



BSI Standards Publication

Digital living network alliance (DLNA) home networked device interoperability guidelines

Part 1-1: Architecture and protocols – Core architecture and protocols

National foreword

This British Standard is the UK implementation of IEC 62481-1-1:2017. It supersedes BS EN 62481-1:2014, which is withdrawn.

This standard has not been adopted by CENELEC as the standard series has been agreed as exempt from parallel procedure. Therefore, BS EN 62481-1:2014 has been withdrawn to allow for the publication of BS IEC 62481-1-1:2017.

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**Digital living network alliance (DLNA) home networked device interoperability
guidelines –
Part 1-1: Architecture and protocols – Core architecture and protocols**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**DIGITAL LIVING NETWORK ALLIANCE (DLNA) HOME
NETWORKED DEVICE INTEROPERABILITY GUIDELINES –****Part 1-1: Architecture and protocols –
Core architecture and protocols****FOREWORD**

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International Standard IEC 62481-1-1 has been prepared under technical area 8: Multimedia home systems and applications for end-user network, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

This third edition cancels and replaces IEC 62481-1 published in 2013 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) removal of Bluetooth, printers (DMP_r, +PR1+ and +PR2+), Mobile Digital Media Uploader (M-DMU), Mobile Digital Media Downloader (M-DMD), Mobile Network Connectivity Function (M NCF) and Media Interoperability Unit (MIU);
- b) removal of CEA2014 guidelines (RUISRC, RUISINK, RUICTRL, RUIPL);
- c) addition of IPv6;
- d) heading levels adjusted to be no deeper than heading level 5.

The text of this standard is based on the following documents:

CDV	Report on voting
100/2730/CDV	100/2880/RVC

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 62481 series, published under the general title *Digital living network alliance (DLNA) home networked device interoperability guidelines*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Overview

Consumers are acquiring, viewing, and managing an increasing amount of digital media (photos, music, and video) on devices in the consumer electronics (CE), mobile device, and personal computer (PC) domains. Consumers want to conveniently enjoy that content, regardless of the source, across different devices and locations in their homes. The digital home vision integrates the Internet, mobile, and broadcast networks through a seamless, interoperable network, which will provide a unique opportunity for manufacturers and consumers alike. In order to deliver on this vision, it was recognized that a common set of industry design guidelines would be required to allow companies to participate in a growing marketplace, leading to more innovation, simplicity, and value for consumers.

The Digital Living Network Alliance answered this challenge by taking the initiative to develop a workable framework for interoperable product design. The DLNA Home Networked Device interoperability guidelines have been created in a unique cross-industry effort that combined the efforts of over 100 consumer electronics, PC-industry and mobile device companies from around the world that worked together with the aim of achieving the world's first substantial platform for true interoperability between personal computer and consumer electronic devices. The interoperability guidelines provide product developers with a long-term architectural view, plus specific guidance for IP-networked platforms, devices and applications in the home. The interoperability guidelines will be introduced in phases over several years to accompany the market adoption of usages and the availability of needed technology and standards.

The interoperability guidelines that are the object of this document are based on an architecture (see Clause 4) that defines interoperable components for devices and software infrastructure. It covers physical media, network transports, device discovery and control, media management and control, media formats, media transport protocols, and remote user interfaces. Table 1 shows a summary of the key functional components and technology ingredients that are covered by these interoperability guidelines.

Table 1 – Key technology ingredients

Functional components	Technology ingredients
Connectivity	Ethernet, IEEE 802.11 (including Wi-Fi Direct), MoCA, HD-PLC, HomePlug-AV, and HPNA
Networking	IPv4 suite, IPv6 suite
Device discovery and control	UPnP device architecture
Media management and control	UPnP AV, EnergyManagement, DeviceManagement
Media formats	Required and optional format profiles
Media transport	HTTP (mandatory), HTTP adaptive delivery (DASH) and RTP
Remote User Interfaces	HTML5, RVU
Device profiles	CVP-2

The protocols defined in this standard are based on the DLNA interoperability guidelines version 4.0. Device implementations advertise adherence to the protocols selecting value 4.0 in the fields and flags designed to expose the DLNA protocol version.

The interoperability guidelines are intended for the following audiences:

- marketing professionals who specify requirements for home networked media products;
- developers who design and build home networked media products;
- quality assurance personnel who test and validate home networked media products.

DIGITAL LIVING NETWORK ALLIANCE (DLNA) HOME NETWORKED DEVICE INTEROPERABILITY GUIDELINES –

Part 1-1: Architecture and protocols – Core architecture and protocols

1 Scope

This part of IEC 62481-1, the DLNA guidelines series, specifies the core architecture and protocols of DLNA implementations.

The interoperability guidelines consist of five parts covering Architecture and Protocols, Media Formats, Link Protection, DRM Interoperability Systems and Device Profiles. This part of the DLNA guidelines provides vendors with the information needed to build interoperable networked platforms and devices for the digital home. The necessary standards and technologies are now available to enable products to be built for networked entertainment-centric usages. However, standards and technologies need to be clarified and options limited to ensure interoperability. The five parts of the DLNA Home Networked Device interoperability guidelines fulfill that role.

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¹ In this document, it is also referred to as AVv1.

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3 Terms, definitions, symbols, abbreviated terms and conventions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Terms and definitions

3.1.1

ADU

Application Data Unit

unit as used for the RTP Media Transport

Note 1 to entry: The definition of an ADU is different for each media stream. For audio media streams, an ADU is typically an audio frame. For video media streams, an ADU is typically a "slice" (e.g. an NAL unit) or in some cases a complete video picture. Also, as a special case when MPEG-2 TS encapsulation is used, each TS packet is an ADU

3.1.2

ACK

Acknowledge

term typically used to describe an action following a network packet being successfully received

3.1.3

AP

Access Point

specially configured Network Infrastructure Device on a wireless local area network (WLAN) that acts as a central transmitter and receiver of WLAN radio signals

Note 1 to entry: APs used in home networks are generally small, dedicated hardware devices featuring a built-in network adapter, antenna, and radio transmitter. These APs support Wi-Fi wireless communication standards

3.1.4

ARP

Address Resolution Protocol

protocol in the TCP/IP family that resolves an IPv4 address to a hardware address, such as an Ethernet address

3.1.5

ATSC

Advanced Television Systems Committee

one of the standard bodies for digital television broadcasting

3.1.6**AV****Audio with Video**

media content that contains both moving picture and sound

3.1.7**AVP****Audio/Visual Profile**

profile as used for the RTP Media Transport

3.1.8**AVPF****Extended Audio/Visual Profile for RTCP-based Feedback**

profile as used for the RTP Media Transport

3.1.9**AVT****AVTransport Service**

UPnP service that provides network-based control for common transport operations such as Play, Stop, Pause, Next, Previous, and Seek

Note 1 to entry: The AVTransport Service specification is a standard UPnP DCP.

3.1.10**Background Transfer**

media transfer mode where the target content binary is transferred at any rate up to the maximum achievable rate for the communication channel and the two communicating parties

Note 1 to entry: This mode is typically used for example when downloading or uploading content.

3.1.11**Basic Tuner**

minimal DLNA tuner implementation based on ISO/IEC 29341-20-12:2016.

3.1.12**BE****Best-Effort User Priority**

priority-based QoS level for Best-Effort User Priority

3.1.13**Bearer**

physical and link-level network transport, such as IEEE 802.11

3.1.14**BK****Background User Priority**

priority-based QoS level for Background User Priority

3.1.15**Byte-based Seek Operations**

identify the rendering endpoint request and the content source response that allows the former to obtain a segment of the content for playback, where such a segment is specified in units of bytes

3.1.16**Cacheable Content**

content binaries whose binary representations remain static over time and are considered cacheable content

Note 1 to entry: By default HTTP allows intermediate HTTP caches to store such items and respond to similar HTTP requests as a means to accelerate the interaction with the user.

Note 2 to entry: In these interoperability guidelines cacheable content includes (but it is not limited to)

- Image, Audio, AV content that exists as stored files,
- content resulting from transcoding or encoding operations when the output binaries can be preserved over time.

3.1.17

CDB

Coded Data Buffer

buffer space that is used to store compressed data before decoding, used for the RTP Media Transport

3.1.18

CDS

ContentDirectory Service

UPnP service that provides network-based discovery of content

Note 1 to entry: The ContentDirectory Service specification is a standard UPnP DCP

3.1.19

CE

Consumer Electronics

class of devices used in the home, such as DVDs, DVRs, PVRs, PDAs, TVs, set-top boxes, cellular phones

3.1.20

Channel

one or more media streams that, together, constitute a unique entity for the purpose of announcement, selection, and rendering

Note 1 to entry: For example, for digital television sources, a Channel is equivalent to an ATSC "virtual channel", a DVB "service", or an MPEG-2 "Program". For digital radio sources, a Channel is equivalent to a single "station".

3.1.21

Channel Lineup Container

available tuner channels exposed in a CDS container for an Extended Tuner

Note 1 to entry: The content may or may not be streamed over the network.

3.1.22

Channelized Content

content that is available via a particular distribution channel such as a tuner and that is available on that channel according to a schedule

3.1.23

CMS

Connection Manager Service

UPnP service that provides information about the supported transport protocols and media formats of a UPnP device

Note 1 to entry: The ConnectionManager Service specification is a standard UPnP DCP.

3.1.24

CNAME

Canonical Name

name used for the RTP Media Transport

3.1.25

Content

aggregation of one or more works

**3.1.26
Comply
Conform**

to be in accordance with referenced requirements; where the reference includes both mandatory and optional requirements, only the mandatory elements are considered necessary for compliance, optional requirements continue to be optional

Note 1 to entry: Any variation from these expectations shall be specifically noted.

Note 2 to entry: "Comply with" can be used interchangeably with "conform to" (includes variations of complies, complying, compliant, compliance, conforms, conforming, conformant, conformance)

**3.1.27
Content Binary**

binary representation of content for the purpose of storage or transfer over communication links

**3.1.28
Content Transformation**

transcoding, transrating, or scaling of a content binary

**3.1.29
Content Source**

endpoint that places content onto the network for transfer to another endpoint

**3.1.30
Content Receiver**

endpoint that consumes content received via a network transfer from another endpoint

**3.1.31
Controller-byte Seek Operations**

identifies the Control Point request and the UPnP AV MediaRenderer response that allows the former to specify a segment of the content to be rendered by the latter, where such a segment is specified in units of bytes

**3.1.32
Controller-time Seek Operations**

identifies the Control Point request and the UPnP AV MediaRenderer response that allows the former to specify a segment of the content to be rendered by the latter, where such a segment is specified in units of time

**3.1.33
Converted Content**

content that is either transcoded, transcribed, remuxed, or transformed in any other way

**3.1.34
CP
UPnP Control Point**

generic reference to any UPnP Control Point

**3.1.35
CSRC
Contributing Source**

source used for the RTP Media Transport

**3.1.36
CSS
Cascading Style Sheets**

format defined by W3C to add style information to documents

3.1.37

DA

Device Architecture 1.0

UPnP Device Architecture version 1.0 document

3.1.38

DCP

Device Control Protocol

specification that is standardized by the UPnP Forum. Related specifications produced by a UPnP working committee are often identified by the working committee name. For example, UPnP AV 1 DCP

3.1.39

DDC

Device Discovery and Control

subclause heading in the interoperability guidelines that defines the underlying interoperability architecture for the discovery and control devices

3.1.40

Decoder Friendly Point

point in the stream where the decoder can begin to process data without any other internal state information about the stream

Note 1 to entry: The decoder can begin processing at that point and create a valid output rendering.

3.1.41

Device Capability

set of Device Functions (at least 1) aggregated to support a system usage

Note 1 to entry: A Device Capability cannot stand alone, and shall be deployed in conjunction with an implementation of a valid DLNA Device Class. Since a Device Capability does not stand alone, it is not required to have components in all layers of the DLNA architecture. A Device Capability can have a one to one correspondence to a Device Function. A Device Capability is a certifiable entity only when it is implemented as an addition to at least one Device Class.

3.1.42

Device Category

group of Device Classes with the same environmental characteristics and sharing common system usages that are enabling home networking use case scenarios

Note 1 to entry: Examples of device categories used within this standard (IEC 62481-1-1) are HND (Home Network Device), and MHD (Mobile Handheld Device).

Note 2 to entry: While Device Classes are grouped within a Device Category, a single physical device can support Device Classes that fall into multiple Device Categories.

3.1.43

Device Class

set of Device Functions

Note 1 to entry: A Device Class specifies the features supported on a device regardless of its physical attributes.

Note 2 to entry: Examples used within this standard (IEC 62481-1-1) are DMS (Digital Media Server) and DMP (Digital Media Player).

Note 3 to entry: A single device can support multiple Device Classes. A DLNA device shall support at least one Device Class and can support one or more Device Capabilities.

Note 4 to entry: A Device Class is the certifiable entity in DLNA.

3.1.44

Device Function

non-decomposable operational property

EXAMPLE IP Connectivity

Note 1 to entry: Device Functions should be supported by existing standards.

3.1.45

Device Option

optional extensibility to existing DLNA architecture

Note 1 to entry: A Device Option can add optional extensibility to an existing Device Function or add new optional Device Function to the DLNA architecture

3.1.46

Device Type

device defined by its realization and its usage models

EXAMPLES DVD players, TVs, DVRs, Mobile Phones, Cameras, Picture Frames, etc.

Note 1 to entry: Device Types are primarily used for marketing descriptions, and they should not be used in guideline definitions.

DHCPv4

Dynamic Host Configuration Protocol for IPv4

protocol to automatically provide IPv4 addresses and other network configuration information to network nodes

3.1.47

DIDL

Digital Item Declaration Language

XML schema for representing the metadata of digital content

3.1.48

DIDL-Lite

Digital Item Declaration Language – Lite

XML schema used by the UPnP Forum for representing the metadata of digital content. The XML schema uses a subset of the DIDL schema with additional metadata properties defined by the UPnP Forum

3.1.49

DLNA

Digital Living Network Alliance

organization that created these guidelines

3.1.50

DLNA Recognized Rating Authorities

authorities referenced and recognized by DNLA

Note 1 to entry: DLNA recognizes certain rating authorities and their associated rating codes.

Note 2 to entry: These Rating Authorities and their codes are listed in Annex J.

3.1.51

DLNAQOS

DLNA defined QoS model used in this standard (IEC 62481-1-1)

3.1.52

DLNAQOS_UP

DLNA QoS User Priority

DLNA-defined QoS label used to correlate an underlying IEEE 802.1Q User Priority and WMM Access Category, HomePlug AV Channel Access Priority, or HD-PLC Priority to a DLNA Traffic Type(s)

3.1.53

DMC

Digital Media Controller

DLNA Device Class having home network environmental characteristics, with the role of finding content exposed by a DMS or M-DMS and matching it to the rendering capacities of a DMR and setting up the connections between the DMS and the DMR

3.1.54

DMP

Digital Media Player

DLNA Device Class having home network environmental characteristics, with the role of finding content exposed by a DMS or M-DMS and rendering the content locally

3.1.55

DMR

Digital Media Renderer

DLNA Device Class having home network environmental characteristics, with the role of rendering content it receives after being setup by another network entity

3.1.56

DMS

Digital Media Server

DLNA Device Class having home network environmental characteristics, with the role of exposing and distributing content throughout the home

3.1.57

DNS

Domain Name System

protocol that enables hierarchical names for Internet domains and addresses

Note 1 to entry: The protocol includes the means to translate between numerical IP addresses and text host names

3.1.58

DSCP

Differentiated Services (DiffServ) Code Point

QoS field, defined by the DiffServ discipline IETF RFC 2326:1998, found in the layer 3 header of IP packets

3.1.59

EPG Item

CDS item that describes a piece of content that usually does not reside on the local server

Note 1 to entry: It refers to a broadcast item that is available through a tuner, or it can be content accessible via a URL.

Note 2 to entry: In general there is a time associated with an EPG item that describes the broadcast time and duration of the content or the time period in which it is available for on demand retrieval via an URL. Items described by an EPG item can be recorded with the SRS service and can then actually reside on a local server.

3.1.60

ES

Elementary Stream

general term for a coded video, coded audio or other coded bitstream

3.1.61

Exposed

content that is listed by a UPnP AV ContentDirectory Service (CDS)

Note 1 to entry: Content does not necessarily exist at the time that it is exposed (for example, needs transcoding or conversion).

3.1.62**Extended Tuner**

DLNA tuner implementation based upon the TUNER Feature defined in ISO/IEC 29341-4-12:2008 and higher specifications

3.1.63**Full TS**

piece-wise constant rate MPEG-2 Transport Stream that is fully compliant with ISO/IEC 13818-1:2000, 2.4.2.2

Note 1 to entry: A Full TS is characterized by a consistent temporal relationship (or "even spacing") between any two adjacent TS Packets.

3.1.64**GOP****Group Of Pictures**

group of successive pictures within a coded video stream and the associated structure (GOP structure) that specifies the order in which intra- and inter-frames are arranged in MPEG

3.1.65**HD Capable Device**

DLNA Device Class that is certified for a DLNA AV Media Format Profile that has an HD video component

Note 1 to entry: For example, an AV Media Format Profile with a resolution greater than or equal to 1 280 p × 720 p.

3.1.66**HDTV****High Definition Television**

higher quality display, with a vertical resolution display from 720p to 1080i and higher and an aspect ratio (the width to height ratio of the screen) of 16:9, for a viewing experience similar to watching a movie

3.1.67**HND****Home Network Device**

Device Category that groups together all the applicable DLNA Device Classes with home network environmental characteristics (requirements)

Note 1 to entry: Device Classes in this Device Category are: DMS, DMP, DMR and DMC

3.1.68**HTTP****Hyper Text Transfer Protocol**

protocol for transferring files across the Internet

Note 1 to entry: Requires an HTTP client program on one end, and an HTTP server program on the other end

3.1.69**ICMP****Internet Control Message Protocol**

protocol in the TCP/IP family that is used for out-of-band messages related to network operation

3.1.70**Ideal Network Conditions**

network state used only for testing and validation of guideline compliance

Note 1 to entry: The effective network capacity shall be substantially greater than the aggregate bandwidth of the content under test, and there are no additional devices competing for available network resources at the time of test.

3.1.71

IGD

Internet Gateway Device

multifunction Network Infrastructure Device that routes and/or bridges global internet with the local area network

3.1.72

Instance State Variable

state variable defined by AVTransport and RenderingControl services

Note 1 to entry: Instance State Variables are state variables associated with a virtual instance of a service. Both services use an evented state variable by the name of LastChange, to report a value change of an instance state variable.

3.1.73

Interactive Transfer

media transfer mode where the target content binary is transferred at the maximum achievable rate for the communication channel and the two communicating parties

Note 1 to entry: This mode is typically used when sending images for immediate display.

3.1.74

IPv4

Internet Protocol version 4

OSI network layer 3 protocol

3.1.75

IPv6

Internet Protocol Version 6

OSI network layer 3 protocol intended to replace IPv4

Note 1 to entry: In the DLNA architecture IPv4 and IPv6 are mandatory, with preference given to IPv4. They will run in a dual stack model.

3.1.76

JPEG

Joint Photographic Experts Group

coding standard for compression of still images (pictures)

3.1.77

LAN

Local Area Network

closely administered network segments such as within the home or office

3.1.78

Link-level Bearer

restricts the bearer concept to include only the physical layer and link-layers as described for the ISO's OSI model

3.1.79

Link Protection

protection of a content stream between two devices on a DLNA network from illegitimate observation or interception

3.1.80

LPCM

Linear Pulse Code Modulation

uncompressed audio encoding

3.1.81**M-DMC****Mobile Digital Media Controller**

DLNA Device Class having mobile handheld environmental characteristics, with the role of finding content exposed by a DMS or M-DMS and matching it to the rendering capacities of a DMR and setting up the connections between the DMS or M-DMS and the DMR

3.1.82**M-DMP****Mobile Digital Media Player**

DLNA Device Class having mobile handheld environmental characteristics, with the role of finding content exposed by DMS or M-DMS and rendering the content locally

3.1.83**M-DMS****Mobile Digital Media Server**

DLNA Device Class having mobile handheld environmental characteristics, with the role of exposing and distributing content throughout the home

3.1.84**Media Class**

type of media a Device Type or Device Class supports

Note 1 to entry: The Media Classes used in this standard are **Image**, **Audio** only, and Video with Audio (**AV**).

3.1.85**Media Collection File**

content binary whose purpose is to reference other content binaries usually for sequenced playback

Note 1 to entry: Media collection files are often used for audio or AV playlists or image slideshows.

3.1.86**Media Format**

format type for content of a Media Class that is exposed by a UPnP AV MediaServer contained in a device that acts as a DMS

Note 1 to entry: Examples for the Media Classes are: Image – JPEG; Audio – LPCM; AV – MPEG-2.

3.1.87**Media Stream**

single elementary stream or MPEG-2 TS or MPEG-2 PS multiplex

Note 1 to entry: This definition applies to Media Stream as used for the RTP Media Transport.

3.1.88**Media Transfer Mode**

type of transfer used to deliver content from a Content Source to a Content Receiver

Note 1 to entry: There are three types of DLNA media transfer modes: Streaming Transfer, Interactive Transfer, and Background Transfer.

3.1.89**MF****Media Formats**

collection of Media Format Profiles defined in IEC 62481-2:2017

3.1.90

MHD

Mobile Handheld Device

Device Category that groups together all the applicable DLNA Device Classes with mobile handheld environmental characteristics (requirements). Device Classes in this Device Category are: M-DMS, M-DMP and M-DMC.

3.1.91

MIME

Multipurpose Internet Mail Extension

standard system for identifying the type of data contained in a file. MIME is an Internet protocol that allows sending binary files across the Internet as attachments to e mail messages. This includes graphics, photos, sound, video files, and formatted text documents.

3.1.92

MM

Media Management

subclause heading in the interoperability guidelines

3.1.93

MPEG

Moving Picture Experts Group

organization for the development of standards related to audiovisual information

3.1.94

MRCP

MediaRenderer Control Point

UPnP control point that issues actions to an MRD

3.1.95

MRD

MediaRenderer Device (also known as MediaRenderer)

UPnP device that provides network-based control for the rendering of content

Note 1 to entry: Minimally, a MediaRenderer will have a RenderingControl Service and a ConnectionManager service. The MediaRenderer specification is a standard UPnP DCP

3.1.96

MSCP

MediaServer Control Point

UPnP AV control point that issues actions to an MSD

3.1.97

MSD

MediaServer Device

MediaServer

UPnP device that provides network-based discovery of content

Note 1 to entry: Minimally, a MediaServer will have a ConnectionManager Service and a ContentDirectory Service. The MediaServer specification is a standard UPnP DCP.

3.1.98

MT

Media Transport

subclause heading in the interoperability guidelines

3.1.99

Native Device

<server> device that creates a virtual server and adds functionality to an existing server in the network

Note 1 to entry: The existing server in the network is known as the Native Server.

Note 2 to entry: Either a Native Server or Native Renderer is known as a Native Device. These Native Devices are in contrast to a Virtual Server or Renderer (see 3.1.154 and 3.1.155).

3.1.100

Native Device

<renderer> device that creates a virtual renderer and adds functionality to an existing renderer in the network

Note 1 to entry: The existing renderer in the network is known as the Native Renderer.

Note 2 to entry: Either a Native Server or Native Renderer is known as a Native Device. These Native Devices are in contrast to a Virtual Server or Renderer (see 3.1.154 and 3.1.155).

3.1.101

NC

Networking and connectivity

subclause heading in the interoperability guidelines

3.1.102

Network De-Jitter Buffer

Buffer space that is used to store data for de-jittering and de-interleaving, including RTP header and payload

Note 1 to entry: This definition applies to Network De-Jitter Buffer as used for the RTP Media Transport.

3.1.103

NID

Network Infrastructure Device

devices that provide supporting functionality in the home network such as access points, bridges, Internet gateways, routers, and switches

Note 1 to entry: These devices facilitate a good user experience with DLNA devices but are only covered at this time in this document by informative recommendations in Annex A.

3.1.104

Non-Cacheable Content

content binaries whose binary representations are valid only for one particular transaction at a particular instant of time

Note 1 to entry: Intermediate HTTP caches need directives to prevent the default caching of such content. In the IEC 62481 series of standards, the non-cacheable content includes (but it is not limited to):

- live TV streams;
- content resulting from transcoding or encoding operations when the output binaries have been optimized for a particular transaction (e.g. encoding to match the channel conditions for a given transaction).

3.1.105

Non-Streamable Channel Object

non-streamable CDS objects (i.e. no <res> property value) which represent a single channel of a broadcast source that presents content in a “channelized” format

Note 1 to entry: Since these CDS items are not streamable, a <res> property value is not needed. But having a <res> property without a URI value can be useful by UPnP AV MediaServer control points in determining the DLNA Media Format Profile for the Non-Streamable Channel Object by examining the res@protocolInfo property's DLNA.ORG_PN value in the fourth field.

3.1.106

NTSC*

National Television Systems Committee

standard for broadcast and reception of analogue television signals

3.1.107

Open-end Recording

recording which the scheduled duration is not specified for

Note 1 to entry: The duration of an open-end recording is determined by the UPnP AV MediaServer.

3.1.108

OSI

Open Systems Interconnection

networking stack model (7 layers)

3.1.109

PAL*

Phase Alternating Line

standard for broadcast and reception of analogue television signals

3.1.110

Partial SPTS

partial MPEG-2 Transport Stream which is also a Single Programme Transport Stream (SPTS)

3.1.111

PCR

Programme Clock Reference

refer to MPEG-2 standard ISO/IEC 13818-1:2000

3.1.112

PNG

Portable Network Graphics

coding standard for compression of still images (pictures)

3.1.113

Post-decoder Buffer

buffer space used to store decompressed data before rendering

Note 1 to entry: This definition applies to Post-decoder Buffer as used for the RTP Media Transport.

3.1.114

Power Save Operation

support for intermediate power consumption states between zero (power OFF) to nominal power consumption during active use of a device

3.1.115

Pre-decoder Buffer

hypothetical reference decoder buffer that is used to contain a media (audio/video) stream after it has arrived from the network and before it is decoded into a renderable frame

Note 1 to entry: This definition applies to Pre-decoder Buffer as used for the RTP Media Transport.

3.1.116

Primary ProtocolInfo Set

first, second, and third fields of protocolInfo plus the additional DLNA.ORG_PN value that appears in the fourth field

Note 1 to entry: In other words, the primary set defines a transport method (first value), a mime type (third value), and a DLNA Media Format Profile.

3.1.117

PS

Programme Stream

usually in reference to an MPEG-2 AV stream format

3.1.118**QoS****Quality of Service**

service that provides guarantees on the ability of a network to deliver predictable results

3.1.119**RCS****Rendering Control Service**

UPnP service that provides network-based control for the adjustment of rendering attributes such as volume, brightness, contrast, and mute

Note 1 to entry: The RenderingControl Service specification is a standard UPnP DCP.

3.1.120**Receiver Buffer**

total buffer space used to store data received from the server before the decoding

Note 1 to entry: This definition applies to Receiver Buffer as used for the RTP Media Transport.

3.1.121**Receiving Endpoint**

defined specifically through guideline 11.4.4.5, which requires an RTP client and an RTSP client

3.1.122**Rendering Endpoint**

Content Receiver devices with the capability of rendering the content they receive

Note 1 to entry: These devices could play the content at the time of the transfer, right after the transfer has finished, or at a later time after the transfer has finished.

Note 2 to entry: For the purposes of this standard, devices in the following Device Classes constitute the only known Rendering Endpoints: DMP, DMR, M-DMP.

3.1.123**Remote UI**

user interface provided by an application on a server device, that can be rendered by one or more client devices

3.1.124**RTP****Real Time Protocol**

media transport that provides end-to-end network transport functions for transmitting real-time data, such as AV, and provides services such as payload type identification, sequence numbering, time-stamping, and delivery monitoring

3.1.125**RTP Media Transport**

mechanism for real-time media streams between DLNA device classes and capabilities

Note 1 to entry: This transport mechanism uses RTP, RTCP, RTSP, SDP protocols, and RTP payload formats with their associated media profiles.

3.1.126**RTP Session**

one or more RTP Streams that are transmitted to the same destination IP address and UDP port

Note 1 to entry: Typically, there is a one-to-one mapping between RTP Streams and RTP Sessions, but it is possible for multiple RTP Streams to use the same RTP Session (port multiplexing). Note that associated RTCP traffic is also part of that RTP Session although the packets are sent to the next higher UDP port number.

3.1.127

RTP Stream

Media Stream that is encapsulated in RTP

Note 1 to entry: All of the RTP packets have the same SSRC and are transmitted on the same RTP Session.

3.1.128

RTSP Session

complete RTSP "transaction", for example the viewing of a movie

Note 1 to entry: A session typically consists of a client creating one or more RTP Sessions (SETUP), starting the stream with PLAY or RECORD, and closing the RTSP Session with TEARDOWN. RTSP Sessions are identified using the RTSP "Session" header.

3.1.129

RUI

Remote User Interface

user interface provided by an application on a server device, that can be rendered by one or more client devices

3.1.130

Scaling

changing the visual extent of an image or video portion of an AV media stream

3.1.131

SCPD

Service Control Protocol Description

XML-encoded file describing a UPnP service

Note 1 to entry: This is also known as a service description file.

3.1.132

SEI

Supplemental Enhancement Information

message format carried in the 3D media content to inform decoders about any special attributes of the compressed video

3.1.133

Serving Endpoint

defined specifically through guideline 11.4.4.4, which includes the RTP server and RTSP server

3.1.134

SOAP

Simple Object Access Protocol

XML-based messaging protocol used to exchange service requests and responses over a network

3.1.135

SSDP

Simple Service Discovery Protocol

UPnP device discovery protocol

3.1.136

Streamable Channel Object

Non-Streamable Channel Object with one or more <res> properties containing valid URI values for an Extended Turner

Note 1 to entry: This enables content for a tuner channel to be streamed over the network.

3.1.137**Streaming Transfer**

Audio and AV streams in which the packets are transferred minimally at a rate sufficient for real-time rendering

Note 1 to entry: This definition does not imply that the receiving endpoint will always render content exchanged using Streaming Transfer (e.g. it might store the content).

3.1.138**System Usage**

device interaction model between Device Classes and/or Device Capabilities

Note 1 to entry: System usages are derived when enabling home networking use case scenarios.

3.1.139**TCP****Transmission Control Protocol**

protocol in the TCP/IP family used for the reliable exchange of data over a network

3.1.140**Test Conditions**

conditions that imply that all of the following are satisfied:

- there is only 1 Content Receiver and only 1 Content Source;
- there is only 1 active connection at any given time;
- both devices (Content Receiver and Content Source) are configured by vendors before testing begins to have sufficient resources to successfully complete the stated test requirements;
- devices interact with each other under Ideal Network Conditions

3.1.141**Thrashing**

situation occurring in a synchronization system that consists of a server and multiple clients

Note 1 to entry: Thrashing is a deadlocked system state where the clients are changing items on the server multiple times in the same way without user intervention. For example, in a system with a server (S) containing a single item (I) and two clients (A and B), if client A makes a change to I and that change causes client B to change I, thrashing can occur if A and B now continue to make the same changes that they had previously made to item I without user intervention or authorization. Because the change from A generates the automatic change from B which generates a repeat of the change from A, the system is deadlocked.

3.1.142**Time-based Seek Operations**

operations identifying the Rendering Endpoint request and the Content Source response that allows the former to obtain a segment of the content for playback, where such a segment is specified in units of time

3.1.143**Transcoding**

changing of the coding system used for a content binary

3.1.144**Transrating**

changing of the rate or compression parameters used within the coding system for a content binary

3.1.145**TS****Transport Stream**

usually in reference to an MPEG-2 AV stream format

3.1.146

TTS

Timestamped Transport Stream

Transport Stream which is composed of a timestamped TS packet

Note 1 to entry: The timestamped TS packet is a 192-byte packet consisting of a 188-byte ISO MPEG-2 TS packet plus a 4-byte timestamp in advance of the TS packet.

3.1.147

UDP

User Datagram Protocol

protocol in the TCP/IP family used for the unreliable exchange of data over a network

3.1.148

UP

User Priority

3-bit field of the QoS Control field in the WMM Specification and a Tag control information field in the VLAN tag header of IEEE 802.1Q:2003 that defines the relative priority of a packet

3.1.149

UHD Capable Device

DLNA Device Class that is certified for a DLNA AV Media Format Profile that has an UHD video component

Note 1 to entry: For example an AV Media Format Profile with a resolution greater than 1920 p × 1080 p.

3.1.150

UPnP

architecture for pervasive peer-to-peer network connectivity of devices of all form factors

Note 1 to entry: It is designed to bring easy-to-use, flexible, standards-based connectivity to ad-hoc or unmanaged networks whether in the home, in a small business, public spaces, or attached to the Internet. It is a distributed, open networking architecture that leverages TCP/IP and Web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices in the home, office, and public spaces.

3.1.151

URI

Uniform Resource Identifier

W3C's codification of the name and address syntax of present and future objects on the Internet

Note 1 to entry: In its most basic form, a URI consists of a scheme name (such as file, http, ftp, news, mailto, gopher) followed by a colon, followed by a path whose nature is determined by the scheme that precedes it. URI is the umbrella term for URNs, URLs, and all other Uniform Resource Identifiers.

3.1.152

VI

Video User Priority

priority-based QoS level for Video User Priority

3.1.153

Virtual Instance

mechanism by which a UPnP device can have multiple instances of the same UPnP service

Note 1 to entry: Control points that interact with the AVTransport and RenderingControl services shall interact with a virtual instance of the service. Each virtual instance is identified by a non-negative InstanceID value.

3.1.154

Virtual Renderer

DMR that accepts content and sends it to another DMR within the network for rendering

Note 1 to entry: A Virtual Renderer accepts a wider range of content types, formats, rates, or sizes than the Native Device.

3.1.155

Virtual Server

DMS or M-DMS which exposes content existing on another DMS or M-DMS, possibly containing additional media types, through content transformation

3.1.156

Virtual Tuner Container

CDS container for an Extended Tuner that contains only CDS items (Virtual Tuner Objects) that allow channels to be streamed using a single connection (i.e. switch the content stream from one channel to another over the same URI connection)

3.1.157

Virtual Tuner Object

CDS item in an Extended Tuner that allow channels to be streamed using a single connection (i.e. switch the content stream from one channel to another over the same URI connection)

3.1.158

VLAN Tag

field on a layer-2 packet header defined by IEEE 802.1Q:2003

3.1.159

VO

Voice User Priority

priority-based QoS level for Voice User Priority

3.1.160

VSI

Vendor-Specific Infoframe

message sent from the HDMI source to inform the display device that the video signal is 3D and the type of 3D delivery format

3.1.161

WAN

Wide Area Network

network outside the home or office, typically in reference to the entire global Internet

3.1.162

WMM

Wi-fi MultiMedia

describes the QoS guidelines and associated test plans published by the Wi-Fi alliance for IEEE 802.11 wireless networks

3.1.163

XML

eXtensible Markup Language

text-based declarative language used to describe structured data for information exchange

3.2 Symbols

3.2.1

ΔT_{PCR}

as used for the RTP Media Transport, this value is the difference in time, measured in 90 kHz clock units, between successive PCR values in the TS stream. It is represented mathematically as:

$$\Delta T_{PCR} = PCR_{n+1} - PCR_n$$

This value is used in timestamp equations in 11.4.4.77.

3.3 Abbreviated terms

3DFC	3D Frame Compatible
AFD	Active Format Descriptor
DVB	Digital Video Broadcasting
DVD	digital versatile disc
DVR	digital video recorder
HD	high definition
IP	Internet protocol
OSD	on-screen display
PC	personal computer
PVR	personal video recorder
RTCP	real-time control protocol
RTSP	real-time streaming protocol
S3D	stereoscopic 3D
SAR	sample aspect ratio
SDES	session description item
SDP	session description protocol
SPTS	single programme transport stream
SSRC	synchronization source
URL	uniform resource locator
UTF	unicode transformation format
VLAN	virtual local area network

3.4 Conventions

In this document, a number of terms, conditions, mechanisms, sequences, parameters, events, states, or similar terms are printed with the first letter of each word in uppercase and the rest in lowercase (e.g., Move). Any lowercase uses of these words have the normal technical English meaning.

4 DLNA home network architecture

4.1 General

To achieve interoperability between connected digital media devices in the home, a common set of building blocks based on existing standards is needed as a basis to develop the DLNA Home Networked Device interoperability guidelines. Table 1 shows the specific functional components and technology ingredients that are covered in the interoperability guidelines. Figure 1 illustrates these functional components within the networking architecture of the interoperability guidelines. The interoperability guidelines define usage of these functional components to ensure interoperability among Device Classes defined in Clause 5. A brief overview of each functional component follows in the subsequent subclauses.

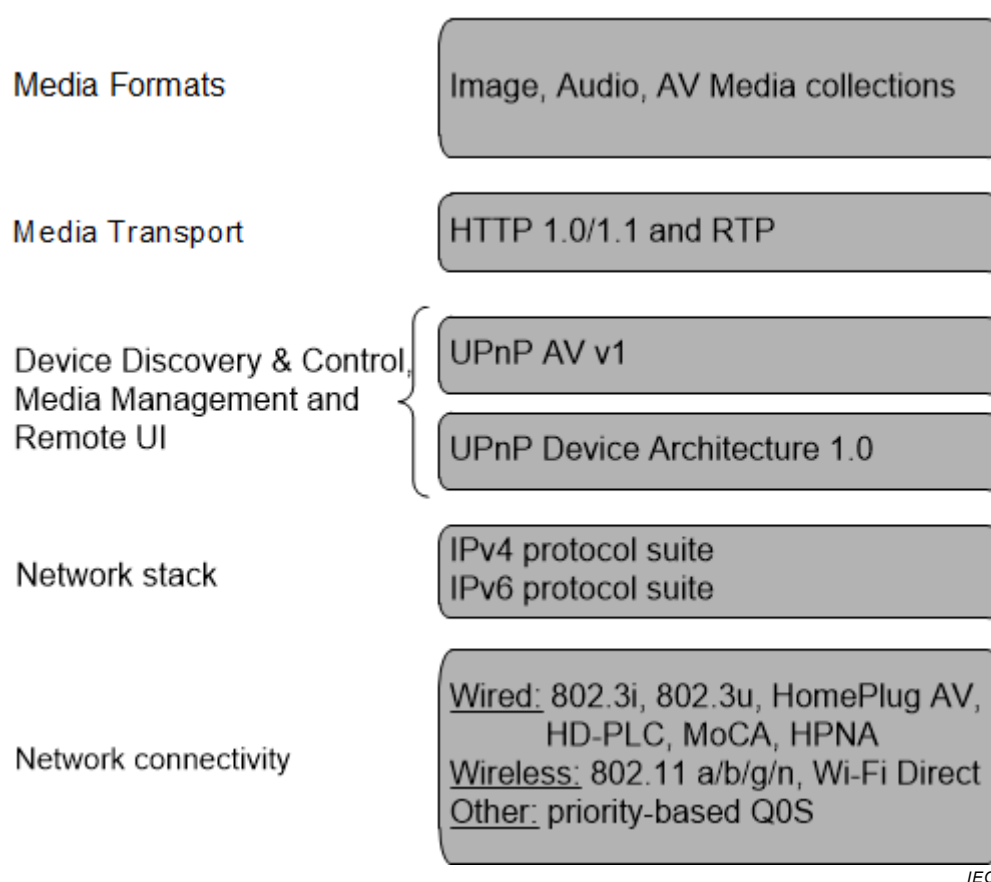


Figure 1 – DLNA functional components

4.2 Networking and connectivity

4.2.1 General

The Internet Protocol suites (IPv4 and IPv6) are the foundation for networking and connectivity for DLNA devices in the digital home. The general term IP refers to all versions of the Internet Protocol. DLNA requires support for IPv4 to ensure compatibility with a wide range of IPv4-only devices and defines an IPv6 device function to allow DLNA devices to interoperate with new IPv6-only devices going forward.

IP provides the underlying network communications for applications on the Internet. Based on industry-standard specifications from the IETF, IP is implemented and supported in a wide range of devices. IP has several advantages for use by DLNA devices:

- IP has demonstrated that it allows applications to run over different network topologies transparently;
- IP allows connecting every device in the home to the Internet;
- IP connectivity solutions are widely used and are cost effective. The most common ones are Ethernet (IEEE 802.3i and IEEE 802.3u) and wireless technologies (IEEE 802.11a, IEEE 802.11b, IEEE 802.11g and IEEE 802.11n) for devices in the home networking environment. In the mobile handheld environment, Wi-Fi is the prevalent wireless technology in use.

Subclause 8 specifies the detailed guidelines to enable interoperability between DLNA devices in the digital home. In addition, the home environment requires supporting network infrastructure, such as access points, bridges, Internet gateways, routers, and switches. These non-normative devices are referred to in this standard as Network Infrastructure Devices (NID). Annex A

provides informative recommendations for Network Infrastructure Devices to facilitate a good user experience and interoperability with DLNA devices.

4.2.2 Network quality of service

Multimedia applications on IP networks benefit from quality of service (QoS) functionality to optimize the way shared network resources are allocated among different applications. Without QoS, all applications running on different devices have an equal opportunity to transmit data frames. Multimedia applications such as video streaming and music streaming are sensitive to excessive latency variations and throughput reductions. With prioritized QoS, application label (tag) packets indicate the User Priority (UP). UP dictates how the packets are allowed to access network resources.

The DLNA QoS model is intended to allow DLNA applications that wish to take advantage of User Priority to have common usage rules for tagging. Devices that do not wish to use QoS shall be tolerant of tagging. In addition to interoperability, the DLNA QoS model promotes fair and consistent usage of priorities and balanced performance across all DLNA traffic types, thus enhancing the overall user experience.

4.3 Device discovery and control

Device discovery and control enables a device on the home network to discover the presence and capabilities of other devices on the network and collaborate with these devices in a uniform and consistent manner. The UPnP Device Architecture, version 1.0 (ISO/IEC 29341-1:2011), addresses all of these needs and simplifies device networking in the home. For this reason, UPnP Device Architecture is the device discovery and control solution for DLNA devices. Clause 9 specifies the detailed guidelines to enable interoperability between DLNA devices in the digital home.

4.4 Media management

Media management enables devices and applications to identify, manage, and distribute media content across the home network devices. UPnP Audio/Video (AV) technology addresses all of these needs for the home network and is the media management solution for DLNA devices.

The UPnP AV architecture defines the interaction model between UPnP AV devices and associated control point applications. UPnP AV devices can instantiate themselves in a variety of form factors, including (but not limited to) TVs, VCRs, DVD players, Set-Top Boxes, stereo systems, still-image cameras, portable media players, cell phones, and PCs. The UPnP AV architecture allows devices to support entertainment content in any format using any media transfer protocol. The UPnP AV specification defines two types of UPnP devices on the home network: UPnP AV MediaServers and UPnP AV MediaRenderers. The specifications also define four services hosted by UPnP AV MediaServers and UPnP AV MediaRenderers, as stated below. The existence of UPnP control points that interact with UPnP AV devices and services is implied.

- a) Content Directory Service: Exposes the available content.
- b) Connection Manager Service: Determines how the content can be transferred from the UPnP AV MediaServer to the UPnP AV MediaRenderer devices.
- c) AV Transport Service: Controls the flow of the content.
- d) Rendering Control Service: Controls how the content is played.

See Clause 5 for further information on how UPnP technology components are mapped into DLNA Device Classes.

Subclause 9.2.37 specifies the detailed guidelines to enable interoperability between DLNA devices in the digital home.

4.5 Media formats

Media formats describe how content is encoded and formatted for transport and how it is rendering on the home network. The DLNA media format model is intended to achieve a baseline for network interoperability while encouraging continued innovation in media codec technology. For each Device Category, the DLNA media format model defines a set of mandatory and optional Media Format Profiles for each of the three classes of media: imaging, audio, and AV. A Media Format Profile is a set of attributes, parameters, and system and compression level details sufficient to describe the media format of a content binary to enable interoperability between DLNA devices in each Device Category. In order to support interoperability between devices of different Device Categories, the Media Interoperability Unit performs basic translation between the required Media Format Profiles of different Device Categories. In addition, the DLNA media format model specifies rules about conversion between optional and mandatory formats to ensure that content can be enjoyed on all devices. The interoperability guidelines Media Formats, IEC 62481-2:2017, specify the detailed guidelines to enable interoperability between DLNA devices in the digital home.

4.6 Media transport

Media transport defines how content travels across the home network. DLNA devices that source or receive media content across the home network shall support HTTP as the baseline transport mechanism for the transfer of content. In addition, the RTP transport can optionally be used as a media transport; but the mandatory requirements for HTTP shall always be supported. Subclause 11 specifies the detailed guidelines to enable interoperability between DLNA devices in the digital home.

4.7 Remote UI

Remote UI defines how UI content is described, formatted, and transported from one device to another over the network. This also includes mechanisms for sending events and UI updates between different devices.

5 DLNA device model

5.1 Overview

These guidelines address the requirements of devices with differing environmental characteristics, such as home network and mobile handheld devices. Home Network Devices (HNDs) and Mobile Handheld Devices (MHDs) are Device Categories that have a differing set of requirements in media formats and network connectivity. This clause provides a device model with consistent terms and usages for these Device Categories.

In summary, the key points about Device Categories are:

- each is uniquely optimized for the requirements of a particular environment;
- the device guidelines focus on interoperability of devices within a Device Category;
- there are guidelines for devices which facilitate interoperability between Device Categories;
- a device can choose to be a member of multiple Device Categories.

5.2 Device model elements

As described in Clause 4, devices adhering to the DLNA Home Networked Device interoperability guidelines have six architectural layers. In summary, they are Media Formats for describing conformant content, Media Management for describing how content is found and controlled to achieve different system usages, Device Discovery and Control for device control, Media Transport for the transfer of content, Network Stack for IPv6 and IPv4 protocol requirements, and Network Connectivity for supporting different network physical layers. The following are terms used within this clause and throughout the guidelines. Their interdependence is illustrated in Figure 2.

A Device Category is an aggregation of Device Classes with common environmental characteristics (e.g. mobile devices) and sharing system usages that enable home networking use case scenarios. An example of a Device Category is the set of all Device Classes with system usages that solve requirements in media formats and network connectivity in a home network environment, such as a HND. Device Classes are grouped within a Device Category, but a single physical device can fall into multiple Device Categories.

A system usage describes a device interaction model between Device Classes and/or Device Capabilities. System usages are derived when enabling home networking use case scenarios. An example is a rendering device with a dedicated user interface that is browsing, selecting, and playing content from a media server on the home network, such as the 2-box Pull system usage, see 5.7.2.

A Device Class is a set of Device Functions (at least one) aggregated to be used in a system usage that enables home networking AV use case scenarios. A Device Class shall provide support for all layers in the DLNA architecture except when defined within the Home Infrastructure Device Category which is providing interoperability between one or more layers in the DLNA architecture. A Device Class is a certifiable entity by DLNA and is derived from system usages. It specifies the capabilities supported by a device regardless of the device's physical attributes. An example of a Device Class is a device with the role of exposing and distributing content throughout the home such as a "DMS". A single physical device can support multiple Device Classes.

A Device Capability is a set of Device Functions (at least one) aggregated to be used in a system usage that is enabling home networking AV use case scenarios. A Device Capability does not provide support for all layers in the DLNA architecture. It typically contains Device Functions at the Device Discovery and Control, Media Management, and Media Transport layers only. A Device Capability is not a Device Class and cannot stand alone. It shall always be deployed in conjunction with an implementation of a valid Device Class. A Device Class might already contain some of the Device Functions required to provide a Device Capability. An example of a Device Capability is any DLNA device that incorporates the additional feature (capability) of pushing content to a rendering device, such as a "Push Controller".

A Device Function is a non-decomposable operational property. Device Functions should be supported by existing standards or specifications. A Device Function usually applies to a single layer within the DLNA architecture. An example of a Device Function is an operational component at the Device Discovery and Control layer of the DLNA architecture such as a "UPnP Device". Device Classes and Device Capabilities are composed of a set of Device Functions. Device Functions are the building blocks of DLNA devices.

A Device Option provides optional extensibility to an existing Device Class definition, such as upload or scheduled recording functionality added to a MediaServer Device (MSD), or it provides a new optional Device Function to the DLNA architecture, such as RTP. A Device Option differs from a Device Class or Device Capability in that it normally enables a Device Class or Device Capability to perform an existing system usage in a different way (e.g., RTP). In the case where a Device Option achieves a new system usage, it adds functionality to an existing Device Class or Device Capability to support a new interaction such as the Upload system usage.

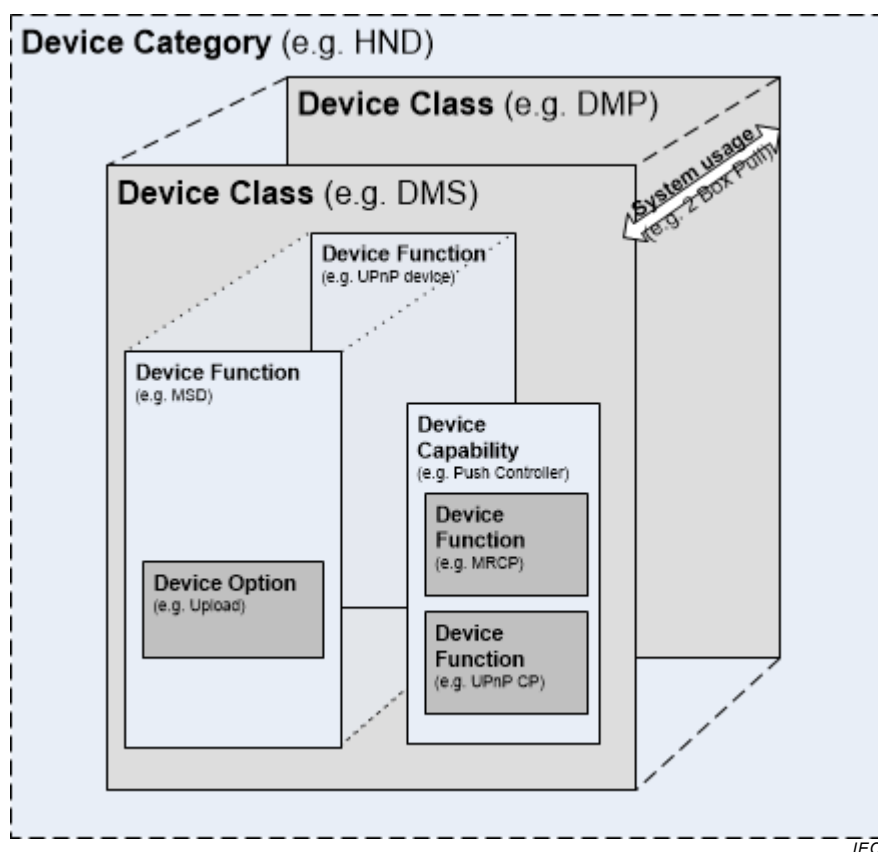


Figure 2 – DLNA device model terms hierarchy

5.3 Device Functions

For the interoperability guidelines and system usages, the Device Functions below are defined for the DLNA architecture.

- IP Connectivity – Network Connectivity and Network stack (8). This incorporates Ethernet (IEEE 802.3) and IEEE 802.11, with IP networking using the IPv4 protocol suite.
- IPv6 Connectivity – a Device Function that builds upon the basic connectivity of IP Connectivity by adding IPv6 to the Network Connectivity and Network stack.
- UPnP Device and UPnP Control Point (UPnP CP) – Device Discovery and Control based upon the UPnP Device Architecture (9). This incorporates the baseline device architecture used by all Device Classes and Device Capabilities.
- UPnP AV MediaServers (MSD), UPnP AV MediaServer control point (MSCP), UPnP AV MediaRenderer (MRD) and UPnP AV MediaRenderer control point (MRCP) – Media Management (9.2.37). This incorporates the control functionality that is layered on top of a UPnP Device or a UPnP control point to fulfill a role for a Device Class or a Device Capability in a system usage. An MSD provides methods to access content. An MSCP is a controller that can browse and select content provided by an MSD. An MRD provides methods to render content. An MRCP is a controller that selects the content to be rendered by an MRD.
- Media Transport Server and Media Transport Client – Media Transport (11). These are the Device Functions for the transport of content. The mandatory transport for content is HTTP which has the components of an HTTP Server and an HTTP Client. An optional transport for content is RTP which has the components of an RTP Serving Endpoint and an RTP Receiving Endpoint. RTP is an example of a Device Option which provides optional extensibility to system usages utilizing a Media Transport.
- Content – interoperability guidelines Media Formats, IEC 62481-2:2017, defines the DLNA mandatory and optional Media Format Profiles for content.

- Generic HTTP URLs (GENURL) – Media Management (7.4). This incorporates the DNS Client functionality which resolves domain names into IPv4 addresses. A GENURL Device Function provides support for HTTP protocol messages to request and receive media resources from servers internal or external to the home network.

5.4 Device Categories

Device Categories are a grouping of Device Classes that share common environmental characteristics (requirements) with system usages. There were no Device Categories explicitly defined in version 1.0 of the interoperability guidelines, as all of the Device Classes operated in the same environment. All of the version 1.0 guidelines were defined as if the following Device Category applied:

- Home Network Devices (HNDs) are a group of Device Classes that share system usages in the home network with the same media format and network connectivity requirements.

In these interoperability guidelines, the following two additional Device Categories are defined:

- Mobile Handheld Devices (MHDs) are a group of Device Classes that share the same system usages as the HND Device Category, but have different requirements for media format and network connectivity.

5.5 Device Classes and roles

In version 1.0 of the interoperability guidelines, the following two Device Classes were defined to support the 2-box Pull system usage for the HND Device Category.

- A Digital Media Server (DMS) with the role of exposing and distributing content.
- A Digital Media Player (DMP) with the role of finding content exposed by a DMS and playing the content locally on the DMP.

In these interoperability guidelines, the following three additional Device Classes are defined for the HND Device Category.

- A Digital Media Renderer (DMR) with the role of playing content it receives after being setup by another network entity.
- A Digital Media Controller (DMC) with the role of finding content exposed by a DMS and matching it to the rendering capacities of a DMR and setting up the connections between the DMS and DMR.

The following Device Classes are defined for MHD Device Category.

- A Mobile Digital Media Server (M-DMS) with the role of exposing and distributing content.
- A Mobile Digital Media Player (M-DMP) with the role of finding content exposed by an M-DMS and playing the content locally on the M-DMP.
- A Mobile Digital Media Controller (M-DMC) with the role of finding content exposed by an M-DMS and matching it to the rendering capabilities of a DMR and setting up the connections between the server and renderer.

Many of these mobile Device Classes have counterparts in the HND Device Category; however, they differ from their counterpart at the network connectivity layer and at the media format layer in the DLNA architecture. For example, an M-DMC can be connected via mobile specific network connectivity while a DMC has to meet the HND network connectivity requirements. This should not be taken to imply that MHD and HND devices cannot interact directly. The discussion above and in the definition of terms of the MHD and HND Device Classes, mobile Device Classes interact with other mobile Device Classes, such as an M-DMP interacting with an M-DMS. However, if the mobile and home devices have compatible network connectivity, and can exchange compatible Media Format Profiles, nothing in these statements should be taken to imply that an M-DMP cannot directly connect to a DMS to complete a system usage. See Table 2, and Table 4 for a listing of the required device interoperations and those that are only possible in consideration of compatible network and Media Format Profile capabilities.