

Web and Home Networks

Third W3C Web & TV Workshop, 19-20 September, 2011, Hollywood, CA, USA
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Abstract

One of the key goals of the Web & TV IG is to identify requirements for the Web to function effectively with TV services on TV devices and TV-like devices. In addition to the premium content offered from the cloud, connected TVs and other CE devices (e.g. game consoles, tablets, etc.) are being targeted to consume in-home premium commercial content (e.g. DVR, broadcast) over the home network from service provider set-top boxes. In order to provide seamless access to cloud content and home network content, service providers are interested in use of web presentation technologies such as HTML5, CSS, JavaScript, etc. The paper presents home networking specifications and technologies, such as DLNA/UPnP, that need to be considered to enable seamless access to home network content using web technologies. Potential collaboration opportunities between W3C and other home networking specification organizations are also identified.

Commercial Content, Home Networks & Web Technologies

Definition of the <video> tag in the W3C HTML5 specification provides an opportunity to commercial content service providers to provide access to content services embedded in HTML5 web pages in a standardized manner. Rich UI pages can be developed using with HTML5 and related technologies such as Cascading Style Sheets (CSS) and JavaScript. Developing UI applications using HTML5 and related technologies is also advantageous in terms of rapid application development and deployment.

However, currently defined capabilities of the HTML5 and related specifications are predominantly designed to address use cases of content delivered from the cloud over the Web. Before migrating to cloud to ground delivery for all of their content services, commercial content service providers would like to utilize their existing content delivery infrastructure to deliver content services to connected devices in the home. This typically involves a termination device (e.g. set-top-box, gateway) that is connected to various CE devices such as connected TVs, game consoles, etc. using a home network. This termination device offers commercial content (DVR, broadcast, etc.) to connected devices over the home network without the need of additional service provider specific termination devices. Interoperability guidelines developed by DLNA (Digital Living Network Alliance) is a predominant technology that is used to enable sharing of commercial content over home networks.

Commercial content service providers would like to utilize HTML5 and related web technologies to offer consistent UI on all of the connected devices in the home to provide access to commercial content that is offered both locally over the home network as well as over the cloud. In order to accomplish this goal, home networking capabilities need to be added in HTML5 and related web technologies. W3C has taken steps towards achieving this with the formation of Home Networking Task Force (HN-TF); however further steps are

needed to ensure that the work of the HN-TF gets integrated into HTML5 and related specifications.

DLNA

Members of Digital Living Network Alliance (DLNA) share a vision of an interoperable network of personal computers (PC), consumer electronics (CE), mobile devices in and beyond the home, enabling a seamless environment for sharing and growing new digital media and content services. Founded in 2003, the group established and maintains a platform of interoperability based on open and established industry standards. More than 200 multi-industry companies from around the world have joined DLNA. DLNA's Promoter Members include: ACCESS, AT&T, AwoX, Broadcom, CableLabs, Cisco, Comcast, DIRECTV, DTS, Dolby Laboratories, Ericsson, HP, Huawei, Intel, LG, Microsoft, Motorola, Nokia, Panasonic, PROMISE Technology, Qualcomm, Samsung, Sharp, Sony, Technicolor and Verizon. Service provider community is well represented in DLNA and is driving new guideline development efforts. A significant number of DLNA companies are also members of W3C: ACCESS, AT&T, CableLabs, Cisco, Comcast, Ericsson, France Telecom, HP, Intel, LG, Microsoft, Motorola, Nokia, Samsung, Sony, Telecom Italia, Toshiba, etc.

DLNA Guidelines

DLNA defines interoperability guidelines based on open and established industry standards. DLNA guidelines outline different device categories, device classes, & usage scenarios for networked homes [1]. A single multi-functional device may fall under multiple device categories and device classes.

Five device classes defined for Home Network Device (HND) category are [2]:

- Digital Media Server (DMS) devices provide media acquisition, management recording, storage, sourcing & distribution capabilities, as well as content protection enforcement as required. e.g. set-top-boxes, Network Attached Storage (NAS) devices, personal computers, etc.
- Digital Media Player (DMP) devices find content exposed by a DMS (or M-DMS) and pulls the selected content from the server to provide playback and rendering capabilities. e.g.: TVs, game consoles, etc.
- Digital Media Renderer (DMR) devices play content received from a DMS (or M-DMS) after being setup by another home network device (i.e. DMC). e.g. TVs, audio/video receivers, video displays and remote speakers, etc.
- Digital Media Controller (DMC) devices find content exposed by a DMS and match it to the rendering capabilities of a DMR, setting up the connections between the DMS and DMR. Example: Intelligent remote control, mobile phone
- Digital Media Printer (DMPr) devices provide printing services to the DLNA home network. Photo printing is the application DLNA prioritized, but other types of content can also be printed from a DMPr.

The Mobile Handheld Device (MHD) category is made up of similar five Device Classes: M-DMS, M-DMP, M-DMC, M-DMD and M-DMU; with M-DMD providing ability to download content from a (M-)DMS and M-DMU providing ability to upload content to a (M-)DMS. MHD device category has different requirements for media formats and network connectivity. See [2] for more details.

DLNA guidelines define various practical usage scenarios that can be enabled using DLNA guidelines. Two predominant usage scenarios are [1]:

- **“Find & Play”**: Using a connected TV in the bedroom locate a recorded episode on a living room STB-DVR and stream it to the bedroom TV.
- **“Find & Play to”**: Use a mobile device (e.g. tablet, phone, etc.) to locate a recorded video episode on a living room STB-DVR and stream it to a bedroom room TV for playback

DLNA guidelines follow layering model where standards are specified for a device at different networking layers. DLNA guidelines define both mandatory and optional standards. Devices are required to support all mandatory standards specified for a specific device class to obtain certification for that device class. UPnP A/V specification [3] is a foundation of DLNA media management and media transport guidelines. HTTP is a mandatory transport protocol and RTP is optional. Distribution of commercial content over the home network is protected using DLNA Link Protection Guidelines that mandate use of Digital Transmission Copy Protection over IP (DTCP-IP) and optionally require Windows Media DRM for Network Devices (WMDRM-ND). For details on key technology components of DLNA Interoperability guidelines see [4]:

Link Protection	DTCP/IP (mandatory) WMDRM-ND (optional)
Media Formats	MPEG-2, MPEG-4, AVC/H.264 LPCM, MP3, AAC LC JPEG, XHTML-Print + Optional formats
Media Transport	HTTP (mandatory) RTP (optional) Quality of Service
Media Management	UPnP A/V 3.0 UPnP Print Enhanced 1.0
Discovery & Control	UPnP Device Architecture 1.0
IP Networking	IPv4 Protocol Suite
Connectivity	Wired: Ethernet 802.3, MoCA Wireless: Wi-Fi 802.11, Wi-Fi Protected Setup

Figure 1: DLNA- Interoperability at all layers

Certification & Logo Program

DLNA not only develops interoperability guidelines, but also has a certification and logo program to validate interoperability between devices that are built to DLNA guidelines. Since September 2005, DLNA has certified more than 11,000 products. In just first quarter of 2011, DLNA certified more than 1,000 models in North America, Europe, Korea and Japan. There are more than 4,000 DLNA certified television models available for consumers [5]. Market research firm, In-Stat, expects that there will be more than 1 billion units of DLNA-certified devices shipping annually by 2014 [6]. After passing certification testing, DLNA CERTIFIED logo can be obtained upon signing a licensing agreement. Since Jan 2011, DLNA has also started Software Certification program where DLNA functionality implemented in software (e.g. a DLNA App) can be certified [7]. For more details on DLNA certification see [8].

Enabling Commercial content

In May 2011, DLNA announced release of new interoperability guidelines for the playback of high-quality, premium commercial video [9]. These guidelines utilize DTCP-IP link protection while streaming premium content over the home network across digital televisions, game consoles, blu-ray players, etc. Content service providers in DLNA were instrumental in development of these guidelines. These guidelines provide a common interface to deliver commercial content to various retail consumer electronics devices from service provider supplied set-top boxes.

tru2Way[®] Home Networking

tru2Way Home Networking is suite of specifications for cable set-top boxes [10] developed by CableLabs[®] to enable sharing of premium content over the home network between cable operator provided set-top boxes and other CE devices in the home. These specifications are based on DLNA Interoperability Guidelines; so they enable seamless interoperability with DLNA devices. Multi-room DVR service offered by leading cable operators in North America are based on this specification [11] [12] [13]. One component of these specifications is home networking APIs for the OpenCable Application Platform (OCAP) to discover and control devices and content over the home network. Even though underlying protocol specification is based on UPnP/DLNA, the APIs are designed to be generic so that they can be used with any underlying home networking protocol.

W3C & Home Networking

Commercial content service providers are interested in utilizing HTML5 and related technologies to provide consistent UI on various retail consumer devices that can provide seamless access to their rich library of content located either in the cloud or in the home. Consumers would like to utilize the same UI to realize “Play To” types of scenarios described earlier; where content selection is performed on one device (e.g. mobile phone, tablet, etc.), but actual content streaming happens on another device in the home (e.g. Television). In order to support such scenarios using HTML5 based UI in a standardized manner home network specific APIs need to be added in W3C specifications. Enabling home networking using web-based technologies seems to be one of the key requirements for the web to function effectively with TV services and TV-like devices, which is one of the key goals of Web & TV IG. W3C has formed Home Networking TF to define discovery and control APIs for home network devices and content. However, additional steps seem to be

necessary to provide support for DLNA streaming, different media formats & associated TV services, copy protection/DRM, etc. to realize home networking scenarios of interest for commercial content providers and consumers. Four Last Call bugs have already been submitted for the HTML5 specifications to address some of this functionality [14][15][16][17].

W3C & DLNA: Opportunities

As mentioned earlier, W3C has formed HN-TF to define device and services discovery & control APIs. DLNA and W3C specifications seem to be complementary to each other and closer co-operation between the two organizations is likely to benefit the industry and such collaboration certainly seems beneficial to the interests and goals of Web & TV IG. Commercial service provider community from all over the world is well represented in DLNA and is shaping the guideline development efforts within DLNA [9]. DLNA defines interoperability guidelines for different classes of devices that are based on specifications defined by external organizations at all layers. W3C defines specifications predominantly at the presentation layer. A potential liaison agreement between DLNA and W3C to define APIs that address DLNA usage scenarios would be beneficial to the goals of the Web & TV IG.

Use of web technologies in the CE devices is fundamentally different than use of web technologies on PC browsers in terms of resource availability, software/firmware upgradeability, hardware model, etc. and has its own sets of challenges. Ensuring application to platform interoperability as well as device to device interoperability seems to be important for consumer electronic devices. W3C can take advantage of these complementary functions provided by DLNA to ensure effective adoption of Web technologies in CE devices. DLNA can potentially define interoperability guidelines for web technologies that are targeted specifically for CE devices. DLNA organizes plugfest for pre-production devices and also offers comprehensive certification program to ensure interoperability. Logo program offered by DLNA can be leveraged to help consumers choose appropriate devices in the marketplace. W3C and DLNA have recently established a “simple” liaison agreement between the two organizations [18] and further collaboration would benefit the industry.

Summary & Conclusion

Commercial content service providers have a need to offer premium content in the cloud as well as in the home to ever expanding CE devices purchased by their customers in the home. They are interested in use of HTML5 and related web technologies to provide a consistent UI to provide seamless access to both cloud content as well as in-home premium content. Consumers are interested in the flexibility and convenience offered by “Play To” scenarios where content selection happens on one device and the actual playback or rendering happens on another device over the home network. Web & TV interest group needs to address such home networking scenarios to in order to meet one of the key goals of making Web work effectively with TV services on TV & TV-like devices. DLNA offers complimentary functions to W3C such as defining interoperability guidelines for different device classes, certification & logo program, etc. Commercial service providers are participating actively in DLNA. Potential collaboration between W3C and DLNA would be beneficial to the industry.

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