

INTERNATIONAL STANDARD

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

Withhold



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INTERNATIONAL STANDARD

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

Without DLNA

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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International Standard IEC 62481-1 has been prepared by IEC technical committee 100: Audio, video and multimedia systems and equipment.

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

CDV	Report on voting
100/1127/CDV	100/1213/RVC

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

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

A list of all parts of the 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 publication will remain unchanged until the maintenance result date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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

Withdrawn

0 Introduction

0.1 General

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 (DLNA) answered this challenge by taking the initiative to develop a workable framework for interoperable product design. The DLNA home networked device interoperability guidelines (hereinafter referred to as the interoperability guidelines) has been created in a unique cross-industry effort that combined the efforts of over 100 CE, PC-industry and mobile device companies from around the world who 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 of this part of IEC 62481 include several informative annexes: Annex A, Annex B, Annex C, Annex D, Annex E, Annex F and Annex G.

The media formats contain

- a) ASF recommended procedures (informative);
- b) IFO file format (normative).

0.2 Purpose

The interoperability guidelines consists of two volumes covering architecture and protocols and media formats. It provides vendors with the information needed to build interoperable networked platforms and devices for the digital home. The necessary standards and technologies are available now 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 interoperability guidelines fulfil that role.

The interoperability guidelines 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, and media transport protocols.

Table 1 – Interoperable components

Key technology ingredients	
Functional components	Technology ingredients
Connectivity	Ethernet, IEEE 802.11 and Bluetooth
Networking	IPv4 suite
Device discovery and control	UPnP* Device Architecture v1.0
Media management and control	UPnP AV v1 and UPnP Printer:1
Media formats	Required and optional format profiles
Media transport	HTTP (mandatory) and RTP (optional)

0.3 Audience

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.

0.4 Organization

This part of the interoperability guidelines is organized as follows. All annexes are informative.

Clause 2 Normative references: Information on ISO, IEC and recognized normative references contained in this standard. Other informative documents are listed in the bibliography.

Clause 3 Terms and acronyms: Definitions of terms and acronyms used in this standard.

Clause 4 DLNA home network architecture: An overview of the DLNA home networking architecture.

Clause 5 DLNA device model: An overview of the major device categories used to group guideline requirements.

Clause 6 Guideline terminology and conventions: Definitions for the compliance and usage classifications used for guideline requirements.

Clause 7 Guideline requirements: Covers guideline requirements for DLNA devices excluding media formats which are covered in another part of IEC 62481.

Annex A (informative) Network infrastructure device (NID) recommendations: Covers a set of recommendations for home network infrastructure devices such as gateways, routers, and hubs to ensure they work well with DLNA devices.

Annex B (informative) Tuner representation: Describes the way DLNA devices should represent tuner-based content.

Annex C (informative) UPnP devices with multiple network interfaces: Describes how a DLNA device can represent itself on multiple network interfaces. The annex also discusses how a content source should expose content URI values for different network interfaces.

Annex D (informative) Printer support: Introduces developers to the technical considerations required to support printers and also discusses some of the usability aspects of printing that are important for a good user experience.

Annex E (informative) Example applications of the uniform client data availability model: Clarifies the general applicability of the uniform client data availability model (UCDAM). It describes the data accessibility assumptions for both content sources and content receivers. The UCDAM model strives for completeness by using examples derived from stored, converted, and live content streams. The model also accounts for caching of data by content receivers.

Annex F (informative) Auto-IP developer guidance: Provides guidance for developers on extending Auto-IP support for IP stacks that have problems with full conformance to Auto-IP.

Annex G (informative) Mobile network connectivity and power saving operation principles: Provides guidance on network connectivity for mobile devices, including Bluetooth security and NC power-saving modes.

Annex H (informative) RTP protocol stack and SDP/RTSP/RTCP parameters: Provides graphic layout of the protocol stack for the RTP transport and SDP/RTSP/RTCP parameters.

Withdrawn

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

Part 1: Architecture and protocols

1 Scope

This part of IEC 62481 specifies the information needed to build interoperable networked platforms and devices for the digital home on audio, video and multimedia systems, including interoperable components for devices and software infrastructure, physical media, network transports, device discovery and control, media management and control, media formats, and media transport protocols. This standard also provides product developers with a long-term architectural view, plus specific guidance for IP-networked platforms, devices and applications in the home.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62481-2, *Digital living network alliance (DLNA) home networked device interoperability guidelines – Part 2: Media formats*

ISO/IEC 13818-1:2000, *Information technology – Generic coding of moving pictures and associated audio information: Systems*

ISO/IEC 13818-9:1996, *Information technology – Generic coding of moving pictures and associated audio information – Part 9: Extension for real time interface for systems decoders*

ISO 8601:2004, *Data elements and interchange formats – Information interchange – Representation of dates and times*

ISO 10646:2003, *Information technology – Universal Multiple-Octet Coded Character Set (UCS)*

IEEE 802.1D:2004, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – IEEE standard for local and metropolitan area networks – Common specifications – Media access control (MAC) Bridges*

IEEE 802.1Q:2003, *IEEE Standard for Information Technology – Telecommunications and information exchange between systems – IEEE standard for local and metropolitan area networks – Common specifications – Virtual Bridged Local Area Networks*

IEEE 802.3:2002, *IEEE Standard for information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specification*

IEEE 802, *IEEE Standard for information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications*

3 Terms, definitions and acronyms

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

3.1 Terms and definitions

3.1.1

AC 3

audio format standard for delivering up to 5.1 audio channels developed by Dolby Laboratories popularly known as Dolby Digital

3.1.2

access point

AP

device specially configured as a network infrastructure device on a wireless local area network (WLAN)

NOTE Access points act as a central transmitter and receiver of WLAN radio signals. 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.

3.1.3

acknowledge

ACK

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

3.1.4

address resolution protocol

ARP

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

3.1.5

advanced television systems committee

ATSC

one of the standard bodies for digital television broadcasting

3.1.6

application data unit

ADU

unit of data used for the RTP media transport

NOTE 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" (for example, 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.

3.1.7

audio/visual profile

AVP

profile used for the RTP media transport

3.1.8

authentication

process by which an entity verifies that another entity is who or what it claims to be (examples of entities are: device, person, process.)

NOTE Authentication for Bluetooth is defined in Specification of the Bluetooth System (Volume 1 – Core, Volume 2 – Profiles, Addendum, Errata), Specification of the Bluetooth System, version 1.1, Bluetooth SIG, February 22, 2001, as the process of verifying which device is at the other end of the link. Authentication is

performed for devices based on their Bluetooth Address (BD_ADDR). In Bluetooth this is achieved by the authentication procedure based on the mutually stored link key or by pairing.

3.1.9

authorization

process of access check to determine whether the authenticated entity has access to the resource

NOTE Authorization for Bluetooth is defined in Specification of the Bluetooth System (Volume 1 – Core, Volume 2 – Profiles, Addendum, Errata), Specification of the Bluetooth System, version 1.1, Bluetooth SIG, February 22, 2001, as the process of deciding if a device is allowed to have access to a particular service. This is where the concept of “trusted” exists. Trusted devices (authenticated and indicated as “trusted”) are allowed access to services. Untrusted or unknown devices may require authorization based on user interaction before access to services is granted. This does not exclude the case where the authorization might be given by an application automatically. Authorization for Bluetooth always includes authentication.

3.1.10

extended audio/visual profile for RTCP-based feedback

AVPF

profile used for the RTP media transport

3.1.11

AVTransport:1 Service

AVT

UPnP service that provides network-based control for common transport operations such as play, stop, pause, next, previous, and seek, a standard UPnP DCP

3.1.12

background user priority

BK

priority-based QoS level for background user priority

3.1.13

bearer

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

3.1.14

best-effort user priority

BE

priority-based QoS level for best-effort user priority

3.1.15

bluetooth device address

BD_ADDR

unique 48-bit bluetooth hardware address

3.1.16

Bluetooth network encapsulation protocol

BNEP

bluetooth PAN profile concept

3.1.17

cacheable content

content binaries whose binary representations remain static over time

NOTE 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. In the 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.

3.1.18**canonical name****CNAME**

canonical endpoint identifier used to associate streams and differentiate sources in RTP media transport

3.1.19**channel**

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

NOTE 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".

3.1.20**coded data buffer****CDB**

data buffer used for the RTP media transport, buffer space that is used to store compressed data before decoding

3.1.21**ConnectionManager:1 Service****CMS**

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

3.1.22**consumer electronics****CE**

class of devices used in the home, such as DVD, DVR, PVR, PDA, TV, set top box, cellular phones

3.1.23**content**

aggregation of one or more works

3.1.24**content binary**

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

3.1.25**ContentDirectory:1 Service****CDS**

UPnP service that provides network-based discovery of content, a standard UPnP DCP

3.1.26**content receiver**

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

3.1.27**content source**

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

3.1.28**content transformation**

transcoding, transrating, or scaling of a content binary

3.1.29

contributing source

CSRC

source used for the RTP media transport

3.1.30

Data – High Rates 1 through 5

DH1-5

bluetooth specific physical layer packet types

3.1.31

Data – Medium Rates 1 through 5

DM1-5

bluetooth specific physical layer packet types

3.1.32

decoder friendly point

point in the stream that the decoder can begin to process data without any other internal state information about the stream so that the decoder can begin processing at that point and create a valid output rendering

3.1.33

device architecture 1.0

DA

UPnP device architecture version 1.0 document

3.1.34

device capability

set of device functions (at least 1) aggregated to support a system usage

NOTE A device capability cannot stand alone and should 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 may 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.

3.1.35

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 Examples used within this standard are home network device (HND), mobile handheld device (MHD), and home infrastructure device (HID). While device classes are grouped within a device category, a single physical device may support device classes that fall into multiple device categories.

3.1.36

device class

class defined by a set of device functions. It specifies the features supported on a device regardless of its physical attributes

NOTE Examples used within this document are digital media server (DMS) and digital media player (DMP). A single device may support multiple device classes. A DLNA device must support at least one device class and may support one or more device capabilities. A device class is the certifiable entity in DLNA.

3.1.37

device control protocol

DCP

specification that is standardized by the UPnP forum

NOTE Related specifications produced by a UPnP working committee are often identified by the working committee name. For example, UPnP AV 1 DCP.

3.1.38**device discovery and control****DDC**

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

3.1.39**device function**

non-decomposable operational property (for example, IP connectivity) which should be supported by existing standards

3.1.40**device option**

function which provides optional extensibility to existing device function requirements or a new optional device function to the DLNA architecture

3.1.41**device type**

specific device defined by its realization and its usage models, DVD players, TVs, DVRs, mobile phones, printers, cameras, picture frames, etc., which are used primarily for marketing descriptions, and should not be used in guideline definitions

3.1.42**differentiated services (DiffServ) code point****DSCP**

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

3.1.43**digital item declaration language****DIDL**

XML schema for representing the metadata of digital content

3.1.44**Digital item declaration language – Lite****DIDL-Lite**

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

3.1.45**digital media controller****DMC**

DLNA device class having home network environmental characteristics, 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 the DMR

3.1.46**digital media player****DMP**

DLNA device class having home network environmental characteristics, with the role of finding content exposed by a DMS and rendering the content locally

3.1.47**digital media printer****DMPr**

DLNA device class having home network environmental characteristics, with the role of providing document and image printing services to other DLNA devices

3.1.48

digital media renderer

DMR

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

3.1.49

digital media server

DMS

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

3.1.50

digital video broadcasting

DVB

one of the standard bodies for digital television broadcasting

3.1.51

DLNA QoS user priority

DLNAQOS_UP

DLNA-defined QoS label used to correlate an underlying IEEE 802.1Q user priority and WMM access category to a DLNA traffic type(s)

3.1.52

domain name system

DNS

protocol that enables hierarchical names for Internet domains and addresses which includes the means to translate between numerical IP addresses and text host names

3.1.53

dynamic host configuration protocol

DHCP

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

3.1.54

elementary stream

ES

single stream of several MPEG-2 carried components

3.1.55

exposed

content that is listed by a UPnP AV ContentDirectory service (CDS) and may not necessarily exist at the time that it is exposed (i.e. will require transcoding or conversion)

3.1.56

extensible markup language

XML

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

3.1.57

full TS

piece-wise constant rate MPEG-2 transport stream that is fully compliant with 2.4.2.2 of ISO/IEC 13818-1 which is characterized by a consistent temporal relationship (or "even spacing") between any two adjacent TS packets

3.1.58**high definition****HD**

picture quality at an HDTV level

3.1.59**high definition television****HDTV**

television system which provides a 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

3.1.60**home infrastructure device****HID**

device category that groups together all the applicable DLNA device classes, which provide support for interoperability between device classes of different device categories, where device classes in this device category are: MNCf and MIU

3.1.61**home network device****HND**

device category that groups together all the applicable DLNA device classes with home network environmental characteristics (requirements), where device classes in this device category are: DMS, DMP, DMR, DMC, and DMPr

3.1.62**hyper text transfer protocol****HTTP**

protocol for transferring files across the Internet which requires an HTTP client program on one end, and an HTTP server program on the other end

3.1.63**ideal network conditions**

conditions of a network state used only for testing and validation of guideline compliance

NOTE The effective network capacity should 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.

3.1.64**instance state variable**

new type of state variable defined by the AVTransport and RenderingControl services which are state variables associated with a virtual instance of a service

NOTE Both services use an evented state variable by the name of LastChange, to report a value change of an instance state variable.

3.1.65**interactive transfer**

media transfer mode where content that does not contain internal timing information is being transferred for the purpose of immediate user interaction with the content, for example, sending images that are to be displayed immediately to a user

3.1.66**Internet control message protocol****ICMP**

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

3.1.67

Internet gateway device

IGD

multifunction network infrastructure device that routes and/or bridges global internet with the local area network

3.1.68

Internet protocol version 4

IPv4

OSI network layer 3 protocol

3.1.69

joint photographic experts group

JPEG

coding standard for compression of still images (pictures)

3.1.70

linear pulse code modulation

LPCM

uncompressed audio encoding

3.1.71

link-level bearer

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

3.1.72

link management protocol

LMP

Bluetooth specific protocol

3.1.73

local area network

LAN

closely administered network segment(s) such as within the home or office

3.1.74

logical link control and adaptation protocol

L2CAP

bluetooth link layer protocol

3.1.75

low frequency enhancement

LFE

DVB-specified way to transmit additional sound information

3.1.76

media class

type of media a device type or device class supports

NOTE The media classes used in this document are image, audio only, and video with audio (AV).

3.1.77

media collection file

content binary whose purpose is to reference other content binaries usually for sequenced playback, often used for audio or AV playlists or image slideshows

3.1.78**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 Examples for the media classes are: Image – JPEG; Audio – LPCM; AV – MPEG-2.

3.1.79**media formats****MF**

section heading in the interoperability guidelines

3.1.80**media interoperability unit****MIU**

DLNA device class that provides media format interoperability between devices in the HND and MHD device categories

3.1.81**media management****MM**

section heading in the interoperability guidelines

3.1.82**MediaRenderer:1 Control Point****MRCP**

UPnP control point that issues actions to an MRD

3.1.83**MediaRenderer:1 Device****MRD**

UPnP device that provides network-based control for the rendering of content, where minimally a MediaRenderer must have a RenderingControl Service and a ConnectionManager service

NOTE The MediaRenderer specification is a standard UPnP DCP.

3.1.84**MediaServer:1 Control Point****MSCP**

UPnP AV control point that issues actions to an MSD

3.1.85**MediaServer:1 Device****MSD**

UPnP device that provides network-based discovery of content where, minimally, a MediaServer must have a ConnectionManager Service and a ContentDirectory Service.

NOTE The MediaServer specification is a standard UPnP DCP.

3.1.86**media stream**

single elementary stream or MPEG-2 TS or MPEG-2 PS multiplex as used for the RTP media transport

3.1.87**media transfer mode**

type of transfer used to deliver content from a content source to a content receiver

NOTE There are three types of DLNA media transfer modes: streaming transfer, interactive transfer and background transfer.

3.1.88

media transport

MT

section heading in the interoperability guidelines

3.1.89

mobile digital media controller

M-DMC

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

3.1.90

mobile digital media downloader

M-DMD

DLNA device class having mobile handheld environmental characteristics, with the role of downloading content from an M-DMS

3.1.91

mobile digital media player

M-DMP

DLNA device class having mobile handheld environmental characteristics, with the role of finding content exposed by an M-DMS and rendering the content locally

3.1.92

mobile digital media server

M-DMS

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

3.1.93

mobile digital media uploader

M-DMU

DLNA device class having mobile handheld environmental characteristics, with the role of uploading content to an M-DMS

3.1.94

mobile handheld device

MHD

device category that groups together all the applicable DLNA device classes with mobile handheld environmental characteristics (requirements), where device classes in this device category are: M-DMS, M-DMP, M-DMD, M-DMU, and M-DMC

3.1.95

mobile network connectivity function

MNCF

DLNA device class that provides interoperability by bridging the network connectivity layer between devices in the HND and MHD device categories

3.1.96

multimedia home platform

MHP

optional application interface used together with MPEG-2 transmissions

3.1.97**multipurpose Internet mail extension****MIME**

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

3.1.98**national television systems committee****NTSC**

standard for broadcast and reception of analogue television signals

3.1.99**native device**

device creating a virtual device and adding functionality to an existing device in the network

NOTE Device can be server or renderer. These native devices are in contrast to a virtual server or renderer.

3.1.100**network abstraction layer unit****NAL unit**

term specific to H.264 RTP payload format which is a 1-byte header and the payload byte string (as defined in IETF RFC 3984, RTP Payload Format for H.264 video)

3.1.101**network access point****NAP**

Bluetooth PAN profile concept

3.1.102**networking and connectivity****NC**

section heading in the interoperability guidelines

3.1.103**network de-jitter buffer**

buffer space that is used to store data for de-jittering and de-interleaving as used for the RTP media transport which includes RTP header and payload

3.1.104**network infrastructure device****NID**

device which provides supporting functionality in the home network such as access points, bridges, Internet gateways, routers, and switches, but which is not a member of the normative HID device category

NOTE These devices facilitate a good user experience with DLNA devices but are only covered at this time in this standard by informative recommendations in Annex A.

3.1.105**non-cacheable content**

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

NOTE Intermediate HTTP caches need directives to prevent the default caching of such content. In these interoperability guidelines 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 (for example, encoding to match the channel conditions for a given transaction).

3.1.106

**open systems interconnection
OSI**

networking stack model (7 layers)

3.1.107

**PAN user
PANU**

bluetooth PAN profile concept

3.1.108

partial SPTS

partial MPEG-2 transport stream which is also a single program transport stream (SPTS)

3.1.109

**personal area network
PAN**

one of the Bluetooth profiles

3.1.110

**personal computer
PC**

general-purpose computer equipped with a microprocessor and designed to run commercial software (such as a word processor or World Wide Web browser) for an individual user

3.1.111

**phase alternating line
PAL**

standard for broadcast and reception of analogue television signals

3.1.112

**portable network graphics
PNG**

coding standard for compression of still images (pictures)

3.1.113

post-decoder buffer

buffer space used to store decompressed data before rendering as used for the RTP media transport

3.1.114

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 as used for the RTP media transport

3.1.115

printer

device defined in UPnP Printer:1 Annex A V1.0, Printer:1 Device Template Version 1.01 with Annex A – Optional Service Addition V1.0

NOTE Printers are required to provide a printer service called PrintEnhanced and can optionally provide other services (for example, a fax service). In the case of the DLNA DMPv device class, the required print service is PrintEnhanced:1.

3.1.116

**printer control point
PrCP**

UPnP control point that issues actions to a PrD

3.1.117**printer device****PrD**

UPnP device that provides network-based control for the printing, which minimally must have a PrintEnhanced service

NOTE The printer device specification is a standard UPnP DCP.

3.1.118**printing controller**

DLNA device capability that contains a UPnP control point that allows the user to select the content they want to print, select the printer they want to use and monitor the status on the job.

NOTE The printing controller will be the component that composes the XHTML-print document that is then passed to the printer. A printing controller can be the source of Image content (+PR1+). The device capability acronyms used in these guidelines are +PR1+ and +PR2+.

3.1.119**program clock reference****PCR**

term defined by ISO/IEC 13818-1

3.1.120**program stream****PS**

content binary stream usually in reference to an MPEG-2 AV stream format

3.1.121**quality of service****QoS**

quality of service to provide guarantees on the ability of a network to deliver predictable results

3.1.122**real time protocol****RTP**

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

3.1.123**receiver buffer**

total buffer space used to store data received from the server before the decoding as used for the RTP media transport

3.1.124**receiving endpoint**

endpoint defined specifically through 7.5.6.2.4, which requires an RTP client and an RTSP client

3.1.125**renderingControl:1 Service****RCS**

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

3.1.126

rendering endpoint

term used to denote any device class that receives content for playback or streaming scenarios, for example, the DMP or M-DMD device classes

3.1.127

RTP media transport

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

NOTE This transport mechanism uses RTP, RTCP, RTSP, SDP protocols, and RTP payload formats with their associated media profiles.

3.1.128

RTP session

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

NOTE 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.

3.1.129

RTP stream

media stream that is encapsulated in RTP

NOTE All of the RTP packets have the same SSRC and are transmitted on the same RTP session.

3.1.130

RTSP session

session typically consisting of a client creating one or more RTP Sessions (SETUP), starting the stream with PLAY or RECORD, and closing the RTSP Session with TEARDOWN, complete RTSP "transaction", for example, the viewing of a movie

NOTE RTSP sessions are identified using the RTSP "session" header.

3.1.131

scaling

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

3.1.132

service control protocol description

SCPD

XML-encoded file describing a UPnP service known as a service description file

3.1.133

serving endpoint

endpoint defined specifically through 7.5.6.2.3, which includes the RTP server and RTSP server

3.1.134

simple object access protocol

SOAP

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

3.1.135

simple service discovery protocol

SSDP

UPnP device discovery protocol

3.1.136**streaming transfer**

term indicating that the packets are transferred minimally at a rate sufficient for real-time rendering for audio and AV streams

NOTE This definition does not imply that the receiving endpoint will always render content exchanged using streaming transfer (for example, it may store the content).

3.1.137**system usage**

usage which describes a device interaction model between device classes and/or device capabilities derived when enabling home networking use case scenarios

3.1.138**test conditions**

test conditions when all of the following conditions are satisfied:

- only 1 content receiver and only 1 content source;
- only 1 active connection at any given time

NOTE Both devices (content receiver and content source) should be 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.

3.1.139**tagged image file format****TIFF**

media format of still images (pictures)

3.1.140**transcoding**

changing the coding system used for a content binary

3.1.141**transmission control protocol****TCP**

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

3.1.142**transport stream****TS**

content binary stream usually in reference to an MPEG-2 AV stream format

3.1.143**transrating**

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

3.1.144**uniform resource identifier****URI**

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

NOTE 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.

3.1.145

UPnP

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

NOTE 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.

3.1.146

UPnP control point

CP

generic reference to any UPnP control point

3.1.147

user datagram protocol

UDP

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

3.1.148

user priority

UP

3-bit field of the QoS control field in the WMM Specification, Wi-Fi WMM (wireless multimedia) 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

video user priority

VI

priority-based QoS level for video user priority

3.1.150

virtual instance

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

NOTE Control points that interact with the AVTransport and RenderingControl services should interact with a virtual instance of the service. Each virtual instance is identified by a non-negative instanceID value.

3.1.151

virtual renderer

DMR that accepts content and sends it to another DMR within the network for rendering which accepts a wider range of content types, formats, rates, or sizes than the native device

3.1.152

virtual server

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

3.1.153

VLAN tag

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

3.1.154

voice user priority

VO

priority-based QoS level for voice user priority

3.1.155**wide area network****WAN**

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

3.1.156**Wi-Fi multimedia****WMM**

name used to describe the QoS guidelines and associated test plans published by the Wi-Fi Alliance for IEEE 802.11 wireless networks

3.1.157 **ΔT_{PCR}**

difference in time, measured in 90 kHz clock units, between successive PCR values in the TS stream as used for the RTP media transport, represented mathematically as

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

NOTE This value is utilized in timestamp equations in the "Guidelines for encapsulation of MPEG-2 Transport streams".

3.2 Acronyms

AV	Audio with Video
BT	Bluetooth
DLNAQOS	DLNA-defined QoS model
DVD	Digital Versatile Disc
DVR	Digital Video Recorder
IP	Internet Protocol
IPR	Intellectual Property Rights
MPEG-2	Moving Picture Experts Group phase 2
NC-PS	Network Connectivity Power Saving
PVR	Personal Video Recorder
RTCP	Real Time Control Protocol
RTSP	Real Time Streaming Protocol
SDS	Session Description Item
SDP	Session Description Protocol
SPTS	Single Program Transport Stream
SSRC	Synchronization Source
TTS	Timestamped Transport Stream

URL	Uniform Resource Locator
UTF	Unicode Transformation Format
VLAN	Virtual Local Area Network

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 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.

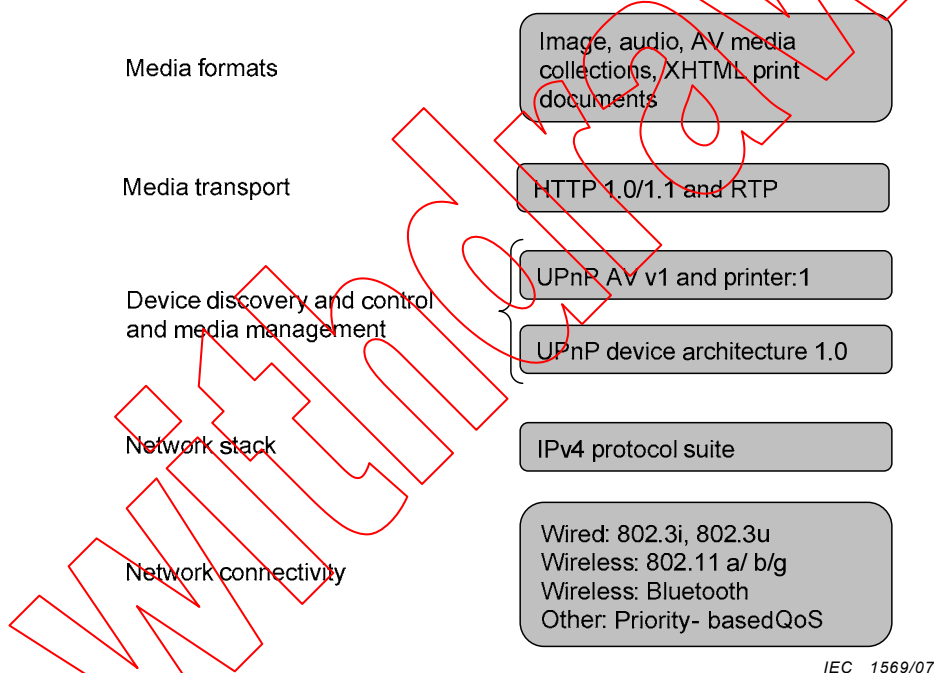


Figure 1 – DLNA functional components

4.2 Networking and connectivity

4.2.1 General

The IPv4 protocol suite is the foundation for networking and connectivity for DLNA devices in the digital home. IP also 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 the following 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 (802.3i and 802.3u) and wireless technologies (802.11a, 802.11b, and

802.11g) for devices in the home networking environment. In the mobile handheld environment, Bluetooth is the prevalent wireless technology in use.

Subclause 7.2 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, applications label (tag) packets to indicate the user priority (UP) that 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 must be tolerant of tagging. The DLNA QoS model promotes fair and consistent usage of priorities and balanced performance across all DLNA traffic types, in addition to interoperability, 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, 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. Subclause 7.3 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) and UPnP printer 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. 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.

The UPnP printer architecture defines the interaction model between UPnP printing devices and associated control point applications. Examples of UPnP printer devices are photo printers. The UPnP printer architecture defines a UPnP printer device which specifies the UPnP PrintEnhanced:1 service which in turn specifies XHTML-print, CSS print, and CSS print enhanced layout extension as the page description language.

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

Subclause 7.4 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 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. IEC 62481-2 specifies 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 must 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 must always be supported. Subclause 7.5 specifies the detailed guidelines to enable interoperability between DLNA devices in the digital home.

5 DLNA device model

5.1 Overview

The interoperability 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. To support interoperability between home network devices and mobile handheld devices, it is possible for a home network device to meet all the requirements for the corresponding mobile handheld device. It is also possible for a mobile handheld device to meet all the requirements for the corresponding home network device. In these cases, such a device is a member of both the HND and a MHD device categories; but, in most cases, that may not be feasible, so another way to achieve interoperability is via a group of devices that will be able to provide bridging or content transformation services between these two device categories. These devices belong to a device category referred to as the home infrastructure device (HID). The following summarizes these devices.

- Bridging network connectivity between the MHD and the HND device categories (7.2).
- Media format interoperability services between the MHD and the HND device categories (7.7).

In summary, the key points about device categories are as follows.

- 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 may choose to be a member of multiple device categories.

5.2 Device model elements

As described in Clause 4, devices adhering to the 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 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 (for example, 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 an HND. Device classes are grouped within a device category, but a single physical device may 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.

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 must 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 may 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 must always be deployed in conjunction with an implementation of a valid device class. A device class may 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

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 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 (for example, 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.

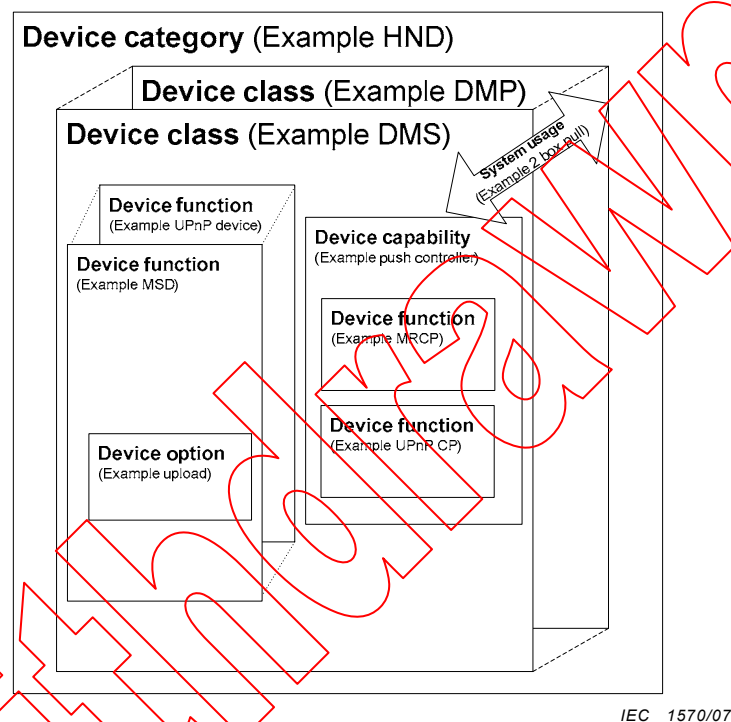


Figure 2 – DLNA device model terms hierarchy

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 (see 7.2). This incorporates Ethernet (802.3), 802.11, and/or Bluetooth connectivity and IP networking using the IPv4 protocol suite.
- **UPnP device** and **UPnP control point (UPnP CP)** – Device discovery and control based upon the UPnP Device Architecture (see 7.3). 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), UPnP AV MediaRenderer control point (MRCP), UPnP printer device (PrD), and UPnP printer control point (PrCP)** – Media management (see 7.4). This incorporates the control functionality that is layered on top a UPnP Device or a UPnP control point to fulfil a role for a device class or a device capability in a system usage. An MSD provides methods to access to content. An MSCP is a controller that can browse and select content provided by an MSD. An MRD provide methods to render content. An MRCP is a controller that selects the content to be rendered by an MRD. A PrD provides the ability to print image content. A PrCP is a controller that creates print jobs for selected content to be printed by a PrD.

- **Media transport server and media transport client** – Media transport (see 7.5). 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** – IEC 62481-2. This standard defines the DLNA mandatory and optional media format profiles for content.

5.4 Device categories

Device categories are a grouping of device classes that share common environmental characteristics (requirements) with system usages.

- In the interoperability guidelines, the following three device categories are defined: **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.
- **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.
- **Home infrastructure device (HID)** supports interoperability between device categories.

5.5 Device classes and roles

In the interoperability guidelines, the following five device classes are defined 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.
- A digital media renderer (DMR) with the role of playing content it receives after being set up 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.
- A digital media printer (DMP_r) with the role of printing images.

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 uploader (M-DMU) with the role of sending content to an M-DMS with upload functionality.
- A mobile digital media downloader (M-DMD) with the role of finding and downloading content exposed by an M-DMS and playing the content locally on the M-DMD after downloading.
- 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 may be connected via mobile specific network connectivity while a DMC must meet the HND network connectivity requirements. This should not be taken to imply that MHD and HND devices cannot interact directly. In 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 connect direct to a DMS to complete a system usage. See Table 2 and Table 3 for a listing of the required device interoperations and those that are only possible given compatible network and media format profile capabilities.

In order to allow HND and MHD devices to interact even with different network and media format profile capabilities, these guidelines define infrastructure devices of the HID device category that support interconnecting HND and MHD devices. The following device classes are defined within the HID device category.

- A mobile network connectivity function (M NCF) with the role of providing a bridging function between the MHD network connectivity and the HND network connectivity. An M NCF also provides support for security and power-saving modes. If a device in the MHD device category has only mobile specific network connectivity, it connects to home network via an M NCF. A device in the MHD device category with HND compatible network connectivity can connect to the home network direct.
- A media interoperability unit (MIU) with the role of providing content transformation between required media formats for the HND device category and the MHD device category. If a connected device in the MHD device category and a device in the HND device category have compatible media capabilities, they can interoperate direct without the need of an MIU. If they have different media capabilities, the MIU can be used to provide media interoperability.

The device functions that are incorporated in these device classes are illustrated in the figures that provide the details for system usages and their respective device interaction models in 5.7.2 through 5.7.8.

5.6 Device capabilities and roles

In these interoperability guidelines, the following device capabilities are defined.

- A push controller (+PU+) with the role of pushing its local content to a DMR.
- A printing controller-1 (+PR1+) with the role of controlling a DMP_r to print image content. A +PR1+ is also responsible for serving the image content and the XHTML-print document to the DMP_r.
- A printing controller-2 (+PR2+) with the role of controlling a DMP_r to print image content. Although a +PR2+ is not responsible for serving the image content, it is responsible for finding the image content on a DMS or M-DMS, providing the XHTML-print document to the DMP_r and instructing the DMP_r to print the images from the DMS or M-DMS.
- An upload controller (+UP+) with the role of sending content to a DMS or M-DMS with upload functionality.
- A download controller (+DN+) with the role of downloading content from a DMS or M-DMS to itself.

The device functions that are incorporated in these device capabilities are illustrated in the figures that provide the details for system usages and their respective device interaction models in 5.7.2 through 5.7.8.

5.7 System usages

5.7.1 Overview

In describing the flow of content in the system usages, indicated by the largest arrow in the system usage diagrams in 5.7.2 through 5.7.8, the terms push and pull are used. The terms push and pull are used in system usages to characterize the user's perception of the source or sink location in the process of content transfer. That is, "pull" means that the content is travelling to the user, while "push" means that the content is travelling from the user.

perception is not a reflection of the technical underlying transport mechanism utilized to perform the transfer the content from the source to the sink (for example, HTTP and RTP).

In the interoperability guidelines, the following seven system usages are defined that map to all of the use case scenarios being enabled by the detailed guidelines.

- **2-box pull system usage**
This usage involves a user at a DMP or an M-DMP, which enables the user to find and play content that is advertised and distributed by a DMS or M-DMS.
- **2-box push system usage**
This usage involves a user at a push controller, which enables the user to distribute content to a DMR for playback purposes.
- **3-box system usage**
This usage involves a user at a DMC or an M-DMC, which enables the user to find content on a DMS that in turn will be played on a user-selected DMR.
- **2-box printing system usage**
This usage involves a user at a printing controller-1, which enables the user to set up image print tasks with a DMP.
- **3-box printing system usage**
This usage involves a user at a printing controller-2, which enables the user to find images on a DMS or M-DMS and then set up a print tasks with a DMR.
- **Download system usage**
This usage involves a user at a download controller or an M-DMD, which enables the user to download content from a DMS or an M-DMS so that the download controller or the M-DMD has its own copy.
- **Upload system usage**
This usage involves a user at an upload controller or an M-DMU, which enables the user to send content to a DMS or an M-DMS with the upload device option so that the DMS or the M-DMS can distribute the content to other endpoints.

Subclause 5.7.2 through 5.7.8 will briefly describe each of the system usages and their respective device interaction models. In these system usages, devices in the MHD and HND device categories can achieve interoperability by utilizing an MIU with the responsibility for media format level conversions, and/or an M-NCF for bridging the networking connectivity layers between the two device categories. These elements are described in 5.8. For clarity, the device interaction model diagrams in 5.7.2 through 5.7.8 show HND and MHD devices interacting direct. All these system usages are shown with device functions that are media transport agnostic. All of these system usages imply HTTP as the mandatory media transport and other optional media transports, such as RTP, can be substituted.

5.7.2 2-box pull system usage

The 2-box pull system usage pulls DLNA compliant content from a media server (DMS/M-DMS) to be rendered locally by the device pulling the content (DMP, M-DMP). The user perspective is that content is being pulled to the DMP or the M-DMP for immediate rendering on the device. The user is browsing and selecting content on the DMS or the M-DMS. Note that the rendering function is not exposed onto the network in a DMP or an M-DMP implementation. Also note that in all of the following system usage diagrams, the media transport client/server is for the media transport layer only. The UPnP Device/CP has HTTP functions independent of the media transport layer and is implied as being part of the UPnP device/CP device functions. Figure 3 illustrates this device interaction model. The following steps are performed in this system usage.

- a) Invoke UPnP actions to browse and select content.
- b) Request the content for playback.

c) Transport the content to the DMP or the M-DMP.

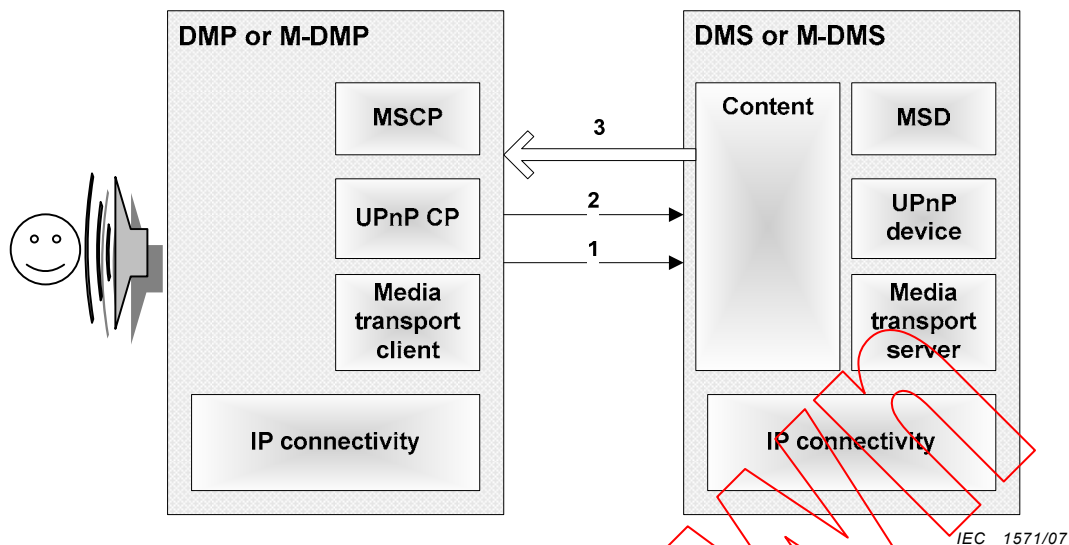


Figure 3 – 2-box pull system usage interaction model

5.7.3 2-box push system usage

The 2-box push system usage pushes DLNA compliant content to a rendering device (DMR). The user perspective is that content is being pushed to the DMR even though content may actually be transported in a "pull" manner depending on the media transport used. The user is selecting content at the device where the content is resident. Figure 4 illustrates this device interaction model. The following steps are performed in this system usage.

- Invoke UPnP actions to set up a playback session.
- Request the content for playback.
- Transport the content to the DMR.

Note that the push controller device capability functionality can only be incorporated as part of any physical device with a valid DLNA device class. It must never appear as a stand-alone device. This is how the push controller device capability inherits other device functions (for example, IP connectivity) at other layers in the DLNA device architecture. This is applicable to device classes in both the HND and MHD device categories.

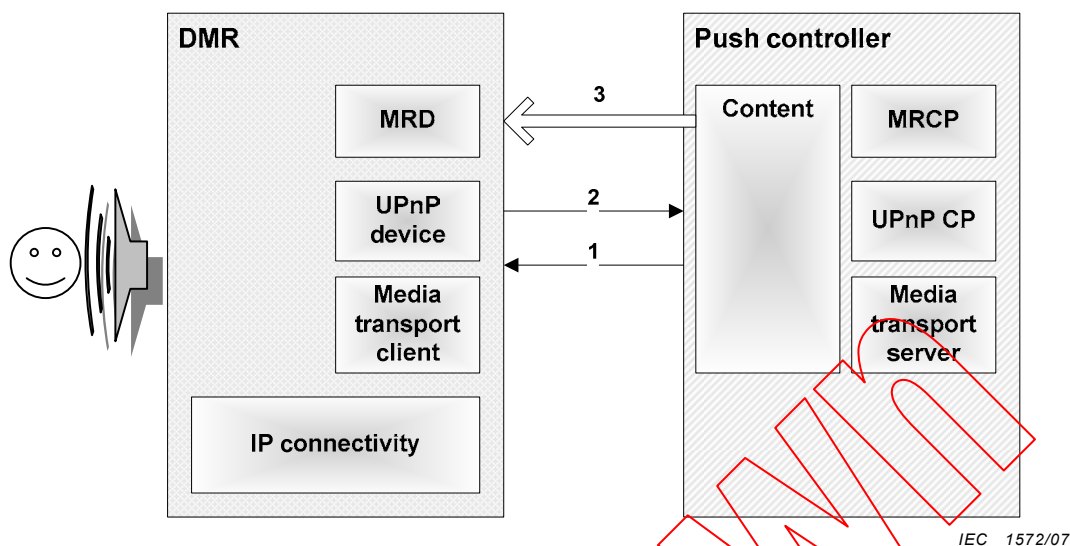


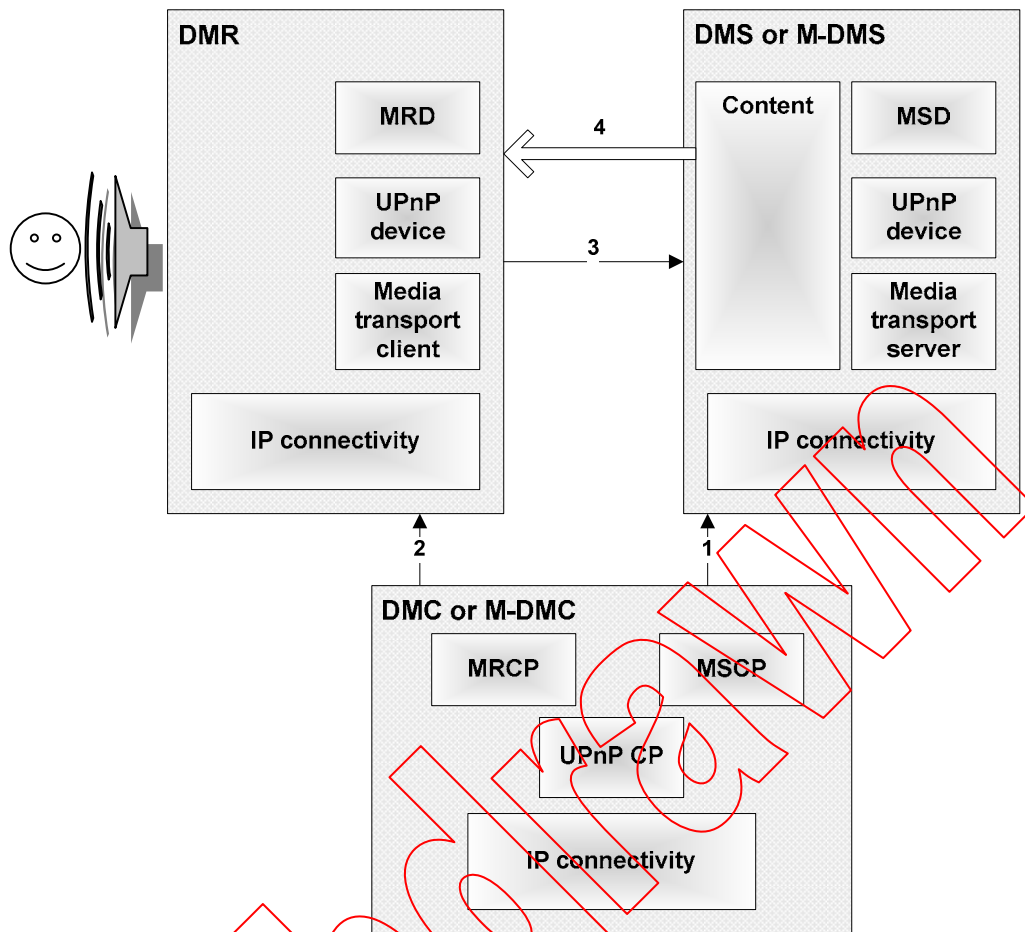
Figure 4 – 2-box push system usage interaction model

5.7.4 3-box system usage

The 3-box system usage uses a device controller (DMC/M-DMC) to browse content on a media server (DMS/M-DMS) and to select a rendering device (DMR) to play the selected content. The DMC or the M-DMC is responsible for making sure a DMR can render the selected DLNA content.

Figure 5 illustrates this device interaction model. The following steps are performed in this system usage.

- Invoke UPnP actions to browse and select content.
- Invoke UPnP actions to verify that the DMR has the capability to render the selected content and then set up a connection for the selected content between the DMR and the DMS or the M-DMS.
- Request the content for playback.
- Transport the content to the DMR.



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Figure 5 – 3-box system usage interaction model

5.7.5 2-box printing system usage

The 2-box printing system usage has a printing controller-1 that instructs an image printing device (DMPr) to print image(s) served locally by the printing controller-1. Print jobs are XHTML-print documents that are sourced by the printing controller-1 and all images referenced in an XHTML-print document are served up locally by the printing controller-1.

Figure 6 illustrates this device interaction model. The following steps are performed in this system usage.

- Invoke UPnP actions to the DMPr to initiate the print job by providing the URL to the XHTML-print document.
- The DMPr acquires the XHTML-print document from the printing controller-1.
- The DMPr requests the image content from the printing controller-1.
- The printing controller-1 responds with the image content.

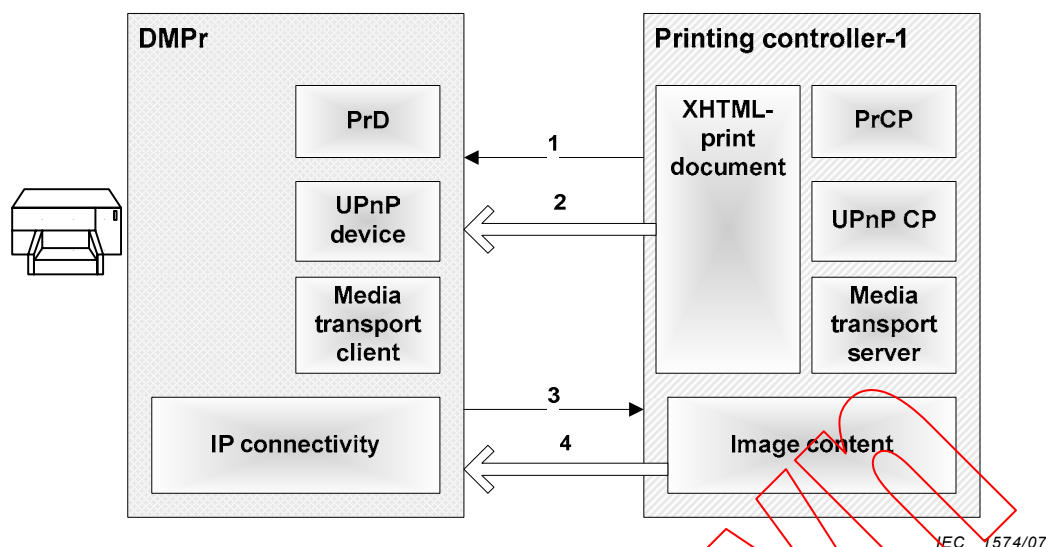


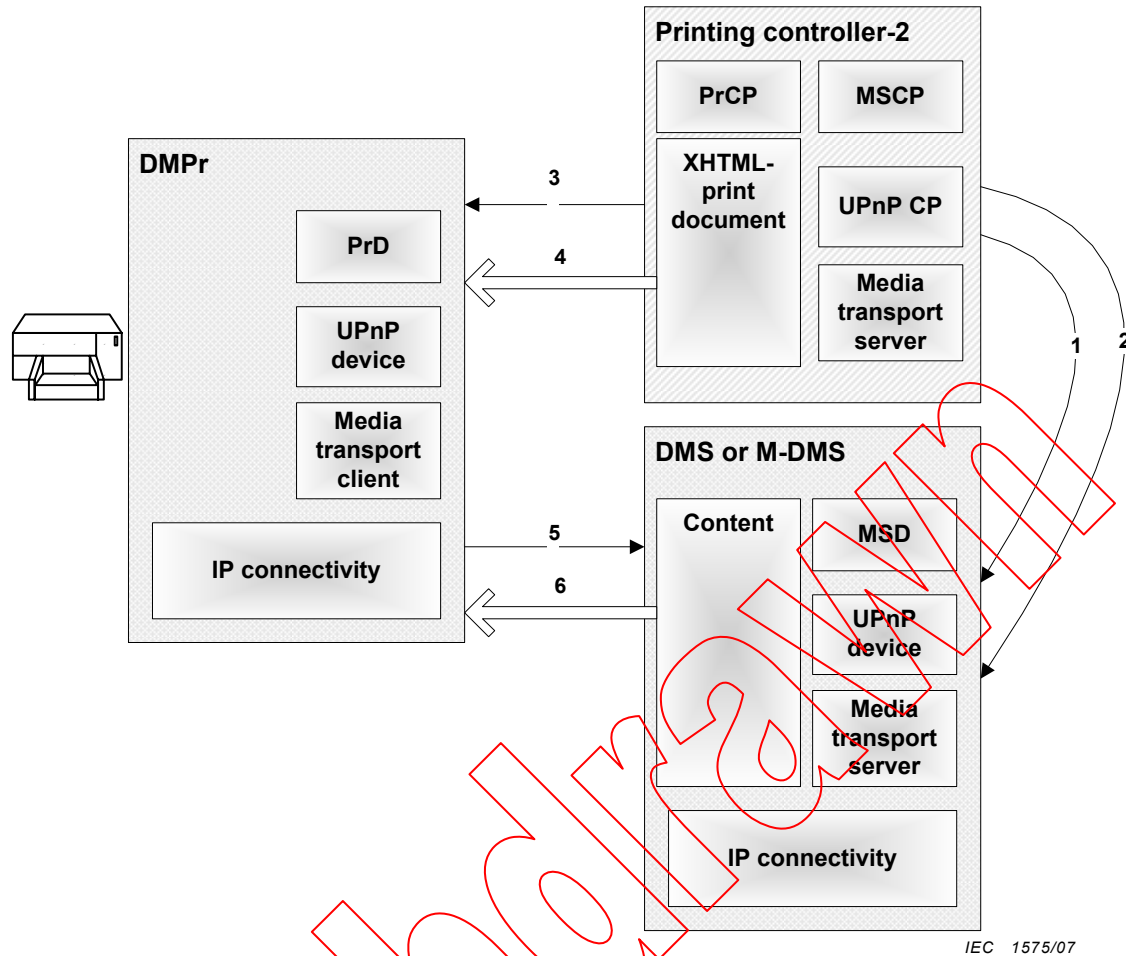
Figure 6 – 2-box printing system usage interaction model

5.7.6 3-box printing system usage

The 3-box printing system usage has a printing controller-2 that instructs an image printing device (DMPr) to print image(s) served by a DMS or M-DMS device class. The printing controller-2 has the additional functionality for finding and selecting the image(s) exposed by a DMS and/or M-DMS. Print jobs are XHTML-print documents that are sourced by the printing controller-2 and all images referenced in an XHTML-print document are served up by a DMS and/or M-DMS.

Figure 7 illustrates this device interaction model. The following steps are performed in this system usage.

- a) Invoke UPnP actions to browse and select image content.
- b) Get the URLs for the selected image content and reference the URLs in the XHTML-print document.
- c) Invoke UPnP actions on a DMPr to initiate the print job by providing the URL to the XHTML-print document.
- d) The DMPr acquires the XHTML-print document from the printing controller-2.
- e) The DMPr requests the Image content from the DMS or M-DMS.
- f) The DMS or M-DMS responds with the image content.



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Figure 7 – 3-box printing system usage interaction model

5.7.7 Download system usage

The download system usage allows a download controller or an M-DMD to transfer and store DLNA content from a media server (DMS or M-DMS).

Figure 8 illustrates this device interaction model. The following steps are performed in this system usage.

- Invoke UPnP actions to find content to download.
- Request the content that needs to be downloaded.
- Transport content to the download controller or the M-DMD.

Note that the download controller device capability functionality can only be incorporated as part of any physical device with a valid DLNA device class. It can never appear as a stand-alone device. This is how the download controller device capability inherits other device functions (for example, IP connectivity) at other layers in the DLNA device architecture. In the MHD environment, this system usage can be accomplished by a device with only this functionality, hence the need for an M-DMD device class to provide support for all layers in the DLNA architecture. This is not a requirement in the HND environment which must incorporate this functionality as an addition to an existing device class.

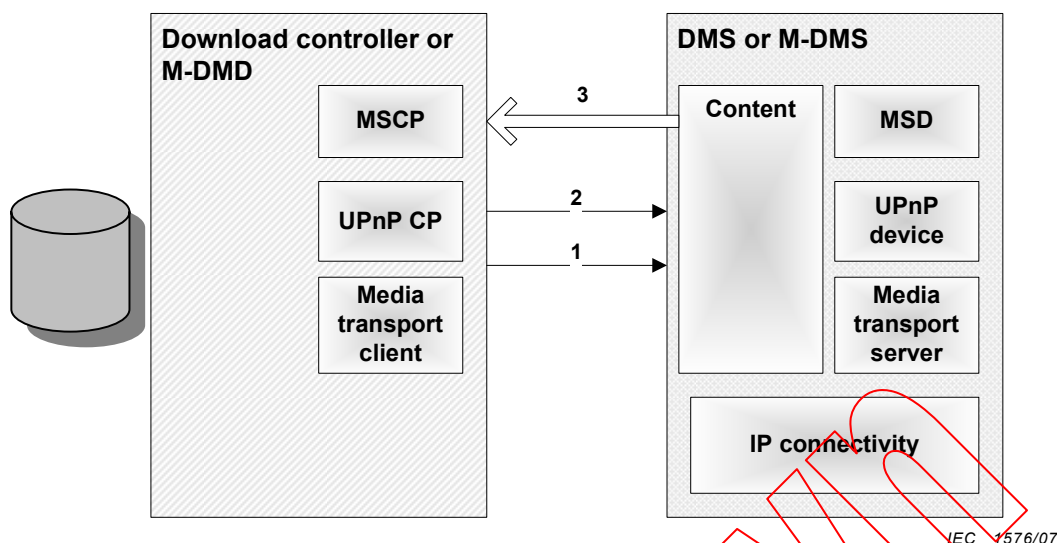


Figure 8 – Download system usage interaction model

5.7.8 Upload system usage

The upload system usage has an upload controller device capability or an M-DMU to instruct a media server (DMS/M-DMS) to accept some new content to be added to its list of available content.

Figure 9 illustrates this device interaction model. The following steps are performed in this system usage.

- Invoke UPnP actions to create a CDS entry for the content to be uploaded.
- Transport the content being uploaded to the DMS or the M-DMS.

Note that the upload controller device capability functionality can only be incorporated as part of any physical device with a valid DLNA device class. It must never appear as a stand-alone device. This is how the upload controller device capability inherits other device functions (for example, IP connectivity) at other layers in the DLNA device architecture. In the MHD environment, this system usage can be accomplished by a device with only this functionality, hence the need for an M-DMU device class to provide support for all layers in the DLNA architecture. This is not a requirement in the HND environment which must incorporate this functionality as an addition to an existing device class.

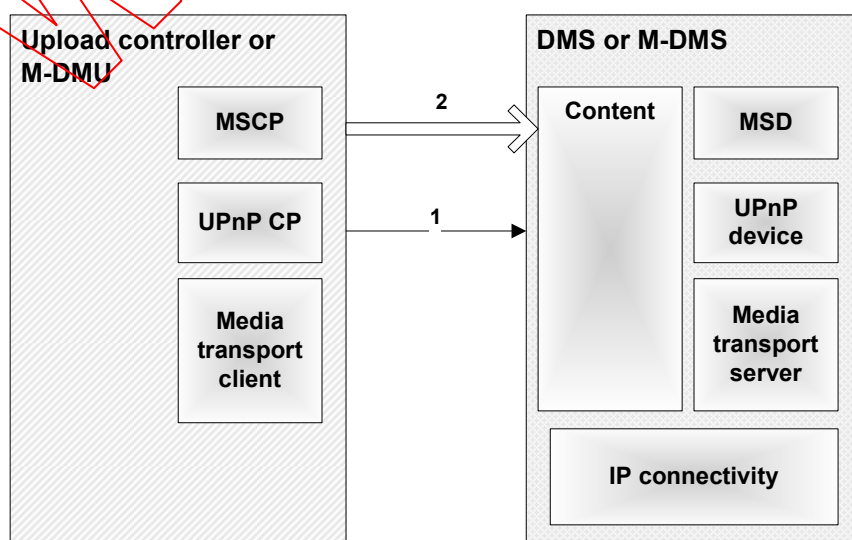


Figure 9 – Upload system usage interaction model

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5.8 Home infrastructure device (HID) system usage

5.8.1 General

As described in 5.1, the HID device category contains device classes that enable interoperability for common system usages between different device categories. In particular, the HND and MHD device categories share similar system usages, but they differ in their network connectivity and media format requirements. The device class for bridging the network connectivity layer is the M-NCF device class. The device class for bridging the media format layer is the MIU device class. Both of these entities are described in 5.8.

Figure 10 illustrates these bridging functions for the 2-box pull system usage between device classes in the MHD and HND device categories. The same concept can be applied to all of the system usages described previously. In summary, network layer traffic is bridged by the M-NCF for communications between the MHD and HND device categories as needed, and the MIU provides content transformation between the HND and MHD device categories as needed.

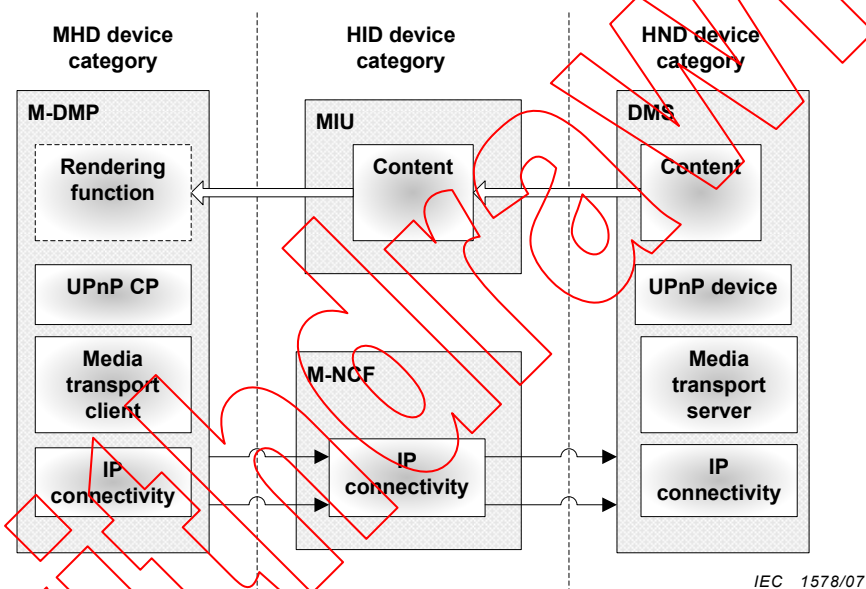
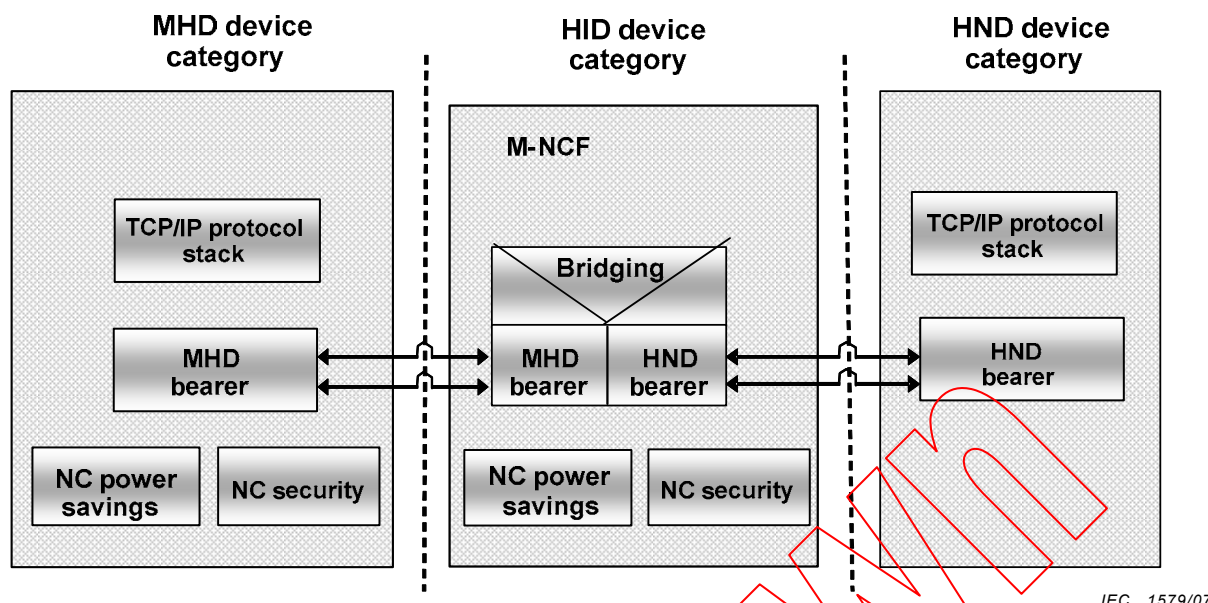


Figure 10 – 2-box pull system usage interaction model between device categories

5.8.2 Bridging HND and MHD network connectivity

Because devices in the HND and MHD device categories have different form factors, energy requirements and usages, they may support different link-level bearers to provide connectivity. For instance, it is common for MHD devices to support short-range and low-power consumption wireless bearers, such as Bluetooth. Furthermore, besides selection of bearers, MHD devices usually have different requirements from HND devices in two other areas at the network connectivity (NC) level, namely support for NC power savings and NC security. For instance, different requirements in the area of NC power savings may be due to the fact that most MHD devices are battery-operated, while in the area of NC security to the fact that MHD devices may belong to visitors who only need to be given temporary access to the home network. To bridge the network connectivity gap between MHD and HND device categories that is created by possibly different bearers and different needs in NC power savings and NC security, the mobile network connectivity function (M-NCF) device class is introduced. An example of the operation of the M-NCF is illustrated in Figure 11.



IEC 1579/07

Figure 11 – M-NCF bridging the network connectivity gap between MHD and HND device categories

Devices in the MHD device category may support different bearers from those supported by devices in the HND category. It is the role of the M-NCF to do link-level bridging between different MHD and HND bearers. This link-level bridging function is transparent at the IP connectivity level and above. Furthermore, the M-NCF has the role of providing support for NC power savings to MHD devices that wish to conserve energy. This is done by leveraging the underlying power saving mechanisms provided by the MHD bearers and by, optionally, performing traffic reduction operations to prevent excess multicast and broadcast traffic from reaching the MHD devices. Finally, it is the role of the M-NCF to provide authenticated and encrypted access to MHD devices to the home network, whenever desired by its owner-administrator. To achieve that, the M-NCF provides required functionality to establish, manage and revoke the necessary permanent or temporary access rights for any MHD devices to be able to connect to the home network.

It is important to note that not all MHD devices are required to connect to the home network via an M-NCF. For example, an MHD device which supports a bearer which is also an HND bearer may connect to the home network without an M-NCF, in the same way that any HND device supporting this bearer would. However, whenever an M-NCF supporting the necessary MHD bearer exists, it is recommended that MHD devices connect to the home network via the M-NCF, to ensure better interoperability and better meeting the unique requirements of the MHD devices.

5.8.3 Bridging HND and MHD media formats

Because devices in the HND and MHD device categories have different form factors and usages, they also differ in the mandatory media format profiles which are supported. For instance, all HND devices that operate on audio/video data must be able to process a profile based on MPEG2, while all MHD devices that operate on audio/video data must be able to process a profile based on MPEG 4 Part 10. This leads to a potential lack of interoperability between devices of the different categories. The media interoperability unit (MIU) is a device class of the HID device category that is defined to bridge this gap for the mandatory media format profiles and ensure media level interoperability between devices of the MHD and HND device categories. The operation of the MIU device class is shown in the following diagram.

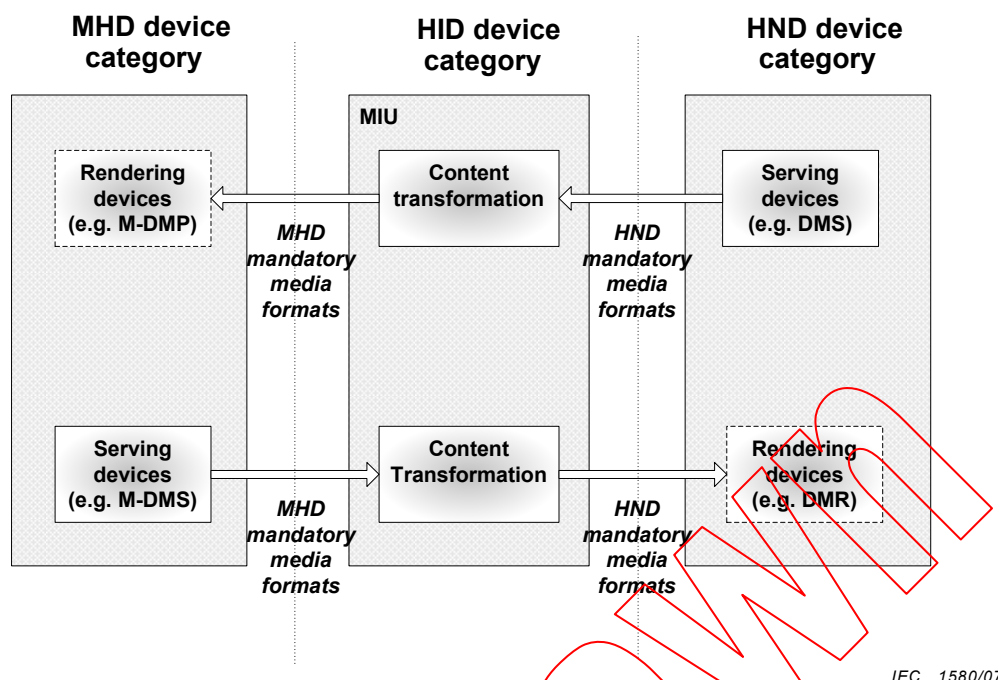


Figure 12 – Media interoperability between device categories

The devices of the MHD or HND device categories can serve or consume content in the mandatory media format profiles of the given device category. It is the role of the MIU to convert between the media format profiles so that content created and stored on an MHD device can be rendered on an HND device and vice versa.

It is important to note that the MIU is responsible only for media format level conversions. Because the core architecture of both the MHD and HND devices is the same set of UPnP devices, MHD devices are free to connect direct with their peer HND devices at any time, provided that they abide by the HND media format requirements. For example, MHD servers may find a DMR that can render their particular media format profiles, but they must not expect that functionality from an HND device. In the case where the HND device does not meet the media requirements direct, the MHD device should connect to the MIU for the necessary services.

5.9 Interoperability guidelines usage

The guideline requirements tables found in Clause 7 contain a column that specifies which device classes apply to a requirement. For the interoperability guidelines, five device classes are defined for the HND device category. They are a DMS, DMP, DMC, DMR, and DMP_r. The MHD device category with five device classes is introduced along with the two device classes of the HID device category. Table 2 summarizes all of the device classes in the HND device category and the mnemonics used within the interoperability guidelines. Table 3 summarizes all of the device capabilities that can be deployed with any device class and the mnemonics used within the interoperability guidelines. Table 4 summarizes all of the device classes in the MHD device category and the mnemonics used for these device classes. Table 5 contains the device classes in the HID device categories and the mnemonics used for these device classes.

Table 2 – DLNA device classes in the HND device category

DLNA device class	Media management components	Media transport components	Functional description	Device classes or capabilities interacted with for defined system usages	Device classes interacted with given compatible networking and media formats profiles
DMS	MSD	Media	Serves up media	DMP, DMC, DMR, M-DMP, M-DMP _r	M-DMP, M-DMP _r

(digital media server)		transport server		DMP, other endpoints with +UP+, +DN+, or +PR2+ capabilities	M-DMD, M-DMU
DMP (digital media player)	MSCP	Media transport client	Selects, controls and renders the selected media	DMS	M-DMS
DMC (digital media controller)	MSCP MRCP	N/A	Controls the content selection and content rendering between networked devices	DMS, DMR	M-DMS
DMR (digital media renderer)	MRD	Media transport client	Renders content	DMC, DMS, other endpoints with +PU+ capabilities	M-DMC, M-DMS
DMP (digital media printer)	PrD	Media transport client	Prints images	DMS, other endpoints with +PR1+ or +PR2+ capabilities	M-DMS

A device capability can be applied to any valid DLNA device class. Table 3 summarizes all of the device capabilities used in the system usages and the mnemonics used within these interoperability guidelines to specify which requirements apply to them.

Table 3 – DLNA device capabilities

DLNA device capability	Device capability controller identifier	Applicable device classes	Media management components	Media transport components	Required device classes interacted with for defined system usages	Device classes interacted with given compatible networking and media formats profiles
Push controller	+PU+	Any	MRCP	Media transport server	DMR	N/A
Printing controller-1	+PR1+	Any	PrCP	Media transport server	DMP	N/A
Printing controller-2	+PR2+	Any	PrCP MSCP	Media transport server	DMP, DMS	M-DMS
Download controller	+DN+	Any	MSCP	Media transport client	DMS	M-DMS
Upload controller	+UP+	Any	MSCP	Media transport client	DMS	M-DMS

The MHD device category has different media format and network connectivity requirements because of various device constraints. Table 4 summarizes all of the device classes in the MHD device category and the mnemonics used within the interoperability guidelines.

Table 4 – DLNA device classes in the MHD device category

DLNA device class	Media management components	Media transport components	Functional description	Device classes interacted with for defined	Device classes or capabilities interacted with given
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				system usages	compatible networking and media formats profiles
M-DMS (mobile digital media server)	MSD	Media transport server	Serves up media	M-DMP, M-DMC, M-DMD, M-DMU	DMP, DMC, DMR, DMPr, other endpoints with +UP+, +DN+, or +PR2+ capabilities
M-DMP (mobile digital media player)	MSCP	Media transport client	Selects, controls and renders the selected media	M-DMS	DMS
M-DMC (mobile digital media controller)	MSCP MRCP	N/A	Controls the content selection and content rendering between networked devices	M-DMS, DMR	DMS
M-DMU (mobile digital media uploader)	MSCP	Media transport client	Uploads the selected media to servers	M-DMS	DMS
M-DMD (mobile digital media downloader)	MSCP	Media transport client	Selects, controls and downloads the selected media	M-DMS	DMS

Due to the differences in the media format profile support and network connectivity requirements, the interoperability for device classes is only assured within a device category. To extend interoperability for the device classes in the MHD device category throughout the home network, including the device classes in the HND device category, a special device category named home infrastructure device (HID) is defined. The HID device category ensures interoperability between devices of different categories and ensures interoperability between the device classes and capabilities and the devices listed in the final two columns in the above tables. Table 5 summarizes all of the device classes in the HID device category and the mnemonics used within the interoperability guidelines.

Table 5 – DLNA device classes in the HID device category

DLNA device class	Media management components	Media transport components	Functional description
M-NCF (mobile network connectivity function)	N/A	N/A	Provides a network connectivity bridge between devices in the HND and MHD device categories
MIU (media interoperability unit)	MSD, MRD, MSCP, MRCP	Media transport server Media transport client	Provides virtual services for content transformation between required media formats for devices in the HND and MHD device categories

6 Guideline terminology and conventions

6.1 Guideline compliance classifiers

IETF RFC 2119 provides a description of terminology conventions used in all IETF RFC documents. The terminology and conventions used by the interoperability guidelines are adapted from this reference. The details of each guideline will carry a compliance classifier from the following set.

[M]ust, Required, Must:

This is the minimum set of requirements that will ensure interoperability and/or robust operation between devices. All devices are expected to comply with these requirements when expressed in unconditional form. A conditional requirement expressed in the form, "If X, then Y must be implemented", means that the requirement "Y" must be met when the conditional aspect "X" applies to a given implementation.