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Edition 2.0 2024-09

INTERNATIONAL STANDARD

colour
inside

Multimedia gateway in home networks – Guidelines

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MULTIMEDIA GATEWAY IN HOME NETWORKS – GUIDELINES

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IEC 62514 has been prepared by technical area 18: Audio, video and multimedia applications for end-user network, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

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

a) addition of new multimedia processing functions and requirements the HMG shall support, including adaptive multimedia processing, audio/video remote processing, and play function enhancement, in Clause 6;
b) addition of home automation functions and requirements of audio/video analysis, recognition and alarm services based on AI technologies in Clause 7;
c) addition of upgrade function and requirements of HMG in Clause 12.

The text of this International Standard is based on the following documents:

Draft	Report on voting
100/4160/FDIS	100/4175/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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INTRODUCTION

In the smart-home system, in order to meet the various requirements of home intelligence, all kinds of communication devices (computers, consumer-electrical products, etc.) and multimedia devices (TVs, surveillance cameras, etc.) are integrated into a home network. Such a network (comprising home information, entertainment, control services, etc.) thus forms a system of information exchange with outside networks.

In a home network system, terminal devices such as information devices, communication devices, entertainment devices, household appliances, meters of gas, water and electricity, health-care equipment, and lighting and security systems are interconnected through the Internet of Things (IoT) technology to implement the network management and services and share the resources and services in the network. Based on the interconnection of terminal devices, home network systems can also provide comprehensive multimedia processing services through the use of multi-screen interactive services, remote access, image recognition, and other audio and video processing technologies.

The multimedia services and the management for devices mentioned above can be performed through a home multimedia gateway.

MULTIMEDIA GATEWAY IN HOME NETWORKS – GUIDELINES

1 Scope

This document describes the general guidelines for typical applications of the home multimedia gateway in home networks supporting IP networking.

This document specifies recommended functions and services to be supported by the home multimedia gateway and, where appropriate, refers to existing standards supported in the market. For general requirements, it is expected that widely adopted standards and technologies will be considered by implementers.

This document gives supplementary applications to the IEC 62481 series, which specifies a central management model in home networks supporting various interfaces on the LAN side and on the WAN side (optional).

This document is applicable to home multimedia gateways in the home network or networks of similar environments.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 (all parts), *Digital living network alliance (DLNA) home networked device interoperability guidelines*

IEC 62481-1:2017, *Digital living network alliance (DLNA) home networked device interoperability guidelines – Part 1: Architecture and protocols*

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

ISO/IEC 29341 (all parts), *Information technology – UPnP Device Architecture*

ISO/IEC 29341-1, *Information technology – UpnP Device Architecture – Part 1: UpnP Device Architecture Version 1.0*

RFC 2663, *IP Network Address Translator (NAT) Terminology and Considerations*

RFC 3022, *Traditional IP Network Address Translator (Traditional NAT)*

IEEE 802.1Q™, *IEEE standard for Local and metropolitan Area Networks – Bridges and Bridge Networks*

3 Terms, definitions and abbreviated terms

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

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

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

3.1 Terms and definitions

3.1.1
home multimedia network
high speed network system to transport multimedia information within the home network

3.1.2
home multimedia gateway
HMG
logical device in the home network, which provides such functions as multimedia processing and home automations, interconnection, QoS and security

Note 1 to entry: It can connect LAN with outside networks (for example internet), implementing protocol translation and offer various network services.

3.1.3
control point
logical device that retrieves device and Service descriptions, sends actions to Services, polls for Service state variables and receives events from Services

Note 1 to entry: 'Service' is a term that is also defined in the ISO/IEC 29341 series.

3.1.4
terminal device
device in the home network that can be controlled and managed by HMGs and control points

3.1.5
media receiver
MR
device that receives media contents

Note 1 to entry: It normally refers to the media content player.

3.1.6
home media receiver
HMRec
device that receives media contents in the home network

Note 1 to entry: HMRec should fully support the function of DMR and DMP which are DLNA device classes defined by IEC 62481-1.

3.1.7
media source
MS
device that owns media resources and sends media contents

3.1.8
home media source
HMSou

device that provides media contents in the home network; it can be a media server

Note 1 to entry: HMSou should fully support the function of DMS and +PU+, which are defined by IEC 62481-1 and IEC 62481-2.

3.1.9
WAN media source
WMS

device that provides media contents in the Wide Area Network (WAN)

3.1.10
WAN media receiver
WMR

device that receives media contents in the Wide Area Network (WAN)

3.2 Abbreviated terms

+DN+	download controller
+PR+	printing controller
+PU+	push uploader
+UP+	upload controller
AAC	Advanced Audio Coding
ADSL	Asymmetric Digital Subscriber Line
ANSI	American National Standards Institute
ARP	Address Resolution Protocol
ATA	analogue telephone adapter
ATRAC	adaptive transform acoustic coding
AV	audio and video
AVC	Advanced Video Coding
CDS	content distribution service
CPU	central processing unit
DHCP	Dynamic Host Configuration Protocol
DLNA	Digital Living Network Alliance
DMC	digital media controller
DMR	digital media renderer
DMP	digital media player
DMPr	digital media printer
DNS	domain name system
DRM	digital rights management
DSCP	differentiated service code point
DSL	Digital Subscriber Line
DTV	digital television
EPG	electronic program guide
ETH	Ethernet
FTP	File Transfer Protocol
GENA	general event notification architecture

HMRec	home media receiver
HMG	home multimedia gateway
HMSou	home media source
HTTP	Hyper Text Transfer Protocol
ICMP	Internet Control Message Protocol
ID	identification
IGD	internet gateway device
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPTV	Internet Protocol television
ITU	International Telecommunication Union
JPEG	Joint Photographic Experts Group
LAN	local area network
LPCM	Linear Pulse Code Modulation
MAC	media access control
MIU	media interoperability unit
MPEG	Moving Picture Experts Group
MR	media receiver
MRCP	mediarenderer:1 control point
MS	media source
MSCP	mediaserver:1 control point
NAT	Network Address Translation
NAPT	port-level NA
NID	network infrastructure device
PAN	personal area network
PC	personal computer
QoS	quality of service
RID	request identity
RIP	Routing Information Protocol
SOAP	Simple Object Access Protocol
STB	set top box
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
UPnP	Universal Plug and Play
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
VDSL	Very-high-bit-rate Digital Subscriber Line
VOD	video on demand
VOIP	voice over Internet Protocol
WAN	wide area network
WMS	WAN media source
WMM	wireless multimedia
WMR	WAN media receiver

4 HMG architecture

4.1 Architecture of a home multimedia network

A home multimedia network adopts a multiple-level network topology consisting of two network segments, i.e. a home multimedia network and a home control sub-network. The home control sub-network is optional, where appropriate.

The home multimedia network supports the central management mode, which can be functioned by HMG, as well as supporting peer-to-peer mechanisms as specified in the IEC 62481 series. The home multimedia network can access the outside network through an HMG, while the home control sub-network can be connected to the home multimedia network through a home control sub-network gateway. The devices in a home control sub-network can intercommunicate and further access outside networks by sub-gateways and HMGs.

The typical architecture of a home multimedia system is shown in Figure 1.

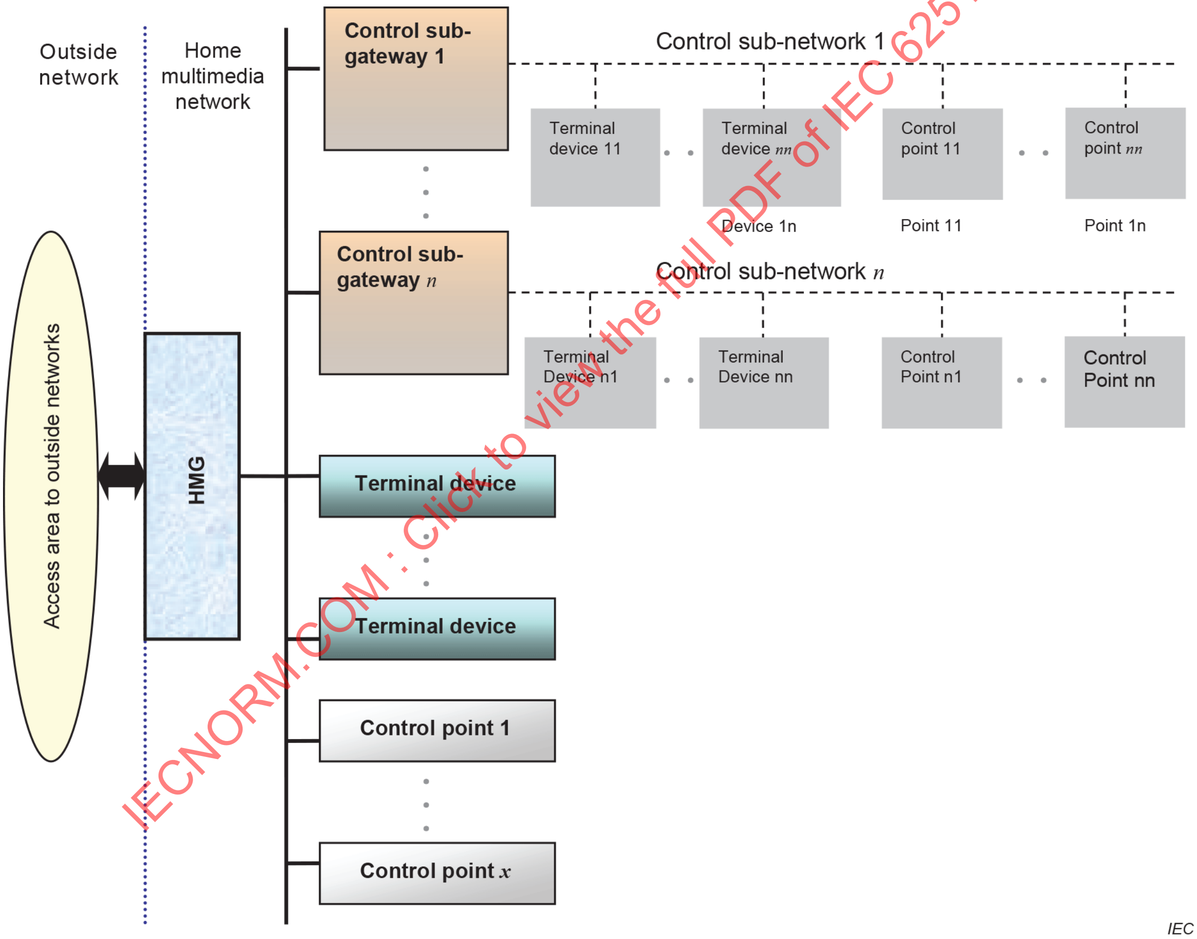
Outside network
Home multimedia network
Control sub-gateway 1
Control sub-network 1
Terminal device 11
Terminal device nn
Device 1n
Control point 11
Point 11
Control point nn
Point 1n
Control sub-gateway n
Control sub-network n
Terminal Device n1
Terminal Device nn
Control Point n1
Control Point nn
Access area to outside networks
HMG
Terminal device
Terminal device
Control point 1
Control point x
IEC

Figure 1 – Architecture for a home multimedia network

4.2 HMG architecture

4.2.1 General

From the aspect of the functional structure, the HMG provides such functions as multimedia processing and applications, interconnection, and QoS and security. The architecture of the HMG is shown in Figure 2.

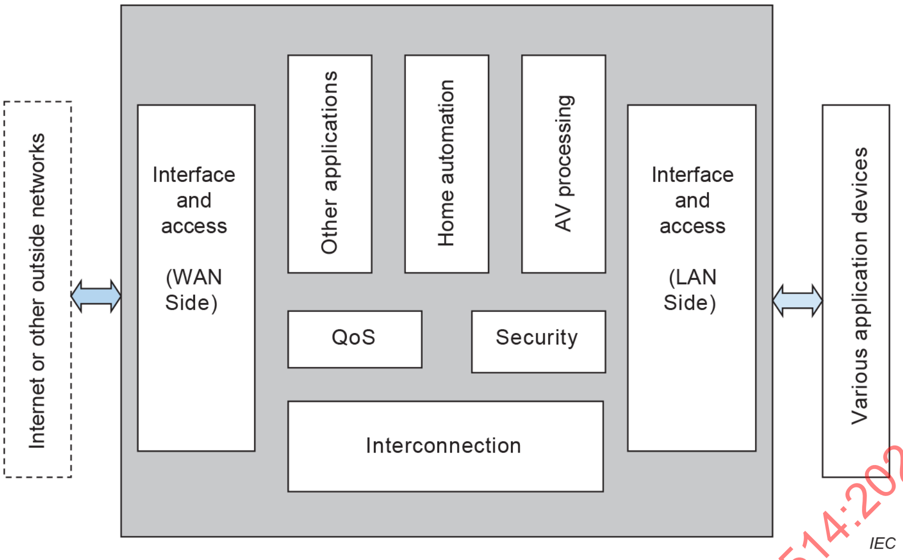
Internet or other outside networks
Interface and access (WAN Side)
Other applications
Home automation
AV processing
Interface and access (LAN Side)
Various application devices
QoS
Security
Interconnection
IEC

Figure 2 – HMG architecture

4.2.2 AV processing

HMGs shall provide various application services of video and audio in the home multimedia network. It shall fully support all the functions of MIU (includes MSCP, MRCP), DMPr and +UP+/+DN+/+PR+, which are defined in IEC 62481-1 and IEC 62481-2.

4.2.3 Home automation

HMGs can offer local management and remote management, as well as various control services to the devices in the home network.

4.2.4 QoS

HMGs should support QoS features in order to transport multimedia contents effectively in the home network where the HMG is involved.

If the HMG supports QoS features, then the HMG shall use the priority tag of QoS in order to transfer the multimedia contents that have IEEE 802.1Q User Priority, WMM Access Category or DSCP.

The detailed requirements of QoS shall be compliant with IEC 62481-1:2017, 8.3.

4.2.5 Security

HMGs shall support DRM, key management, authentication and security to log onto outside networks.

4.2.6 Interconnection

HMGs shall support the network management, protocol translation, address assignment, configuration and management on the home networked devices, in different multimedia networks.

4.2.7 Interfaces and access

These provide the connection between the home network and outside networks (for example, the Internet) when necessary, which is optional.

The detailed interface and communication protocol requirements on both the LAN side and the WAN side are specified in Clause 11. The specific protocol that is to be applied depends on the application case.

5 Interconnection

5.1 General connection requirements

Where the home multimedia network is an IP network, the requirements for the HMG are as follows:

- HMGs shall implement a Dynamic Host Configuration Protocol (DHCP) server in order to assign IP address to DHCP client in the home network where the HMG is involved.
- HMGs should support Domain Name System (DNS) in order to use device name for better user experience.
- Those messages are formatted by using the SOAP HTTP binding, which shall be compliant with ISO/IEC 29341-1.
- HMGs should collect information with respect to all the devices connected to the home network by using the device description and the service description of each device in order to manage the devices.
- HMGs also should control other devices such as HMRec and HMSou by using appropriate actions to realize use cases described in this document.

HMGs shall also conform to the following requirements defined and specified in IEC 62481-1:

- HMGs shall support a TCP/IP stack that includes IPv4, TCP, UDP, ARP, and ICMP.
- HMGs may also support general capability recommendations and device recommendations.
- The detailed methods of interconnection shall be compliant with IEC 62481-1:2017, 7.3 (Device discovery and control).
- HMGs shall support Simple Object Access Protocol (SOAP) header and body elements, and the messages are delivered via HTTP. The HMG as well as HMSou and HMRec support the messaging scheme by using the GENA protocol to exchange the event information inside the high-speed system. A control point invokes the action to the device's service in order to control it and when the action has completed or failed, the service returns any results or errors of the action.
- HMGs shall support the detailed methods of device management.

5.2 Address assignment and resolution

5.2.1 Address assignment

HMGs shall support the functions of address assignment as follows:

- HMGs shall assign the identifiers to each control sub-network in order to identify different sub-networks.
- The control sub-network gateway shall apply for the addresses, which comply for the higher-level network protocol and are composed of sub-network identifier and network address, from the HMG.

- HMGs shall have the following address assignment functions.
  - HMGs shall support DHCP servers to assign the addresses for the devices managed in the home network. Through a management and configuration interface on the HMG, the DHCP can be enabled or disabled, and the data such as address pool assignment on the DHCP can be configured as well.
  - The terminal devices shall also support AutoIP if there is no DHCP server in the sub-network.

5.2.2 Address resolution

HMGs shall support the functions and requirements of address resolution as follows:

- If the source devices and destination devices are located in the same control sub-network or multimedia network, then the HMG shall forward the data packet directly without any processing.
- If the source devices and the destination devices are not located in the same control sub-network or multimedia network, then
  - the source devices shall know the identifier and network address of the control sub-network or multimedia network in which the destination devices are located;
  - the HMG shall resolve the data packet sent from the source devices and identify the identifiers and network addresses of the control sub-network or multimedia network in which the source devices and destination devices are located, respectively;
  - the HMG shall confirm the network and address of the destination devices located according to the identifier and network address of that control sub-network or multimedia network;
  - the HMG shall confirm the communication protocol of the destination devices from the device registry;
  - the HMG shall then re-pack the data and send to the destination device in accordance with the communication protocol confirmed.
- The HMG shall support the ARP protocol as well.

5.3 Data transfer

HMGs

- shall support router working mode, bridge working mode or the hybrid working mode of both router and bridge;
- shall support the static router in the router working mode;
- should support the dynamic router and support RIP V1/V2 in the router working mode;
- shall support NAT and NAPT in accordance with RFC 2663 and RFC 3022 in the bridge working mode;
- shall support the transparent bridge protocol in accordance with IEEE 802.1Q in the bridge working mode;
- shall support the relevant functions of both router working mode and bridge working mode when working the hybrid mode of router and bridge.

5.4 Protocol translation

HMGs shall support the application protocol translations when communicating and interacting between different networks or sub-networks.

6 AV processing

6.1 General

HMGs may offer services for applications in home network systems. In summary, service requirements include multimedia transformation and multimedia stream control and may be fulfilled by using the services and actions that are defined by UPnP AV specifications (ISO/IEC 29341-3 series) and DLNA guidelines (IEC 62481 series). HMGs need to meet some hardware and software requirements to enable all these AV processing services.

6.2 Multimedia transformation service

6.2.1 Requirements summary

The following requirements apply.

- HMGs shall provide the media conversion service, including code conversion (transcoding), resolution conversion (transcaling), and shall provide the media conversion service of the frame rate conversion (transrating).
- HMGs should support voice code conversion.
- The media conversion service request message shall include the URI of the media resources, which specifies media code format, resolution, frame rate and transport protocols needed by the requester. In the case of getting contents from WMS, it can also include the code format, resolution and frame rate of the requested contents, as well as the media transport protocols supported by the media content owner.
- HMGs should be able to convert audio streams into voice streams.
- HMGs should be able to convert voice streams into audio streams.
- HMGs should be able to provide the video clip function, which shall be done in accordance with the capability of receiving terminals.
- HMGs shall be able to convert multimedia based on the receiver's ability.
- HMGs shall be able to convert multimedia based on the network environment.
- HMGs shall be able to request multimedia with specific parameters from the media source.
- HMGs shall be able to communicate with remote HMRecs.

6.2.2 Applications mode

6.2.2.1 Media conversion

6.2.2.1.1 General

Media stream conversion is the act of converting a media stream from one mode to another. It includes code conversion, resolution conversion, rate conversion and transport protocol translation. As shown in Figure 3, the green media stream indicates a dynamic conversion process; the HMG converts a MPEG2 media stream transmitted from the HMSou into an H.264 media stream transmitted through the hypertext transfer protocol (HTTP); then the HMG sends the stream to the HMRec. If the media server can know the devices at the user's home and the media formats supported, it can use the remaining capabilities of the HMG to convert the media contents on the media server into the format needed by the players. In this way, when such contents are played, they need not be dynamically converted, as the conversion might affect the QoS in real-time playback.

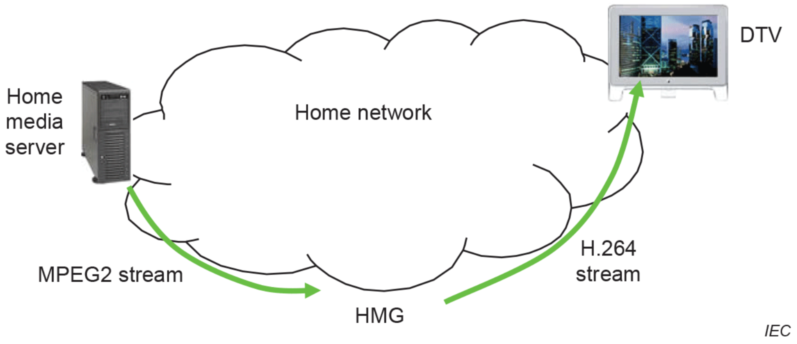

Figure 3 – Conversion of media streams

As shown in Figure 3, media conversion can be performed in two modes. In the first mode, the media sender sends the media to the HMG; then the HMG converts the media and sends it to the media receiver. The one that requests the media conversion might be the media sender or the media receiver. In the second mode, the device sends the media to the HMG. After being converted, the media is returned to the device and is irrelevant for other application devices. In this mode, the HMG can be regarded as an extension of the device. In this case, there is no transport protocol translation.

Subclauses 6.2.2.1.2, 6.2.2.1.3 and 6.2.2.1.4 describe the possible work modes of the HMG.

6.2.2.1.2 HMRec requests media conversion service

Figure 4 shows the process of how the HMRec requests the media conversion service from the HMG when HMRec gets media resource from HMSou Here it is supposed that:

- The HMG has obtained the uniform resource identifier (URI) for media resources on HMSou. The HMG can browse/search the directory of devices providing media contents and obtain the URI. The HMG also has obtained the code format, resolution and frame rate of the media resources.
- The HMG shall support to convert the media format and expose all of them in the CDS which is defined in the ISO/IEC 29341 series.
- The HMRec has obtained the uniform resource identifier (URI) for media resources on HMG. The HMRec can browse/search the directory of devices providing media contents and obtain the URI. The HMRec also has obtained the code format, resolution and frame rate of the media resources.

The request process is as follows:

1. The HMRec sends a request content message to the converted media URI of HMG.
2. The HMG sends a request content message to the original media URI of HMSou.
3. The HMSou accepts the request of the HMG and sends the original media stream to the HMG.
4. The HMG converts the media stream and sends the converted media stream to the HMRec.

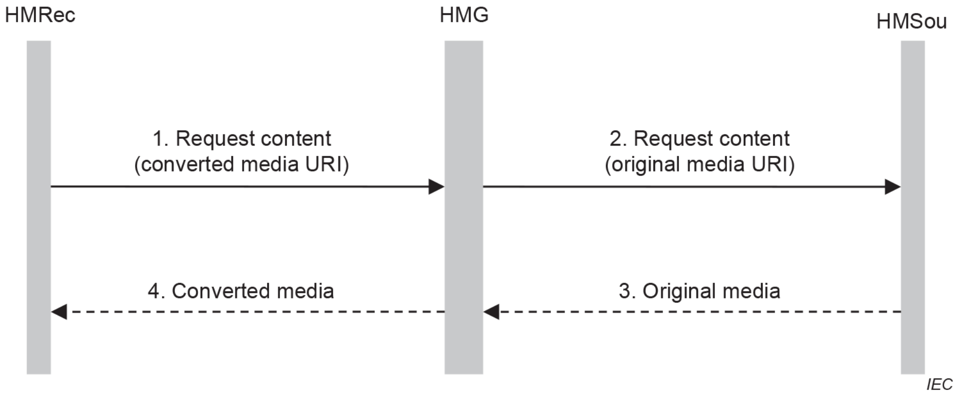
HMRec
HMG
HMSou
1. Request content (converted media URI)
2. Request content (original media URI)
3. Original media
4. Converted media
IEC

Figure 4 – HMRec requests media conversion from HMG

When the MS is the WMS, if DRM and authority management are taken into account, the process shall include the procedure of how the HMG can pass the WMS authentication. Because there are a rich variety of DRM and authority management modes, the HMG cannot support all DRM systems and authority management modes.

6.2.2.1.3 HMRec requests WMS to support redirection

Figure 5 shows an optimized process. Before the HMRec requests the media conversion service from the HMG, it first requests media stream redirection from the WMS. Here, it is supposed that:

- the HMRec has obtained the URI of the needed media resources;
- the HMRec might have obtained the code format, resolution and frame rate of the needed media resources;
- the HMRec might have known the media transport protocol used by the media sender;
- the HMRec needs the conversion service for sure;
- the HMRec has finished necessary DRM authentication and device authentication with the WMS.

The process is as follows:

1. The HMRec sends a Request Redirection message to the WMS, which includes:
   - the URI of the media resources on the WMS requested by the HMRec.
2. The WMS satisfies the request of the HMRec and allocates a Request identity (RID) in the response message.

   NOTE When the media source receives a media service request from the media receiver, it allocates an identity to authenticate the media conversion service device, that is, the HMG, provided by the media receiver (MR). This identify is called the request identity. The media conversion service is originated by the media receiver; the request identify allocated by the media source is transferred to the HMG. When obtaining original media contents from the media source, the HMG needs to provide the request identity to the media source to prove its validity.
3. The HMRec sends a request conversion message to the HMG, which includes:
   - the URI of the media resources on the WMS requested by the HMRec;
   - the media code format, resolution and frame rate needed by the HMRec;
   - media transport protocols supported by the HMRec;
   - RID allocated by the WMS;
   - (optional) media code format, resolution and frame rate of the media contents requested by the HMRec;
   - (optional) media transport protocols supported by the WMS.

4. If the HMG can accept the conversion request, it can send a message to the HMRec, indicating that the request is accepted; otherwise the HMG shall send a message to refuse the request.
5. The HMG requests the media resources needed by the HMRec from the WMS. The request message shall include the RID and the URI of the media resources on the WMS requested by the HMRec; or the RID shall be sent back upon the request of the WMS. If the HMG cannot request resources, or if the HMG cannot make conversion after the resources are obtained, it shall send a message to the HMRec, indicating that the service cannot be fulfilled
6. The WMS accepts the request of the HMG after authenticating the RID. Then it sends the original media stream to the HMG.
7. The HMG converts the media stream and sends the converted media stream to the HMRec according to the media code format, resolution and frame rate needed by the HMRec.

In the above procedure, the WMS does not implement DRM authentication on the HMG but transmits the media stream directly. DRM authentication is completed by the HMRec before step 1. The WMS authenticates the RID to verify the validity of the HMG. In this way, the HMG does not need to support various DRM methods, but has new requirements on the WMS.

In practice, encrypted transmission is needed between the WMS and the HMG, and between the HMG and the HMRec. As a result, keys need to be exchanged between the WMS and the HMG, and between the HMG and the HMRec. It is easy to exchange keys between the HMRec and the HMG, as both devices are at home and can adopt a standard method. Because different service systems in the WAN adopt different DRM systems and different encryption algorithms, it is hard for the HMG to satisfy the media conversion requests from various service terminals. It is easy to unify the DRM method in the home network; however, it is hard to unify various services in the WAN. The HMG is required to support various encryption algorithms and key exchange methods. Even if a control channel is reserved between the HMRec and the WMS for key exchanges, through which the HMRec sends to the HMG the key exchanged with the WMS, the HMG still needs to support multiple encryption algorithms.

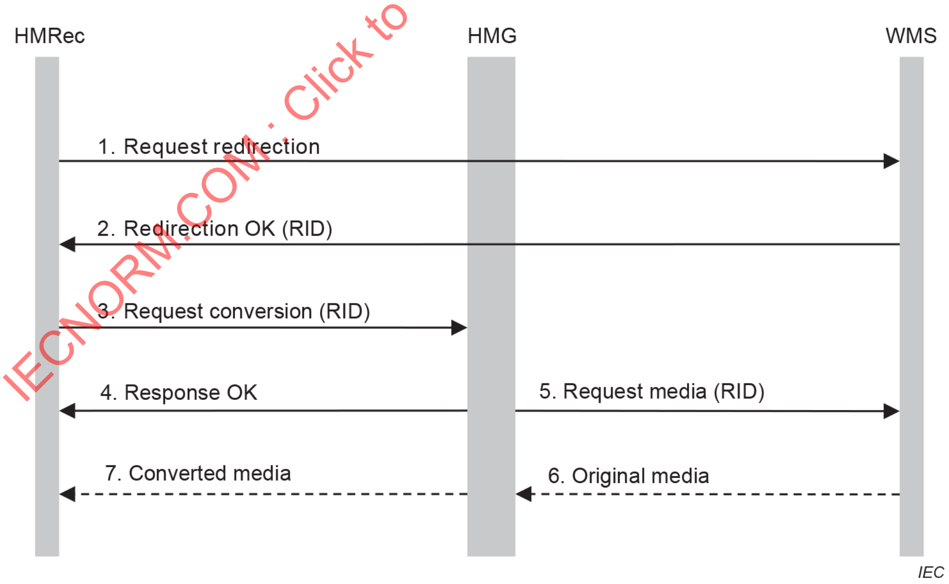

Figure 5 – HMRec requests WMS to support redirection

In order to support the workflow of HMRec requests media conversion, HMGs are required to observe the following rules.

- HMGs shall provide the media conversion service. Upon receiving a media conversion request message from the HMRec, it should request media contents from the WMS.
- The HMG should judge whether it can accept the media conversion request according to the capability needed by the requester, available capability, and its processing capability.

- If the HMG finds that it cannot satisfy the requirement of the conversion service requester after obtaining the media resources, it should send a message to the conversion service requester, explaining that the conversion service cannot be fulfilled.
- The HMG should support the conversion of streaming media.
- The HMG should support the DRM.
- If the HMG receives a RID from the HMRec, it shall include the RID when requesting media contents from the WMS; or it shall feedback the RID upon the query of the WMS.
- HMGs should support encrypted transmission with the WMS.
- HMGs should support encrypted transmission with the HMRec.
- HMGs should support various encryption algorithms.
- HMGs should support various key management methods.

In order to support the workflow of media conversion, WMSs are required to observe the following rules:

- WMSs should be able to accept the media redirection request of the HMRec.
- After the WMS accepts a media redirection request from the media receiver, it can allocate a RID to the media receiver so as to authenticate the HMG.
- Existing DRM methods should be optimized to support the media conversion service.
- New DRM methods should be adopted to support the media conversion service.

In order to support the workflow of media conversion, HMRecs are required to observe the following rules:

- HMRecs should be able to send a media redirection request to the WMS.
- HMRecs should be able to request the media conversion service from the HMG. The request message should include the URI of the media resources, media code format, resolution, frame rate and transport protocols needed by the HMRec. It can also include the code format, resolution and frame rate of the requested contents, as well as the media transport protocols supported by the media content owner.
- If the HMRec sends a media redirection request to the WMS and receives a RID allocated by the MS, it should include this RID when sending a media conversion service request to the HMG.

6.2.2.1.4 HMSou requests media conversion service

When the HMSou actively sends media contents to the HMRec, it can request the media conversion service from the HMG and sends media contents to the HMRec after they are converted.

Supposing that the HMG shall support to convert the media format and expose all of them in the CDS, then the process in Figure 6 is as follows:

1. The HMSou sends a request conversion message to the HMG, requesting the media conversion service. The message may include:
    - the media code format, resolution and frame rate of the media contents sent by the HMSou;
    - the media transport protocol of the HMSou;
    - the URI for the media source sent by HMSou.

2. The HMG sends a request conversion message to the HMRec, requesting the media conversion service. The message may include:
   - the media code format, resolution and frame rate of the media contents sent by the HMG,
   - the media transport protocol of the HMG,
   - the URI for the media source sent by HMG.
3. The HMRec requests the converted media content from the HMG.
4. The HMG requests the original media content from the HMSou.
5. The HMSou transmits media streams to the HMG.
6. The HMG converts media streams and sends them to the HMRec.

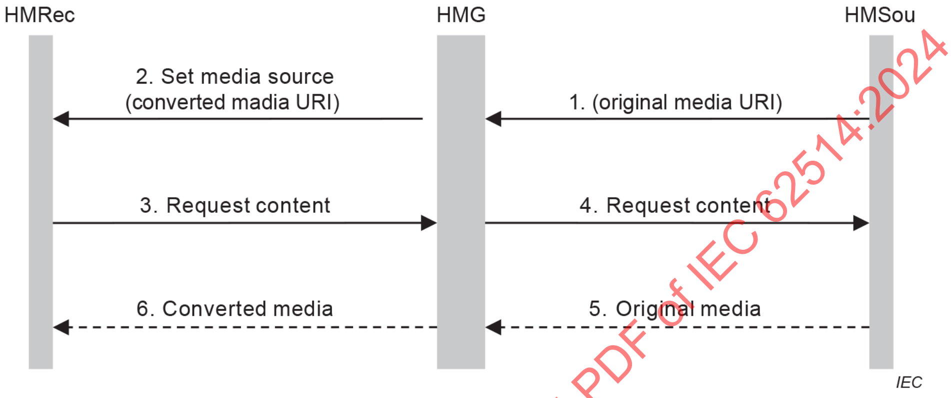

Figure 6 – HMSou actively sends media to HMRec

The HMSou and the HMRec can be located in different home networks. As a result, the HMG can be in the same home network as the HMSou or the HMRec. If the HMG and the HMSou are in the same home network, the HMSou can know the HMG address through automatic discovery or configurations. If the HMG and the HMSou are in different home networks, the HMRec shall notify the HMSou of the HMG address.

In order to support the HMSou requests media conversion workflow, HMGs are required to observe the following rules:

- The HMG shall support to convert the media format and expose all of them in the CDS.
- If the HMG cannot fulfil the conversion process, it shall notify the HMSou that the conversion service cannot be fulfilled.

In order to support the HMSou requests media conversion workflow, the HMSou should observe the following rules:

- The HMSou should send a Set Media Source request to the HMG when transmitting media contents. The request message from the HMSou may include the media code format, resolution and frame rate of the transmitted media contents, as well as the transport protocols used by the HMSou.

In order to support the HMSou requests media conversion workflow, HMRecs should observe the following rules:

- The HMRec should receive and interpret Set Media Source request properly and send Request Content to HMG accordingly.

6.2.2.2 Video clip

To video clip is to clip some parts from high-resolution video pictures and transmit them to a low-resolution media terminal. For example, in video surveillance, the resolution of the pictures provided by a camera might be 720 × 480. When a user views a picture taken by the designated cameras through a hand-held device, for example his mobile phone, the user needs to zoom out the picture, as the screen of the hand-held device is quite small; otherwise, the user can only see part of the picture. Besides, the media source does not need to send all original data to the hand-held device. The user can view part of the picture taken by the cameras to keep the high definition of the picture. If so, the system can clip the expected part of the original video picture and encode it before transmitting it to the hand-held device. As a result, the quantity of data transmitted can be reduced. The user can move the picture on the terminal and send commands to the HMG to update the coordinates of the clipped picture. When a camera is fixed, the user can view different parts of the picture. Because the uplink bandwidth of the home network is always small, the picture can be clipped and encoded before being transmitted. In this way, the uplink bandwidth can be saved, while loads on the access network and the public network can be lessened. Figure 7 shows the video clip applications.

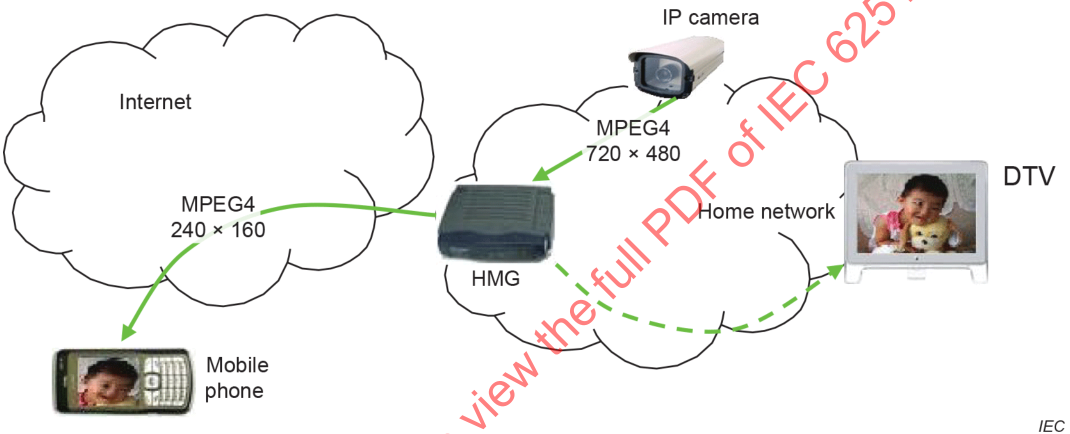

Figure 7 – Video clip

In order to support video clip applications, HMGs shall observe the following rules:

- HMGs can provide the video clip function. The service request message should include the relative coordinates and the scale of the video receiving terminal.
- HMGs should be able to quickly respond to the coordinates switching command sent by the terminal.

6.3 Multimedia stream control service

6.3.1 Requirements summary

- The HMG should be able to provide the AV media stream division service and divide the audio and video parts into two streams.
- The HMG should be able to provide the stream combination service and combine the video stream and the voice/audio stream into an AV stream.
- The HMG should be able to provide the media stream duplication service, which supports multiple player terminals to receive the same media content.
- The HMG should be able to use the Internet group management protocol (IGMP) to multicast media streams to provide the duplication function.
- The HMG should be able to duplicate unicast streams to provide the duplication function.
- The HMG should be able to provide the media stream redirection service.

6.3.2 Application mode

6.3.2.1 Stream division

Stream division is to separate the audio part from the video part of an AV media stream so that they can be transmitted through different channels. In a videophone stream, the voice stream is separated by the HMG from the video stream, the voice stream is transferred to videophone and the video stream is transferred to TV. In the stream division operation provided by the HMG, the audio part might not be converted into voice contents, but simply separated from the video part and transmitted. This process shall be executed according to the instructions of the device. Figure 7 shows the AV media stream division.

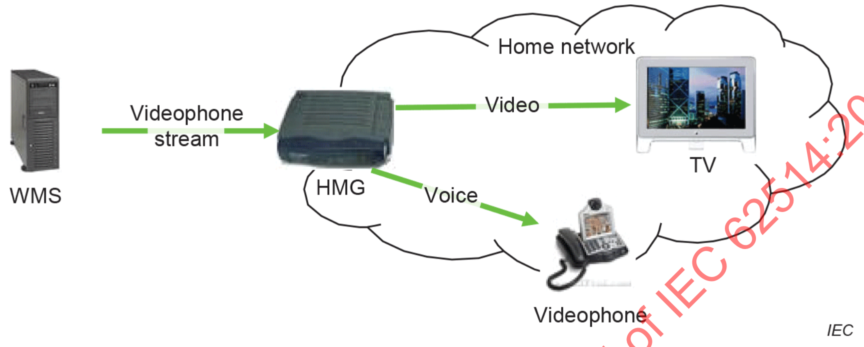
Home network
WMS
Videophone stream
HMG
Video
TV
Voice
Videophone
IEC

Figure 8 – AV media stream division

The stream division operation is a process in which the media receiver requests the media conversion service, see Figure 9.

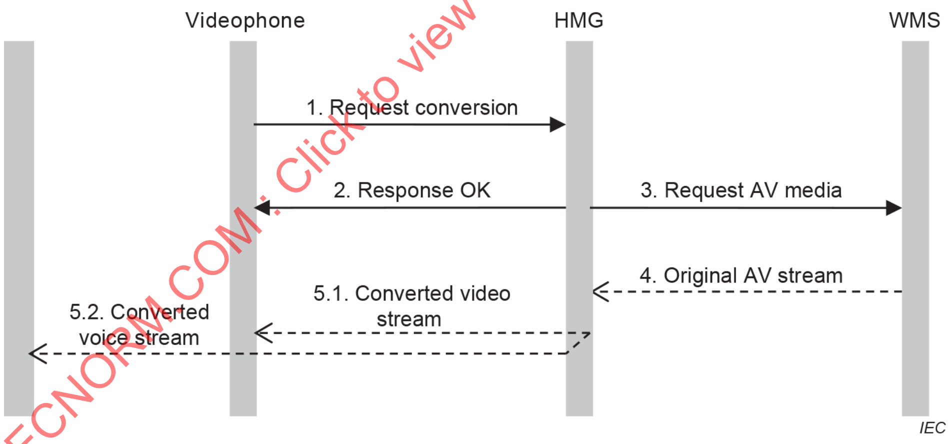
Videophone
HMG
WMS
1. Request conversion
2. Response OK
3. Request AV media
4. Original AV stream
5.1. Converted video stream
5.2. Converted voice stream
IEC

Figure 9 – Stream division process

Functions of an HMG in stream division process:

- The HMG should be able to provide the AV media stream division function and divide the audio part and the video part into two streams.
- The HMG should be able to convert audio streams into voice streams.
- The HMG shall set up channels with the videophone for video and voice transmission.
- The HMG shall be able to set up channels for video and voice transmission with the stream division service requester, and send video and voice to the service requester.
- If the HMG provides the stream division service, the stream division request message shall include the URI of the AV resources, needed video code format and voice code format.

Functions of a videophone in stream division process:

- The videophone shall be able to set up IP connections with the HMG.
- The videophone shall be able to request the stream division service from the HMG. The request message shall include the URI of AV resources.

6.3.2.2 Stream combination

Stream combination is the reverse of stream division. In video communications, the user might use a camera to capture a video stream and a videophone to capture a voice stream; the HMG should combine the video stream and the voice stream into an AV stream before forwarding it to the WMS.

Figure 10 shows the stream combination application.

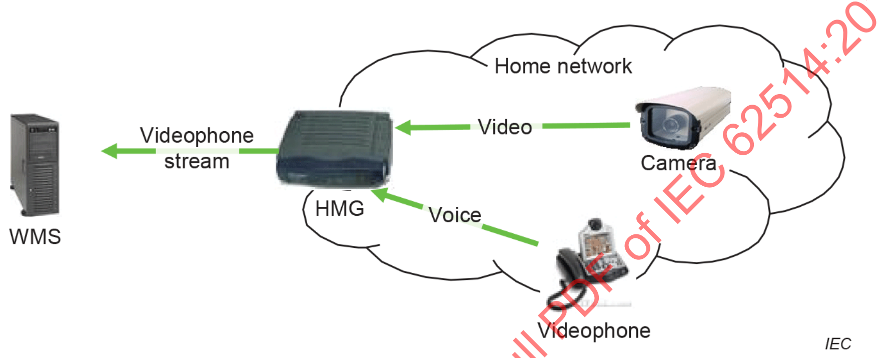
Home network
Videophone stream
Video
Camera
HMG
Voice
WMS
Videophone
IEC

Figure 10 – Combination of media streams

The stream combination operation is a process in which the media sender requests the media conversion service; see Figure 11.

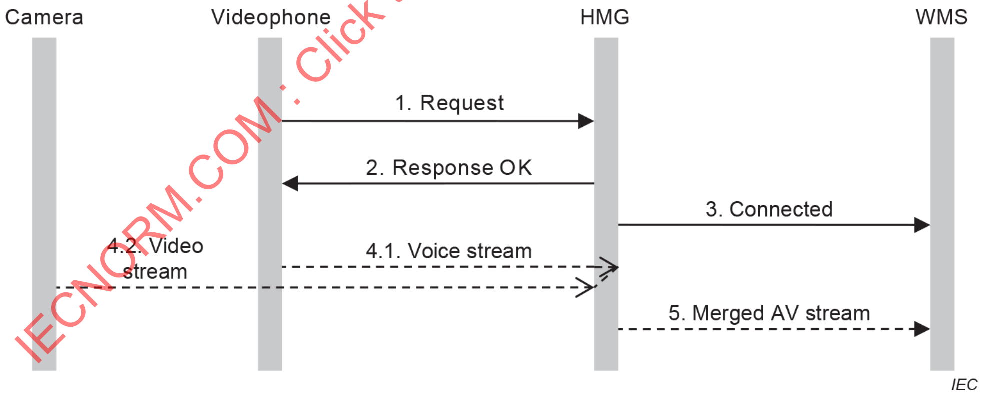
Camera
Videophone
HMG
WMS
1. Request
2. Response OK
3. Connected
4.2. Video stream
4.1. Voice stream
5. Merged AV stream
IEC

Figure 11 – Stream combination process

HMGs shall conform to the following items in the stream combination process:

- The HMG should be able to provide the function of combining video and voice streams into an AV media stream.
- The HMG shall be able to convert voice streams into audio streams.
- The HMG shall set up channels with the videophone for voice and video transmission.
- If the videophone does not indicate the audio and video code formats at the AV stream receiver in the stream combination request message, the HMG shall be able to interact with the AV stream receiver and obtain the code formats.

- If the HMG provides the stream combination service, it shall be able to set up channels for video and voice transmission with the stream combination service requester, and receive video and voice from the service requester.
- If the stream combination service requester does not specify the audio/video code formats used by the AV stream receiver in the stream combination request message, the HMG shall be able to interact with the AV stream receiver to get the code formats.

Videophones shall conform to the following items in stream combination process:

- The videophone shall be able to set up IP connections with the HMG.
- The videophone can request the stream combination service from the HMG. The request message shall include the address of the AV stream receiver and possibly the audio and video code formats needed by the receiver.

6.3.2.3 Duplication

Media stream duplication is to duplicate the transmitted media stream and send it to multiple receiving terminals. In general, the media server can support multicast protocols and support the preceding duplication operation. Nevertheless, if the media stream is to be converted, the HMG becomes the last multicast node on the multicast path and converts the media stream before sending it to multiple terminals. The HMG can also duplicate the media stream through the multicast technology of the application layer, thus generate multiple unicast streams. When different receiving terminals need different codes, resolutions and transport protocols, the HMG shall duplicate the media stream separately and send them after conversion. Figure 12 shows application for duplication of media streams.

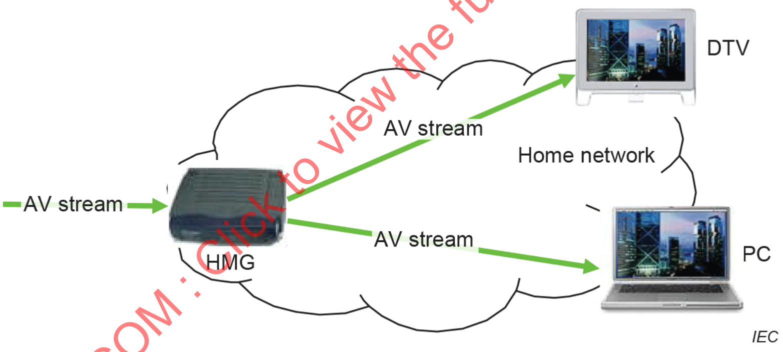

Figure 12 – Duplication of media streams

The duplication operation can be regarded as an application terminal joining a multicast group. There may be two cases:

- the original media stream passes through the HMG;
- the original media stream does not pass through the HMG.

In the first case, the duplication operation occurs on the HMG and can be easily fulfilled. In the second case, if the media server does not support the duplication operation, considerations shall be made about how to redirect the media stream to the HMG.

In user operations, there are two cases that can lead to the duplication of the media stream. Suppose HMRec1 is playing a programme, while the media stream shall be duplicated to HMRec2.

- The user operates HMRec1. The user browses the list of players and selects HMRec2. HMRec2 can be used to watch the programme being played by HMRec1.
- The user operates HMRec2. The user browses the list of programmes and selects the programme being played. Both HMRecs can play the same programme simultaneously. The user can browse the list of players on HMRec2 and select HMRec1 to join the multicast group of the programme being played on HMRec1.

In either of the above operations, if the media stream passes through the HMG, operation commands will be sent to the HMG, which directly duplicates the media stream to HMRec2. If the media stream does not pass through the HMG, operation commands shall also be sent to the HMG. This can avoid the situation in which the media server does not support duplication operations, for example, ordering programmes on the WAN media server. In this case, the media stream shall be switched to the HMG and forwarded from the HMG to HMRec1. Then the media stream can be duplicated to HMRec2. That is to say, if the media stream does not pass through the HMG, operations shall be done so that the media stream passes through the HMG.

Figure 13 and Figure 14 show how HMRec1 duplicates the media stream to HMRec2 and how HMRec2 requests to join the multicast group of the programme being played on HMRec1, in the case of the original media stream passing through the HMG. HMRec1s and HMRec2s that support the DMC function of DLNA can satisfy both the flows in Figure 13 and Figure 14.

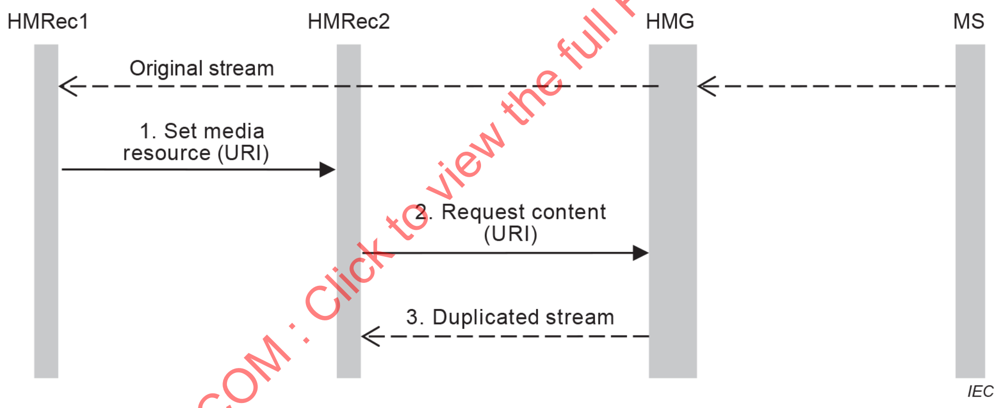
HMRec1
HMRec2
HMG
MS
Original stream
1. Set media resource (URI)
2. Request content (URI)
3. Duplicated stream
IEC

Figure 13 – HMRec1 duplicates media stream to HMRec2

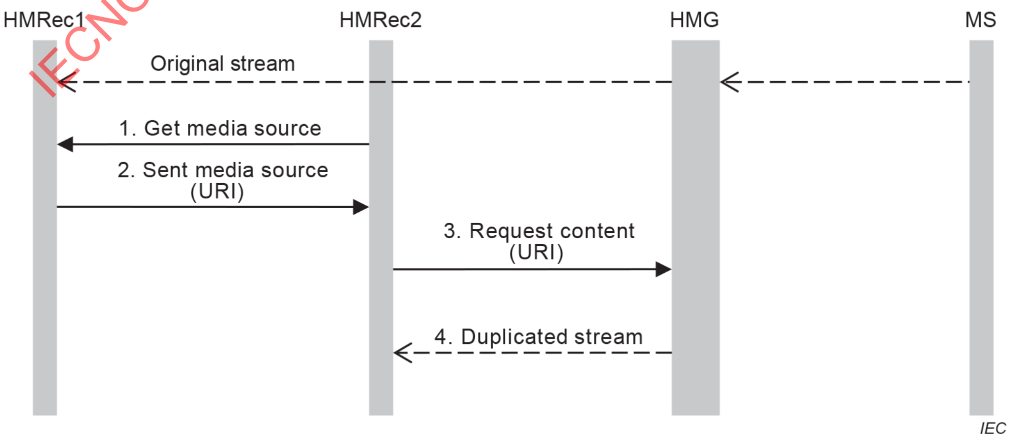
HMRec1
HMRec2
HMG
MS
Original stream
1. Get media source
2. Sent media source (URI)
3. Request content (URI)
4. Duplicated stream
IEC

Figure 14 – HMRec2 requests to join the multicast group of the program being played on HMRec1

Figure 15 shows how HMRec1 requests the duplication of the media stream to HMRec2 if the original media stream does not pass through the HMG. Steps 1 to 4 are similar to the process of requesting the media conversion shown in Figure 3. Here, the HMG is not used for media conversion. The media stream passes through the HMG to facilitate duplication operations. The request message in step 1 shall include the URI of the programme being played and the position of contents played. Here, the media conversion request message can be used. The media format and other parameters needed by HMRec1 are completely consistent with the parameters provided by the MS. In the media conversion request, a parameter can be added to indicate the start position of playback. When the HMG requests media contents from the MS in step 2, this position information shall be included in the request message. Then the MS shall send contents to the HMG from the designated position. An HMRec1 that supports the DMC function of DLNA can satisfy the flow in Figure 14.

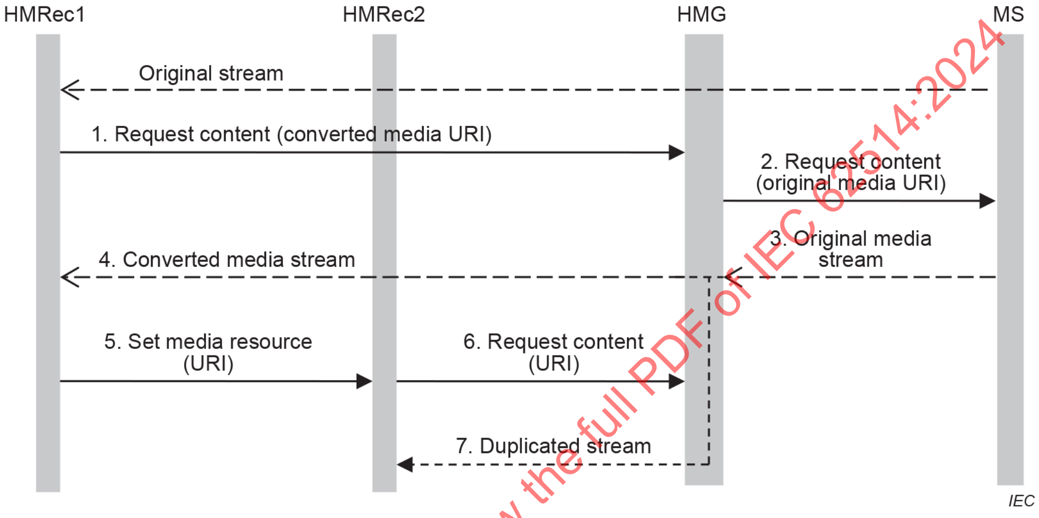
HMRec1
HMRec2
HMG
MS
Original stream
1. Request content (converted media URI)
2. Request content (original media URI)
3. Original media stream
4. Converted media stream
5. Set media resource (URI)
6. Request content (URI)
7. Duplicated stream
IEC

Figure 15 – HMRec1 requests media stream from HMG and duplicates media stream to HMRec2

Before step 1, HMRec1 shall terminate the media transmission connection with the MS. This procedure is not included in Figure 15. Because HMRec1 needs to receive subsequent media contents from the HMG after terminating the connection with the MS, the playback on HMRec1 will be interrupted temporarily during the duplication process.

Like the defect of the media conversion method shown in Figure 4, the method shown in Figure 15 cannot be realized if DRM, device authentication or user identity authentication is involved. Figure 16 shows the duplication process by requesting media redirection, which is similar to Figure 5. The request messages in step 3 and step 5 shall include the stream position information. An HMRec1 that supports the DMC function of DLNA can satisfy the flow in Figure 16.

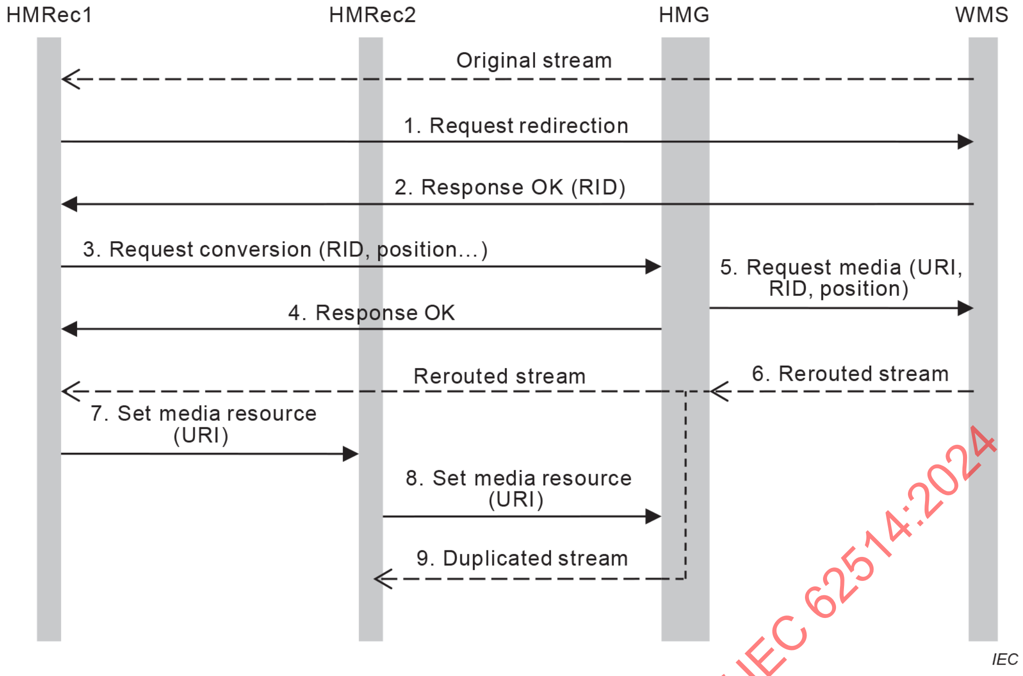
HMRec1
HMRec2
HMG
WMS
Original stream
1. Request redirection
2. Response OK (RID)
3. Request conversion (RID, position...)
4. Response OK
5. Request media (URI, RID, position)
Rerouted stream
6. Rerouted stream
7. Set media resource (URI)
8. Set media resource (URI)
9. Duplicated stream
IEC

Figure 16 – HMRec1 duplicates media stream to HMRec2 after requesting MS to redirect media stream to HMG

If the original media stream does not pass through the HMG, HMRec2 can request to join the multicast group of the media stream being played on HMRec1. If DRM and authentication are not considered, the process shown in Figure 16 can be adopted, but request messages are all sent by HMRec2. If DRM and authentication are taken into consideration, HMRec2 shall first log on to the MS for authentication; the HMRec2 can adopt the process shown in Figure 16; request messages are all sent by HMRec2.

The functions of the HMG are described below:

- The HMG shall be able to provide the media stream duplication function and support multiple player terminals to share the same media contents.
- The HMG should be able to use the Internet group management protocol (IGMP) to multicast media streams so as to provide the duplication function.
- The HMG should be able to duplicate unicast streams to provide the duplication function.
- If the HMG supports the duplication function, it shall support direct duplication when the original media stream passes through the HMG.
- If the HMG supports the duplication function, it shall support the duplications if the original media stream does not pass through the HMG.
- If the HMG supports the duplication function, it shall support the request of the original media stream receiver for duplicating the media stream to other terminal devices.
- If the HMG supports the duplication function, it shall support the request of the terminal device for joining the existing multicast group of a media stream.
- If the HMG supports the duplication function, it shall support the media stream redirection.
- If the HMG supports the duplication function, it shall support exceptional conversion operation, which is the forwarding of the media stream without conversion.
- If the HMG provides the duplication service, when the original media stream receiver requests to duplicate the media stream to other terminals, the duplication operation can succeed even if the destination terminal device is off. After the destination terminal device is turned on, it will automatically receive duplicated media streams.

6.3.2.4 Redirection

The redirection operation is to change the transmission destination of the media stream to another device, as shown in Figure 17. The user shifts the programme to redirect the media stream from the DTV to the PC. The bookmark technology is adopted to suspend the playback of the redirected media stream. When the user moves to a new media receiving terminal, the user can perform a simple operation to resume playing the paused programme.

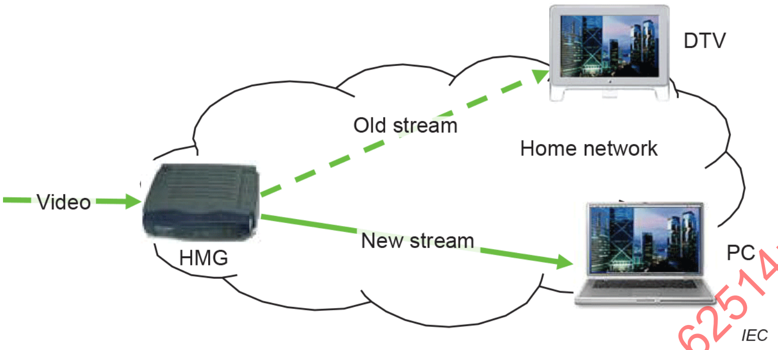

Figure 17 – Media stream redirection

Figure 17 shows the redirection of the original media stream when it passes through the HMG. Authentication is also considered in the process. First of all, HMRec1 sends a request redirection message to the HMG. The message shall include the temporary URI of media contents allocated by the HMG to HMRec1. Upon receiving the request message, the HMG saves the media stream location information and sets a bookmark. It terminates the media stream under transmission. HMRec2 can get the bookmark from the HMG. After media redirection, HMRec2 shall show the user that the programme is paused and display the last picture at pause. The HMRec1 and HMRec2 that support the DMC function of DLNA can satisfy the flow in Figure 17. The HMRec1 and HMG that support the DMR function of DLNA can get and record the status of media, so they can support the media redirection function.

Figure 18 shows the HMRec1 requests to redirect a media stream to HMRec2.

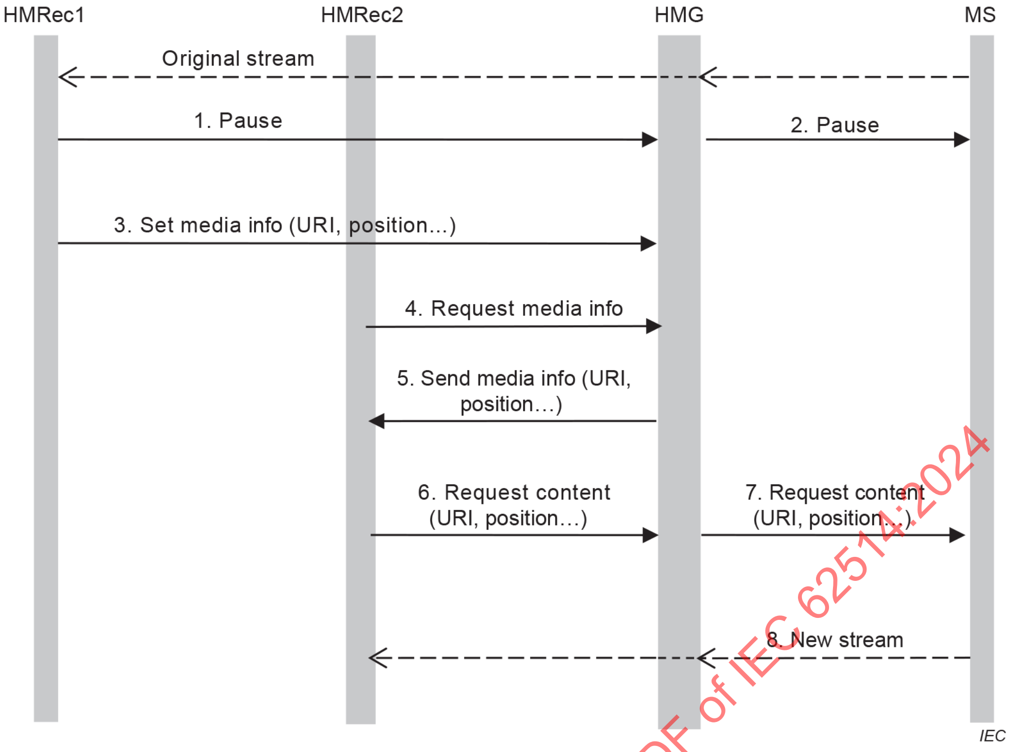
HMRec1
HMRec2
HMG
MS
Original stream
1. Pause
2. Pause
3. Set media info (URI, position…)
4. Request media info
5. Send media info (URI, position…)
6. Request content (URI, position…)
7. Request content (URI, position…)
8. New stream
IEC

Figure 18 – HMRec1 requests to redirect media stream to HMRec2

Functions of the HMG and the destination device in redirection are as follows:

- If the HMG provides the media stream redirection service, the redirection operation can be conducted even when the destination device is off.
- If the HMG successfully redirects a media stream, the position where the media stream pauses shall be recorded.
- If the HMG successfully redirects a media stream, the last picture at pause shall be sent to the destination device of the redirection.
- If the redirection operation is successful, the destination device of the redirection shall support the HMG to continue transmitting the media stream through the play operation.

6.3.2.5 Adaptive processing

6.3.2.5.1 General

Adaptive processing refers to the HMG parameter conversion capability of media streams according to the receiver's capabilities and network environments, including resolution, bit rate and encapsulation format. Figure 19 displays an AV stream delivered to HMRec1 from MS and then redirected to HMRec2 with the parameter adjusted through HMG. This operation is under certain conditions. The conversion of resolution is only applicable to the conversion from high to low; the conversion of bit rate is only applicable to the conversion from high to low; and the conversion of the encapsulation format is not restricted. Figure 19 shows the technical workflow of the HMG adaptive processing operation.

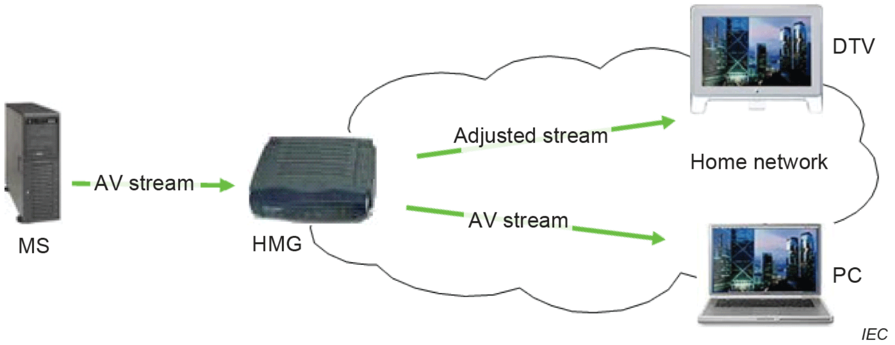
DTV
Adjusted stream
Home network
MS
AV stream
HMG
AV stream
PC
IEC

Figure 19 – Adaptive processing of HMG

6.3.2.5.2 HMG adaptive process media stream to HMRec2

Figure 20 shows the process of HMG adaptively process the media stream displayed on HMRec1 and delivered converted media to HMRec2. It is supposed that:

- the HMG stores capabilities of all HMRec;
- the original media is delivered from MS to HMG and HMRec1.

The process is as follows:

1. The MS sends original media stream to HMG and HMRec1 and the HMRec1 sets targeted media stream info to HMG.
2. The HMRec2 sends request to HMG for the same media info displayed in HMRec1.
3. The HMG accepts the request from HMRec2 and the media info from HMRec1, and processes the media stream parameters based on the capability of HMRec2. The HMG then sends back the converted media stream to HMRec2.

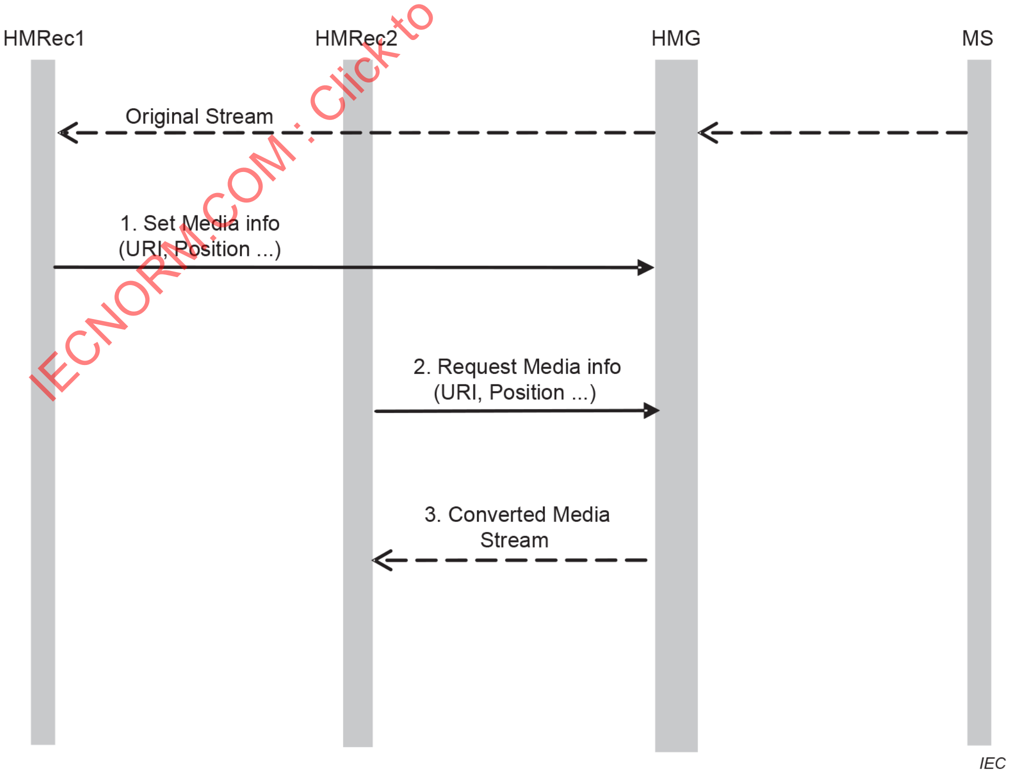
HMRec1
HMRec2
HMG
MS
Original Stream
1. Set Media info
(URI, Position ...)
2. Request Media info
(URI, Position ...)
3. Converted Media
Stream
IEC

Figure 20 – HMG adaptive process media stream to HMRec2

6.3.2.5.3 HMRec requests HMG to adaptive process media stream based on the network environment

The workflow in Figure 21 displays the process of the HMRec requesting the media stream from the HMG and the HMG processing the stream based on the HMRec network environment. It is supposed that:

- the HMG is able to detect the network environment of the HMRec;
- the HMG is able to convert the media stream based on the network environment of the HMRec.

The process is as follows:

1. the HMRec sends a request content message to the HMG;
2. the HMG forwards to request content message to MS;
3. the MS accepts the request and sends the original media to the HMG;
4. the HMG sends a request to detect the network environment of the HMRec;
5. the HMRec replies to the HMG with network information;
6. the HMG makes adjustments on the media based on the network condition of the HMRec and then sends the HMRec the converted media stream.

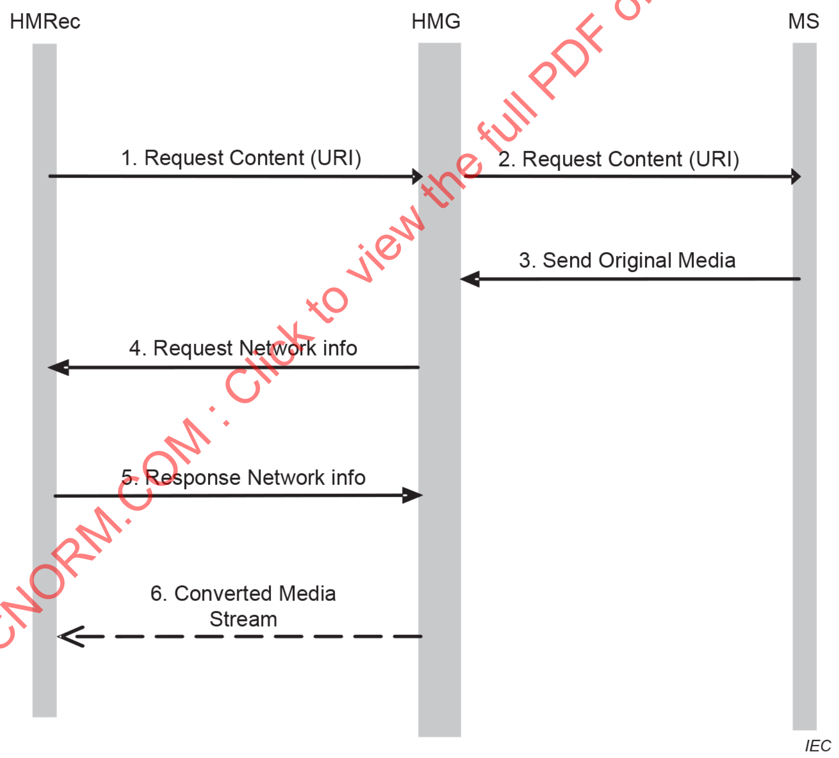

Figure 21 – HMRec requests HMG to adaptive process media stream based on the network environment

6.3.2.5.4 HMG requests specific parameters from MS

Figure 22 shows the process used by the HMG to detect HMRec network info and request media with specific parameters from MS. It is supposed that:

- the HMG is able to detect the network environment of HMRec;
- the HMG is capable of requesting media content with specific parameters from the MS based on the network condition that HMRec is in.

The process is as follows:

1. the HMRec requests content from HMG;
2. the HMG accepts the request and sends a network information request to HMRec;
3. the HMRec accepts the request and sends network information to the HMG;
4. the HMG determines the media stream parameters that fit the HMRec based on the HMRec network information and device capability. After that, HMG requests content with specific parameters from the MS;
5. the MS accepts the request and sends converted media stream to HMRec.

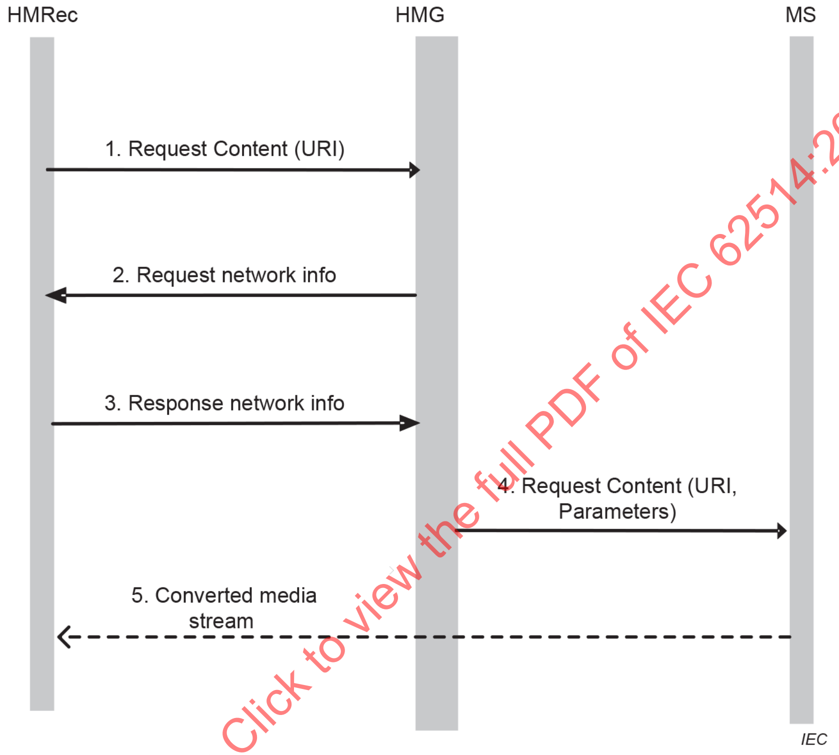

Figure 22 – HMG requests specific parameters from MS

Therefore, the HMG adaptive processing functions are as follows:

- The HMG shall be able to convert multimedia sent from the MS based on the receiver's ability.
- The HMG shall be able to convert multimedia sent from the MS based on the network environment of the HMRec.
- The HMG shall be able to request multimedia with specific parameters from the media source.

6.3.2.6 Remote processing

6.3.2.6.1 General

Remote processing is the capability to setup remote access (media stream outward sharing, inward sharing, etc.) between home media devices and remote media devices (i.e. WMR or WMS outside the home network). This operation has requirements for the HMG, the WMS and the WMR, and authentication among them is required in this process. Figure 23 is the process of the PC in the home network sharing the media stream to the mobile phone in WAN through an app and Figure 24 is the process of the mobile phone in WAN inwardly sharing a media stream to the DTV at home through the HMG.

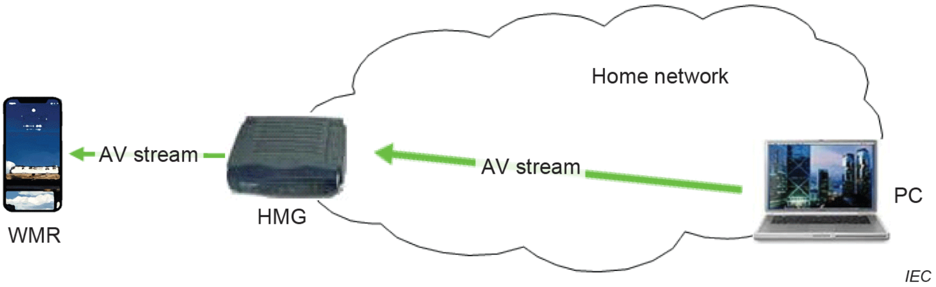

Figure 23 – Outward remote sharing from HMSou to WMR

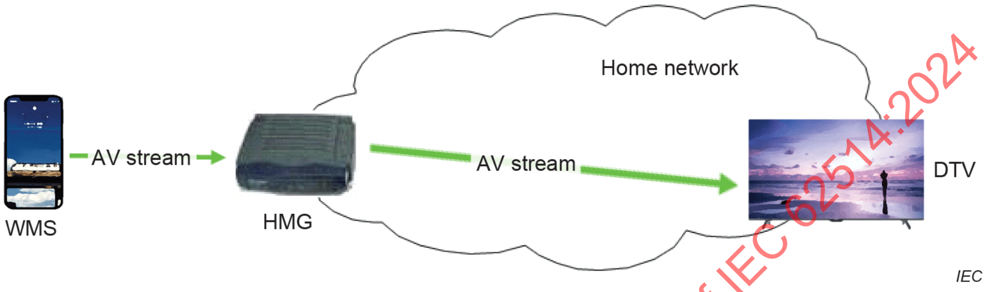

Figure 24 – Inward remote sharing from WMS to HMRec

6.3.2.6.2 WMR requests content from HMSou for outward remote sharing

Figure 25 shows the process of WMR requesting content from the HMSou. Here, it is supposed that:

- the WMR has obtained the URI of the needed media resources;
- the WMR might have obtained the code format, resolution and frame rate of the needed media resources;
- the WMR might have known the media transport protocol used by the media sender;
- the WMR needs the conversion service;
- the WMR has finished necessary DRM authentication and device authentication with the WMS.

The process is as follows:

1. The WMR sends content request message to HMSou, which includes:
   - the URI of the media resources on the HMSou requested by the WMR.
2. The HMSou satisfies the request of the WMR and allocates an RID in the response message.
3. The WMR receives the RID and sends a request conversion message to the HMG, which includes:
   - the URI of the media resources on the HMSou requested by the WMR;
   - the media code format, resolution and frame rate needed by the WMR;
   - media transport protocols supported by the WMR;
   - RID allocated by the HMSou.
4. If the HMG can accept the request, it then sends a message to the WMR, indicating that the request is accepted; otherwise the HMG shall send a message to refuse the request.
5. The HMG requests the media resources needed by the WMR from the HMSou. The request message shall include the RID and the URI of the media resources on the HMSou requested by the HMRec; or the RID shall be sent back upon the request of the HMSou.

6. The HMSou accepts the request of the HMG after authenticating the RID. Then it sends the original media stream to the HMG.
7. The HMG converts the media stream and sends the converted media stream to the WMR according to the media code format, resolution and frame rate needed by the WMR.

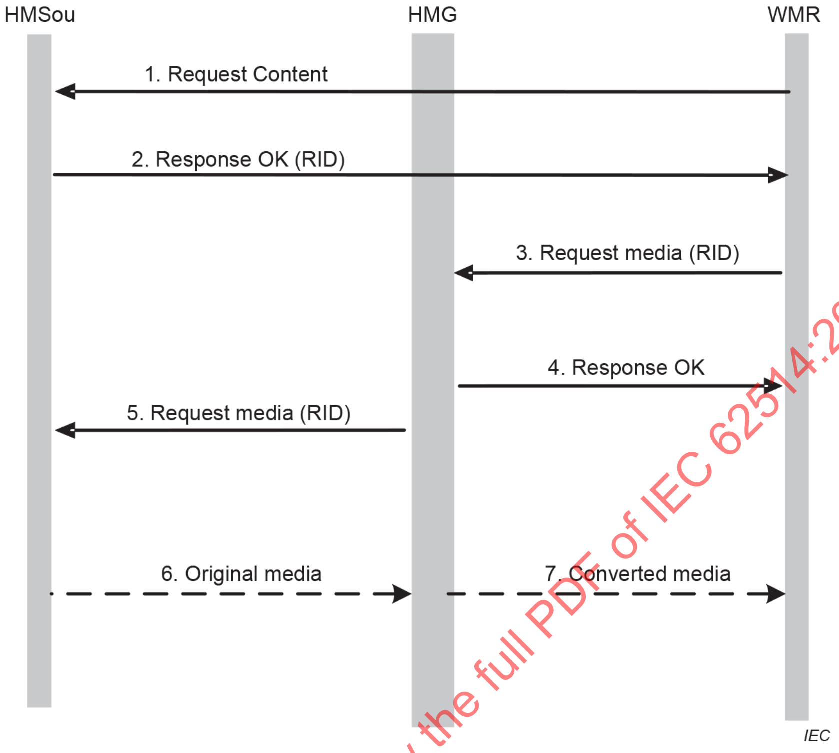

Figure 25 – WMR requests content from HMSou for outward remote sharing

6.3.2.6.3 Outward remote sharing from HMSou to WMR

There is another occasion which actively sets the media resource from home media device to the device in the WAN, which is presented in Figure 26. Here, it is assumed that:

- the original stream is delivered from the HMSou to the WMR through the HMG;
- the WMR has finished necessary DRM authentication and device authentication with the HMSou;
- the WMR might have known the media transport protocol used by the HMSou;

The process is as follows:

1. The HMSou sends media share request message to the WMR for media duplication.
2. The WMR satisfies the request and allocates an RID in the response message.
3. The HMSou sends set media resource message to the HMG, indicating the media resource to be duplicated. The message may include:
   - the URI of the media resources on the HMSou requested by the WMR;
   - the RID allocated by the HMSou.
4. The HMG sends the set media resource message received from the HMSou to the WMR, indicating which media resource from the HMSou is about to be duplicated.
5. The WMR then sends a request content message to the HMG.
6. If the HMG accepts the WMR request, it then sends a message to the WMR, indicating that the request is accepted; otherwise, the HMG shall send a message to refuse the request.

7. The HMG requests the media resource from the HMSou with a defined URI and a defined RID in the message.
8. The HMSou accepts the HMG request and sends the original media as a response.
9. The HMG receives the original media and sends the duplicated media stream to the target WMR.

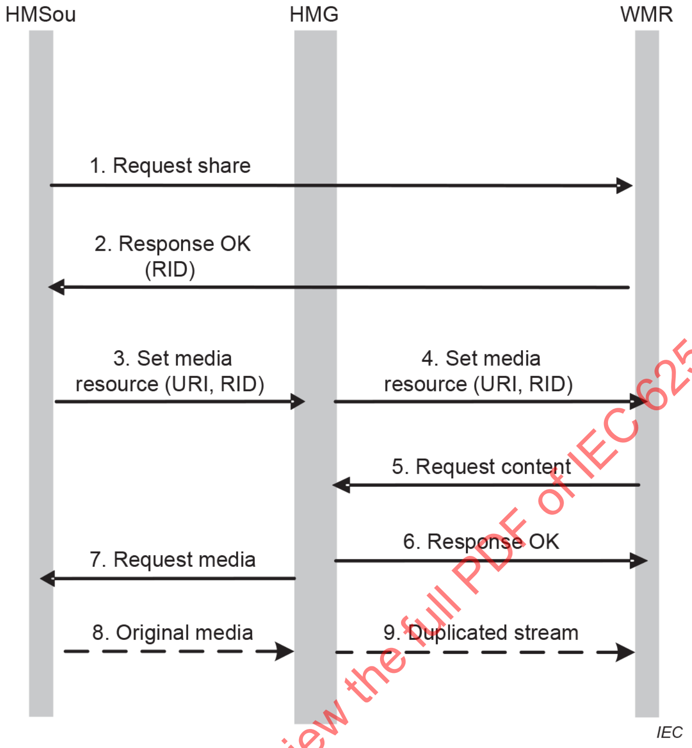
HMSou
HMG
WMR
1. Request share
2. Response OK (RID)
3. Set media resource (URI, RID)
4. Set media resource (URI, RID)
5. Request content
6. Response OK
7. Request media
8. Original media
9. Duplicated stream
IEC

Figure 26 – Outward remote sharing from HMSou to WMR

6.3.2.6.4 Inward remote sharing from WMS to HMRec

Inward sharing refers to the media device in WAN shares media stream to device in LAN through HMG. Figure 27 shows the process of inward remote sharing from the WMS to the HMRec. Here, it is supposed that:

- the HMRec might have obtained the code format, resolution and frame rate of the needed media resources;
- the HMRec might know the media transport protocol used by the media sender;
- the HMRec has finished necessary DRM authentication and device authentication with the WMS.

The process is as follows:

1. The HMRec sends a request duplication message to the WMS.
2. The WMS satisfies the request of the HMRec and allocates an RID in the response message.
3. The WMS sends a set media resource message to the HMG, which includes:
   - the URI of the media resources on the WMS requested by the HMRec;
   - the media code format, resolution and frame rate needed by the HMRec;
   - media transport protocols supported by the HMRec;
   - RIDs allocated by the WMS.
4. If the HMG can accept the conversion request, it can send a message to the HMRec indicating that the request is accepted; otherwise, the HMG shall send a message to refuse the request.

5. The HMRec sends request media content message to HMG. The request media content message may include the URI of the media resources needed by the HMRec from the WMS.
6. The HMG responds OK if it accepts the request; otherwise, it shall send a refusal message as a reply.
7. The HMG then sends a request media message with RID to WMS.
8. The WMS accepts the request of the HMG after authenticating the RID. Then it sends the original media stream to the HMG.
9. The HMG converts the media stream and sends the duplicated media stream to the HMRec.

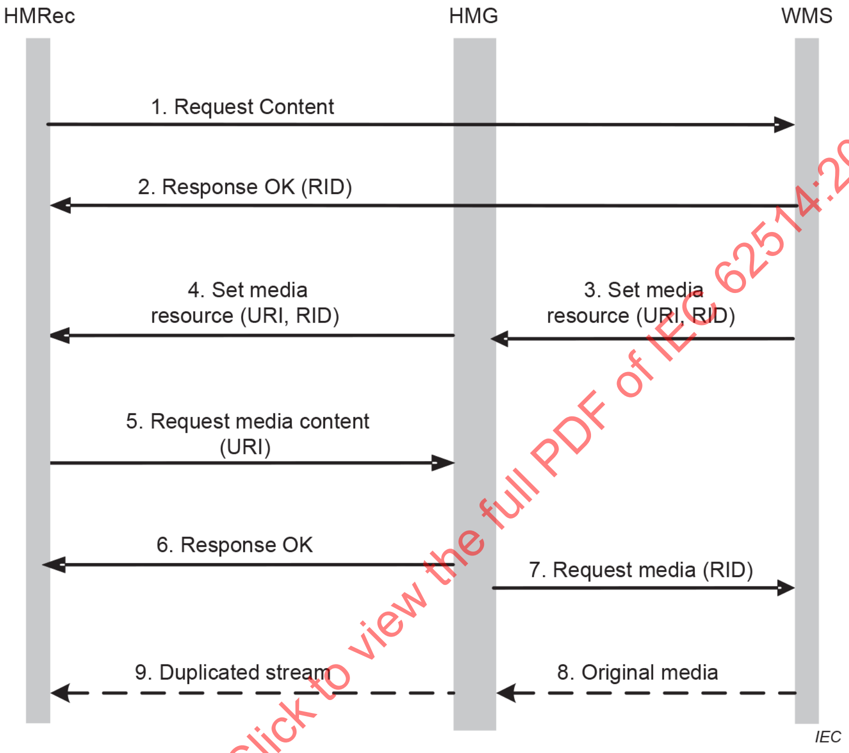
HMRec
HMG
WMS
1. Request Content
2. Response OK (RID)
4. Set media resource (URI, RID)
3. Set media resource (URI, RID)
5. Request media content (URI)
6. Response OK
7. Request media (RID)
9. Duplicated stream
8. Original media
IEC

Figure 27 – Inward remote sharing from WMS to HMRec

The functions of HMG remote processing shall observe the following items:

- the HMG shall be able to detect if media receiver is in LAN;
- the HMG shall store the symmetric key and share with WMR and WMS;
- the HMG shall encrypt outward data with key;
- the HMG shall decrypt inward data with key.

The functions of the WMS and the WMR shall observe the following items:

- If the WMS share media content to the home network, it shall indicate the receiver;
- If the WMR requests media content, it shall indicate the media source;
- The WMS and WMR shall be able to store the key shared with HMG;
- The WMS and WMR shall be able to encrypt inward data with key;
- The WMS and WMR shall be able to decrypt outward data with key.

6.3.2.7 Playing jump control

6.3.2.7.1 General

HMGs shall be able to support media content playing jump control function. When the HMRec specifies the progress bar position, the HMG returns the corresponding media stream according to it. If the targeted media content is stored locally in the HMG, the media content will be directly returned to the HMRec; otherwise, the corresponding media content will be requested from the MS. Figure 28 shows the process of the HMG executing the play jump control for the PC's request. The interaction between the MS and the HMG is not mandatory if the HMG has the requested media resource. In Figure 29, the request message in step 1 shall include the URI of the media content being played and the designated progress bar position. In Figure 30, When the HMG requests media contents from the MS, the position information should be included in the request message. Then, the MS sends contents to the HMG from the designated position and the HMG operates the media content adjustment.

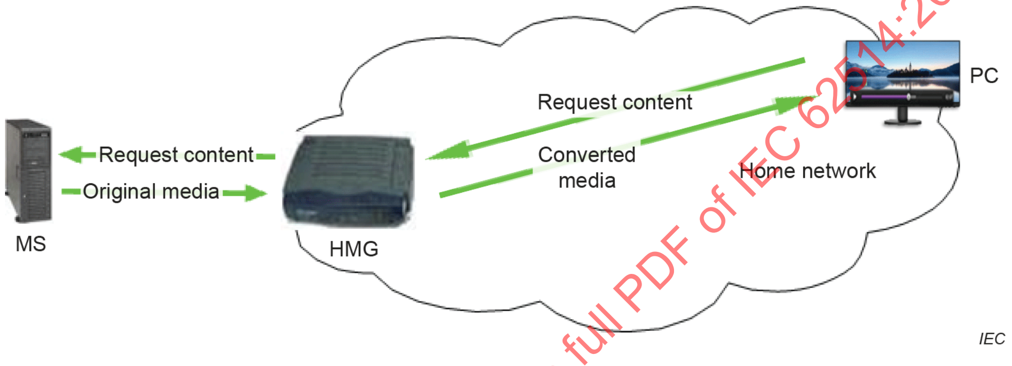

Figure 28 – Media play jump control

6.3.2.7.2 Media content targeted by progress bar returned from HMG

Figure 29 shows the HMRec request later or earlier content of the media stream, then the HMG returns the content it already cached or stored. It is supposed that:

- the original stream is delivered from the MS to the HMRec through the HMG;
- the HMG caches or stores the targeted media resource.

The process is as follows:

1. The HMRec sends request content message to the HMG with information of progress bar position and media URI.
2. The HMG accepts the request and searches the cached or stored content internally. The HMG sends back the converted media stream to the target HMRec.

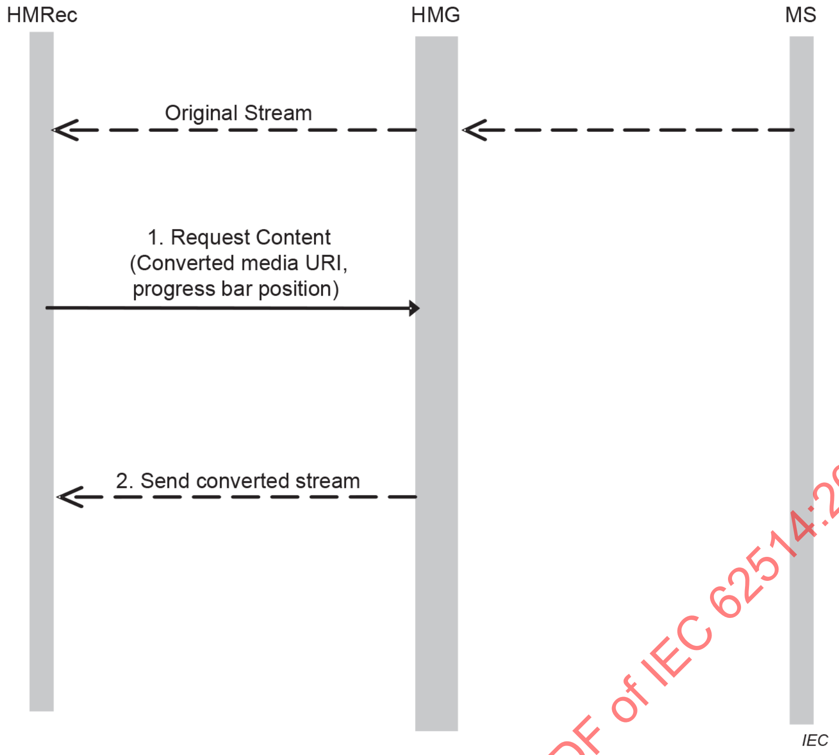
HMRec
HMG
MS
Original Stream
1. Request Content
(Converted media URI,
progress bar position)
2. Send converted stream
IEC

Figure 29 – Media content targeted by progress bar returned from the HMG

6.3.2.7.3 Media content targeted by progress bar returned from MS

Figure 30 shows the HMRec request later or earlier content of the media stream, then the HMG requests the content from the MS, which then sends back the original media to the HMG, which supposes that:

- the original stream is delivered from the MS to the HMRec through the HMG;
- the HMG does not cache or store required media resources and it needs to request content from the MS.

The process is as follows:

1. The original stream is delivered from the MS to the HMRec through the HMG. The HMRec sends a request content message to the HMG.
2. In this condition, the HMG does not have the required content, therefore the HMG continues to send a request content message to the MS.
3. The MS delivers the original media to the HMG and the HMG then does the media conversion.
4. The HMG sends the converted media to the HMRec as requested.

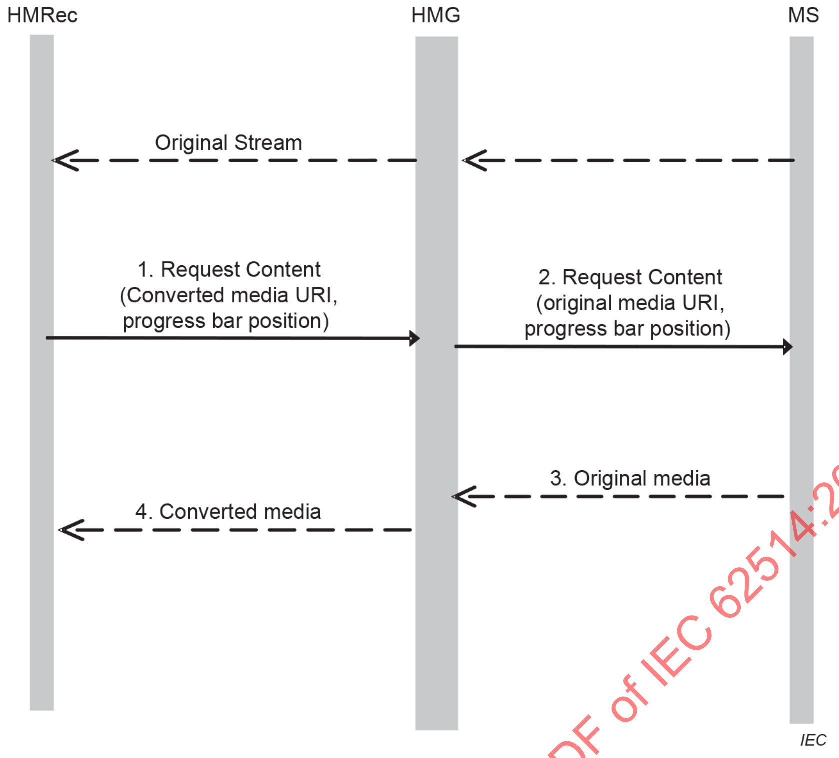

Figure 30 – Media content targeted by progress bar returned from MS

Requirements for HMG jump control are as follows:

- the HMG shall be able to provide the jump control function for the media stream;
- the HMG shall search the content cached or stored in it; if there is no requested content, the HMG should request media contents from the MS.

6.3.3 Content directory service

6.3.3.1 Overview

Media resources might come from multiple devices or channels. To guarantee a good user experience, the user shall access the resources from a uniform portal. IEC 62481-1 has proposed the concept of a virtual media server, which is used to provide a unified content directory. This document will expand the so-called "media resources" so that they are not restricted to media contents. Printers and surveillance cameras are also accessible media resources rather than merely devices.

6.3.3.2 Unified content directory

In a home network, media contents might exist in multiple devices, for example one or several home media servers, STBs with hard disks, laptops, digital cameras or video cameras, and mobile phones that can take pictures. When searching for media contents in the home network, the user might want to see a unified content directory, which classifies contents according to a certain method. The user can query contents by category or key words, instead of searching all devices. In this way, the user can have a pleasant experience. This task can be enabled by the HMG. The HMG collects all possible media contents in the home network and presents them to the HMRec in the unified directory mode. The HMRec needs to connect to the HMG to access this unified directory. Moreover, the HMG can contain the directory of contents on registered media servers, for example the electronic programme guide (EPG) for IPTV.

By combining media content directories on various media source devices, the directory service of the HMG provides single directory ingress for the HMRec, which can order media programmes in all positions. When the HMRec searches for a programme in the home network, it first accesses the unified directory provided by the HMG, browses the programmes and makes a selection. In this process, the HMRec can know the encoding and decoding formats, resolution and frame rate of the selected media programme. The HMG can know the playback capability of the HMRec. When the HMRec decides to play the programme, it can send the media data through the HMG. If no data conversion is needed, the HMRec can directly obtain media data from the media source device according to the URI of the media content provided by the HMG. When the HMRec decides to play the programme, if the HMG knows that the HMRec cannot play the selected media contents, the HMG redirects the URI provided to the HMRec to the HMG itself. The HMRec requests the selected contents from the HMG, then the HMG requests the contents from the actual media owner and sends them to the HMRec after conversion. On the contrary, if the HMG knows that the HMRec can directly play the selected media contents, it redirects the URI provided to the HMRec to the media content owner, and the HMRec requests the selected media contents from the media owner.

Figure 31 shows the preceding process in which the HMG needs to implement media conversion. During this process, the HMRec does not request the media conversion service from the HMG, because the URI provided by the HMG to the HMRec points to the HMG. In this case, the HMRec can regard the HMG as the provider of media contents in the designated format.

If the URI provided by the HMG to the HMRec points to the HMSou, the HMRec can request the media conversion service from the HMG, if it obtains media contents from the HMSou but cannot play the contents. In this case, the process as described in Figure 4 should apply.

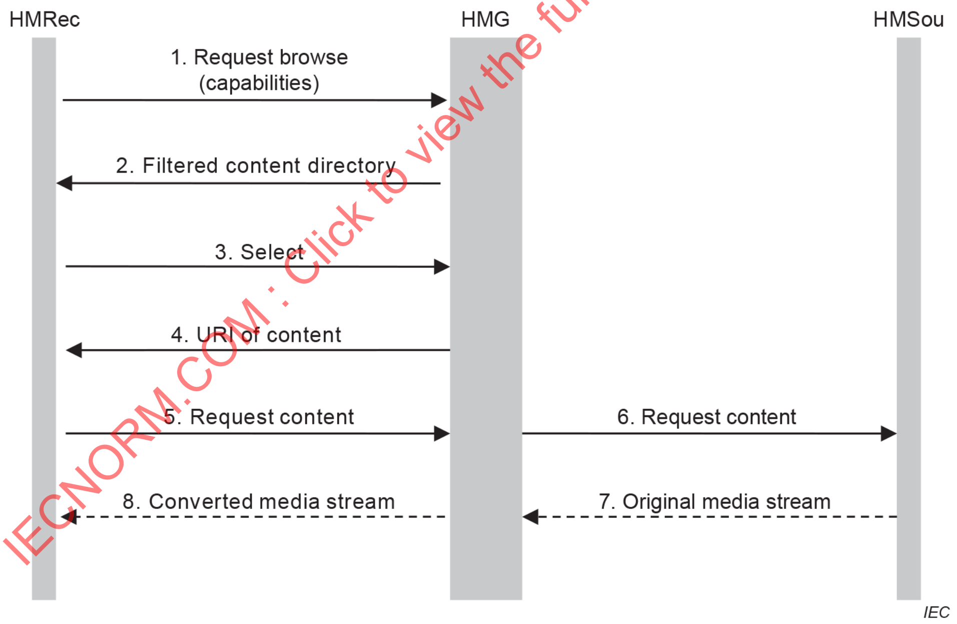

Figure 31 – HMRec selects media contents through the directory service of HMG

When the HMRec accesses the directory service of the HMG, the HMG can know the type of media services played by the HMRec. The directory only shows the media types that can be played by the HMRec, as indicated by steps 2, 3 and 4 in Figure 31. For example, for an electronic photo frame that only plays photos, the HMG merely presents the collected photos to the photo frame; for an MP3 player, the HMG presents music media contents.

The HMG shall support the following functions:

- The HMG should provide the unified directory service.
- The HMG should be able to collect media contents from various media devices in the home network to form a unified directory.
- The HMG should be able to classify media contents according to various standards, including the content type, content creation time, content creator, content author, and content title.
- The HMG should be able to query contents according to key words.
- If the HMG detects that the HMSou can directly provide the contents requested by the HMRec without conversion, the URI provided by the HMG to the HMRec can point to the HMSou; otherwise, the URI points to the HMG. In this case, the HMG should actively obtain contents from the device that contains the selected media contents and transmit the contents to the HMRec after conversion.
- The HMG should filter all media contents according to the media types requested by the HMRec and present the directory of filtered contents to the HMRec.
- The HMSou should provide the directory query interface, media content directory and contents.
- The HMRec should be able to automatically connect to the HMG to access its directory and browse the directory.

6.4 Media format

The media format requirements shall fully support the specification of IEC 62481-2.

What specific media format is applicable depends on the application case. Table 1 displays mandatory and optional formats for each media class.

In order to establish the actual interoperability, IEC 62481-2 defines profileIDs which specify various parameters of those codecs. The serving endpoints, such as HMSou and HMG, expose profileIDs which they support and the rendering endpoints, such as HMSou and HMRec, use those profileIDs to identify the rendering capabilities.

Table 1 – Mandatory and optional media formats

Media class	Mandatory format set	Optional format set
Images	JPEG	GIF, TIFF, PNG
Audio	LPCM (2 channel), MP3 and MPEG4 AAC LC	WMA9, AC-3, MPEG2 AAC, ATRAC3plus, MPEG4 (HE AAC, AAC LTP, BSAC), AMR, ATRAC3plus, G.726, WMA, LPCM
Video	MPEG2, MPEG4 AVC (AAC LC Assoc Audio)	MPEG1, MPEG4, WMV9, VC1, H.263, H.264, H.265, H.266, MPEG4 part 2, MPEG4 AVC (BSAC or other for Assoc. Audio)

7 Home automation

7.1 Requirements summary

In the home network system, the automation and control applications of the home network can be supported by the HMG. HMGs should support all the requirements of ISO/IEC 14762. Clause 7 describes some typical multimedia applications supported by the HMG:

- device control functionality in directory services (7.2);
- multimedia message service (7.3);
- devices management service (7.4);

- meters reading service (7.5);
- household appliance control service (7.6);
- AV recognition and alarm (7.7).

7.2 Devices in directory

7.2.1 Printer

The directory services provided by the HMG should include printers. When the user uploads photos or pictures from video to a printer through any device, it means that the photos or pictures should be printed. The HMG should provide the printer driver and printing task management.

HMGs shall support the following functions:

- If the home network contains a printer, the directory services provided by the HMG should include the printer. The HMG should be able to detect the printer automatically or configure the printer passively.
- When the HMRec uploads pictures and text contents to the printer directory, the HMG should regard them as printing tasks. If the pictures and text contents cannot be printed immediately, a prompt should be provided.
- If the printer is not a network printer, the HMG should support the printing task management function.
- The HMG can convert the contents uploaded from the HMRec to the printer into the needed format.
- The HMG should only present the printer in the directory views of uploaded pictures and text contents.

7.2.2 Surveillance cameras

The directory services provided by the HMG should also include the surveillance cameras. When the user selects a camera through the video terminal, it means that the user needs to view the current picture of the cameras. The HMG can automatically provide resolution conversion and coding/decoding conversion services according to the capability of the terminal device. It can also clip pictures according to the operations on the terminal. The HMG should also consider the situation when multiple application terminals access the same camera at the same time.

HMGs should support the following functions:

- If the home network contains a surveillance camera, the directory services provided by the HMG should include the cameras. The HMG should be able to detect the cameras automatically or configure the cameras passively.
- When an application terminal selects the cameras, the HMG should regard it as viewing the cameras' contents. The HMG should actively receive the contents from the cameras and perform conversion, compression and clipping operations according to the requirements of the application terminal.
- The HMG should support multiple application terminals accessing the same camera at the same time.
- The HMG should only present the cameras in the directory views of downloaded pictures and videos.

7.2.3 Intelligent household appliance

The directory services provided by the HMG can also include the controllable home appliances. When the user selects a home appliance, it means that the user is to control the home appliance. In this case, the HMG can send a control web page to the terminal, and the terminal controls the home appliance through the control web page.

HMG shall support the following functions:

- The HMG should be able to support control on home appliances and can list home appliances in the directory.
- When a terminal selects a home appliance, the HMG can send a control web page to the terminal. The web page can be provided by the HMG or the home appliance itself.
- Home appliances should only appear in the directory views accessed by web-enabled terminals.

7.3 Multimedia message application

7.3.1 Requirements summary for HMG

- The HMG should be able to provide email detection and notification functions.
- If the HMG provides the email detection function, it should send the notifications of new emails to the device that can receive the notifications in the user's home network, for example the STB, intelligent telephone and the user's personal device.
- If the HMG provides the email detection function, it should provide an interface to configure the user's email address, user name, personal device, public device that can receive the email, and password for viewing the email text through the public device.

7.3.2 Multimedia message

A multimedia message application means a device generates an event and sends a message, which is presented in the multimedia form in the home network. For example, when the user is watching TV while the fixed telephone rings, the user can see the calling number on the TV screen. Another example is that the user hears a voice saying the clothes are all washed when reading a newspaper in the study. Such multimedia message applications can be realized through a unified multimedia message application platform in the home network.

7.3.3 Requirements for multimedia message

In the home network, events that occur on devices can be heard or seen. These events include incoming call, incoming email, ordered messages received, washing finished by washers, heating finished by the microwave oven, and hot water ready in the bathtub. Such events can be heard from the TV set and IP acoustic devices, or seen from devices with displays, for example TV sets, video doorbells, PDAs, and mobile phones, or from indicators on the devices. The user can hear voice, music and ring tones, mostly voice. Sometimes, the user can set music or ring tones for specific events. Things to be seen include characters, pictures, video and icons; they can include various effects or mainly character information, because characters are the most direct expression mode. Sometimes, the user can set special pictures, videos and icons for specific events.

A unified multimedia message application platform in the home network allows any device to send a message and displays the message on the designated or dedicated display or indication device.

To support the unified multimedia message application platform in the home network, a unified message format should be made. Each message should meet the following recommendations:

- The message should contain the ID of the device that sends the message so that the message receiver can classify and match the message. The device ID should be unique inside the home network.
- The message should have a message ID so that the message receiver can retrieve the message. The message ID can be used with the device ID. Therefore, the message ID should be unique in the device that sends the message.
- The message should contain the type of the message content. Content types include text, picture, audio, voice and video.

- The message should contain the media that presents the message contents. Message contents should be able to be presented through indicators, display, loudspeaker and other media. According to the ways of obtaining information, messages can be presented by looking and hearing. The specific presentation mode is determined by the message receiver. The message sender should specify whether the message will be heard or seen. If the content type is inconsistent with the presentation media, contents of the message might be converted, for example from text into voice.
- The message should be able to contain the duration of presentation of message contents.
- The message should contain the information about the length of message contents.
- The message should contain the content body. The format of the contents is determined by the contents; for example a video involves the resolution, frame rate and code format, which are determined by the content body.
- Notification in the form of a special message should be sent to the display device to delete the previously sent messages.

7.3.4 Multimedia message format

Table 2 describes a general multimedia message format that is recommended.

Table 2 – Multimedia message format recommended

Device ID (4 bytes)	**Message ID** (2 bytes)	**Message Media Type** (1 byte)	**Presentation Media Type** (1 byte)	**Keeping Time** (4 bytes)	**Length of Message Body** (4 bytes)	**Message Body** (LMB bytes)

- Device ID: the device ID is allocated by the multimedia application platform in a unified mode; it can be the IP address or MAC address of the device.
- Message ID: allocated by the device that sends the message.
- Message Media Type: indicates the content type of the message body; 0-no message body; 1-text; 2-picture; 3-audio; 4-voice; 5-video; 6-event code.
- Presentation Media Type: 0 – unknown (that is, not designated); 1 – looking; 2 – hearing; 3 – looking and hearing.
- Keeping Time: 0 – delete the message designated by device ID + message ID; non 0 – duration of keeping, in seconds; if the message is not explicitly deleted after the time is due, the device deletes it automatically. Because no message is to be displayed permanently, there is no need to define a value to indicate that the message will be permanently displayed.
- Length of Message Body: The range is 0–0xffffffff; if the value of the message content type is 0, this field is also 0.
- Message Body: message contents to be displayed. If the content type is voice, audio, picture or video, the format is determined by the message body. That is, the format of the message body is its storage format. The message receiver will process the message body as a file. Before the message body reaches the receiver, however, it may be converted through the intermediate device. If the message content type is event code (6), the message body is an event code represented by a decimal number. The event code is defined by the message sender, while the corresponding information content is provided by the HMG. The message media type (MMT), presentation media type (PMT) and keeping time (KT) can be defined on the HMG; in the message, these contents can be omitted.

7.3.5 Send a message

The message sender can directly send the message to the destination device or the HMG. The HMG can select the destination device automatically or according to settings. Either the message sender or the HMG can use the unicast mode or broadcast mode to send the message. It is recommended that all devices in the home network send messages to the HMG, while the HMG forwards the messages to the display device. This can not only simplify service configurations, but also facilitate unified allocation of device IDs. Moreover, the HMG can convert the message body if necessary.

7.3.6 Delete a message

After the message sender is sure that the user has known the sent message, a special message can be sent to the message receiver, notifying the receiver to delete the previous message. The method is to assign the same message ID to the special message and set the keeping time to 0.

When the message sender is sure that the user has viewed the displayed message, the displayed message can be deleted and not displayed again.

7.3.7 Requirements for HMGs

HMGs shall observe the following points:

- The HMG should accept the registration of multimedia services by the application device.
- The HMG should support the receiving and forwarding of multimedia messages.
- The HMG should automatically detect the status of the application device and determine the message forwarding destination. It can also adopt the broadcast mode to forward messages.
- The HMG should match the media format of the message and the media processing capability of the message receiver. If necessary, it should convert the message body.

7.4 Devices management by HMG

7.4.1 Device status

In 7.2, introduction is given to the presentation of the printer, surveillance cameras and home appliances in the directory. The HMG needs to know whether these devices are usable. Even when a device enters the hibernation mode due to power management and can be remotely woken up, the device is usable if the HMG can wake up the device.

The HMG should record the state of the device under its management. States include usable and unusable. Usable states include the online state and the hibernation mode, in which the device can be woken up by the HMG.

7.4.2 Connection status

If a media stream from the MS to the HMRec passes through the HMG, if the MS fails or the connection between the MS and the HMG fails, the HMG can detect the failure. The HMRec can also detect the failure, as it cannot receive media data from the HMG, and terminate the connection with the HMG automatically or under user operation. If the connection between the HMRec and the HMG is abnormal, if the HMG makes no special processing, it can continue obtaining media data from the MS, although it is insignificant to do so. Therefore, when detecting any exception on the connection between the HMG and the HMRec, the HMG should actively terminate or suspend the transmission to the MS, to save processing capabilities and resources to serve other connections.

The HMG should be able to judge whether the transmission connection on itself is normal. When the transmission connection is abnormal, it should terminate or suspend the media service.

7.4.3 Energy saving and power management

The home media service centre and player terminals, which store and manage media contents, might be in the hibernation mode to save energy when they are not in use. When the HMG accesses the media service centre and player terminals, it should be able to wake up these devices. Therefore, the HMG should be able to support the power wake-up function. Wake-up messages can be saved on the HMG or queried by the HMG from other devices. (A specific solution is needed.)

In some special cases, the HMG might force a device to enter the hibernation mode. For example, if the HMG detects that the TV is on but there is no-one at home, or no-one near the room with the TV, it can turn off the TV. In this case, the TV actually enters a hibernation mode.

HMGs shall observe the following points:

- the HMG should be able to wake up other devices in the hibernation mode;
- the HMG should be able to save the wake-up messages sent by other devices before entering the hibernation mode;
- the HMG should be able to query the wake-up messages from other devices;
- the HMG can send the dormancy command to other devices.

7.5 Reading of meters

The reading of meters is an important function in home automation. It can significantly reduce the operation expenditures of water, electricity and gas companies. This function should not add any burden on users. For each user, if meters of water, gas and electricity are located outdoors, the user normally does not pay attention to meter reading by water, electricity and gas companies. As a result, the user is not interested in automatic meter reading, unless there are some advantages; for example, the user can query the consumptions of water, electricity and gas through a PC, a TV and a mobile phone to know family expenditures.

Because the water, electricity and gas companies do not have operation networks, the deployment of automatic meter reading needs the cooperation between these companies and network operators. This can involve the settings of many parameters, for example the server addresses and the data report time.

If the metering data for water, electricity and gas is automatically reported by the home network, the payment information should also be sent to the user's home through the home network. The network should adopt a method to notify the user to query the payment information, for example displaying payment information on TV.

The HMG communicates with water, electricity and gas meters through wired or wireless mode in the home network system.

HMGs shall observe the following points:

- the HMG should be able to support the three-meter reading function;
- the HMG should provide interfaces for communicating with water, electricity and gas meters;
- the HMG should provide the user query interface;
- the HMG should provide the configuration interface for some parameters, for example the URL of the data report server and the data report time;
- the HMG should provide an interface for receiving payment information, or query the payment information from the suppliers' servers.

7.6 Household appliance control

Home appliance control can be performed by means of a directory service. The HMG is the control centre that support different forms of control. For example, it can control home appliances by receiving short messages sent by mobile phones, through voice interaction, or by logging on to a web page.

HMGs shall observe the following items:

- the HMG should support control through short messages;
- the HMG should be able to receive short messages;
- the HMG should resolve the message content, authenticate the password, and resolve and execute the control command when the HMG receives a short message;
- the HMG should be able to send a message, notifying the command execution result to the number that sends the control command when the HMG receives a short message;
- the HMG should be able to support web proxies and provide control web pages for various home appliances;
- the HMG should support web proxies and allow the user to log on to web pages. It should provide user identity authentication and display the status and control results of home appliances through web pages.

7.7 AV recognition and analysis

The audio/video analysis and recognition function of HMG refers to the usage of artificial intelligent tools and it is important in home special care scenarios. The HMG shall be able process and recognize images captured by a home device and send out alarm messages for any abnormal audio and video result. Abnormal conditions include a stranger intruding, fire/smoke warning, and special noises such as a baby crying.

Functions of HMG audio/video recognition and analysis are as follows:

- the HMG shall support AV analysis and recognition abilities;
- the HMG shall be able to make an alarm reminder for abnormal conditions.

8 QoS

8.1 General

There might be multiple streams or multiple types of streams passing through the HMG. The HMG needs to distinguish the priority level of each HMRec and the level of the stream type. If the HMG has a limited output bandwidth and a limited processing capability, it should guarantee the bandwidth requirement and quality of service (QoS) of devices of high priority.

The QoS for the HMG is compatible with the UPnP-QoS:3, which is defined in the ISO/IEC 29341 series. The HMG should support the UPnP-QoS Device:3 service.

The following paragraph is the reference from UPnP-QoS Architecture:3 document. Refer to UPnP-QoS:3 for more details.

The QoS for the HMG defines three services which are the QosPolicyHolder Service [QPH:3], the QosManager Service [QM:3] and the QosDevice Service [QD:3]. All three services are shown in Figure 32.

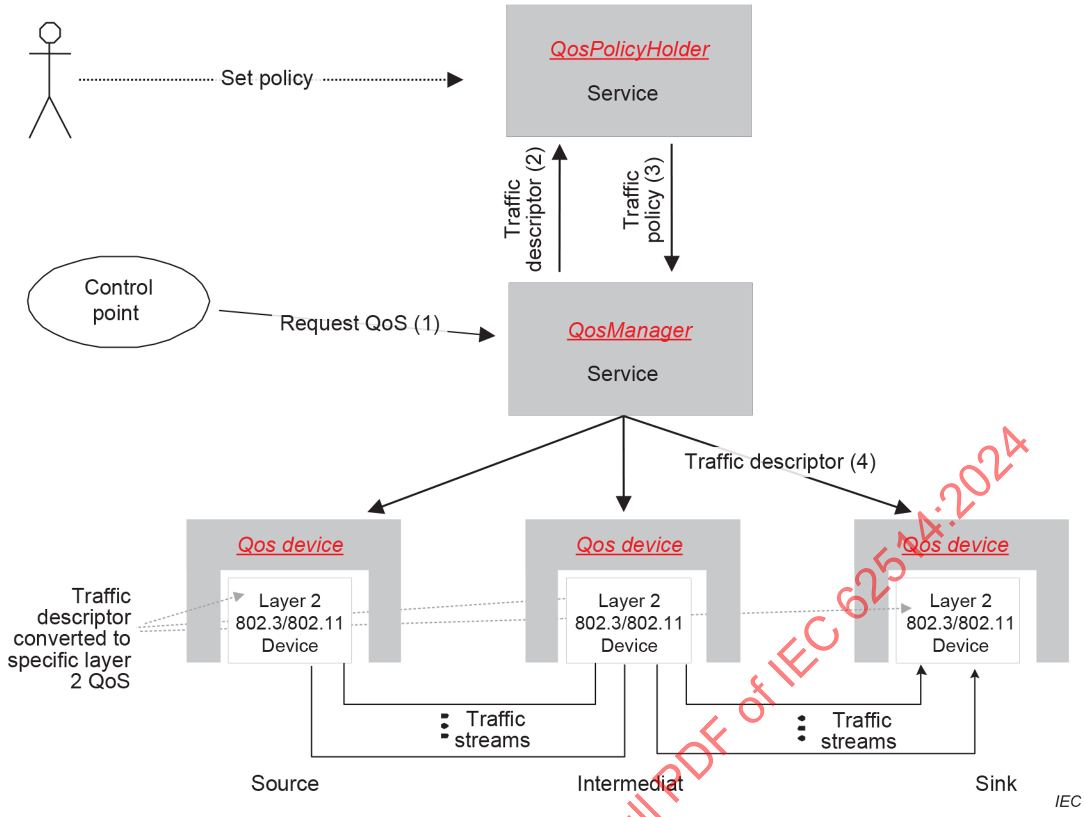
Set policy
QosPolicyHolder
Service
Traffic descriptor (2)
Traffic policy (3)
Control point
Request QoS (1)
QosManager
Service
Traffic descriptor (4)
Qos device
Qos device
Qos device
Traffic descriptor converted to specific layer 2 QoS
Layer 2 802.3/802.11 Device
Layer 2 802.3/802.11 Device
Layer 2 802.3/802.11 Device
Traffic streams
Traffic streams
Source
Intermediat
Sink
IEC

Figure 32 – QoS Architecture overview

Fundamentally, the QoS for the HMG manages the QoS for a traffic stream that flows between a source and a sink device. A traffic stream is viewed as a uni-directional flow from a source device to a sink device, possibly passing through intermediate devices. In the interaction described in this clause, a control point application is assumed to have the knowledge of source, sink and content characteristics to be streamed, along with the content's traffic specification (TSPEC). The control point constructs a TrafficDescriptor structure and requests a QosManager service on the network to setup QoS for a traffic stream (step 1). The control point in the QosManager Service (from here on referred to as "QoS Manager") requests the QosPolicyHolder Service (step 2) to provide appropriate policy for the traffic stream described by the TrafficDescriptor structure (step 3). Based on this policy, the QoS Manager configures the QosDevice Service(s) for establishing the QoS for the new traffic stream (step 4).

8.2 QoS for HMG

- The HMG should support the UPnP-QoS Device:3 service defined in the ISO/IEC 29341 series.
- The HMG should guarantee the bandwidth and QoS needed by the streaming media.
- The HMG should be able to implement priority control on transmission connections according to the device priority. For example, the telephone is of higher priority than the STB; the STB is of higher priority than the PC.
- The HMG should be able to implement priority control on transmission connections according to the content priority. For example, voice contents are of higher priority than audio contents; audio contents are of higher priority than video contents; video contents are of higher priority than pictures.
- The HMG should be able to reject new media service requests, or terminate connections of the lowest priority, if the remaining bandwidth or processing capability is insufficient.
- The HMG should support new QoS requirements for remote AV processing.

9 Security

9.1 Requirements summary

- The HMG shall prevent the leakage of protected media contents and transmit the media contents only to the media service requester. The HMG shall not save the media contents locally.
- The HMG shall accept authentication by the HMRec.
- The HMG should be able to implement DRM authentication on the service requester as a procedure in the DRM.
- The HMG shall support encrypted transmission with the MS.
- The HMG shall support encrypted transmission with the HMRec.
- The HMG shall support multiple encryption algorithms.
- The HMG shall support multiple key management methods.
  - The HMG shall fully support multiple DRM and link protection methods, including the digital transmission contents protection over DTCP-IP: Digital Transmission Content Protection over Internet Protocol.
- The HMG should be able to replace the media service requester in accepting user identity authentication by the media sender.
- If the HMG replaces the HMRec in identity authentication, the HMG shall transmit related authentication data with the HMRec in the encrypted mode.
- The HMG shall not store related authentication data.
- The HMG shall support firmware and software upgrades initiated from WAN side or LAN side.
- The HMG shall check the firmware and software integrity before flashing procedure.
- The HMG shall provide a mechanism that guarantees the basic functionality can be recovered in the case of a failure of a firmware and software upgrade.
- The HMG should support WMS authentication through the RID allocated by the WMS. If the HMG receives an RID from the media service requester, this RID shall be included in the request when the HMG requests media contents from the WMS, or the HMG shall feed back the RID upon the query of the WMS.

Suppose that the HMG is allowed to disguise itself as a media service requester, and accepts device authentication by the media sender. The HMG shall authenticate the MS to prevent unauthorized devices from obtaining the user's account and password.

9.2 DRM

Some previous chapters have already talked about the digital rights management (DRM). In general, DRM is used for two purposes. One is to encrypt transmission to prevent contents from being intercepted. The other is to manage copies to prevent unauthorized copies. The purpose of preventing unauthorized copies is to restrict the propagation of media contents in the authorized range; unauthorized devices will not be able to obtain protected contents. When the HMG is involved, however, media contents are actually duplicated, which makes the situation more complicated. In this case, a new DRM system should be designed to add supports for media format conversion and transmission adaptation, or the existing DRM system can be expanded to support media format conversion and transmission adaptation.

HMGs shall observe the following points:

- The HMG should prevent the leakage of protected media contents and transmit the media contents only to the media service requester. The HMG should not save the media contents locally.
- The HMG should be able to implement DRM authentication on the service requester as a procedure in the DRM.
- The HMG should accept authentication by the HMRec.

9.3 Key management

In addition to the encryption of transmitted contents by the DRM system, other contents not involving copyright might also be encrypted during transmission to avoid being intercepted; for example, in video communications, video transmitted is encrypted. The HMG can support the conversion service only if it gets a key and decrypts the media stream sent by the MS. Therefore, the HMG needs to get a key from the HMRec, or exchange the key and negotiate about the encryption method with the MS.

If the media stream received by the HMG is encrypted, the HMG shall also encrypt the converted media stream before sending it to the HMRec. The HMG can adopt the same encryption method used between the HMRec and the MS to secretly transmit media streams to the HMRec. It can also adopt another encryption method.

The HMG shall support key management.

9.4 Authentication

In the media conversion service method shown in Figure 4, the HMG wholly replaces the HMRec in requesting media contents from the MS. In addition to the DRM authentication, the MS might implement device authentication on the HMG to check whether the device is permitted to use services. The MS might also authenticate the user identity to make sure that the user is authorized. The authentication process might include the following.

- Device authentication: some services might require device authentication. Only registered and authorized devices can use these services. The authentication process might require the device to own or provide the following information:
  - device authentication key;
  - device authentication certificate;
  - unique identifier of device.

  The above information is bound with the device. If the HMG obtains such information and replaces the HMRec in accepting MS authentication, the HMG is actually disguised as the HMRec, which shall be prohibited. The only exception is that a device type is defined to support the disguise and new authentication process and device specifications are made in the new DRM system.

User identity authentication: some services might need to authenticate the user's identity. The user can use a service only if he can provide the authorized account and password, and shall always use the service on the same device. The authentication process needs the following information:

- account name and password;
- a key used to encrypt account and password in transmission.

In order to perform authentication, HMG shall observe the following points:

- the HMG should be able to replace the media service requester to accept the user identity authentication by the media sender;
- the HMG shall accept authentication by the HMRec;
- the HMG shall encrypt related authentication data transmitted by the HMRec;
- the HMG shall not save related authentication data;
- the HMG shall prevent the leakage of protected media contents and transmit the media contents only to the media service requester. The HMG shall not save the media contents locally;
- suppose that the HMG is allowed to disguise itself as a media service requester, and accept device authentication by the media sender. The HMG shall authenticate the MS to prevent unauthorized devices from obtaining the user's account and password.

9.5 Credibility of HMG

For the consideration of the DRM, the HMG shall be an authorized device. This means not only when replacing the HMRec in obtaining media from the media source, the HMG shall appear as an authorized device; it also means HMRec shall confirm authorization of the HMG. Therefore, the HMRec needs to authenticate the HMG. In encrypted transmission not involving the DRM, it shall be ensured that the HMG will not disclose the media contents. For such reasons, the HMRec needs to authenticate the HMG so that the HMG is credible.

The HMG shall accept the authentication by the HMRec.

10 Performance requirements

- The HMG shall support simultaneous processing of at least two input media streams and two output media streams, including media stream transcoding, resolution adaptation, transport protocol adaptation, stream combination, stream division, duplication, redirection, encryption and decryption.
- If the HMG provides the video clip function, it shall be able to quickly respond to the coordinate switching command sent by the terminal.
- The HMG shall enter the energy-saving state when it does not provide services, for example, by reducing the CPU rate.
- The HMG shall be able to work normally in the energy-saving state and receive service requests.
- The HMG shall recover from the energy-saving state once it receives a service request.

11 Interfaces and protocols of HMGs

11.1 General

The HMG is a logical device which can be combined into any physical device in home network as well as can be a separate physical device. The HMG shall be in accordance with the requirements if HMG adopts the optional interfaces given in Table 3 and Table 4.

11.2 WAN side interfaces

Table 3 – WAN side interfaces

Optional interfaces	Requirements and options
ADSL and ADSL2+	1) The HMG should include an internal ADSL modem. 2) The HMG should comply with requirements as specified in ANSI T1.413:1998 [1], ANSI T1.413a-2001 [1] and ITU 992.1 [2] for Annex A depending upon regional requirements. 3) The HMG should support FDM-mode per ANSI T1.413 [1], and ITU-T G.992.1 [2]. 4) The HMG should comply with ITU G.992.3 [3], (ADSL2) and ITU G.992.5 [4], (ADSL2+). 5) The HMG should comply with ITU G.992.3 [3], Annex L (RE-ADSL2).
VDSL2	1) The HMG should include an internal VDSL2 modem. 2) The HMG should be compliant with ITU-T G.993.2 [5]. 3) The HMG should include support for the following application reference models from ITU-T G.993.2 [5]: – G.993.2 [5].section 5.4.2, Data with POTS service – G.993.2 [5].section 5.4.1, Data service (no POTS or ISDN)
Ethernet (WAN)	1) If the HMG supports an optional WAN Ethernet port, it should support 10BASE-T/100BASE-T presented on an RJ-45 jack. 2) If the HMG supports both a WAN Ethernet port in addition to another physical WAN link type (e.g., ADSL, VDSL2, ONT function, etc.), simultaneous use of both WAN ports should not be supported. 3) Any Ethernet port used as a WAN link should be non-blocking for LAN to LAN and LAN to WAN traffic flows. This may occur in some implementations that use one port of a multi-port Ethernet switch for WAN use, sometimes as a result requiring LAN to LAN traffic to be forwarded and processed through the device CPU.
GPON	1) The HMG should include an integrated GPON ONT interface. 2) The HMG should comply with all mandatory requirements for the ONT as specified in ITU G.984.1 [6] (General Characteristics), G.984.2 [8] Amd 1 (Physical Media Dependent Layer), G.984.3 [8] (Transmission Convergence Layer) and G.984.4 [9] (ONT Management and Control Interface). 3) The HMG should support requirements contained in Table 3.2 of ITU-T G.984.2:2003 [7] Amd1 (optical budget, source type, transmitter range, mean launched power min/max, extinction ratio, etc.).
Numbers in square brackets refer to the Bibliography.	

11.3 LAN side interfaces

Table 4 – LAN side interfaces

Optional interfaces	Requirements and options
ETH	1) The HMG shall have at least one 10/100BASE-T Ethernet port (RJ-45 jack) for connecting it to the home data network. 2) The HMG shall be able to support both 10BASE-T and 100BASE-T with auto negotiate for speed and duplex on a port-by-port basis according to IEEE 802.3u. 3) The Ethernet LAN interface should allow for adjusting the inter-frame and collision back off timers so that traffic marked with Ethernet priority (as defined in IEEE 802.1Q) can get statistically better treatment on broadcast LAN Segments.
G.hn	1) The HMG should be compliant with G.hn Physical Layer (recommendation ITU-T G.9960 specification). 2) The HMG should be compliant with G.hn Data Link Layer (recommendation ITU-T G.9961 specification).
Wireless	1) The HMG shall be compliant with the IEEE 802.11 b/g specifications. 2) The HMG shall be Wi-Fi CERTIFIED™ for all applicable IEEE 802.11 standards. 3) The HMG shall be Wi-Fi CERTIFIED™ for WPA2-Personal. 4) The HMG shall support setting the Ethernet VLAN identifier, defined in IEEE 802.1Q, of incoming wireless traffic to a configurable value based on SSID.

12 Upgrade

Software and firmware upgrade is necessary for maintaining stability and security. HMGs shall support upgrade functions as follows:

- HMGs shall provide the ability to upgrade software and firmware related to multimedia processing, including but not limited to multimedia control and management;
- HMGs shall provide upgrade setting option to support online automatic upgrade or user manual upgrade;
- when new software/firmware is available, HMGs shall offer a manual upgrade function for users;
- HMGs shall verify the source and integrity of the upgrade package before upgrading;
- When the upgrade fails, the availability of the original multimedia processing capability shall be maintained and the user should be given corresponding prompts.

Annex A
(informative)

Application scenario

A.1 Entertainment

A.1.1 Scenario 1: playback

Description:

A home network might contain one or multiple media servers, which support a lot of media contents. Other user terminals, for example, the STBs, mobile phones and digital cameras, might also contain some media contents. Once these devices are on, the user can access the resources and select a media content to be played on the media player.

Precondition:

Media contents are stored on the media server and some other devices.

There is at least one media player that can play media contents.

Application process 1:

The user operates the media player, which displays all media contents found in the home network. The user selects some contents and starts playing the contents.

Application process 2:

The user operates a control device, for example a remote control or a PC, which displays all media contents found in the home network. The user selects some contents. The control device also displays usable players in the home network. The user selects a player and starts playing the selected media contents.

Functional requirements:

- The HMG can provide the directory service to collect all media contents in the home network, mainly contents on media servers.
- The HMG can provide the media conversion service when necessary, so that media formats not supported by a player can be played on the player.
- The HMG can provide the transport protocol translation service when necessary, so that the player can play the selected media content if the player and the device that provides media contents use different transport protocols.
- The HMG should support the conversion of the control protocol when providing the transport protocol translation service.
- Devices containing media contents should actively report their contents to the HMG, or accept queries from the HMG.

A.1.2 Scenario 2: VOD

Description:

The user can play media programmes on demand from the public network through a TV set, a PC and various hand-held devices.

Precondition:

The server in the WAN might authenticate the identities of the user and devices. The contents provided might be protected by the digital rights management (DRM) technology.

Application process 1:

The user logs on to the media server through the STB. The programme list is displayed on the TV set. The user selects a programme, and the programme is smoothly played.

Application process 2:

The user surfs the Internet through the PC. On a web page, the user finds a video media hyperlink. The user clicks the hyperlink and the video is smoothly played.

Functional requirements:

- The HMG should provide the media conversion service, so that the player can play media formats it does not support.
- The HMG should be able to meet the DRM requirements.

A.1.3 Scenario 3: change player

Description:

When the user watches a programme on demand on a device, the user wants to transfer the programme to another device and continue watching.

Precondition:

The user owns multiple players, all of which are connected to the home network.

Application process:

The user watches a movie on demand on the PC in the study.

After watching for a while, the user finds the movie very interesting and wants to transfer the programme to the TV set in the sitting room. The user suspends the programme and selects the TV set in the sitting room from the device list. The programme is transferred to the TV set in the sitting room.

The user comes to the sitting room and turns on the TV set and switches to the VOD channel. The TV screen shows the last picture of the programme and a prompt, "Please press OK to continue." The user presses OK on the remote control. The programme is played from the previous break point.

Functional requirements:

- The HMG can support the media stream redirection function and support programme transfer.
- Even if the destination device is not on, the programme transfer can succeed.
- After the programme is successfully transferred, the destination device should display the last picture at programme pause.
- The user can press the prompted key on the destination device to continue playing the programme.
- If the destination device does not support the original media format, the HMG should provide the conversion service.
- If programme transfer is supported through the HMG, the HMG should meet the DRM requirements.

A.1.4 Scenario 4: multicast

Description:

While watching TV programmes on demand or programmes stored in the home network, the user wants to output the currently played programme on multiple player terminals, so that family members can watch the same programme in different rooms or on various types of devices.

Precondition:

Related players are connected to the home network so that they can interwork with one another.

Application process 1:

The user orders a programme.

The user selects multicast from the menu or through the functional key of the remote control. The list of all players is displayed on the TV set.

The user selects multiple players that are used for simultaneous playback.

The user presses OK. The current programme on demand is played on all selected TV sets.

Application process 2:

The user views the VOD or playback programme being played in the home network through the player. The user selects the programme being played and starts playing the programme on his device.

Functional requirements:

- Through the HMG, a terminal device can join the multicast group of a programme being played.
- The HMG should be able to accept a terminal device passively joining of a multicast group.
- The HMG should be able to accept a terminal device actively joining of a multicast group.
- For a terminal device passively joining a multicast group, the joining operation should succeed, even if the device is not on.
- A terminal device passively joining a multicast group will play the multicast contents once it is turned on.

- When the HMG forwards media contents to multiple terminals, it should convert media streams in orientation to the capabilities of different media receivers, if necessary.
- The HMG can accept the Stop Playback request from any terminal, which means leaving the multicast group.
- The HMG should permit trick mode operations by any terminal in the multicast group.
- The HMG should support multicast under the permission of the DRM.

A.1.5 Scenario 5: remote sharing

Description:

User 1 transfers some media contents in the home network to the media player of user 2, so that user 2 can remotely enjoy the contents provided by user 1.

Precondition:

User 1 can access the home network and the player of user 2 and transmit data to user 2.

Application process:

User 1 notifies user 2 of some media contents. User 2 is asked to turn on a device and share the device with user 1.

Upon the request of user 1, user 2 turns on the TV set in the sitting room and tells user 1 about the share ID.

User 1 accesses the home network of user 2 through his PC. User 1 enters the share ID and finds the shared TV set. User 1 selects the TV set as a remotely shared media receiver.

User 1 browses the media directory at home, selects the needed contents and starts playing. At the time, the PC of user 1 starts playing the selected media. At the same time, user 2 sees the contents transferred by user 1 on the TV set.

Functional requirements:

- If the remote device does not support the format of the transferred media, the HMG should provide the media conversion service.
- In the home network of user 1, the HMG can provide the directory service.

A.1.6 Scenario 6: remote playback

Description:

User 1 accesses the contents on the media server in the home network from the WAN. User 2 needs to access the media contents in the home network of user 1.

Precondition:

User 1 has configured relevant permission in the home network so that other users can access his home network from the WAN and access the devices and contents in the authorized range.

Application process:

User 1 or user 2 accesses the home network of user 1.

The user is prompted to enter the account and password.