

CTA Standard

A User Interface Specification for Home Networks Using Web-based Protocols

CTA-2027-B

(Formerly CEA-2027-B)

October 2007



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(Formulated under the cognizance of the CTA **R7 Home Networks Committee.**)

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FOREWORD

The current version of this standard was developed under the auspices of the Consumer Electronics Association (CEA) R7 Home Network Committee.

Warning: CEA-2027-B requirements are not a backward compatible extension of those in the CEA-2027-A specification.

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CEA-2027-B: A User Interface Specification for Home Networks Using Web-based Protocols

1 Scope

This standard addresses user control of remote A/V devices on home networks.

It defines mechanisms that allow the A/V devices to present status and control user interfaces on a network-attached renderer, and specifies a method for encapsulating this UI data using Web and Internet protocols.

User control is exerted through a browser and graphical user interface that is contained in the rendering device. The design of these graphical and user interfaces is determined solely by the implementers of this standard, and may utilize any content design up to and including the full capability of the devices and network technology.

Annex A is normative for implementations utilizing IEEE 1394. Future versions of this standard are expected to address other home networking technologies in additional Annexes.

This specification describes the minimum capabilities of the client browser and the controller/server. A compliant browser may have additional capabilities for worldwide web surfing, E-Commerce, or Enhanced TV applications, but that is out of scope for this standard.

A renderer in the current version of this standard may be a DTV or a PC, but other rendering devices are anticipated. A/V devices may include a source of home-network content, such as a cable or terrestrial set-top box, digital VCR, or DTV.

Warning: CEA-2027-B requirements are not a backward compatible extension of those in the CEA-2027-A specification.

1.1 Revision History

August 2004: Publication of CEA-2027.

July 2006: Publication of CEA-2027-A.

October 24, 2006: CEA-2027-B version 2 draft is released.

All references in this standard to CEA-2027 and 2027 shall apply to CEA-2027-B. Changes from CEA-2027-A to CEA-2027-B:

1. The Browser specifications in Section 4.4 were changed from full RFC compliance to subset itemized in Annex B.
2. The HNCP method of IP address resolution in Annex A was deleted and has been replaced with Bonjour methods described in Section 4.3.
3. New sections in Annex A on 1394 describe the relationship of AV/C commands to CEA-2027-B specification.
4. A new Section 4.8 was added to describe 6 new IP-level commands that apply normatively to all Logical Units that are either controllers or actually make media connections. These commands assist in establishing, allocating resources for, and resolving some conflicts related to media connections between “sink” and “source” “logical units”. These IP connect and reservation commands plus the addition of Bonjour IP-based IP address resolution and 2027 Service Discovery establish the operation of 2027 completely at the IP level with the AV/C discovery on 1394 being at the AV/C / 1394 level.
5. The previously defined push method was eliminated in favor of a new client server based “Notification” system for logical units. The need for transparent frame is eliminated as a result of the notification system. This notification system replaces the need for the Frame Exit Status Return of Section 4.7. So the Frame Exit Status Return command has been removed.
6. An HDTV profile for a web browser/controller attribute is established which require the new relaxed browser specifications and limit the range of screen sizes to 4 which are supported in HDTV web Browsers. Within the HDTV profile the size of the initial control frame is the full screen size.
7. As a result of the control frame for a device always being full screen this eliminates the need to request a size for that object. Also, this precludes maintaining the status frame stack on screen with a control frame, so the example that was in Section 6 will not be consistent with the specification and is removed.
8. Since not all HDTVs display 100% of the video data, the generated On Screen Display should provide an allowance for over-scan in HDTVs.
9. The Proxy mechanism remains approximately the same, but the AV/C legacy device association has changed to make the process robust. There is now a “waiting period” before the expiration of which the device must observe all 2027 Files for proxies which have already attached that device. Also, any proxy capable device must remember which 2027 Devices have proxied AV/C devices which it is capable of proxying. The “waiting period” for taking over a previously proxied AV/C device is much longer. This proxy method utilizes 2027 File descriptions which are advertised via Bonjour and does not require neither config ROM storage nor additional bus resets.
10. The manufacturer’s name is now an attribute of each Logical Unit in addition to that of the IP addressable device that serves the 2027 File. Another addition to the 2027 File requirement is an indication that the LU has recording capabilities.
11. Since the addition of logical unit concept in the first CEA-2027 specification we have always intended that CEA-931-C commands will be sent from one logical unit to another.

The CEA-931-C specification however only allows CEA-931-C specification command format only provides for the sending of a remote control command from one IP address to another IP address. This particular change is indicated in Section 4.5. This addition will appear in a revision of the CEA-931-C specification.

12. All places concerning size of the controller's graphic plane now address the HDTV profile restriction to one of 4 possible sizes.
13. The commands generated which are defined in Section 4.7 now have an optional ?snk=<Logical-unit-name> or ?connID=<ConnectionID> appended to the command to indicate the context for which the UI should be provided.
14. An H.264 decoder addition function and Time Shift Viewing function have been added to example methods of the use of Section 4.8 IP layer commands.
15. Changes were made in Sections 4 and 5 to reflect the removal of the Time Shift Viewing (TSV) function and examples. TSV is still a term used in this specification, but with the advent of FCP/IP the TSV function is carried out as an application using AV/C.
16. The specification documents that describe L3 Bridges and FCP/IP are incorporated as normative. Thus enabling the use of 1394/COAX Bridges with 2027-B compatible devices.
17. Various editorial clarifications to both informative and normative Sections were made. These clarifications, while changes, were refinements to the meaning to the text for clearer statement and easier understanding.
18. Browser requirements now normatively completely aligned with those in CEA-2014-A
19. An allowance for additional optional use of SSDP to announce the URL of the 2027 File.
20. The use of SSDP and UPnP Basic Device for Discovery as further detailed in this specification is normative.
21. The reliance on Zero Config and RFC 3927 for zero configuration is unchanged and still normative.
22. The use of the m-DNS and DNS-SD parts of Bonjour are removed.
23. Lint from the previous removal of Annex B and C was removed.
24. Also the HDTV profile is retained but different Browser conformance was removed and now only connotes larger graphical size requirements.

1.2 Overview

The CEA-2027-B specification is based on the following principles:

1. Address various physical networking media.

2. Reproduce UI of service providers.
3. Respect Digital Rights Management (DRM) requirements of service providers.
4. Provide Home Networking that addresses ease of use and transparent discovery.
5. Provide methodology that easily extends to heterogeneous home networking methodologies.

1.2.1 CEA-2027-B Benefits and Goals

CEA-2027-B offers many benefits to manufacturers of home network devices:

Manufacturers are free to design a common and consistent look and feel for user interaction with their home-networkable devices.

A specific GUI is not mandated nor is the functional division between the GUI and the means of user input specified. Therefore, manufacturers maintain brand identity while complying with this standard.

Servers in the attached devices define the format presentation. Furthermore, since the contents of the device's UI are written in web-based formats, manufacturers can easily alter the look and feel of the UI by using the web design tool Cascading Style Sheets (CSS).

CEA-2027-B allows controlled devices to maintain control over their user interfaces.

This standard reduces the complexity of the user-interface communications technology that would otherwise be incorporated into networked A/V devices. Most of the user interface features are moved from multiple devices to a client device. Only limited user-interface and device-to-device control needs to reside in each device.

This standard defines a common set of user interactions for controlling all devices, thereby affording users a one-time learning curve.

Buyers have the flexibility to connect devices from multiple manufacturers into a home network.

This standard can apply to other home-control systems.

1.2.2 CEA-2027-B Features

CEA-2027-B specifies methods and graphical resources for an HDTV user interface (UI) that consists of a Graphical User Interface (GUI) and a means of user input such as a remote control unit (RCU). The GUI enables convenient user control and operation of a networked cluster of devices, such as audio/video (A/V) equipment. The features of this web-based standard provide a consistent operational format for managing devices remotely on a home network. The basic operations enabled by CEA-2027-B include:

- Determination of device accessibility.
- Selection of a device.
- Determination of available device functions

- Observation and control of device functions.

The GUI is presented on an HDTV, while a handheld RCU, keyboard or touchscreen are used to navigate and to control the networked device functions that have been grouped as **Logical Units**.

The **Top-Level UI** displays (through the GUI) the state of these Logical Units as a collection of **Status Frames**.

The user selects a Logical Unit from the displayed Top-Level UI. A server in that Logical Unit then returns information describing its controllable functions for display on a **Control Frame**. The device manufacturer has freedom to design the display layout.

Each Logical Unit contains an embedded server that manages a Status Frame and a Control Frame. The manufacturer of the device defines the format of these frames which may range from text-only to sophisticated graphics.

The appearance and design of the GUI and the RCU are not specified, nor the division of operations and functions between the GUI and the RCU; the specifics are left to the manufacturer, and are dictated by the currently active controller. RCU commands are specified based on CEA-931-C.

This standard assumes the preexistence of a home network that links the A/V devices, and a connection-management strategy for the dynamic interconnection of these devices as they are added to and removed from the network. Zero Configuration Networking with SSDP announcement and service discovery has been specified since it requires minimum device services for efficient network configuration.

The network configuration model is based on a client (**Renderer** plus RCU) and one or more servers). More than one Renderer may be present in a client device.

Specifications are included for network applications including immediate connections, connections at a later time (such as programmed recording), and connections of known or unknown duration. A Personal Video Recorder (PVR) is an example of a device that may connect for an unknown duration to provide time-shift viewing. Numerous connection examples are provided.

CEA-2027-B can accommodate future formats that may be implemented with auxiliary network devices such as an advanced (H.264) video decoder. Network management tools are specified that can logically bind such auxiliary devices to specific A/V devices. For example, a display might be logically associated with an H.264 decoder while both units are connected as nodes to a home network, rather than through a dedicated wire. XML files (The “2027 File” defined in this standard) contained in each Logical Unit facilitate such logical associations.

Other features include;

- Devices can be linked through various Internet Protocol (IP) capable network technologies. This standard defines the application-layer communications protocols.

- The UI data is conveyed on the home network using web-based technology (XHTML, HTTP, etc.). The GUI is described using XHTML data structures. The GUI is manageable with a browser that has the minimum capabilities that are defined in this standard.
- Navigation by mouse or cursor are not mandatory when this standard is applied to an HDTV
- A Logical Unit may manage multiple sub-devices using a mechanism defined in this standard.

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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 the most recent editions of the standards listed below.

- [1] IETF RFC 2616, HyperText Transfer Protocol – HTTP 1.1, June 1999
- [2] IETF RFC 791, Internet Protocol (IP), J. Postel, September 1981
- [3] IETF RFC 793, Transmission Control Protocol (TCP), J. Postel, September 1981
- [4] ECMAscript Language Specification (Third Edition), December 1999, ECMA-262.pdf, <http://www.ecma-international.org/publications/standards/Ecma-262.htm>
- [5] CEA-931-C, Remote Control Passthrough for Home Networking, June 2007
- [6] CEA-2014-A Web-based Protocol and Framework for Remote User Interface on UPnP Networks and the Internet (Web4CE), June 2007
- [7] Extensible Markup Language (XML) 1.0 (Third Edition) W3C Recommendation 04 February 2004 <http://www.w3.org/TR/2004/REC-xml-20040204>
- [8] XHTML 1.0 The Extensible HyperText Markup Language (Second Edition), W3C Recommendation 26 January 2000, revised 1, August 2002 <http://www.w3.org/TR/2002/REC-xhtml1-20020801/xhtml1.pdf>
- [9] HTML 4.01 specification, W3C REC 24Dec1999, <http://www.w3c.org/TR/1999/REC-html401-19991224>
- [10] IETF RFC 2396, Uniform Resource Identifiers (URI): Generic Syntax, August 1998
- [11] REC-DOM-Level-2- 20001113 Document Object Model (DOM) Level 2 Core Specification, Version 1.0, W3C Recommendation 13 November, 2000; <http://www.w3.org/TR/1998/REC-DOM-Level-2-Core-20001113>
- [12] 1394TA Document 2002010 “A/VC Connection and Compatibility Management Specification 1.1”, January 2003
- [13] CR-css-tv-20030514 CSS TV Profile 1.0, W3C Candidate Recommendation 14 May 2003

- [14] REC-DOM-Level-2- 20001113 Document Object Model (DOM) Level 2 Style Specification, Version 1.0, W3C Recommendation 13 November, 2000;
<http://www.w3.org/TR/1998/REC-DOM-Level-2-Style-20001113>
- [15] REC-DOM-Level-2- 20001113 Document Object Model (DOM) Level 2 Events Specification, Version 1.0, W3C Recommendation 13 November, 2000;
<http://www.w3.org/TR/1998/REC-DOM-Level-2-Events-20001113>
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<http://www.w3.org/TR/2004/CR-css-print-20040225>.
- [17] Portable Network Graphics (PNG) Specification (Second Edition). Available at
<http://www.w3.org/TR/PNG>
- [18] Cascading Style Sheets, level 2 revision 1 “CSS 2.1 Specification” W3C Candidate Recommendation 25 February 2004 <http://www.w3.org/TR/2004/CR-CSS21-20040225>
- [19] Cascading Style Sheets, level 2 “CSS2 Specification” W3C Recommendation 12-May-1998
<http://www.w3.org/TR/1998/REC-CSS2-19980512>
- [RFC 2131] R. Droms, "Dynamic Host Configuration Protocol", RFC 2131, March 1997.
- [RFC 2132] Alexander, S., and Droms, R., "DHCP Options and BOOTP Vendor Extensions", RFC 2132, March 1997.
- [RFC 3927] Dynamic Configuration of IPv4 Link-Local Addresses, May 2005
- [Bridge2] IEEE 1394 Bridged over Coaxial Cable – Part 2: L3 IP Bridges, TS 2006016, Revision 1a, April 11, 2007, 1394 Trade Association.
- [Bridge3] IEEE 1394 Bridged over Coaxial Cable – Part 3: FCP and CMP over IPv4, TS 2006021, Revision d0.5, March 19, 2007, 1394 Trade Association.
- [SSDP] Goland et. al., Simple Service Discovery Protocol/1.0 Operating without an Arbiter <draft-cai-ssdp-v1-03.txt>, October 28, 1999, IETF
- [UPNP] UPnP™ Device Architecture 1.0, Version 1.0.1, 2 December 2003, UPnP Forum.
- [BasicDev] Basic: 1.0 Device Definition Version 1.0 for UPnP™ Version 1.0 12 December 2002, UPnP Forum.

2.2 Informative References

- [20] CEA-775-B, DTV 1394 Interface Specification, July 2004
- [21] AV/C Digital Interface Command Set General Specification, version 3.0, April 15, 1998, 1394 Trade Association.

- [22] Firewire System Architecture, 2nd Ed., IEEE 1394a, published by Mindshare, Inc. and Addison Wesley, July 2002.
- [ZC] Daniel H. Steinberg, Stuart Cheshire, “Zero Configuration Networking: The Definitive Guide,” First Edition December 2005 , ISBN: 0-596-10100-7, (<http://www.oreilly.com/catalog/bonjour/>).
- [Bridge1] IEEE 1394 Bridged over Coaxial Cable – Part 1: MAC and PHY, TS 2006019, Revision 1.0b, March 15,2007, 1394 Trade Association.
- [BridgeArch] IEEE 1394 Bridged over Coaxial Cable – Requirements and Architecture, Revision 2, April 6, 2007, 1394 Trade Association.

2.3 Normative Reference Acquisition

1394TA Standards:

- Contact the 1394 Trade Association (TA), 1111 South Main Street, Suite 100, Grapevine, TX, USA; Phone 817-410-5750; Fax 817-410-5752; Internet <http://www.1394ta.org>
- The documents cited as IEEE 1394 Bridged over Coaxial Cable may be obtained from CEA by contacting standards@CE.org.

ANSI/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>; E-mail global@ihs.com

ECMA Documents:

- ECMA International, Rue de Rhone 114, CH-1204, Geneva; Phone +41 22 849 6000; Fax +41 22 849 6001

IETF Documents:

- Internet Engineering Task Force (IETF) Secretariat, c/o Corporation for National Research Initiatives, 1895 Preston White Drive, Suite 100, Reston, VA 20191-5434, USA; Phone 703- 620-8990; Fax 703-620-9071; Internet www.ietf.org, IETF RFCs may be downloaded from www.ietf.org/rfc.html, IETF Internet drafts may be downloaded from www.ietf.org/ID.html

World Wide Web Consortium Documents:

- World Wide Web Consortium (W3C); Internet <http://www.w3.org/>

UPnPtm Documents

- UPnP Forum, <http://www.upnp.org/>

2.4 Definitions

2.4.1 Conformance

Several keywords are used to differentiate levels of requirements and optionality, as follows:

shall: A keyword that indicates a mandatory requirement. Designers are required to implement all such mandatory requirements to assure interoperability with other products conforming to this standard.

should: A keyword that denotes flexibility of choice with a strongly preferred alternative. Equivalent to the phrase “is recommended.”

may: A keyword that indicates flexibility of choice with no implied preference.

2.4.2 Glossary

The following terms are used in this standard:

2027 Device: A CEA-2027-B compliant physical device

2027 File: An XML formatted file that contains descriptions of various properties of a service device to be controlled and the Logical Unit(s) it contains or is associated with.

AVC Device Type: A 32 bit word where each bit represents a different category of AV/C Device type as defined by value in Table 5.3-1 *Subunit type encoding* on page 9 in Section 5.3.3 of reference [20][21]. There are 32 possible values, 0x0 to 0x1F, each represented by a bit. So bit 0 represents Video Monitors, bit 3 Disc recorder/player (audio or video), bit 4 Tape recorder/player (audio or video), bit 5 Tuners, bit 7 Video cameras. These are the current active device definitions.

Bridge: A device which allows 1394 local clusters to be connected over an extended length. (1394a cables are at a maximum of 4.5 m in length. A 1394 local cluster is a group of devices which are interconnected via a single local run of cables.).

Client Device: A device, or group of devices, consisting of a Renderer and a means of providing user input (such as a remote control unit (RCU), front panel keys or a mouse).

Control Frame: An XHTML object returned by a Logical Unit in response to a specific GET command from a network controller’s browser. This object provides access to the controllable functions in a Logical Unit.

Controlled Device: A device being controlled, which contains a web server and various service functions; also called **Service Device**.

Controller: The controller is responsible for managing interactions with the user, including formation of the Top-Level UI. In a DTV, the Controller is typically part of the control software. Also called “network controller” or “controller device”.

Digital Television (DTV): 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; or a PC and attached monitor; or a handheld unit and associated display).

Icon: A graphic object returned by a Logical Unit in response to a specific GET command from a network controller’s browser. This object contains a bitmapped icon for the controlled device.

L3 Bridge: A bridge that uses protocols and methods above the MAC and PHY layer to interconnect two or more local 1394 clusters over an extended distance.

Logical Unit: A Logical Unit is an abstraction of a Device (or part of a device or a group of devices) and its associated services. Logical Units are the entities that are networked and for which a UI is served. Each Logical Unit presents its user interface to a browser via a server.

Node Unique Identifier: Abbreviated nuid. It is a 16 digit hexadecimal ASCII value for the 64-bit node unique identifier associated with a 1394 device, see page 415 of [22]. It is frequently termed the global unique identifier and abbreviated as guid.

Proxy Code: This is code that resides in one device and provides a portion of the UI and/or control function for another device on the network.

Push Method: A method of providing exception information (i.e. for unusual events) from a Logical Unit by creating a continuous status update link.

Renderer: A device, or group of devices, consisting of a decoder and a display unit.

Service Banner: An XHTML object returned by a Logical Unit in response to a specific GET command from a network controller’s browser. The service banner contains user readable information related to a current content stream.

Service Device: A device being controlled, which contains a web server and various service functions; also called Controlled Device or Logical Unit.

Status Frame: An XHTML object returned by a Logical Unit in response to a specific GET command from a network controller’s browser. This object describes the state and other general information about the Logical Unit for display on the UI.

Status Return: An XML element returned by a Logical Unit in response to a specific polled GET command from a network controller’s browser during an open control action. Status Return

indicates whether the control action is complete or not; and if it is complete, how it was ended; and if not, suggests limits on where the user may browse based on device availability.

Top-Level UI: The full composite user interface created by the Controller.

Type Id: Often represented as **type_id**. It is an ASCII encoded hexadecimal 8 bit, 16 bit, 24 bit, ...value which encodes the subunit type and subunit id for a 1394 device as in Section 5.3.3 AV/C address (subunit_type, subunit_ID) on page 9 of reference [20][21].

Underlying Medium: The wires and I/O ports that deliver content between networked devices. The Underlying Medium may consist of one or more combinations of non-network connections (i.e. point-to-point connections) and network connections between devices.

2.4.3 Abbreviations

The following are abbreviations that are used in this standard:

A/V	Audio/Video
AV/C	Audio/Video Control
AVHDD	Audio/Video Hard Disk Drive
CGI	Common Gateway Interface
CSS	Cascading Style Sheets
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name Server
DRM	Digital Rights Management
DTV	Digital Television
DVD	Digital Versatile Disk
EPG	Electronic Program Guide
FCP	Function Control Protocol
GIF	Graphics Interchange Format
GUI	Graphical User Interface
HTTP	HyperText Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
ILU	Initiator Logical Unit
LU	Logical Unit
NIU	Network Interface Unit
OLU	Owner Logical Unit

OSD	On-Screen Display
PSIP	Program and System Information Protocol
RCU	Remote Control Unit
SnkLU	Sink Logical Unit
SrcLU	Source Logical Unit
STB	Set-Top Box
TSV	Time Shift Viewing
UI	User Interface
XML	Extensible Markup Language
XHTML	Extensible HyperText Markup Language

3 Architectural Model (Informative)

The basic building blocks of the system are **Logical Units**, which are virtual groupings of related and commonly-controlled device functions. (See Section 4.6 “2027 File: Logical Unit”). Each Logical Unit presents its user interface to a browser via a server. A Logical Unit can represent:

- A single physical device (e.g. a DVD player)
- A subset of the functions in a physical device (e.g., a tuner inside an HDTV)
- A set of functions that span more than one physical device (e.g., audio control that encompasses a pre-amp and a power amplifier).

Most Logical Units reside in a single device, some occupy the entire physical device, and a few Logical Units may span several devices.

Figure 3.1 shows four Logical Units resident in three physical devices, within the grey shaded areas.

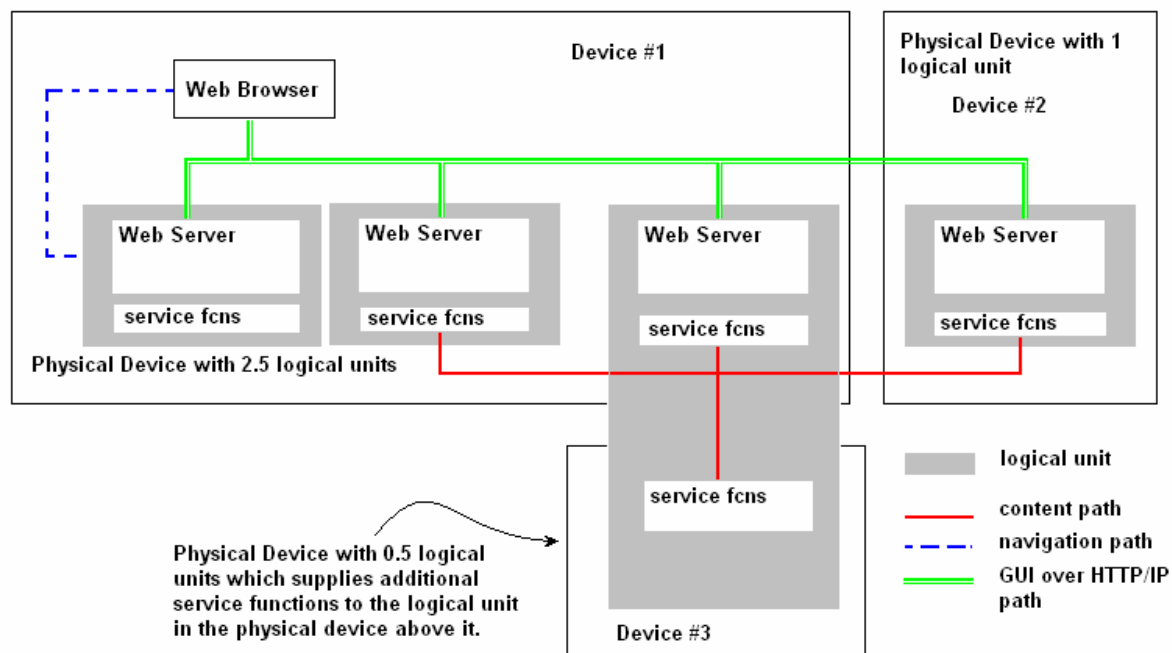


Figure 3.1 – Logical Units and Physical Devices

The basic architecture is illustrated in Figure 3.2, which depicts two devices: an HDTV and an A/V HDD.

The HDTV contains a Browser for navigation, and 3 Logical Units:

- A Controller to form the top-level UI.

- A Tuner with embedded EPG/PSIP server.

- The Display.

The AVHDD functions as both a content recorder and player.

The HDTV may appear to be cluttered with many servers, but note that since three of the Logical Units are contained within the HDTV, the multiple servers are simply multiple instances of a single server.

There are 5 Logical Unit types:

- Streaming Media Sources (“SourceOnly”) - Type 1

- Streaming Media Sinks (“SinkOnly”) – Type 2

- Streaming Media Source and Sink (“Either”) – Type 3

- Not a Streaming Media Source or Streaming Media Sink (“Neither”) – Type 4

- Not intended to be visible to the user (“NotVisible”) – Type 5

The 2027 File returned from each physical device describes the Logical Units defined for that device along with their types. (See Section 4.6 for a complete description of the 2027 File.)

The Logical Units in Figure 3.2 are typed as:

The Tuner – type 1.

The Display - type 2.

The AVHDD – type 3.

Controller - type 5.

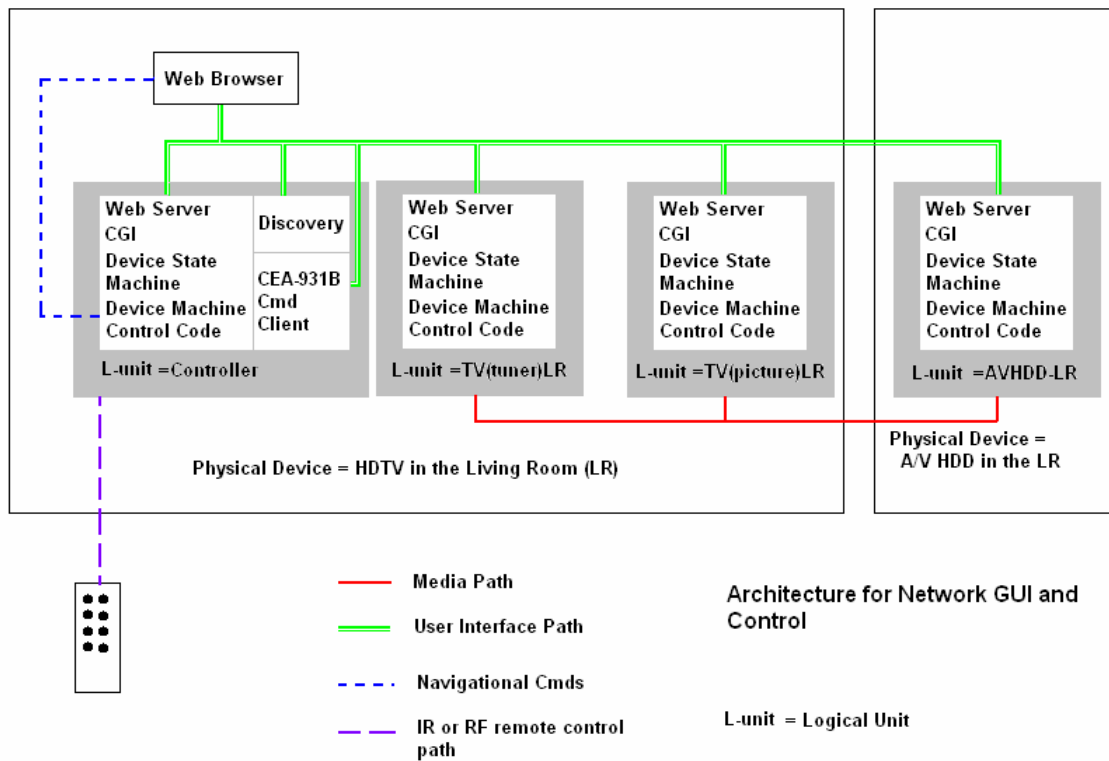


Figure 3.2 – Example Architecture of Logical Units and Physical Devices

4 Requirements (Normative)

Warning: CEA-2027-B requirements are not a backward compatible extension of those in the CEA-2027-A specification.

4.1 Networked Physical Devices

A CEA-2027-B compliant physical device shall deploy zero or more browsers and shall contain or be associated with one or more Logical Units. Each CEA-2027-B device shall be assigned an IP address on the IP network that is used to interconnect the devices. This network shall transmit the UI data and user-provided inputs using GET-method commands over HTTP/TCP/IP. See references [1], [2], [3]. The Underlying Medium for A/V related functionality may be the same IP network, a different network, or another non-networked connection.

4.2 Logical Units, Service and Control

This system presents the user with a view of the networked devices in terms of Logical Units, which are abstractions of devices and their associated services.

The 2027 File returned from each physical device describes the Logical Units defined for that device along with their types. (See Section 4.6 for a complete description of the 2027 File.)

Several Logical Units may reside within a single device, some may occupy the entire device, and some may span several devices. Logical Units are the entities that are networked. Each presents its UI to a client browser via a server.

During operation, Logical Units transmit data which describe the Logical Unit's status and controllable features. These device-specific data constitute the Status and Control Frames which are displayed on the Renderer (DTV). When a client requests a Control Frame, it may be displayed adjacent to the Status Frames or in place of them. The DTV manufacturer has freedom in selecting the display layout.

Logical Units can contain any number and combination of sub-devices which employ various network protocols. It is therefore necessary to isolate the sub-device specifics from user control and device-to-device control, and to present a common platform for user and device interaction.

LU Requirements

Each Logical Unit shall deploy or have access to a Server for the purpose of transmitting UI data in the form of Status and Control Frames.

Logical Units shall accept the commands defined in this specification, and shall determine which commands to implement and which to reject.

Logical Units shall manage their sub-devices, and shall determine which sub-devices to use in connections. In some cases, the selection of a Logical Unit as a source or sink may require the additional selection of a specific sub-device. The determination of the proper sub-device shall not be placed upon other Logical Units but shall be made by the user. Problems resulting from resource limitations that exist within a Logical Unit should be solved by that Logical Unit.

Logical Units may support subdevices with disparate functionality. There is no canonical subdivision of LU functionality. For example, an HDTV LU may contain a Tuner sub-device and a Picture Decoder sub-device.

A CEA-2027-B compliant DTV shall contain a Logical Unit if other controllers are intended to remotely access the DTV User Interface. A Logical Unit is not required if the DTV is not designed to allow other devices to access the DTV UI.

The behavior of links contained in an XHTML page served by a Logical Unit that point to a URI other than that of the serving Logical Unit is undefined by this standard. Links from a Logical Unit should be self-contained; that is, a Logical Unit should link to itself.

Server requirements

Servers shall accept all requests from client browsers, without the need for prior notice.

The server within a Logical Unit might not receive notification that a client has changed focus to another Logical Unit or that the user has exited from the client instance. This lack of notification shall not affect the server operation.

Server contents may change dynamically, therefore servers shall mark dynamic content as “Cache-control: no-cache” [1]. In some cases, headers in non-dynamic content may need to be marked “Cache-control: no-cache” if the content is loaded from dynamic pages. To this end, scripts originating from a Service Device should mark requests “Cache-control: no-cache” as appropriate, and the server should mark responses as appropriate.

Servers shall serve XHTML content with MIME-type “application/xhtml+xml”.

Controller Requirements

The Controller shall manage all interactions with the user, and shall manage the Top-Level UI. The Top-Level UI shall present to the user the Logical Units accessible via the home network and shall enable selection of a particular unit.

The Controller shall manage the framework for the Status Frames and RCU functions for the presentation and management of the Top-Level UI. This framework shall be defined by the controller manufacturer.

A CEA-2027-B compliant DTV shall deploy a browser and control functions capable of rendering the Control Frames from a compliant networked Service Device based on user-initiated requests. The control software in the DTV may be designed to render the entire DTV UI via a web browser served by an integrated web server, but this is not a requirement.

Multiple controllers and DTVs may coexist on a single network

Other Controller implementations include but are not limited to:

1. A web browser may be extended to provide the necessary controller functions in support of this specification.
2. The Controller may be implemented on a web server to generate a web page on which all the frames are aggregated. A conventional browser may then be used to access this web page.

The IP-level commands described in Section 4.8 apply normatively to all Logical Units that are either controllers or actually make media connections.

Top-Level UI

The Top-Level UI shall present to the user the Logical Units accessible via the home network and shall enable selection of a particular unit. This is typically the function of a controller logical unit, and is done by generating a home page for access by an embedded browser.

4.3 IP Addresses, Names, and 2027 Discovery

4.3.1 Zero Configuration Network

A device node acquires a network address at this stage. Two methods are defined: managed and unmanaged. This standard assumes operation of an unmanaged network.

4.3.1.1 Managed Device Addressing

In a managed environment, a server (known as a Dynamic Host Configuration Protocol server, or DHCP server) assigns an IP (Internet Protocol) address to the device. Each device must contain a DHCP client in order to communicate with the DHCP server for address acquisition. See [RFC 2131] and [RFC 2132].

4.3.1.2 Unmanaged Device Addressing

The Auto IP procedure selects an IP address automatically from a pool of reserved addresses. The device tests the availability of an IP address by issuing an Address Resolution Protocol (ARP) probe to determine if any other device responds to that address. A device configured using Auto IP must check every few minutes to determine if a DHCP server has become available. When a DHCP server is found, the device assumes the DHCP-assigned address and may relinquish the Auto IP address.

4.3.1.3 Zero Configuration and Link-Local Addresses

The 2027 Device SHALL implement IPv4 Link-Local Addressing as described in the following document.

<http://files.zeroconf.org/rfc3927.txt>, see [RFC 3927]

The 2027 Device SHALL assign itself a link-local IP address in the absence of a DHCP server [RFC 2131], and it SHALL automatically resolve link-local address conflicts.

The 2027 Device SHALL assign itself a Device Name, and it SHALL automatically resolve Device Name conflicts.

4.3.2 Discovery

The device announcement mechanism for 2027 Devices advertises the url , called 2027url, of the 2027_file. See Section 4.6 for the contents of the 2027_file. The discovery of 2027 device logical units and their properties is done by devices, mostly controllers, through reading multicast notifications or searching. Controllers and other devices first acquire and announcement from a device and then perform the HTTP GET <2027url> to get the 2027_file in response.

4.3.2.1 Simple Service Discovery Protocol (SSDP)

A 2027 Device SHALL use the Simple Service Discovery Protocol, see [SSDP], and the discovery Section 1 in pages 10-21 of the Device Architecture 1.0, see [UPNP], and SHALL add the following 7 requirements:

1. A url, call it BDurl, within the 2027 Device SHALL be provided which returns the completed template of a Basic Device as defined in [BasicDev]. This template results in a small XML formatted file and is the primary requirement of the Basic Device for use with methods of UPnP™. No services or controls are provided to any devices on the network via this Basic

Device. This is a conformance requirement to allow use of the SSDP for CEA-2027-B without interference with UPnP[™] operations. The BDurl SHALL be used with the LOCATION header in SSDP requests and responses.

2. Another url, call it 2027url, SHALL be defined and located within each 2027 Device. Such a url has a form similar to the examples:

- a. <http://2027device.local/path/2027.php>,
- b. <http://2027device.local/path/2027.xml>,
- c. <http://2027device.local/path/2027.cgi>

A 2027 Controller SHALL use HTTP GET <2027url> in order to receive the 2027_file to control 2027 Devices. 2027 Devices SHALL respond with the 2027_file for the GET request. Section 4.6 in CEA-2027-B provides information which formulates the contents of the XML formatted 2027_file. All NOTIFY and SEARCH responses for 2027 Devices SHALL have a specific extension header of the following form:

LOCATION.2027 : <2027url>

The use of this extension header allows the announcement of the 2027_file for that device.

3. The SERVER header SHALL be supplied with the string <manufacturer name> “2027/B” <product name> <product model number>.
4. The USN header SHALL be supplied with <Device Name>.
5. The NTS header shall be used as described without modification.
6. The NT header SHALL always be used with: 2027:rootdevice.
7. The ST header SHALL always be used with: 2027:rootdevice.

.

4.4 Browser Requirements

A CEA-2027-B compliant browser shall be associated with a controller, and shall support the navigation of links. The 2027 Browser shall respond to the CE-HTML client requirements as listed with default parameters in Section 5.4 of CEA-2014-A [6]. The References XHTML [7], XML [6], HTML [8], URI [9], DOM [10], [13], [14], CSS [12],[15], [17], [18] shall be used to determine the requirements of this section, but not to provide additional requirements beyond which have already been specified. It should be noted that the notification system used in CEA-

2027-B is a particular case of the 3rd party notification as described in CEA- 2014-A [6]. Sections other than Section 5.4 in Section 5 in CEA-2014-A [6] are optional but recommended. The color “transparent” shall be defined within the XHTML or CSS of the browser. This color shall be used as a background color to allow the TV video to be visible..

CEA-2027-B compliant browsers shall not cache properties and objects from servers which are marked “Cache-control: no-cache” [1].

Browser implementations may support various native resolutions. Display resolution and display orientation will depend on the type of client device to be supported. For DTV clients, the resolution should be at least 640 pixels wide by 480 pixels high. HDTV clients may support higher resolutions, which HDTV application developers are encouraged to implement. The HDTV profile allows support for 4 graphic plane sizes: 1080x1920, 540x960, 720x1280, 480x640. Smaller form-factor devices should also be supported when appropriate, down to a minimum size of 160 pixels by 120 pixels in either orientation. Mouse and cursor use and support shall not be required.

This specification describes the minimum capability of the client browser and the server. A compliant browser may have additional capabilities for worldwide web surfing, E-Commerce, or Enhanced TV applications, but these are outside of the scope of this standard.

4.5 Remote Control and Connection Methods

All FCP (including AV/C) commands sent to a logical unit shall be sent as described in [Bridge3] using the IP address of the logical unit and the <FCPport> tagged value from the logical units 2027-file. The connection commands described in [Bridge2] shall be used to make all media connections and disconnections.

Each DTV controller shall allow the user to access all of the CEA-931-C commands, see [5], which are indicated in the 2027 File, as implemented in each Logical Unit. (See Section 4.6 for the specification of the 2027 File.) Each CEA-2027-B compliant service device SHALL respond to all commands indicated in its 2027 File. Note that Section 4.2.4 of CEA-931-C defines a message header response field which shall be used in responses to commands that are not implemented. This provides immediate access control when the user presses an RCU key directed to the device within the focal context of the browser UI (highlighted in some manner determined by the controller manufacturer). RCU response may be done with or without graphical prompting. The controller may provide various methods for controlling which device has the focal context for a particular remote control button or function. Common

implementations of controller browsers might use the Exit, Up, Down, Left, and Right keys and Select key for on screen navigation.

The key event shall be mapped to a CEA-931-C key code and sent to the device under focus for that key, if applicable. Some CEA-931-C keys may not be directly generated by or associated with any key on the remote control of the host device; therefore the host device may provide other mechanisms for generating those key codes. Keys and key codes shall be mapped intuitively and with clarity and feedback to the user.

Note that it is not required that a 2027 Device implement the AV/C Panel subunit as described in CEA-931-C.

4.6 2027 File: Logical Unit

4.6.1 Introduction

The properties of the Logical Unit's user interfaces are retrieved with the **GET** <2027url> command, where the value of <2027url> is described in Section 4.3.2. The returned XML file describes all of the device-supported Logical Units as the concatenation of all Logical Unit block descriptions.

4.6.2 2027 File

The following description is the normative definition. The bolded enclosure pairs {} and [] indicate the conditionally normative options in possible multiples, where [] indicates either 0 or 1 occurrences, and {} indicates that 0,1,2,3,... occurrences are possible. The order of child elements in the **Device_2027** element is significant and shall be as shown. The order of child elements in the **logical_unit** element is not significant.

For a physical device that contains the servers for *k* Logical Units, the file shall contain three tagged fields, each an ASCII string the with manufacturer's name, model number, and description, followed by the concatenation of the separate Logical Unit blocks, all enclosed with 2027 tags, or :

```
<?xml version="1.0"?>
<Device_2027 xmlns="http://www.ce.org/2027" >
  <Manufacturer> manufacturer name string </Manufacturer>
  <ModelNo> model number string </ModelNo>
  <Desc> descriptive term string </Desc>
  <logical_unit>
    <PortNo>port1</PortNo>
    ...
  </logical_unit>
```

```

...
<logical_unit>
<PortNo>portk</PortNo>
...
</logical_unit>
</Device_2027>

```

where:

<Manufacturer> the *manufacturer name string* is the ASCII string for the manufacturer, which shall be no more than 40 characters. Clients may ignore leading and trailing whitespace.

<ModelNo> the *model number string* is the ASCII string that represents the model number, which shall be no more than 40 characters. Clients may ignore leading and trailing whitespace.

<Desc> the *descriptive term string* is an ASCII string that represents the device type description for the physical device that contains the Logical Units. Clients are free to ignore leading and trailing whitespace.

Examples of the above three strings are: “Samsung”, “LTN226W”, “LCD HDTV”.

The *n*th Logical Unit block description shall be defined as:

```

<logical_unit >
  [<Profile>
    <ProfileType>HDTV</ProfileType>
    <Graphicsize>1080|540|720|480 </Graphicsize>
  </Profile> ]
  [<Profile>
    <profileType>Converter</profileType>
    { <SubDevAddrInfo>
      <SubDevName>SubDeviceName</SubDevName>
      <SubDevType>[AVC|other]</SubDevType>
      <SubDevAddr>
        //Media specific sub-device address information
        {<streamType>streamType</streamType>}
      </SubDevAddr>
    }
  ]

```

```

        </SubDevAddrInfo>}
    </Profile> ]
    [<Manufacturer> manufacturer name string </Manufacturer>]
    [<PortNo>portn</PortNo>]
    [<FCPport>fcpportn</FCPport>]
    [<Legacy>Proxy=yes</Legacy>]
    [<Graphics>graphicstypen</Graphics>]
    [<Procedures>proctypen</Procedures>]

    {<SubDevAddrInfo>

        <SubDevName>SubDeviceName</SubDevName>

        <SubDevType>[AVC|other]</SubDevType>

        <SubDevAddr>

            //Media specific sub-device address information//

        </SubDevAddr>

    </SubDevAddrInfo>}

    [<Prefix>prefixtextn</Prefix>]
    <UserName>namen</UserName>
    <UnitName>namen</UnitName>
    <UnitType>typen</UnitType>
    [<Record>yes|no</Record>]
    <CEA931commands> 931 command listing </CEA931commands>
    [<MinWidth>minWidthPixels</MinWidth>]
    [<MaxWidth>maxWidthPixels</MaxWidth>]
    [<MinHeight>minHeightPixels</MinHeight>]
    [<MaxHeight>maxHeightPixels</MaxHeight>]
    </logical_unit >

```

where:

<Profile> **<ProfileType>** identifies the profile of the logical unit. (Two profiles, HDTV and Converter, are currently defined.) If a profile type is not of interest then all of the contents inside the Profile tags should be ignored.

<**ProfileType**> Profile type **HDTV** is identified with the ASCII string “HDTV” to indicate screen size for graphics objects. This profile includes the tag field Graphicsize as defined below.

<**Graphicsize**> This tag is applicable to an HDTV-Profile controller LU and indicates a graphics plane of 1080x1920, 540x960, 720x1280, or 480x640 as the full screen graphics size. The first (or vertical) pixel count is used as the indicator value.

<**ProfileType**> Profile type **Converter** is identified with the ASCII string “Converter”, to indicate that the logical unit complies with the profile as described in Annex A.

<**Manufacturer**> the *manufacturer name string* is the ASCII string for the manufacturer, and shall no more than 40 characters. Clients may ignore leading and trailing whitespace.

<**PortNo**> *port_n* is the port number assigned to the nth Logical Unit (decimal or hexadecimal, using 0x prefix, in ASCII). Clients should copy the port element when building a logical unit address. Unless specified, the Port Number shall default to 80.

<**FCPport**> *fcpport_n* is the port number assigned to the nth Logical Unit (decimal or hexadecimal, using 0x prefix, in ASCII). This port number shall be used to address the logical unit with FCP commands. Unless specified, the FCP Port Number shall default to port_n.

<**Legacy**> The Legacy tagged field is used only for devices that are proxied, whereby their UI is supplied with this logical unit. If this field is not present, the logical unit does not proxy any devices. See Annex A for information on 1394 AV/C legacy and proxy support.

<**Graphics**> *graphicstype_n* is the suffix for the graphics object requested in an Icon command (see 4.7.5). It may be “.jpg”, “.gif”, or “.png”, or may be “”, or the tagged field itself may be omitted. If not specified, *graphicstype* shall default to a value of “”. A server may use this element so that a client’s Icon command requests a naturally named file (e.g. “icon_graphic.jpg” or “icon_graphic.gif”). Clients should copy the appropriate *graphicstype_n* when building an Icon command.

<**Procedures**> *proctype_n* is the suffix for server-defined procedural objects in the commands described in Section 4.7. Depending on the service device implementation, it may be “.cgi”, but may be “” or the tagged field itself may be omitted. If not specified, *proctype* shall have a value of “”. Clients should copy the appropriate *proctype_n* when building a command in Section 4.7.

<**SubDevAddrInfo**> The 2027 File will contain a list of named sub-devices for each logical unit. The media specific formatted information is described in the annexes. Each entry contains the device specific information about each sub-device.