug and a specific source device discovered on the bus. This association may be made, for example, via a user setup dialog or by connector labeling. When these conditions are met, both the CONTROL and STATUS forms of the command shall be supported.

If the DTV receives a CONNECT command as above, but not from the currently selected A/V source device, it may disconnect from the currently connected source and select the new device and accept and process the command. Alternatively, it may respond with a REJECTED response.

The producer may offer a user option to selectively withhold audio, video, or OSD to the DTV. If such an option is absent, no output (including analog and uncompressed digital video) shall be withheld.

A producer indicates support for External Jack Selection by setting the value of its **external\_jack\_output\_plug\_ID** contained within the **CEA\_775\_plug\_info** data structure defined in Section 12.3.4, to a single value within the range of 0x80 through 0x9E (inclusive). A DTV shall read **external\_jack\_output\_plug\_ID** to determine the producer's support for External Jack Selection.

NOTE—Consumer devices, including DTVs, should recognize that support (or lack of support) for OSD does not necessarily indicate either support (or lack of support) for External Jack Selection. The reverse is also true.

### 7.12 Content Advisory Information

The DTV shall process any content advisory information that it may receive.

Source devices shall not remove content advisory information that is already present prior to passing the program on.

### 7.13 Content Protection

CEA-775-C adopters are strongly encouraged to implement the “full authentication” mode of content protection defined by the Digital Transmission Content Protection (DTCP) [23] method, in order to be compatible with digital cable set top boxes as authorized by 47 CFR Parts 76.602 and 76.640.

DTCP adoption in a CEA-775-C enabled DTV will also permit viewing of high-value content that may be available from D-VHS recorders or other MPEG-2 based sources in a home network.

DTCP's “full authentication” mode should be supported for optimum interoperability.

## 8 Delivery of OSD Data

The DTV shall support the delivery of OSD data via the Asynchronous Connections method and protocol defined in [3] and [4] with restrictions and differences noted in this Section. In an asynchronous connection, data flows between *producer* and *Consumer* nodes. For this application, the DTV acts as the Consumer and any device on the 1394 bus that is a source of OSD data can act as producer.

Data transfer involves a sequence of asynchronous write transactions from producer to Consumer. The Consumer provides to the producer the address space of a *segment* buffer. The producer writes to the segment buffer and updates a register indicating to the Consumer the availability of data. The Consumer processes data coming into the segment buffer and updates a register in the producer that indicates available buffer space.

Flow control is achieved by this count-update protocol, and effectively limits the rate of data flow to the slower of either the producer or Consumer nodes.

The OSD data is grouped into variable length sequences of data bytes called frames. Each frame shall consist of one or more subframes. Subframes shall be formatted as defined in CEA-799 [8]. A number of different subframe types are defined to deliver the OSD data. Frame boundaries act as synchronization points for these subframes. OSD subframes for OSD data are defined in Section 7.

Reference [3] defines the AV/C commands that are used to set up and take down Asynchronous Connections, and defines the procedures that shall be used to re-establish Asynchronous connections following a bus reset.

The remainder of this Section specifies the normative and optional aspects of Asynchronous Connections with regards to CEA-775-C.

### 8.1 Introduction

Asynchronous connections are designed to be simple and provide an asynchronous equivalent of isochronous data-transfer services. Specific design objectives included the following:

- a) Lightweight: simple asynchronous unidirectional data-transfer protocols should allow large data frames to be efficiently transferred between producer and Consumer nodes.
- b) Robust: the protocols should allow recovery from any number of bus resets and data transmission errors.
- c) Leveraged: existing AV/C resources should be used for connection management purposes.
- d) Extendable. Variations of the basic producer-to-Consumer data-transfer protocols should be available to support multicast, parallel path, and duplex connections.

### 8.2 Data Transfers

Asynchronous connections are optimized for copying data from a producer node to one or more Consumer nodes. With the “push” data transfer model, the producer writes into the Consumer’s data buffer.

The Consumer starts the cycle by indicating how much data the producer can safely write into the buffer by writing a limit-count value into one of the producer’s control registers. Data can then be written into the Consumer’s segment buffer until the end of the segment buffer has been reached. The data consumption is triggered by the producer signaling (through a control register update) when the segment write has completed. After processing this data, the Consumer re-enables writing to the segment buffer by indicating how much data the producer can safely write.

A count register in the producer and a count register in the Consumer provide bi-directional flow control, allowing the data-transfer rate to be paced by the slower of the producer and Consumer nodes. The count registers are updated using **Compare\_Swap4** (a 4-byte lock transaction, called compare-and-swap) transaction, which provides a consistency check.

A standard method for grouping data into (potentially large) *frames* is specified; the count-register update at the end of each frame provides distinctive end-of-frame indications. As an option, data within each frame can be further decomposed into a sequence of subframes, where the length of each subframe is specified by its header.

### 8.3 Data Access Constraints

All of the constraints on access of the Segment Buffer and the Control Registers that appear in [4] Section 4.2 apply to CEA-775-A as well.

### 8.4 Asynchronous Plug Components

In general, Asynchronous Connections support one input port and up to fourteen output ports per Asynchronous Connection Plug. There can be up to 31 plugs per node. The notion of multiple output ports is useful for multicast connections resulting in the ability to output data to several Consumers at the same time. The support of multicast connections is not required nor prohibited in CEA-775-C. For CEA-775-C, only one input port is required of an OSD Consumer (i.e., Consumer **port[0]**) and only one output port is required of an OSD Producer (i.e., producer **port[1]**). The plug used for input and the plug used for output are separately discoverable (see Section 12.3.4). All restrictions on alignment and addresses of the ports and plugs described in [4] apply to CEA-775-C.

### 8.5 Flow Control Registers

#### 8.5.1 iAPR Format

The **iAPR** register shall be written by the producer and shall be located on the Consumer. It shall have the format described in [4] except that the heartbeat bit is not required in CEA-775-C (See Section 8.6.3).

### 8.5.1.1 iAPR.modes Values

Asynchronous Connections, as specified in [4], supports 7 modes for **iAPR**. CEA-775-C only requires 5 out of those 7 modes. JUNK and LOST are not required and shall not be used. Since for a CEA-775-A application, the OSD Consumer is responsible for connecting and disconnecting asynchronous plugs (see section 4.9) the producer shall not use the FREE state as a means for initiating the disconnect sequence.

### 8.5.2 oAPR Format

The producer-resident **oAPR** register shall be written by the Consumer. It shall have the format described in [4] except that the heartbeat bit is not required in CEA-775-C (See Section 8.6.3).

#### 8.5.2.1 oAPR.modes Values

Asynchronous Connections as specified in [4] support 5 modes for **oAPR**. CEA-775-C only requires 4 out of those 5. TOSS is not required and shall not be used.

## 8.6 Asynchronous Communications

As stated in Section iAPR.modes Values.1.1, JUNK and LOST are not required to be supported in **iAPR** and TOSS is not required to be supported in **oAPR**. Therefore, modes shall not be set to these values.

### 8.6.1 Suspended Connection

An OSD Consumer/controller shall suspend the producer port when necessary by changing the mode field of the producer resident **oAPR** to SUSPEND. The Consumer/controller shall resume normal operation by changing the mode field of **oAPR** to RESUME.

A Consumer may suspend a producer at any time there is an established connection. Therefore, the implemented state machine shall provide the necessary transitions to the suspended state (e.g. a transition from the producer WRITE<sup>2</sup> state to the SUSPEND state should be provided). The Consumer may also resume a suspended connection at anytime, at which time the producer shall respond as specified in Section 7.4.

### 8.6.2 Suspend/Resume Asynchronous Connections States

OSD Consumer devices shall implement the data transfer state machine defined in Section 5.10 of [4], including additional state transitions as specified in CEA-775-C Annex C [Normative].

### 8.6.3 Heartbeat Indications

CEA-775-C does not require support of heartbeat indications. However it is considered mandatory in [4]. [4] states in Section 5.6 that “the port with a pending transaction sends a heartbeat to the connected port in lieu of the protocol transaction.” This informs the other port that a delay is expected, but that the port is still active. If a producer or Consumer receives a heartbeat, then [4] requires that the receiving node return a heartbeat confirmation.

Since CEA-775-C does not require heartbeat indications, neither node shall consider the other node defective even though a heartbeat indication or expected transaction has not been received within the last 5 seconds specified in Section 5.8.1 of [4]. As a consequence, neither node shall consider the other node defective even though a heartbeat indication or expected transaction has not been received within the last 5 seconds. A node that initiates a heartbeat shall not consider the connected port to be defective based on the lack of a response within 100 msec (see Section 5.8.3 of [4]).

## 8.7 Frame and Subframe Format

The OSD Subframes in CEA-799 do not follow the recommended format described in Annex C (informative) of [4]. Subframes in that informative annex include an extra byte, which includes the fields **big**, **eui**, and **sLabel**.

## 8.8 AV/C Managed Connection Sequences

In the general Asynchronous Connection standards, the controller can be in the producer, the Consumer, or can be a separate entity. For CEA-775-C, the controller shall be located in the Consumer (see Section c)). Therefore, bus transactions shown from controller to Consumer in [3] actually occur within the

<sup>2</sup> SUSPEND and WRITE are internal producer states found in [4].

Consumer. These transactions still take place within the controller/Consumer, but are completely implementation dependent. For this reason, some AV/C subcommands, such as SUSPEND\_PORT, are not required even though the interface makes use of connection suspension.

Connection management sequences otherwise follow the procedures in Section 5 of [3].

The timing in Section 5.8.1 of [3] shall apply for reconnection after a bus reset.

## 8.9 AV/C Connection Management Commands

In general, AV/C connection-management commands allocate target-resident resources for use by data-connection communications, and perform unit-dependent security checks (if applicable) when the producer is selected.

### 8.9.1 Reserved command frame fields

For fields marked as reserved in [4] and [3], the target shall return a NOT\_IMPLEMENTED response if any of these fields are not zero. For additional fields designated as reserved in CEA-775-C, the target can return NOT\_IMPLEMENTED if the field is not implemented. If the field is implemented, the target shall return the response described in [4] and [3].

### 8.9.2 Command Frames

The common frame format for ASYNCHRONOUS CONNECTION (0x26) command (for **ctype** of CONTROL and STATUS) and response, which provides the Asynchronous Connection and Asynchronous Plug management functionality, is illustrated in Section 6.2 of [3].

Note that the Status form of the Asynchronous Connection command is required of all target nodes that have an Asynchronous Plug.

### 8.9.3 Command Frame Values

All command frame values are as described in Section 6.2 of [3] except as noted below.

There are 13 subfunction values possible for general Asynchronous Connections described in [3]. The **subfunction** field indicates the action to be taken by the target for the command frame, which **ctype** field is CONTROL. Only the three subfunctions contained in Table 2 are required by CEA-775-C as external bus commands. Support of other subfunctions is optional.

| Subfunction     | Value | Meaning                                                                 |
|-----------------|-------|-------------------------------------------------------------------------|
| ALLOCATE_ATTACH | 0x03  | Allocate the producer port resource and connect it to the Consumer port |
| DETACH_RELEASE  | 0x07  | Disconnect and release the producer port resource                       |
| RESTORE_PORT    | 0x40  | Restore the port resource after a bus reset                             |

**Table 2 Subfunction Field Definitions**

In some cases, subfunctions are not required because the action associated with the subfunction is not required by this standard (e.g., ADD\_OVERLAY). In other case, subfunctions are not required as external bus commands because the controller and the Consumer are required to be the same device with regards to CEA-775-C. Therefore commands which are generally sent from a controller to the Consumer are not needed (e.g., ALLOCATE, RELEASE, and SUSPEND\_PORT).

The commands associated with the subfunctions in Table 2 will be sent from the Consumer/controller to the producer. The actions associated with commands that would in general be sent from a controller to the Consumer will take place within the Consumer/controller.

Valid **plug ID** values are shown in Table 6.6 of [3]. The actual plug IDs used are discoverable as described in Section 12.3.4.

The **port ID** field specifies which port of the plug is selected. General Asynchronous Connections can support up to 14 producer ports per plug (1-14). For purposes of CEA-775-C, an OSD Producer is not required to support multicast. It is only required to support producer **port[1]**. However, it is possible that a producer supports more than one port. In this case, the Consumer/controller may set the port ID to 0x1 or 0xF in the **ALLOCATE\_ATTACH** subcommand. The use of 0xF specifies any available producer port. The producer will return the actual port used in the response to the **ALLOCATE\_ATTACH** subcommand.

Valid **port bits** values are shown in Table 6.8 in [3]. CEA-775-C requires only the minimum level of capability designated by these bits. The **port bits** are the **ct** and **m** bits when referring to the Consumer port and is a two bit **limits** field when referring to a producer. Since all of the AV/C Asynchronous Connection commands needed for CEA-775-C travel from the Consumer/controller to the producer, the **port bits** are associated with the producer and therefore indicate the **limits** imposed by the producer. Their functionality is defined in Section 4.2.5 of [4]. The proper value for **limits** would be sent from the producer to the Consumer in the responses to the **ALLOCATE\_ATTACH** and **RESORE\_PORT** commands. The field would be unused otherwise and would be set to 0x03. It is not necessary to place restrictions on how the producer sets these bits since the Consumer does not need to change the size of the frame buffer, just because the producer is capable of handling it.

The **connection count** field indicates the number of overlaid connections the Consumer node holds. The response to a command frame that had been directed at the Consumer would include the current value. However, since there are no AV/C Asynchronous Connection Commands required in CEA-775-C that would be directed at the Consumer, this field is normally not used and shall be populated with 3F<sub>0x00</sub>. It is still expected that the Consumer/controller keep this count internally if it is capable of making use of overlays.

The **ex** bit specifies whether the other controllers are expected to be excluded from this plug or not. If the **ex** bit is set to 1, then only one controller controls the plug. If **ex** bit is set to 0, then other controllers are allowed to also control the plug. Producers and Consumers shall minimally support **ex** set to 1. There is no requirement for Consumers or producers to support **ex**=0 (i.e., multicast, multiple controllers). If a controller/Consumer needs exclusive use of the output plug to which it is connecting, then **ex** shall be set to 1. Otherwise, **ex** can be set to 0. If the producer only supports one output port and an additional controller/Consumer requests a connection to a plug that is already connected, then the second controller would receive a **REJECTED** response.

Valid **connected port bits** values are shown in Table 6.8 in [3]. CEA-775-C requires only the minimum level of capability designated by these bits. The **connected port bits** are the **ct** and **m** bits when referring to the Consumer port and is a two bit **limits** field when referring to a producer. Since all of the AV/C Asynchronous Connection bus commands needed for CEA-775-C travel from the Consumer/controller to the producer, the **connected port bits** are associated with the Consumer and therefore indicate the constraints of the Consumer. CEA-775-C only requires the support of sequential writes (**ct**=0) and non-multicast connections (**m**=0). Their functionality is defined in Section 4.2.4 of [4]. Even if the Consumer supports these mechanisms, the producer is not required to take advantage of them. Therefore, CEA-775-C places no restriction on how the Consumer sets these bits. The Consumer is allowed to set these bits as appropriate, but the producer is not required to support that capability. If the Consumer does not support multicast, then **m**=0. If the Consumer only supports sequential writes, then **ct**=0.

The **write interval** should be set according to [3].

For the purposes of CEA-775-C, the **retry count** field shall always be 0xF.

NOTE—Normally, “the values of write interval and retry count would be provided by the Consumer node using the **RESPONSE** frame. The controller shall pass these values to the producer node.” These bits then affect how a producer should pace the generation of serial bus transactions.

## 8.10 AV/C Connection Command Format

### 8.10.1 ALLOCATE\_ATTACH

The ALLOCATE\_ATTACH subfunction is used for the controller/Consumer to retrieve the offset address of the specified producer plug from the target and to inform the producer node about the Consumer plug resource related information for establishing the connection. The command is sent from the controller/Consumer to the producer. The fields for the control command frame, the ACCEPTED response frame, and the REJECTED response frame shall be populated as shown in Section 6.3.2 of [3].

### 8.10.2 DETACH\_RELEASE

The DETACH\_RELEASE subfunction is used to cause the producer to break the connection it holds and to release the port resource. The command is sent from the controller/Consumer to the producer. The fields for the control command frame, the ACCEPTED response frame, and the REJECTED response frame shall be populated as shown in Section 6.3.8 of [3].

### 8.10.3 RESTORE\_PORT

The RESTORE\_PORT subfunction is used for both the producer and the Consumer, to reestablish the connection after a bus reset. The command is sent from the controller/Consumer to the producer. Normally, this command would also be mandatory in a Consumer, but since the Consumer is the controller, explicit implementation of this command is not required for the Consumer. The fields for the control command frame, the ACCEPTED response frame, and the REJECTED response frame for the producer port shall be populated as shown in Section 6.3.10 of [3].

### 8.10.4 STATUS Command

The STATUS command can be issued to the producer or the Consumer. The fields for the STATUS command frame and the STABLE response frame shall be populated as shown in Section 6.4 of [3].

## 9 AV/C Command Set Support

### 9.1 AV/C General Commands

The DTV shall comply with the AV/C Digital Interface Command Set General Specification [6]. Support for those commands in Table 3 shall be required for CEA-775-C. All of these commands are defined in the AV/C Digital Interface Command Set General Specification [6], except for ASYNCHRONOUS CONNECTION command, which is defined in [3].

| AV/C Command            | Support level<br>(by ctype) |   |   | Comment                                                                      |
|-------------------------|-----------------------------|---|---|------------------------------------------------------------------------------|
|                         | C                           | S | N |                                                                              |
| UNIT INFO               | -                           | M | - |                                                                              |
| SUBUNIT INFO            | -                           | M | - |                                                                              |
| OPEN DESCRIPTOR         | M                           | O | - |                                                                              |
| READ DESCRIPTOR         | M                           | - | - |                                                                              |
| CONNECT                 | M                           | M | R | Required for support of source-driven external jack selection (Section 7.11) |
| ASYNCHRONOUS CONNECTION | M                           | O | O | As required in Section 8.9                                                   |

**Table 3 Supported Commands**

For **ctype**: C=Control, S=Status and N=Notify. The support level is M=Mandatory, O=Optional, R=Recommended, and =Not Applicable

## 9.2 AV/C Asynchronous Connection Subfunctions

The AV/C asynchronous command subfunctions required for CEA-775-C are summarized in Table 4.

| Subfunction     | Value | Meaning                                                                 |
|-----------------|-------|-------------------------------------------------------------------------|
| ALLOCATE_ATTACH | 0x03  | Allocate the producer port resource and connect it to the Consumer port |
| DETACH_RELEASE  | 0x07  | Disconnect and release the producer port resource                       |
| RESTORE_PORT    | 0x40  | Restore the port resource after a bus reset                             |

**Table 4 Subfunction Field Definitions**

## 10 OSD Data

In this section of CEA-775-C, the source of the OSD signal is called the OSD Producer and the DTV Display device is called the OSD Consumer.

### 10.1 OSD Subframes

OSD subframes shall be formatted to CEA-799 [8], the On Screen Display Specification.

### 10.2 Alignment of OSD with video

A square pixel aspect ratio is desirable. The Monitor Subunit function in the display shall align the 640 x 480 display grid with video according to the following constraints:

- The 640x480 grid shall be centered horizontally within the visible display area.
- The 640x480 grid shall be centered vertically within the visible display area, or cover it completely.

Although the 1280x720, 1920x1080 and 950x540 OSDs are optional, there are the following constraints shall apply.

For 1280x720 and 1920x1080:

- The grid shall be centered horizontally and vertically within the visible display area, or cover it completely.
- The grid may not be shown due to overscan. (Some portions of the leftmost, rightmost, top and bottom of the grid might not be displayed.)

For 950x540:

- The grid shall be centered horizontally and vertically within the visible display area, or be doubled (in both dimensions) and cover it completely.
- The grid may not be shown due to overscan. (Some portions of the leftmost, rightmost, top and bottom of the grid might not be displayed.)

An OSD Producer may learn how a DTV will align OSD with various digital video formats by processing data delivered in the Unit Identifier Descriptor, defined in Section 12.3.

### 10.3 Behavior of System during Attach

When an OSD Producer is attached to an OSD Consumer then the OSD Producer may assume that the OSD in the Consumer is transparent.

### 10.4 Behavior of System during Suspend / Resume

The DTV may choose whether or not to clear the OSD buffer to all-zeroes (transparent) entering the OSD SUSPEND state (see Section 8.6.1). It shall be the responsibility of an OSD Producer to define every pixel in the OSD grid following RESUME. Therefore, if the DTV were to take control of OSD for a short time (for example, to display a volume control bar), it could choose not to clear the screen during its use of the screen because it could rely on the full screen being re-initialized when it resumes its connection to the OSD Producer.