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Cable modems

Residential gateway requirements for the support of broadcast and IP-based interactive services over cable television networks

Recommendation ITU-T J.294

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Residential gateway requirements for the support of broadcast and IP-based interactive services over cable television networks

Summary

Recommendation ITU-T J.294 describes objectives, requirements and functional architecture for a residential gateway (RG) supporting broadcast and IP-based interactive services over cable television networks. This Recommendation describes the requirements for the functional components which form logical entities of RG.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T J.294	2010-09-13	9

FOREWORD

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Residential gateway requirements for the support of broadcast and IP-based interactive services over cable television networks

1 Scope

This Recommendation describes objectives, requirements and functional architecture for a residential gateway (RG) supporting broadcast and IP-based interactive services over cable television networks. The RG is supposed to be used with a hybrid set-top box (H-STB) composed of RF TV reception capability and IPTV terminal device (IPTV-TD) functions as well as other devices within a home network environment [ITU-T J.190]. The RG device provides a bridging and/or terminating capability between a cable access network (i.e., WAN) and a home network (i.e., LAN) in every layer. The RG has functionalities for network interface, network control, content delivery, service control and applications to exchange control signal and media flow between WAN and LAN. Each functionality has several functional components. This Recommendation describes the requirements for the functional components which form logical entities of RG.

The RG is assumed to be a home gateway for the reception of enhanced broadcast services over cable television networks defined by [ITU-T J.700], consisting of quality of service (QoS), priority mechanisms, management and provisioning functions.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T J.190]   Recommendation ITU-T J.190 (2007), *Architecture of MediaHomeNet*.

[ITU-T J.218]   Recommendation ITU-T J.218 (2007), *Cable modem IPv4 and IPv6 eRouter specification*.

[ITU-T J.293]   Recommendation ITU-T J.293 (2008), *Component definition and interface specification for the next generation set-top box*.

[ITU-T J.700]   Recommendation ITU-T J.700 (2009), *IPTV service requirements and framework for secondary distribution*.

[ITU-T J.701]   Recommendation ITU-T J.701 (2008), *Broadcast-centric IPTV terminal middleware*.

[ITU-T J.702]   Recommendation ITU-T J.702 (2008), *Enablement of current terminal devices for the support of IPTV services*.

[ITU-T X.1191]   Recommendation ITU-T X.1191 (2009), *Functional requirements and architecture for IPTV security aspects*.

[ITU-T Y.1901]   Recommendation ITU-T Y.1901 (2009), *Requirements for the support of IPTV services*.

[ITU-T Y.1910]   Recommendation ITU-T Y.1910 (2008), *IPTV functional architecture*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 **cable modem** [b-ITU-T J.112]: A modulator-demodulator at subscriber locations intended for use in conveying data communications on a cable television system.

3.1.2 **cable modem termination system** [b-ITU-T J.112]: Located at the cable television system headend or distribution hub, which provides complementary functionality to the cable modems to enable data connectivity to a wide-area network.

3.1.3 **closed captioning** [b-ITU-T J.193]: Text scrolling on a television display that represents the audio portion of the program, typically provided for the hearing impaired.

3.1.4 **conditional access** [b-ITU-T J.193]: The conditional granting of access to cable services and content based upon what service suite has been purchased by the customer.

3.1.5 **IP-based services** [b-ITU-T J.193]: A generic term that includes QoS-controllable both-way and one-way IP-type services rendered over a CATV network on which a high-speed packet-based IP communication system is available. Examples include IP telephony or VoIP, videoconferencing, streaming video feeds, competitive games, and other similar services.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 **access network interface**: The logical interface between the wide area network (WAN) (i.e., access network) and the residential gateway (RG).

3.2.2 **digital rights management**: The definition, management, and enforcement of a set of content usage rules. These usage rules will indicate things such as the right to copy, view, or distribute a particular piece of content.

3.2.3 **domain**: The extent of home-network-compliant direct influence.

3.2.4 **emergency alert system (EAS)**: A system, within which the H-STB participates, that allows a service provider to distribute public emergency alarms and information about the public emergency to all of the customers attached to the cable network.

3.2.5 **home network interface**: The logical interface between the RG and the local area network (LAN) (i.e., home network).

3.2.6 **hybrid set-top-box (H-STB)**: A compilation of hardware and software functional entities contained within one or more physical devices, that, at a baseline level, provides the receiving functions for cable broadcast services. In addition, the hybrid set-top-box should support the interactive functions of IP-based services, additional time critical services between the access and the home network as well as extension and supplemental services.

3.2.7 **local application service delivery platform (LASDP)**: An application and service execution environment that resides within the home network for the purpose of delivering advanced applications and services developed by either a service provider or by a third party to the cable service subscribers.

3.2.8 **MediaHomeNet**: A network that connects multiple elements in a home environment to allow delivery of multi-purpose, multimedia services.

3.2.9 **middleware**: Software within the H-STB which provides a set of APIs that against which applications can be developed, and that provide access to the resources and services of the H-STB.

3.2.10   residential gateway: A grouping of logical elements used to achieve access for home network(s).

3.2.11   services: The set of services that are required and to be supported by the RG.

3.2.12   service provider interface (SPI): A service provider interface residing in the network side for the purpose of delivering advanced applications and services to the user. Applications and services can be developed either by the service provider or by a third party developer.

4   Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AOD	Approved Output Domain
API	Application Program Interface
ASD	Authorized Service Domain
BED	Best Effort Domain
CA	Conditional Access
CAS	Conditional Access System
CM	Cable Modem
CMTS	Cable Modem Termination System
CPE	Customer Premises Equipment
DLNA	Digital Living Network Alliance
DOCSIS	Data over Cable System Interface Specification
DPI	Digital Program Insertion
DRM	Digital Rights Management
DSG	DOCSIS Set Top Gateway
DTCP	Digital Transmission Content Protection
EAS	Emergency Alert System
ECG	Electronic Content Guide
EPG	Electronic Program Guide
ESG	Electronic Service Guide
FW	FireWall
GEM	Globally Executable Multimedia home Platform
GSD	Guaranteed Service Domain
HFC	Hybrid-Fibre/Coax
HN	Home Network
HPNA	Home Phoneline Networking Alliance
HSP	Home Security Portal
H-STB	Hybrid Set-Top-Box
HTML	HyperText Mark-up Language
IGMP	Internet Group Management Protocol

IP	Internet Protocol
IPDV	IP Packet Delay Variation
IPER	IP Packet Error Ratio
IPG	Interactive Program Guide
IPLR	IP Packet Loss Ratio
IPTD	IP Packet Transfer Delay
LAN	Local Area Network
LASDP	Local Application Service Delivery Platform
MLD	Multicast Listener Discovery
MOCA	Multimedia Over Coax Alliance
MPEG	Moving Picture Experts Group
MW	Middleware
NAPT	Network Address Port Translation
NAT	Network Address Translation
OCAP	Open Cable Application Platform
ONU	Optical Network Unit
OSGi	Open Services Gateway Initiative
OSS	Operation Support System
PLC	Power Line Communication
QoS	Quality of Service
RF	Radio Frequency
RFC	Request For Comments
RFoG	RF over Glass
RG	Residential Gateway
RTP	Real-time Transport Protocol
RTSP	Real-time Streaming Protocol
SPI	Service Provider Interface
STB	Set-Top-Box
SVG	Scalable Vector Graphics
TS	Transport Stream
UI	User Interface
UPnP	Universal Plug and Play
V-ONU	Video distribution Optical Network Unit
VM	Virtual Machine
VOD	Video On Demand
VoIP	Voice over IP
WAN	Wide Area Network

5 Conventions

In this Recommendation:

The keywords "**is required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The keywords "**is recommended**" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "**is prohibited from**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

The keywords "**can optionally**" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with the specification.

In the body of this Recommendation and its annexes, the words *shall*, *shall not*, *should*, and *may* sometimes appear, in which case they are to be interpreted, respectively, as *is required to*, *is prohibited from*, *is recommended*, and *can optionally*. The appearance of such phrases or keywords in an appendix or in material explicitly marked as *informative* are to be interpreted as having no normative intent.

6 General

The rapid development of IP technologies enables the RG, with an integrated DOCSIS CM, to provide gateway functions for IP-based services, provide connectivity with the managed IP network, diverse VoIP, real-time services for IP broadcast, VOD and competitive games over IP transport. While DOCSIS CM offers a variety of IP-based services, DOCSIS 3.0 system has a capability of very high-speed data transmission by its bonding facility which enables high quality video transmission over RF without IP technology.

With regard to the transportation of TS over IP networks as a kind of IP-based services, [b-IETF RFC 2250] describes IP encapsulation of MPEG Transport Streams for transport of video and audio streams using the real-time transport protocol (RTP). The document recommends that consideration be given for encapsulations of the MPEG TS and Program Stream (PS) with RTP supporting full semantics of an MPEG system. The RG has to transfer these TS and PS to terminal devices without any signal impairment.

As a physical layer transport, this document assumes the primary usage of coaxial cable networks composed of CM and CMTS which enable efficient transmission of the RF signal and IP packets. However, this transport can also be replaced with FTTH networks owned by cable operators, as a bearer of IP datagrams and RF signals.

Full support for IP multicasting allows a host to create, join and leave host groups, as well as send IP datagrams to host groups. It requires implementation of the Internet Group Management Protocol (IGMP) and extension of the IP and local network service interfaces within the host. When initiating an application and joining a multicast group, the IGMP sends an IGMP membership report message to routers in the subnet to notify them of those joining the multicast group. A router in RG sends an IGMP query message to confirm the presence of H-STBs in the multicast group. Each H-STB returns the IGMP membership report to this query message. By doing this, the router function which resides in the RG detects which STB is present on the interface and sends the multicast packet to the required interface only. Multicast listener discovery (MLD) protocol works in the same way for IPv6 network environment. The RG is required to support the IGMPv2 (IPv4) or MLDv2 (IPv6) protocol.

Furthermore, the H-STB needs to provide the functions of transferring/processing or modifying the content through the use of APIs. [b-ITU-T J.200] and [ITU-T J.701] are available as the baseline API documents for the H-STB. In the similar way, some application platforms are required for providing different services which cable operators will create. Such platforms can be realized using the bundle applications on the application platform.

It is recommended to implement a Java-based application management platform, e.g., open services gateway initiative (OSGi) framework, in the RG to facilitate management of application programs such as network control, CPE device control over UPnP transaction, log services, permission administration functions and customer services as shown in Appendix I. These softwares are so called "bundle software", which can be easily installed to and removed from the RG by operators' intentions. Each bundled software is able to work independently over the OSGi framework by communicating with OSGi servers located in the IP network.

The RG is also required to connect the access network and the home network seamlessly. The home network spans a number of networking technologies (Layer-1/2 – PHY/MAC and upper layers), delivery protocols, application devices, and services from the access and broadcast networks. The RG addresses the bridging and controlling of the home network environment by focusing on IP elements with defined interfaces and proprietary elements that can communicate using proprietary protocols. The main functions required for RG are management and provisioning of home network, addressing, packet handling, quality of service (QoS), security, content protection and delivery of services over the home network.

The cable access network is required to deliver both of RF-based broadcasting services and IP-based interactive services with appropriate quality and permissible latency. The focus of this Recommendation is to clarify the requirements for a residential gateway (RG) that provides functions to receive broadcast and IP-based interactive services over cable television networks. Figure 1 depicts the location of RG within CATV network configuration.
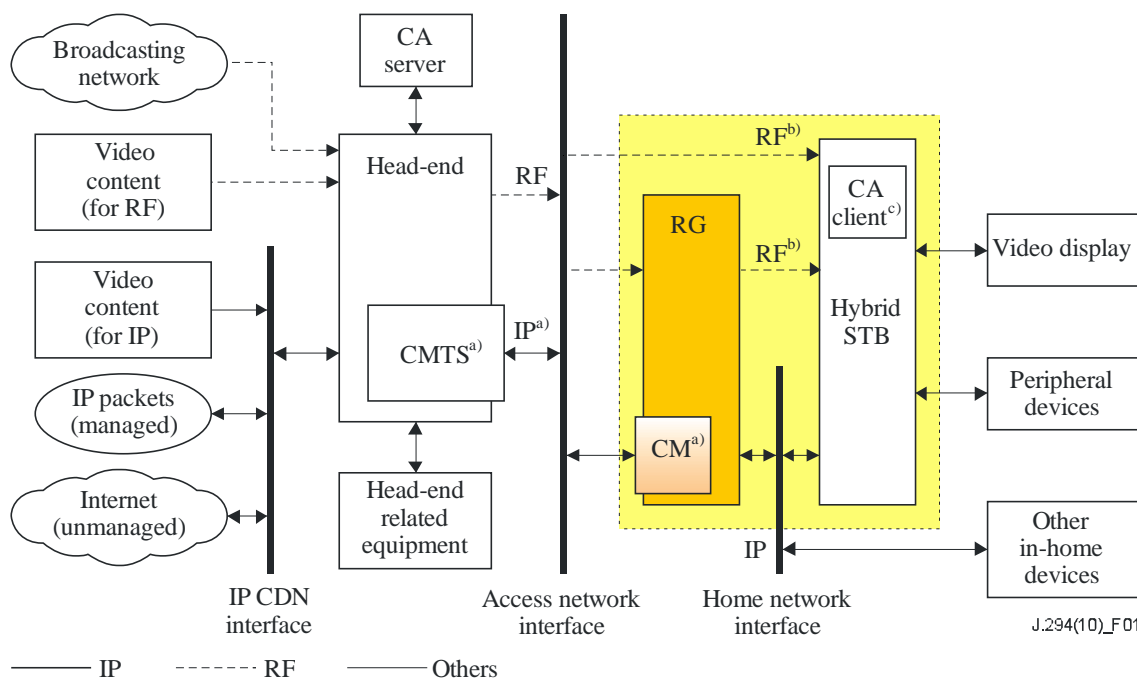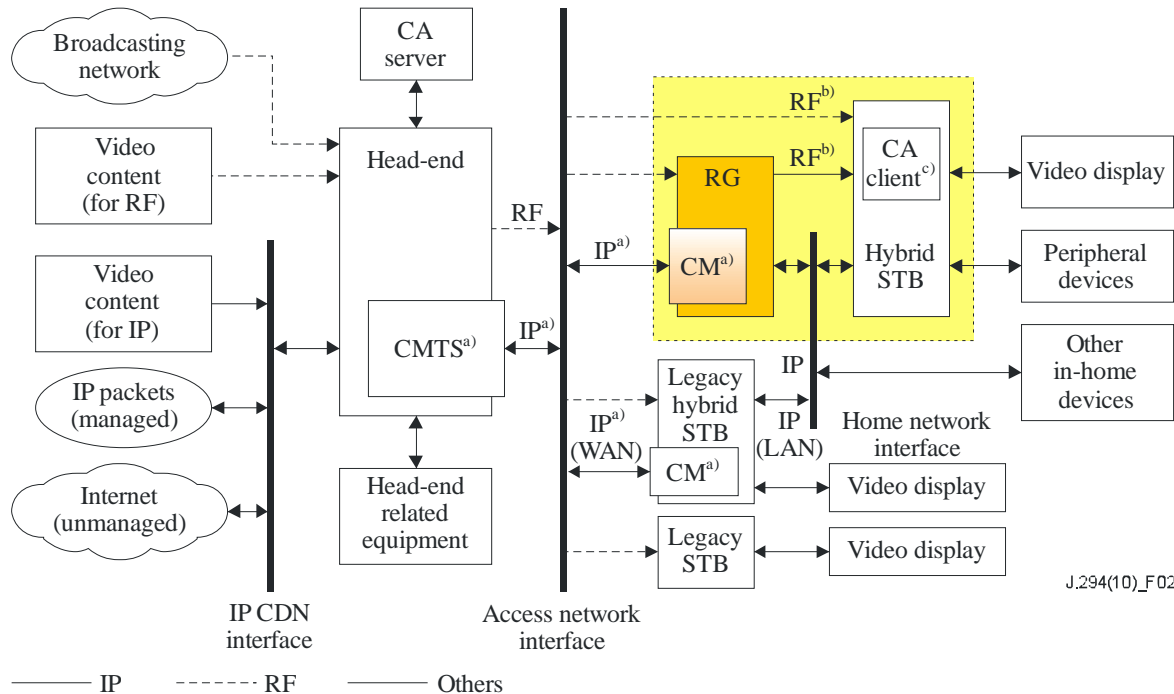

a) "IP" should be interpreted as "IP over DOCSIS or other cable access technology on HFC or RFoG". However, other types of IP networks such as G-PON, GE-PON or other optical transport network should be also allowed. In this case, CMTS and CM will be replaced by OLT and ONU respectively, and "IP" should be interpreted as "IP over PON".
b) Hybrid STB can select either of the two RF signal paths.
c) CA client for RF service is mainly located in hybrid STB.

Figure 1 – Location of RG within CATV network configuration

Note that the cable system element (CMTS-CM) in Figure 1 can be replaced with FTTH network owned by cable operators.

Coexistence of the existing services that do NOT require the RG and new services provided by the RG within the same home network is very important from the rapid and cost-effective deployment aspects. Figure 2 illustrates the configuration of cable-based home networking for this case.

a) "IP" should be interpreted as "IP over DOCSIS or other cable access technology on HFC or RFoG". However, other types of IP networks such as G-PON, GE-PON or other optical transport network should be also allowed. In this case, CMTS and CM will be replaced by OLT and ONU respectively, and "IP" should be interpreted as "IP over PON".
b) Hybrid STB can select either of the two RF signal paths.
c) CA client for RF service is mainly located in hybrid STB.

Figure 2 – Basic configuration with legacy service support

Figure 3 shows the IPTV reference model of [ITU-T J.700]. An RG resides between the network provider and the customer in the cable environment. From the viewpoint of content flow, the content is received from the content provider at the service provider in the content provision function (primary distribution). It acquires, manages, and provisions content according to service provider requirements (e.g., ad-insertion, logo superimposing, encryption, compression, etc.). Content is then sent to the content streamer function to be streamed and delivered to the customer through the network delivery function (secondary distribution). The service control function is used to control interaction with the customer and distribute content via the network provider. The network control and the network delivery functions operate within the network provider entity in order to disseminate and deliver content and data to and from the customer. Each customer entity may contain an RG (owned and/or operated as a CPE by the network provider, service provider, or customer), which functions to receive and send content and data to and from the other CPEs within the home network.
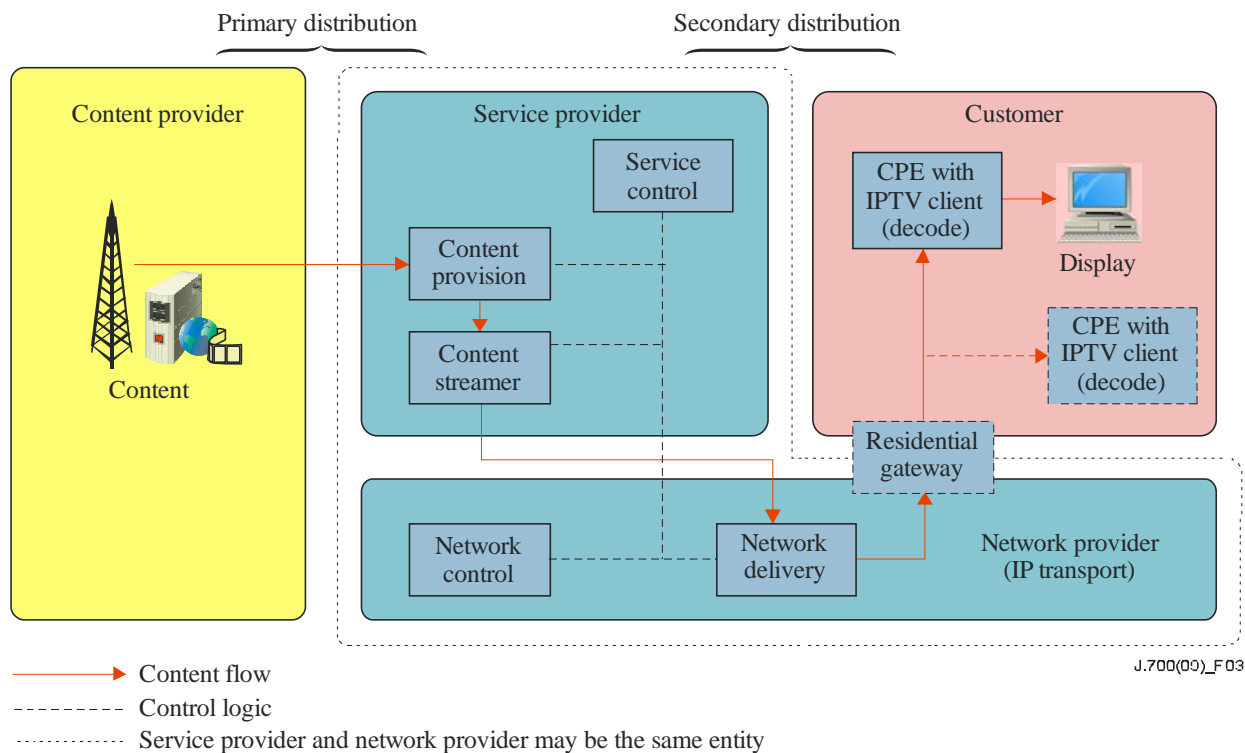
Figure 3 – IPTV reference model

The RG has to handle a variety of control signals, media signals and IP packets for the reception of broadcast and IP-interactive services with or without interaction between the access network and the home network. The way of interaction is basically given by the LASDP which resides in the home network area and/or SDP located in the access network area. Figure 4 depicts an overall conceptual functional diagram for enhanced broadcast services to be provided by cable operators. The diagram contains functional blocks of SDP and LASDP which have the control governance for RG functions.
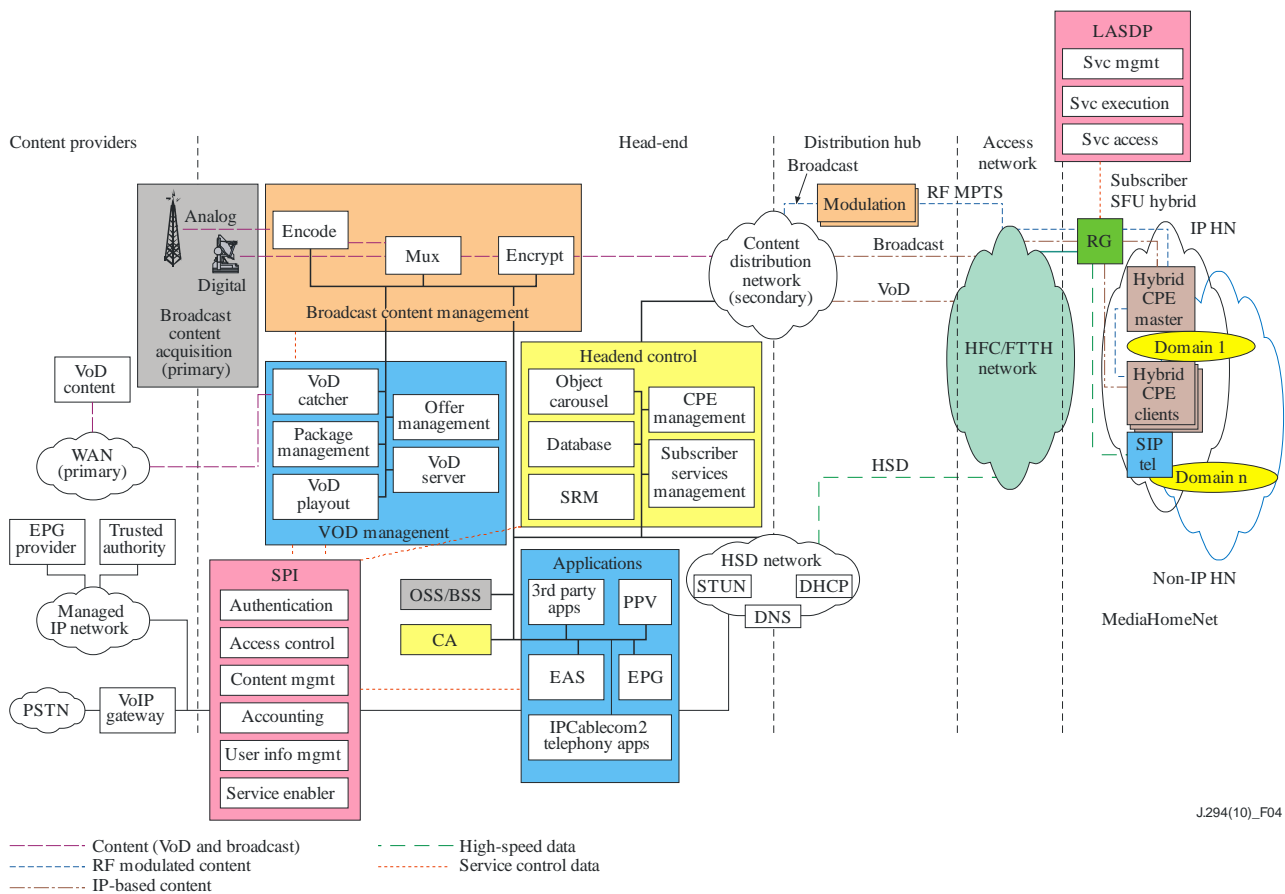
Figure 4 – Overall conceptual functional diagram for enhanced broadcast services

This Recommendation outlines the requirements for an RG that provides a 2-way communications channel with the cable network for service control and management. A vendor can optionally incorporate the H-STB functions into the RG, and the requirements for this configuration are not covered in this Recommendation.

7 Design objectives

7.1 Design objectives for enhanced broadcast services

The following are the design goals and objectives for RG that supports enhanced broadcast services:

- Support interactive and high quality services for H-STB and CPE within a home network.
- Leverage existing standards. The RG strives to specify open, approved industry standards that have been widely adopted in commercial broadcast and communication networks. This includes standards approved by the ITU, ISO/IEC, IETF, IEEE, and other standardization bodies.
- Define an architecture that allows multiple vendors to rapidly develop low-cost interoperable solutions to meet time-to-market requirements.
- Ensure that IP packets and MPEG transport stream (TS) can be transported and processed adequately.
- Provide operation support system (OSS) that enables cable operators to control and manage the STB system and other connected devices.
- Provide for consumer protection inclusive of interests for disabled persons.

- Provide scalable and down-loadable functionalities by software as the technology has progressed.
- Provide facilities to deliver services and content with accessibility enhancements to aid users.
- Provide accessible user interfaces to receive services for the handicapped or elderly person.

7.2 Design objectives for optional advanced features

Following are the design goals and objectives for an RG that supports the optional enhanced features, including broadband CM functionalities:

- Ensure the packet loss rate, jitter, and latency (delay) for the managed IP network can meet the requirements for STB real-time services, including voice.
- Provide a seamless connection means to the home network defined by [ITU-T J.190].
- Support quality of service (QoS) architecture that is scalable and capable of supporting IP-based services.
- Support the telephony services defined by [b-ITU-T J.460.0].

7.3 Implementation

The following specifies requirements related to implementation matter of RG:

- The ITU-T J.294 compliant residential gateway is required to be able not only to be implemented as independent equipment but also to be embedded within other devices such as STB or embedded multimedia terminal adapter (E-MTA).
- Distributed implementation of the residential gateway is required to be allowed. This means that one gateway device does NOT always have all the mandatory functionalities defined by the remainder of this Recommendation. It is also required to allow multiple devices installed within the same home network and having partial responsibility of this Recommendation to work complementarily to provide a complete set of the functionalities of this Recommendation.

7.4 Services

This clause describes services to be supported by the RG. The services encompass the broadcast and IP-based interactive services which are required to the cable network. Its implementation is left to vendor's choice.

| Number	Core service description
Svc 1	The RG is required to support the delivery of digital video and audio content of broadcast to H-STB.
Svc 2	The RG is required to support the IPTV broadcast services for H-STB.
Svc 3	The RG is required to support the content navigation and electronic program guide (EPG) signal transmission for H-STB.
Svc 4	The RG is required to support content on-demand service for H-STB.
Svc 5	The RG is required to support digital program insertion (DPI) for H-STB.
Svc 6	The RG is required to support video game for H-STB.
Svc 7	The RG is required to support interactive television service provided RF-based broadcast for H-STB.
Svc 8	The RG is required to support web-based services/Internet portal access service for H-STB.

Number	Core service description
Svc 9	The RG is required to support telephony services.
Svc 10	The RG is required to support QoS architecture.
Svc 11	The RG is required to support parental control mechanisms for H-STB.
Svc 12	The RG is required to support the SCP (service and content protection) mechanism.
Svc 13	The RG is required to support the home security monitoring service.
Svc 14	The RG is required to control all devices in the home network.
Svc 15	The RG can support textual and instant message service for H-STB.
Svc 16	The RG can support content sharing (video, still images, etc.) for H-STB.
Svc 17	The RG can support audio books service for H-STB.
Svc 18	The RG can support distance learning, telemedicine and other information services for H-STB.
Svc 19	The RG can support telephony integration (Voicemail, Caller ID, etc.) service.
Svc 20	The RG can support 3rd party call control service.
Svc 21	The RG can support video and audio conferencing services.
Svc 22	The RG can support real-time text applications.
Svc 23	The RG can support multi-user online gaming.
Svc 24	The RG can support local digital video recorder (DVR) services.
Svc 25	The RG can support network digital video recorder (DVR) services.
Svc 26	The RG can support the e-commerce service.
Svc 27	The RG can support e-mail service.
Svc 28	The RG can support presence service (presence of an active user and provisioning information).

8 Requirements for functional components

The RG has functionalities for network interface, network control, content delivery, service control and applications to exchange control signals and media flows between WAN and LAN. The functionality has several functional components as shown in Figure 5.

Figure 5 depicts the relationship between RG functional components and HE ones for the reception of enhanced broadcast services defined in [ITU-T J.700]. The details of interfaces for HE-RG and RG-HN in Figure 5 are left for further study.

This clause describes requirements for RG functional components which form the logical entity of RG. In case that RG requires the function described in this clause, the RG is required to satisfy the condition (Required or Optional) in the tables in clause 8.
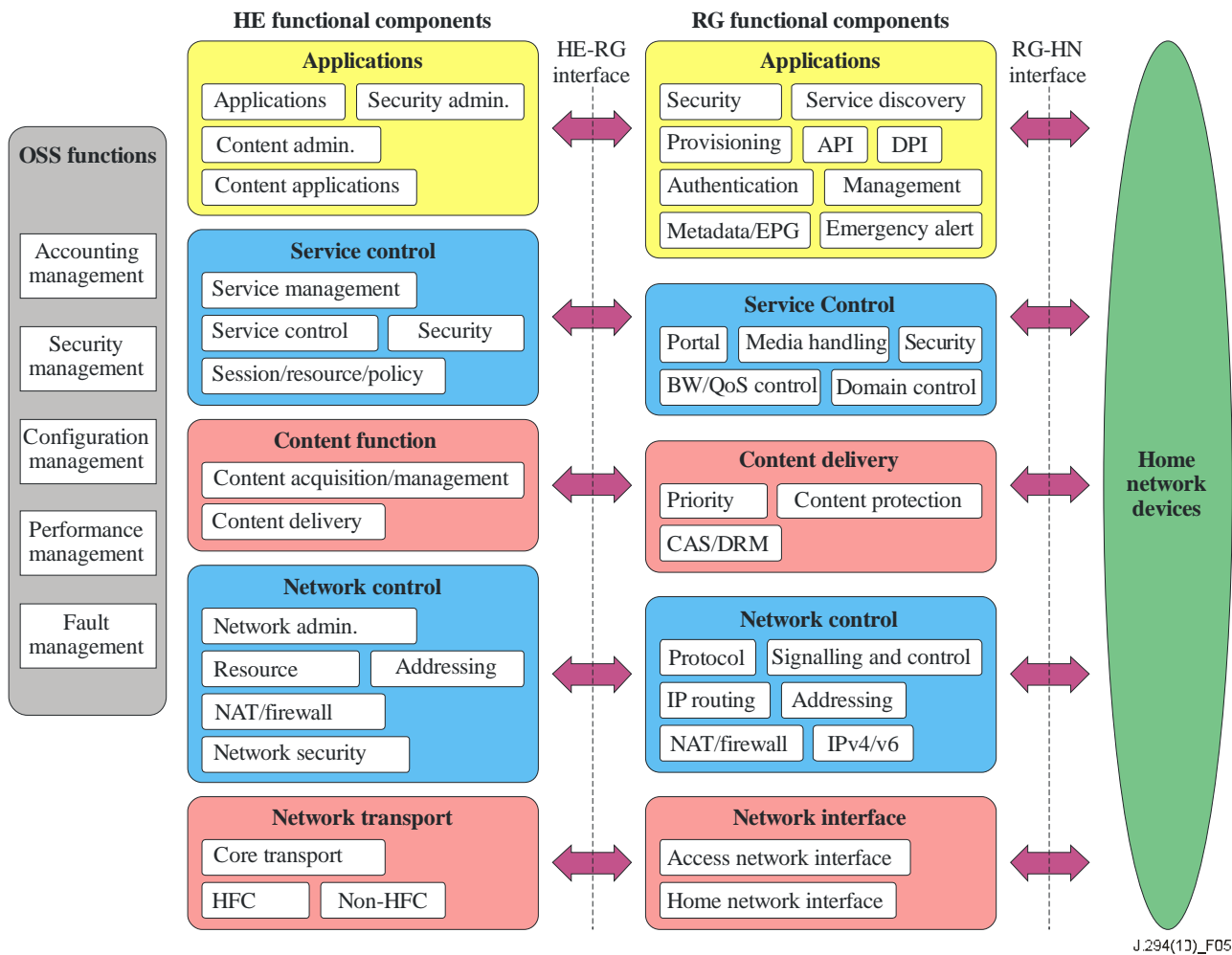
**Figure 5 – Functional components for the reception
of enhanced broadcast services [ITU-T J.700]**

8.1 Applications functionality

8.1.1 Security requirements

The following table outlines the general security requirements for the Applications functionality of the RG. Further security requirements for different functionalities are described in the specific functional areas covered later in this Recommendation.

Number	Security requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Sec App 1	The RG is required to support content protection system.	R	Y	Y
Sec App 2	The RG is required to support copy protection system.	R	Y	Y
Sec App 3	The RG is required to support parental control function.	R	Y	Y
Sec App 4	The RG is required to support code download security function.	R	Y	Y

Number	Security requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Sec App 5	The RG is required to support cryptographic service function.	R	Y	Y
Sec App 6	The RG is required to support removable security function.	R	Y	Y
Sec App 7	The RG is required to support digital rights management (DRM) functions.	R	Y	N
Sec App 8	The RG is required to have home security portal (HSP) functions.	R	Y	N
Sec App 9	The RG is required to have firewall (FW) functions.	R	Y	N
Sec App10	The RG is required to protect security clients in HN.	R	Y	N

8.1.2 Service discovery requirements

The following table outlines the general service discovery requirements for the Applications functionality of the RG. Enhanced broadcast services are required to support both SI-based and web-based service discovery methods.

Number	Service discovery requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Svc Disc 1	The RG is required to support a mechanism of service discovery.	R	Y	Y
Svc Disc 2	The RG is required to support SI-based service discovery.	R	Y	Y
Svc Disc 3	The RG is required to support web-based service discovery.	R	Y	Y
Svc Disc 4	The RG is required to support a usage of metadata/EPG for service discovery.	R	Y	Y
Svc Disc 5	The RG is required to support APIs for service discovery.	R	Y	Y

8.1.3 Provisioning requirements

The following table outlines the general provisioning requirements for the Applications functionality of the RG. It is required not only for IPv4/v6 provisioning, but for CM, if it is contained in RG.

Number	Provisioning requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Prov 1	The RG is required to have MediaHomeNet DHCP portal function.	R	N	Y
Prov 2	The RG is required to have MediaHomeNet DNS portal function.	R	N	Y
Prov 3	The RG is required to have MediaHomeNet testing portal function.	R	N	Y
Prov 4	The RG is required to support IPv4 provisioning with DHCPv4 server.	R	N	Y
Prov 5	The RG is required to support IPv6 provisioning with DHCPv6 server.	R	N	Y
Prov 6	The RG is required to provide a provisioning method for the CM if it is contained in RG.	R	N	N

8.1.4 Application program interface requirements

The following table outlines the general application program interface requirements for the Applications functionality of the RG. Either declarative or procedural API can be used for the reception of enhanced broadcast services.

Number	Application program interface requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
API 1	The RG is required to support content navigation API based on SI-based terminal middleware.	R	Y	Y
API 2	The RG is required to support content navigation API based on Web-based terminal middleware.	R	Y	Y
API 3	The RG is required to support declarative API.	R	Y	Y
API 4	The RG is required to support procedural API.	R	Y	Y
API 5	The RG is required to support a mechanism to allow a user to select IPTV services from a list of the available service providers.	R	Y	Y
API 6	The RG can optionally support a mechanism to interact with a mobile or a portable device and enable the user to receive content from the service provider.	O	Y	Y
API 7	The RG is required to support a mechanism to install or to remove application programs.	R	Y	Y
API 8	The RG is required to support an application to obtain status information and events.	R	Y	Y
API 9	The RG is required to support an application to have self-diagnostic and reporting functions.	R	Y	Y

8.1.5 Digital program insertion requirements

The following table outlines the general digital program insertion requirements for the Applications functionality of the RG. The program insertion can be done either at head-end or terminal side considering efficiency of advertisement.

Number	Digital program insertion requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
DPI 1	The RG can optionally support digital program insertion (DPI) function at the client side.	O	Y	Y
DPI 2	The RG can optionally support DPI function at the server side.	O	Y	Y
DPI 3	The RG can optionally control the upstream delivery of audience measurement information with the aid of the policy server.	O	Y	Y

8.1.6 Authentication requirements

The following table outlines the general authentication requirements for the Applications functionality of the RG. Both authentications for person and device are required to receive enhanced broadcast services.

Number	Authentication requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Auth 1	The RG is required to support personal authentication function.	R	Y	Y
Auth 2	The RG is required to support device authentication function in HN.	R	Y	Y
Auth 3	The RG is required to support key management system for device authentication.	R	Y	Y
Auth 4	The RG is required to support key distribution system for device authentication.	R	Y	Y
Auth 5	The RG is required to support a single sign-on mechanism that allows one authentication session to enable access to multiple services at the same time.	R	Y	Y
Auth 6	The RG is required to support independent login and selection of the service consumption device for each of the different services which a user has subscribed to.	R	Y	Y
Auth 7	The RG can optionally support the root certificates to be used in authenticating servers.	R	Y	Y

8.1.7 Management requirements

The following table outlines the general management requirements for the Applications functionality of the RG. In the table, requirements for HN client control, resource management, policy management, user profile management are included.

Number	Management requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Mgmt 1	The RG is required to control devices in the MediaHomeNet network.	R	Y	N
Mgmt 2	The RG is required to have MediaHomeNet management portal functions.	R	Y	N
Mgmt 3	The RG is required to support management client functions.	R	Y	N
Mgmt 4	The RG is required to support LAN IP device DHCP client.	R	Y	N
Mgmt 5	The RG is required to support LAN IP device echo (Loopback) responder.	R	Y	N
Mgmt 6	The RG is required to support resource management mechanisms.	R	Y	Y
Mgmt 7	The RG is required to support policy management mechanisms.	R	Y	Y
Mgmt 8	The RG is required to support a mechanism of user profile management.	R	Y	Y
Mgmt 9	The RG is required to support a mechanism to identify a default user with a user profile that has limited rights to access.	R	Y	Y
Mgmt 10	The RG is required to support a mechanism for the user to be able to add, remove and modify his/her user profile.	R	Y	Y
Mgmt 11	The RG is required to support a mechanism that utilizes user profiles to target and/or restrict content items.	R	Y	Y
Mgmt 12	The RG is required to support accounting mechanisms.	R	Y	Y

8.1.8 Metadata/EPG requirements

The following table outlines the general metadata/EPG requirements for the Applications functionality of the RG. Metadata and EPG provide useful means for content navigation, selection as well as content linking.

Number	Metadata requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Meta 1	The RG is required to support electronic program guide (EPG) that provides information to users about scheduled content programs.	R	Y	Y
Meta 2	The RG is required to support content guides that provide information to users about the content accessible through content on-demand system.	R	Y	Y
Meta 3	The RG is required to support a mechanism to supply content Metadata from sources to end devices.	R	Y	Y

Number	Metadata requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Meta 4	The RG is required to support a mechanism of Metadata to perform navigation, selection, association (linking) for the contents.	R	Y	Y
Meta 5	The RG is required to support a scalable mechanism to deliver/update Metadata associated with content.	R	Y	Y

8.1.9 Emergency alert requirements

The following table outlines the general emergency alert requirements for the Applications functionality of the RG. The RG is required to install an emergency alert function to notify the user of the emergency status distributed from the emergency control centre.

Number	Emergency alert requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
EA 1	The RG is required to have emergency alert function.	R	N	N
EA 2	The RG is required to accept and fully support alert information detailed in the relevant national standards.	R	N	N

8.2 Service control functionality

8.2.1 Portal service requirements

The following table outlines the general portal service requirements for the service control functionality of the RG. It is required to contain management portal, DHCP portal, QoS portal, test portal and portal service database.

Number	Portal service requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Portal 1	The RG is required to contain management portal function to interact with the following functions.	R	Y	N
Portal 2	The RG is required to contain DHCP portal function to discover devices in the MediaHomeNet network.	R	Y	N
Portal 3	The RG is required to contain QoS portal function.	R	Y	N
Portal 4	The RG is required to contain test portal function.	R	Y	N
Portal 5	The RG is required to contain portal service database which maintains profiles for devices in the MediaHomeNet network.	R	Y	N

8.2.2 Media handling requirements

The following table outlines the general media handling requirements for the service control functionality of the RG. The media to be passed through by the RG are video, audio, still-picture, graphics and text. These media shall not interfere with the RG unless required.

Number	Media handling requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Media 1	The RG is required to not interfere with the delivery of media signals unless required.	R	N	N
Media 2	The RG is required to support video transport.	R	N	N
Media 3	The RG is required to support audio transport.	R	N	N
Media 4	The RG is required to support still-picture transport.	R	N	N
Media 5	The RG is required to support graphics transport.	R	N	N
Media 6	The RG is required to support text transport.	R	N	N
Media 7	The RG is required to support a mechanism to report successful transfer of the digital media or the notification which provides a link to the digital media.	R	Y	Y
Media 8	The RG can optionally provide remote access capability from an authorized remote device outside a home to in-home devices that support media transport.	O	Y	N
Media 9	If [Media 8] is supported, the RG is required to provide access control functionality to grant permission to a remote device to allow access to in-home devices.	R (conditional)	Y	N
Media 10	The RG can optionally provide device discovery functionality to discover in-home devices that support media transport. The discovery result will be provided to the device (in-home device or authorized remote device) that issued discovery request to the RG.	O	Y	N
Media 11	The RG can optionally provide service discovery functionality to discover media transport-related services supported by the in-home devices discovered by the previous functionality [Media 10] from in-home devices or authorized remote devices.	O	Y	N
Media 12	The RG can optionally provide media transport capability from device (in-home device or authorized remote device) to device (in-home device or authorized remote device) directly or indirectly.	O	Y	N

8.2.3 Security requirements

The following table outlines the general security requirements for the service control functionality of the RG. With the aid of authentication and content protection, the RG shall provide security mechanisms for the service control information as well as the delivery of content between source and client.

Number	Security requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Sec Svc 1	The RG is required to have a mechanism of security for service control information.	R	Y	Y
Sec Svc 2	The RG is required to support key management system for the security of service control information.	R	Y	Y

8.2.4 BW/QoS requirements

The following table outlines the general BW/QoS requirements for the service control functionality of the RG. The RG shall have a resource control mechanism such as BW and QoS controls for the delivery of contents in accordance with the service policy defined in LASDP. The BW control is required mainly for broadcast content, while QoS is required for IP-based service content. The RG shall study the QoS function and service status in terminal devices within MediaHomeNet (LAN) as well as QoS level required for content delivery in the access network (WAN). If the service requires more bandwidth than is occupied in the terminal device and home network, the RG is required to report it to the WAN side and try to re-allocate the resource after negotiation with the service control function in the service delivery platform within the pre-assigned time period. The RG shall provide QoS translation/bridging function between WAN and LAN to maintain the end-to-end quality of content at maximum intent.

Number	BW/QoS requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
BW/QoS 1	The RG is required to support BW/QoS control mechanism for broadcast content.	R	Y	Y
BW/QoS 2	The RG is required to support MediaHomeNet QoS functions.	R	Y	N
BW/QoS 3	The RG is required to have QoS translation/bridging function between WAN (AN) and LAN (HN).	R	Y	N

8.2.5 Domain control requirements

The following table outlines the general domain control requirements for the service control functionality of the RG. The RG shall support guaranteed service domain (GSD), authorized service domain (ASD), approved output domain (AOD) and best effort domain (BED) in the MediaHomeNet network. For the non-IP devices within MediaHomeNet network, the RG shall communicate with the HB device which has interpretation function between IP and non-IP devices. See the description in [ITU-T J.190]

Number	Domain control requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Dom 1	The RG is required to support MediaHomeNet domain in HN.	R	Y	N
Dom 2	The RG is required to support proprietary domain in HN.	R	Y	N
Dom 3	The RG is required to support guaranteed service domain (GSD).	R	Y	N
Dom 4	The RG is required to support authorized service domain (ASD).	R	Y	N
Dom 5	The RG is required to support approved output domain (AOD).	R	Y	N
Dom 6	The RG is required to support best effort domain (BED).	R	Y	N
Dom 7	The RG is required to communicate with HB device in MediaHomeNet domain.	R	Y	N

8.3 Content delivery functionality

8.3.1 Priority requirements

The following table outlines the general priority requirements for the content delivery functionality of the RG. The RG shall support the priority mechanism for the delivery of contents in the MediaHomeNet network.

Number	Content protection/DRM requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Prio 1	The RG is required to enable a user to define a set of contents, devices, and services in HN with priority.	R	Y	N
Prio 2	The RG is required to have a default table of service priority.	R	Y	N

8.3.2 Content protection requirements

The following table outlines the general content protection requirements for the content delivery functionality of the RG. The RG shall support a content protection mechanism to deliver contents securely for the client device.

Number	Content protection requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
CP 1	The RG is required to support a content protection mechanism for the scheduled content services with rules governing content usage and distribution within HN.	R	Y	Y
CP 2	The RG is required to be able to process messages containing cryptographic keys.	R	Y	Y
CP 3	The RG is required to support a mechanism for limiting the access to services only to authorized users.	R	Y	Y

8.3.3 CAS/DRM requirements

The following table outlines the general CAS/DRM requirements for the content delivery functionality of the RG. The RG shall support CAS for access limitation and DRM for protection of content within MediaHomeNet environment. Appropriate CAS/DRM shall be selected with media transport. CAS shall be terminated at the first CAS client in the customer premises. Once CAS is terminated at the first CAS client, the DRM function is strictly required for content delivery afterword within the home network, which means interaction is required among the terminal device and the RG.

Number	CAS/DRM requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
CAS/DRM 1	The RG is required to support CAS system for enhanced broadcast services.	R	N	Y
CAS/DRM 2	The RG is required to support DRM system to protect content within the MediaHomeNet network.	R	Y	N
CAS/DRM 3	The RG is required to terminate or pass-through DRM information signal in conjunction with the policy server function for HN.	R	Y	N

8.4 Network control functionality

8.4.1 Protocol requirements

The following table outlines the general protocol requirements for the network control functionality of the RG. The RG shall support widely accepted and proved protocols for IP-based communications and service delivery.

Number	Protocol requirements	Required/ Optional	Interaction with LASDP	Interaction withSPI
Prot 1	The RG is required to support the transmission protocols defined by ITU-T, DVB, IEC, IETF over IP networks as the guideline for the choice of protocols.	R	N	N
Prot 2	The RG is required to support the DOCSIS transmission protocols.	R	N	N
Prot 3	The RG is required to support the multicast transmission protocol for the scheduled content service and download.	R	N	N
Prot 4	The RG is required to support transmission protocols for physical connections deployed in the GPON, GE-PON systems as well as HFC system.	R	N	N
Prot 5	The RG is required to not exclude non-IP protocols which are used by proprietary devices in the HN.	R	N	N
Prot 6	The RG is required to control devices within the MediaHomeNet network using UPnP.	R	Y	N
Prot 7	The RG is required to support functionality to make content and related information applicable to digital living network alliance (DLNA) devices which implement appropriate DLNA protocols in HN.	R	Y	N
Prot 8	The RG is required to support a mechanism of resource allocation between the access network and the home network to deliver the actual content to end devices.	R	Y	N

8.4.2   Signalling and control requirements

The following table outlines the general signalling and control requirements for the network control functionality of the RG. The RG shall support DOCSIS/DSG signalling if it contains DOCSIS CM. The RG shall be monitored remotely from the head-end on an on-demand basis.

Number	Signalling and control requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
SC 1	The RG is required to support DOCSIS/DSG signalling.	R	N	N
SC 2	The RG is required to support IP-based command and control signalling.	R	N	N
SC 3	The RG can optionally support the control function provided by a mobile or portable device.	O	Y	Y
SC 4	The RG is required to not interfere with the session control between the terminal device and the head-end equipment unless required.	R	N	N

Number	Signalling and control requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
SC 5	The RG is required to have a logging function of session control signal exchange between the terminal device and the head-end equipment.	R	N	Y
SC 6	The RG is required to support a remote control mechanism from HE.	R	N	Y

8.4.3 IP routing requirements

The following table outlines the general IP routing requirements for the network control functionality of the RG.

Number	IP routing requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
IP Route 1	The RG is required to support any one of five modes – IPv4 Protocol-Enabled, IPv6 Protocol-Enabled, Dual IP Protocol-Enabled, Disabled or IPv4-IPv6 conversion.	R	N	N
IP Route 2	The RG is required to support IPv4 Protocol-Enabled Mode which forwards IPv4 traffic with NAPT or other possible method and does not forward IPv6 traffic.	R	N	N
IP Route 3	The RG is required to support IPv6 Protocol-Enabled Mode which forwards IPv6 traffic and does not forward IPv4 traffic.	R	N	N
IP Route 4	The RG is required to support Dual IP Protocol-Enabled Mode which forwards IPv4 packets using NAPT as well as IPv6 packets.	R	N	N
IP Route 5	The RG is required to support Disabled Mode which bridges all traffic with CPE, regardless of IP protocol version.	R	N	N

8.4.4 Addressing requirements

The following table outlines the general addressing requirements for the network control functionality of the RG. The RG shall be given a global address and a MAC address to be identified by the cable operator. The RG shall have address translation function between WAN and LAN as well as pass-through function if required. The RG shall also have address resolution function between IP and data link layers.

Number	Addressing requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Address 1	The RG is required to have a global IP address and a MAC address.	R	N	N
Address 2	The RG is required to have MediaHomeNet address translation function.	R	N	N
Address 3	The RG is required to have MediaHomeNet pass-through function.	R	N	N

Number	Addressing requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
Address 4	The RG is required to have upstream selective forwarding switch.	R	N	N
Address 5	The RG is required to have an address resolution function between IP and data link layers.	R	N	N

8.4.5 NAT/Firewall requirements

The following table outlines the general NAT/Firewall requirements for the network control functionality of the RG. The RG shall have NAT/Firewall transversal or NAPT function when it is used in the IPv4 environment.

Number	NAT/Firewall requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
NAT 1	The RG is required to have NAT/FW Traversal or NAPT function.	R	N	N
NAT 2	The RG is required to have a mechanism for the setting of NAT/FW or NAPT by the cable operator.	R	N	N

8.4.6 IPv4/v6 requirements

The following table outlines the general IPv4/v6 requirements for the network control functionality of the RG. The RG shall support multicast in both IPv4 and IPv6 environment for IP-based broadcast services.

Number	IPv4/v6 requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
IPv4/v6 1	The RG is required to support applications that use IPv4 and/or IPv6 to provide back office configuration and other support to the devices.	R	N	N
IPv4/v6 2	The RG is required to support a mechanism which acts seamlessly in IPv4 and/or IPv6 environment.	R	N	N
IPv4/v6 3	The RG is required to support IPv4 and/or IPv6 multicast protocol.	R	N	N
IPv4/v6 4	The RG is required to support CPE provisioning with IPv4 and IPv6 addresses.	R	N	N
IPv4/v6 5	The RG is required to support IPv4 data forwarding with NAPT and IPv6 data forwarding.	R	N	N
IPv4/v6 6	The RG is required to support a mechanism which preserves IP QoS markings on IP data to and from the CPE devices.	R	N	N

8.5 Network interface functionality

8.5.1 Access network interface requirements

The following table outlines the general access network interface requirements for the network interface functionality of the RG. The RG shall terminate the access network in the physical layer.

Number	Access network interface requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
ANI 1	The RG is required to have access network interface.	R	N	N
ANI 2	The RG is required to terminate access network at the physical layer.	R	N	N
ANI 3	The RG is required to be able to connect with the access network by coaxial cable for HFC, RFoG-based FTTH or RF portion of PON-based FTTH.	R	N	N
ANI 4	The RG can optionally be equipped with a separate Ethernet interface for IP transport from/to access network, which will be connected with an external cable modem, V-ONU, ONU or other modem devices.	O	N	N

8.5.2 Home network interface requirements

The following table outlines the general home network interface requirements for the network interface functionality of the RG. The RG shall terminate the home network in the physical layer.

Number	Home network interface requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
HNI 1	The RG is required to have home network interface.	R	N	N
HNI 2	The RG is required to terminate home network at the physical layer.	R	N	N
HNI 3	The RG is required to support IP devices and proprietary protocol devices in MediaHomeNet network.	R	N	N
HNI 4	The RG can optionally be equipped with modems for in-home IP transport, e.g., coaxial modem, PLC or [b-ITU-T G.9960].	O	N	N

8.5.3 Power management requirements

In order to meet the worldwide demand of power saving and improving energy efficiency, the RG shall have power management function for the RG itself as well as devices in the home network.

Number	Power management requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
PMN1	The RG is required to be able to turn into stand-by mode when idle status continues for a pre-determined time.	R	N	N
PMN2	The RG is required to support power management function provided on the device in the HN.	R	Y	N

9 Requirements for optional standardized features

9.1 Requirements to incorporate a full DOCSIS CM into the RG

If an RG implements a broadband CM, the following conditional requirements shall apply:

Number	Embedded DOCSIS CM requirements	Required/ Optional	Interaction with LASDP	Interaction with SPI
DOCS 1	The RG is required to support DOCSIS 3.0 CM.	R	N	N
DOCS 2	The RG is required to support DOCSIS 3.0-compliant CMTSs which is required to seamlessly support DOCSIS 2.0 and DOCSIS 1.x CMs.	R	N	N

Appendix I

Relationship between APIs and bundle application programs

(This appendix does not form an integral part of this Recommendation)

A Java-based application management platform, e.g., Open Services Gateway initiative (OSGi, Release 4 Version 4.2) framework, is recommended to be implemented in the RG (with H-STB functionalities) to facilitate management of application programs such as network control, CPE device control over UPnP transaction, log services, permission administration functions and customer services. These softwares are so called "bundle software", which can be easily installed to and removed from the RG by operators' intentions. Every bundled software is able to work independently over the OSGi framework by communicating with OSGi servers located in the IP network. Figure I.1 shows a relationship between generic RG protocol stacks and bundle software.
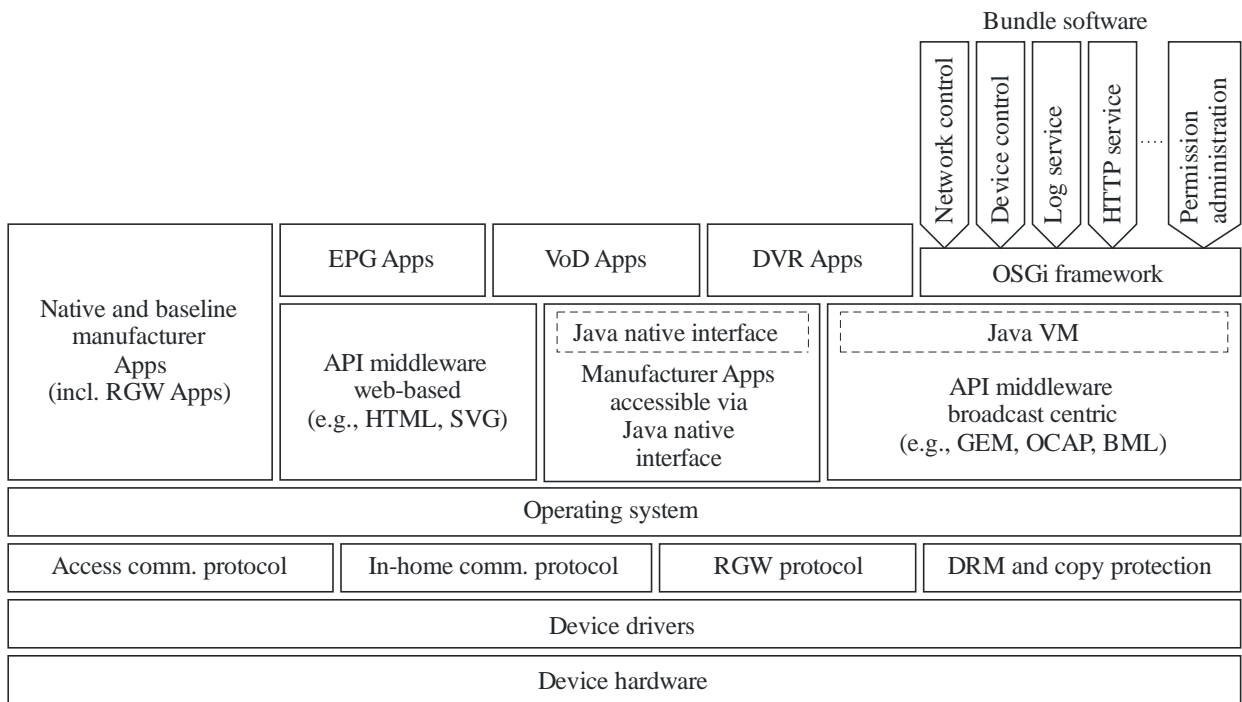
Figure I.1 – A relationship between generic RG protocol stacks and bundle software with H-STB functionalities

Appendix II

Access network configuration aspect

(This appendix does not form an integral part of this Recommendation)

Figure II.1 illustrates the supposed use cases with several types of access network configurations. In this diagram, four types of access network configurations are supported as described in [ITU-T J.700], i.e., HFC, frequency multiplexing-based optical fibre (RFoG), PON-based optical fibre and hybrid use of HFC and optical fibre.

As for the transport method within home, the coaxial cable will be used for RF video signals and Ethernet LAN will be used for IP. Note that IP signals can be also modulated by such technology as multimedia over coax alliance (MOCA), HPNA or [b-ITU-T G.9960], which are multiplexed with the RF video within the coaxial cable.
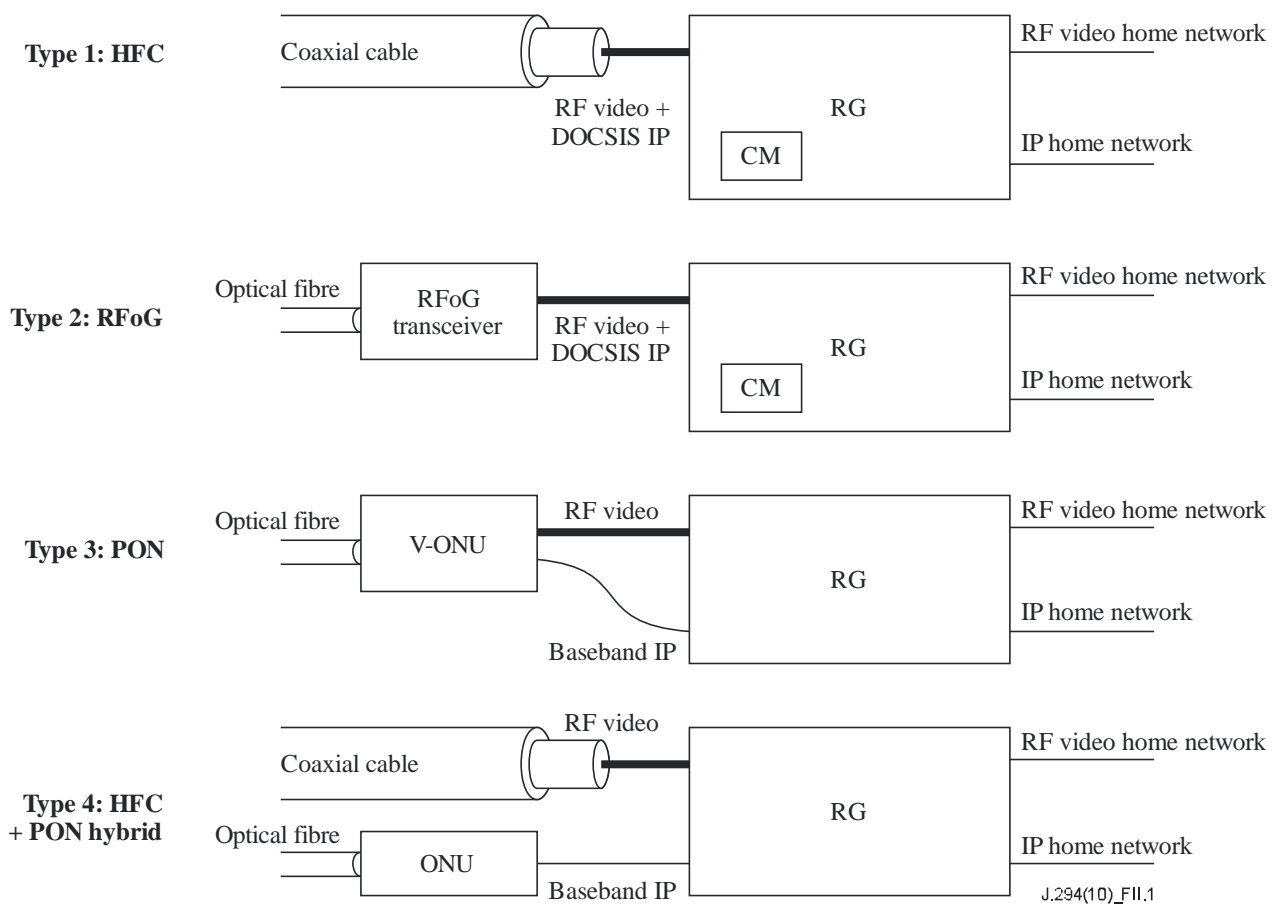
Figure II.1 – Access network configuration types

In addition, content transport among CPEs within home such as multi-room DVR or remote access from an authorized terminal outside home to home devices should be supported in this system.

Appendix III

Application and service aspect

(This appendix does not form an integral part of this Recommendation)

The following steps 1) to 3) constitute an example of the remote content access services assumed in this Recommendation.

1)   *Content transmission to in-home devices*

A user 'A' is travelling around scenic places. He took videos and pictures with his portable device, e.g., digital camera or mobile phone, which is capable of network connectivity. When 'A' feels that he wants to store the videos and pictures to save the storage area of his device or to make them available to his friends or family, 'A' will choose files on his device to upload them to the home storage through the network and the residential gateway.

J.294(10)_FIII.1
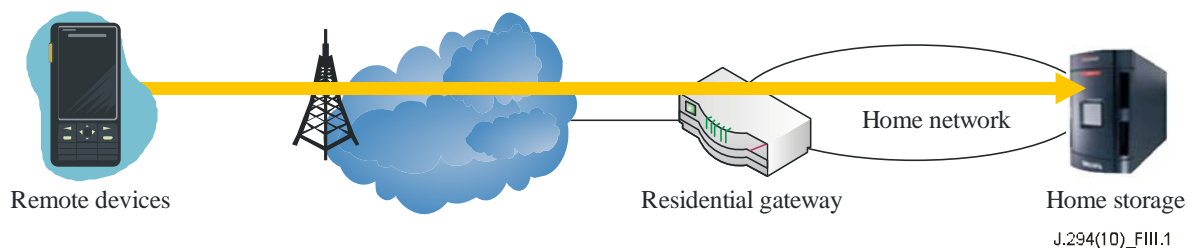
Figure III.1 – Content transmission to in-home devices

2)   *Sharing content with authorized users*

When 'A' thinks about sharing the videos with his friends including 'B', he would choose them from his phonebook on the handset device to whom the content should be made available. Then the device sends a message to the residential gateway with the information regarding those who will be able to see the content. This step will grant access entitlement to the designated users.

3)   *Content retrieval by authorized users*

When 'B' wants to see the videos and pictures taken by 'A', 'B' accesses 'A''s home gateway from 'B''s device at first. Since access permission has already been granted by step 2), 'B''s device would be automatically redirected to 'A''s in-home storage to retrieve the list of the content and the content itself. After retrieval of the content, 'B' would play back the videos and pictures on her handset.
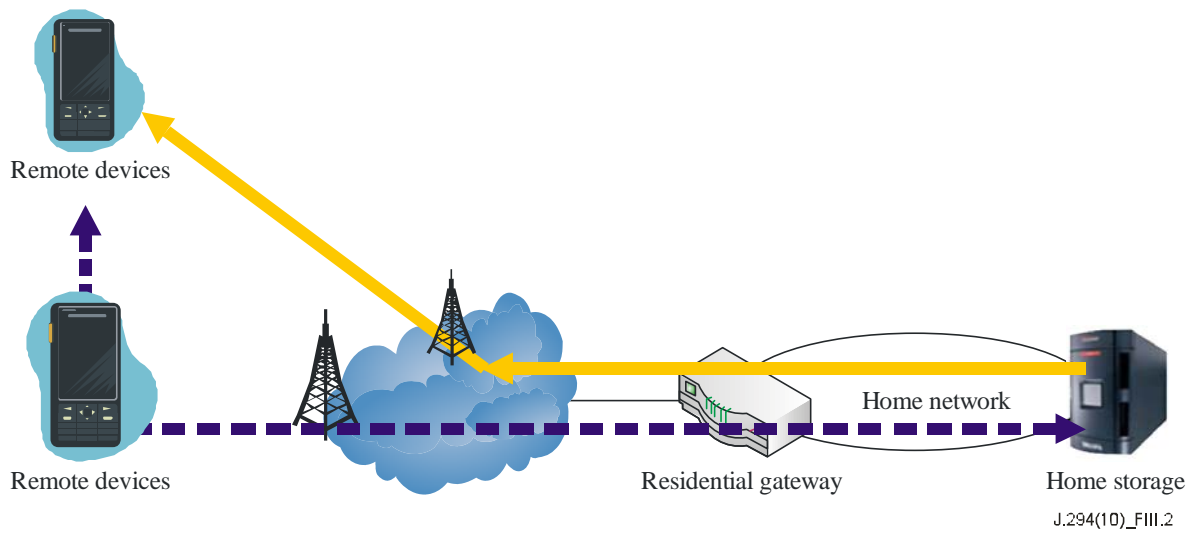
Figure III.2 – Content retrieval by an authorized user

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