

International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

J.190

(07/2007)

SERIES J: CABLE NETWORKS AND TRANSMISSION
OF TELEVISION, SOUND PROGRAMME AND OTHER
MULTIMEDIA SIGNALS

Cable modems

Architecture of MediaHomeNet

ITU-T Recommendation J.190



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Architecture of MediaHomeNet

Summary

ITU-T Recommendation J.190 establishes a flexible and forward-looking home-networking framework that provides a unifying theme for developing a coherent set of home-network interface specifications. The MediaHomeNet infrastructure, initially created for cable access networks, is now designed to be complementary to all IP-based access networks in order to support applications such as video distribution to STB defined in ITU-T Recommendation J.290 (next generation set-top box) and voice over IP defined in ITU-T Recommendation J.160 (IPCablecom) or ITU-T Recommendation J.360 (IPCablecom2), and RF-based broadcast services. MediaHomeNet identifies a set of fundamental architectural elements that can be flexibly combined in a set of configurations, allowing for the consideration of a wide variety of home-networking solutions.

Source

ITU-T Recommendation J.190 was approved on 29 July 2007 by ITU-T Study Group 9 (2005-2008) under the ITU-T Recommendation A.8 procedure.

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ITU-T Recommendation J.190

Architecture of MediaHomeNet

1 Scope

This Recommendation establishes a flexible and forward-looking home-networking framework that provides a unifying theme for developing a coherent set of home-network interface specifications, while at the same time lending itself to future enhancement. The MediaHomeNet infrastructure, initially created for cable access networks, is now designed to be complementary to those of all IP-based access network applications such as video distribution to STB defined in [b-ITU-T J.290] (next generation set-top box) and voice over IP defined in [b-ITU-T J.160] (IPCablecom) or [b-ITU-T J.360] (IPCablecom2), and RF-based broadcast networks, but distinct and operational in the absence of deployment of these applications. This Recommendation identifies a set of fundamental architectural elements that can be flexibly combined in a set of configurations, allowing for the consideration of a wide variety of home-networking solutions.

2 References

None.

3 Terms and definitions

This Recommendation defines the following terms:

- 3.1 access node:** As used in this Recommendation, an access node is a termination device that terminates the network end of an access network connection. The access node is technology specific; for example, in Annex A of [J.112] it is called the INA while in Annexes B and C it is the CMTS.
- 3.2 domains:** The extent of home-network-compliant direct influence.
- 3.3 home access (HA):** A device class that connects access network with home bridge.
- 3.4 home bridge (HB):** A device class that connects home access with home client.
- 3.5 home client (HC):** A device class that connects home bridge with home decoder.
- 3.6 home decoder (HD):** A device class that terminates home network.
- 3.7 home network planes:** User interfaces sharing the same Layer 1/Layer 2 or internal link.
- 3.8 IPNet2Home:** The domain in MediaHomeNet that is well bounded and specified based on Internet protocol layer 3 interoperability, as opposed to other domains that can be independently, arbitrarily, or privately designed to an individual manufacturer's specification.
- 3.9 function:** Capabilities that compromise logical elements.
- 3.10 LAN IP device:** A component using the Internet protocols on a local area network.
- 3.11 logical element:** A collection of one or more functions.
- 3.12 MediaHomeNet:** An ITU-T project that includes an architecture and a series of Recommendations that support the delivery of services over home networks. A network that connects multiple elements in a home environment to allow delivery of multi-purpose, multimedia services.
- 3.13 multimedia terminal adapter (MTA):** Defined by IPCablecom as an element that provides IP packetized multimedia services.

3.14 residential gateway: A logical element that provides in-premise and aggregated security, management, provisioning, and addressing services for logical elements within a compliant IPNet2Home network. In this Recommendation, it is also referred to as portal services (PS).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations:

AN	Access Node
AV	Audio-Visual
BP	Boundary Point
BWMF	Bandwidth Management Function
CAP	IPNet2Home Address Portal
CAT	IPNet2Home Address Translation
CDP	IPNet2Home DHCP Portal
CMP	IPNet2Home Management Portal
CMTS	Cable Modem Termination System
CNP	IPNet2Home Naming Portal
CPT	IPNet2Home Address Passthrough
CQoS	IPNet2Home Quality of Service
CQP	IPNet2Home QoS Portal
CSP	IPNet2Home Security Portal
CTP	IPNet2Home Testing Portal
DHCP	Dynamic Host Configuration Protocol [b-IETF RFC 2131]
DNS	Domain Name System [b-IETF RFC 1034]
DQoS	Dynamic Quality of Service
DRM	Digital Rights Management
DVD	Digital Versatile Disk
EP	Endpoint
FAX	Facsimile (ITU-T Rec. T.30)
FW	Firewall
HA	Home Access
HB	Home Bridge
HC	Home Client
HD	Home Decoder
HE	Headend
HFC	Hybrid Fibre/Coax
HTTP	HyperText Transport Protocol
ICMP	Internet Control Message Protocol [b-IETF RFC 792]
IP	Internet Protocol

KDC	Key Distribution Centre (see Table 5-4)
LAN	Local Area Network
LAN-Pass	LAN Passthrough Address Realm
LAN-Trans	LAN Translated Address Realm
LC	Layer-1/2 Converter
MCF	Management Client Function
MPAC	Media Access Control layer
MPEG	Moving Picture Experts Group
MPF	Management Portal Function
MSF	Management Server Function
MTA	Multimedia Terminal Adapter
NAT	Network Address Translation [b-IETF RFC 1631], [b-IETF RFC 2663] and [b-IETF RFC 3022]
NMS	Network Management System
ONT	Optical Network Termination
PC	Personal Computer
PHY	Physical layer
Prop Trans	Proprietary Translated Address Realm
PS	Portal Services
QCF	QoS Client Function
QoS	Quality of Service
QPF	QoS Portal Function
QSF	QoS Server Function
RSVP	Resource ReSerVation Protocol [b-IETF RFC 2210]
SBM	Subnet Bandwidth Manager
SCF	Security Client Function
SNMP	Simple Network Management Protocol [b-IETF RFC 1157]
SPF	Security Portal Function
SSF	Security Server Function
STB	Set-Top Box
SYSLOG	System Logging
TCP	Transmission Control Protocol
TEL	Telephone
TFTP	Trivial File Transfer Protocol [b-IETF RFC 1350]
UDP	User Datagram Protocol
UPnP	Universal Plug and Play
USB	Universal Serial Bus

USFS	Upstream Selective Forwarding Switch
VPN	Virtual Private Network
WAN	Wide Area Network
WAN-Data	WAN Data Address Realm
WAN-Man	WAN Management Address Realm

5 Reference architecture

5.1 Introduction and motivation

In order to extend the advantages of multimedia services to all devices connected to a home network, the MediaHomeNet architecture provides a framework for home networking. The goal of MediaHomeNet, initially created for cable access networks and now designed to be complimentary to all IP-based access technologies, is to provide new IP-based services as well as RF-based ones to devices within the home, complementing access network, applications, such as video distribution services using next generation video set-top box (e.g., [b-ITU-T J.290]) and IPCablecom (e.g., [b-ITU-T J.160]), and broadcast network infrastructures. Specifically, MediaHomeNet provides an infrastructure, by specifying a home networking environment, over which IPCablecom and other related application services can be delivered, managed and supported. Wherever possible, the architecture framework incorporates ITU-T Recommendations and other existing standards.

The MediaHomeNet architecture is composed of two sub-architectures: IPNet2Home architecture and Proprietary architecture. The IPNet2Home architecture uses an IP-based access network for providing network capabilities. The Proprietary architecture uses the broadcast services on the RF-based network such as HFC or Radio on Fibre (e.g., ITU-T Recs J.185 and J.186).

The MediaHomeNet architecture supports a myriad of operator and service provider business models, and introduces additional features above and beyond existing home networking solutions. One of the goals of the MediaHomeNet architecture is the creation of an operator and service provider configurable gateway centric environment for residential use that will interoperate with existing IP-based home devices (LAN IP devices) and new IPNet2Home devices. The MediaHomeNet architecture must allow for remote detection, access or control of services and applications on the home network from either in-home or out-of-home.

It is a goal of IPNet2Home to remain independent of physical and data link protocols. Home networking technologies such as [b-ITU-T G.9951] are given as examples. IPNet2Home is focused on Layer 3 IP traffic in the home. Similarly, IPNet2Home does not place requirements on higher layers for specific application or codecs. The architecture targets supporting resource intensive services such as MPEG video streaming, toll quality IP telephony and gaming.

5.2 Requirements and terms of reference

MediaHomeNet brings operator driven management, provisioning, QoS, and security to the home. IPNet2Home brings operator driven management, provisioning, QoS, and security to the residential gateway and IP devices. In addition, visibility and remote diagnostics for home IP devices is enabled. A summary of the capabilities provided by the MediaHomeNet follows:

Management and provisioning

- Remote management and configuration of the residential gateway device;
- Simple residential gateway management proxy for IP-based home devices;
- Hands-off provisioning for residential gateway devices;
- Allow for conversions between IP protocol and proprietary protocol;

- Allow for retrieval of services provided by home devices;
- Detection of connection and disconnection to home devices.

Addressing and packet handling

- One-to-many address translation for home devices;
- One-to-one address translation for home devices;
- Non-translated addressing for home devices (for NAT phobic applications);
- Access network traffic protection from in-home device intra-communications;
- Home-addressing support during access network outage;
- Simple DNS server in the residential gateway;
- Allow for the management of addressing and packet handling of the proprietary home devices (address conversion, address assignment, address notification and address retrieval).

Quality of Service (QoS)

- Residential gateway device bridging functionality for network side QoS messaging from/to application side.

Security

- Residential gateway device authentication;
- Secure residential gateway management messages;
- Secure download of configuration and software files;
- Secure QoS on the access network;
- Remote residential gateway firewall management.

Video services

Video services are a core business for some operators and thus the distribution of video content over MediaHomeNet networks merits special consideration. The distribution of quality entertainment video entails the same categories of features as those for general IP networking, but in the case of video, these features often must meet more stringent additional requirements. For example, specific QoS and content protection requirements must be satisfied for the distribution of premium entertainment content. Video distribution requirements are detailed in this clause, and these requirements may be satisfied by a network that is physically separate from the IPNet2Home data network, or by a network that is physically converged with the IPNet2Home data network.

The key features of the MediaHomeNet architecture specific to video distribution include:

Quality of service

- Provide for the establishment of quality of service paths on home networks for video delivery, providing guarantees for parameters such as bandwidth, jitter and delay;
- Provide for the establishment of service priorities on home networks, enabling specific video streams to take precedence over others.

Content protection

- Authentication of all devices participating in the transmission and/or consumption of video content;
- Definition of a rich set of digital rights management content protection business rules (copy restrictions, number of plays, time-limits, etc.);
- Encryption/decryption of video content for transmission and consumption.

Video device provisioning

- Provide configuration of functional parameters which are specific to the task of delivering video over home networks.

Video device management

- Provide management of functional parameters that are specific to the task of delivering video over home networks;
- Provide event reporting for functions that are specific to the task of delivering video over home networks.

The remainder of this clause examines the MediaHomeNet Reference Architecture from five perspectives:

- MediaHomeNet architecture context (see clause 5.3);
- MediaHomeNet logical reference architecture (see clause 5.4);
- IPNet2Home functional reference model (see clause 5.5);
- MediaHomeNet messaging interface model (see clause 5.6);
- IPNet2Home information reference model (see clause 5.7).

5.3 MediaHomeNet architecture context

The scope of "home networking" spans a myriad of networking technologies (Layer-1/2 – PHY/MAC), delivery protocols, application devices, and services from the access and broadcast networks. MediaHomeNet 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. In particular, IPNet2Home focuses on the residential gateway (PS) portion, layer-1/2 converters (LC) and boundary point (BP) as shown in Figure 5-1. The logical elements PS, LC, BP and EP will be introduced in clause 5.4.

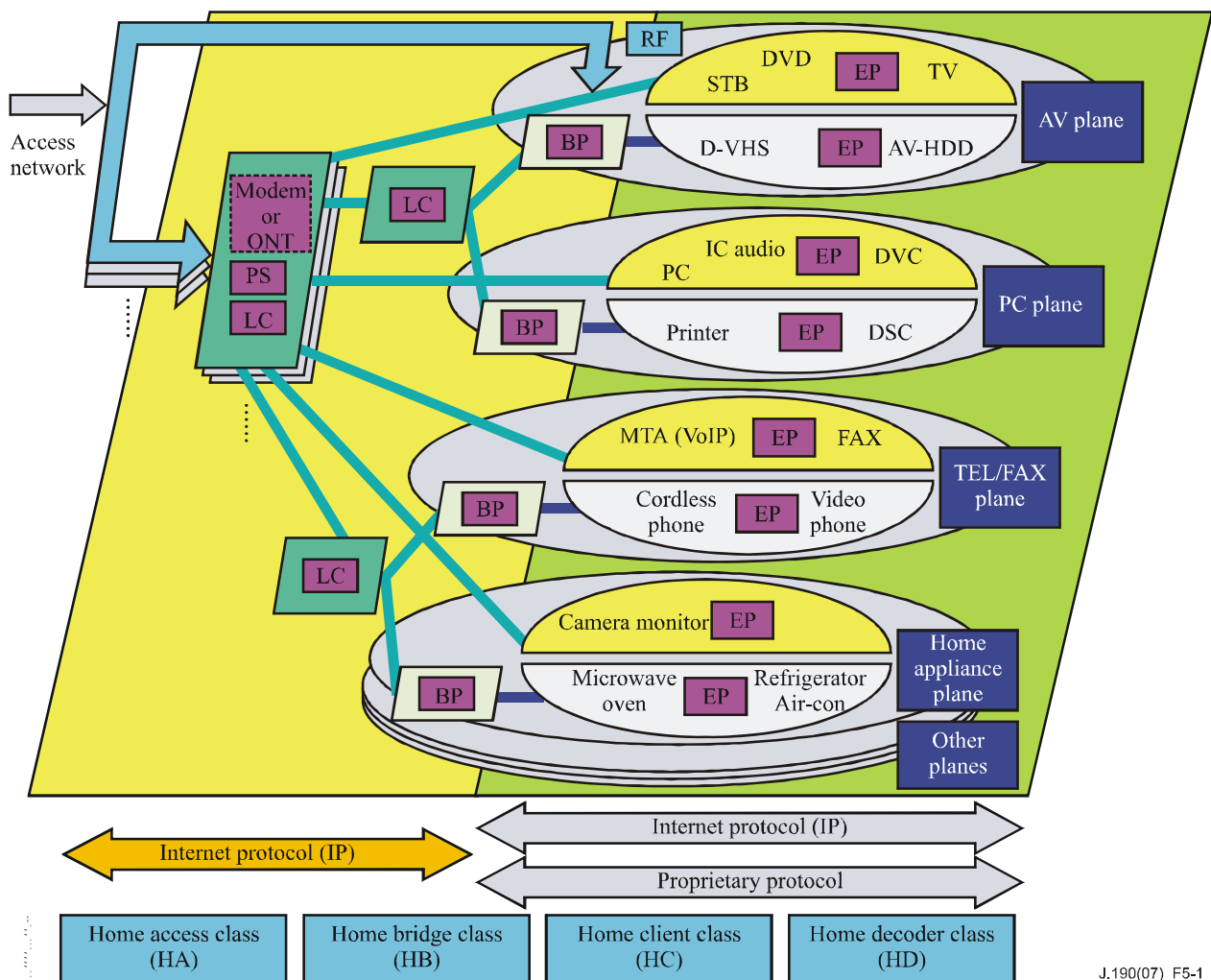


Figure 5-1 – MediaHomeNet context with home networking and access network

From the device point of view, all devices are categorized into four classes as shown in Figure 5-1:

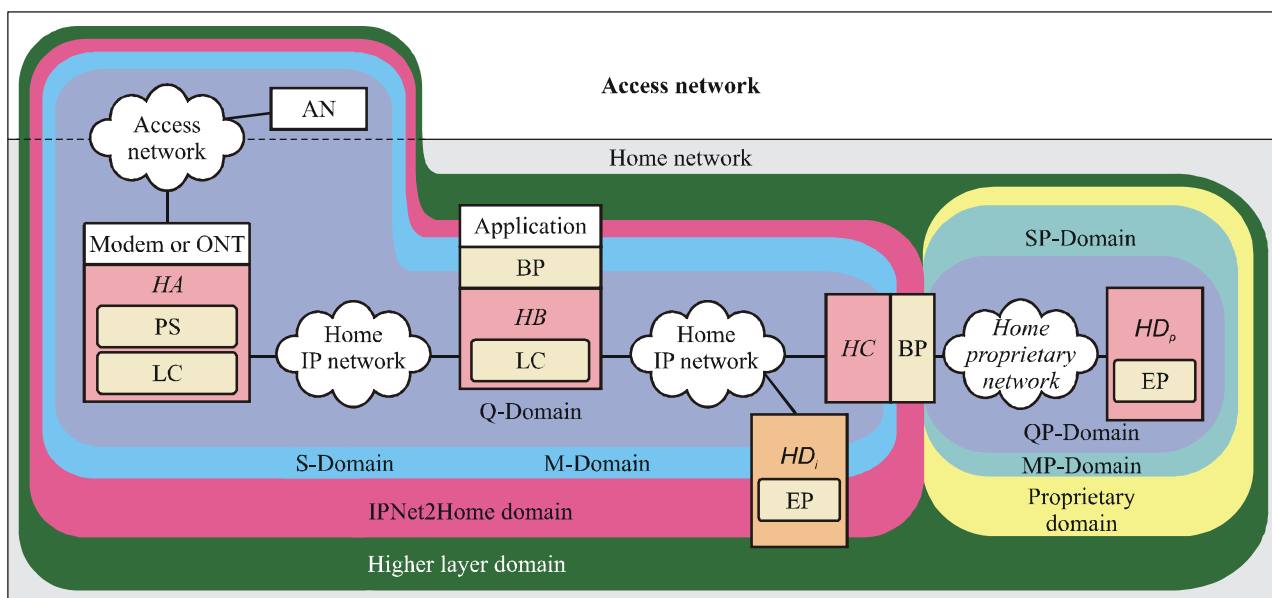
- HA – Interface devices with access network;
- HB – Bridging devices between IPNet2Home domain networks;
- HC – Interface devices between IPNet2Home and proprietary domain devices;
- HD – Devices that can communicate by IP or proprietary protocols. (e.g., DVD, D-VHS, IC-Audio, Printer, etc.).

NOTE – Device classes other than HA can also incorporate PS functionality.

Each device of HC and HD classes belongs to one of the service planes, for example, AV plane, PC plane, TEL/FAX plane, and home appliance plane. Further details concerning device classes and planes are contained in clause 5.4.3.

5.4 MediaHomeNet logical reference architecture

The MediaHomeNet logical reference architecture introduces several concepts that form the foundation for the extension of services to devices connected to the home network. These concepts will help in understanding the MediaHomeNet architectural framework. As shown in Figure 5-2, this clause introduces the concepts of domains, logical elements and device classes.



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Figure 5-2 – MediaHomeNet key concepts

5.4.1 Domains

The MediaHomeNet architectural framework makes use of Domains. Domain represents a concept of functional control area. In the MediaHomeNet architecture, there are three Domains: IPNet2Home domain, proprietary domain, and higher layer domain. These domains represent the effective area of control and management. The IPNet2Home Domain contains the layer 3 messaging while the higher layer domain contains the end-to-end messaging to the EPs. The IPNet2Home domain has three sub-domains: Q, S and M domains. The proprietary domain has three sub-domains: QP, SP and MP domains.

A Domain represents a set of home network elements that are compliant with a set of requirements. Within the IPNet2Home architecture, the IPNet2Home Domain consists of a set of IPNet2Home architectural elements that are compliant with the IPNet2Home Recommendations. Elements that reside within the IPNet2Home Domain (i.e., compliant elements) are directly manageable by operators and can take advantage of their service offerings.

5.4.1.1 IPNet2Home domain

The IPNet2Home Domain is composed of three sub-domains referred to as the Q-Domain (QoS domain), the S-Domain (security domain), and the M-Domain (management domain), as mentioned before.

The Q-Domain consists of the set of elements that are compliant with the IPNet2Home QoS (CQoS) specifications, and can therefore deliver quality guaranteed services. Similarly, the M-Domain consists of the set of elements that are compliant with the IPNet2Home provisioning and management specifications, and can therefore be provisioned and managed by the operator or User. Finally, the S-Domain consists of the set of elements that are compliant with the IPNet2Home security specifications, and can therefore deliver security material managed by the operator and User.

As shown in Figure 5-2, the Q-Domain may be a subset of the M-Domain; all network elements providing CQoS are fully IPNet2Home manageable. This ensures that operators can manage products delivering CQoS-based services to the degree needed to fulfil service quality guarantees. In addition, the M-Domain extends beyond the Q-Domain, allowing IPNet2Home management of products that are not CQoS compliant. This enables IPNet2Home management for legacy products

that are not QoS capable, as well as for products delivering low-bandwidth applications for which QoS may not be appropriate.

5.4.1.2 Proprietary domain

The proprietary domain is composed of three sub-domains referred to as the QP-domain (QoS proprietary domain), the SP-domain (security proprietary domain), and the MP-Domain (management proprietary domain). These three sub-domains are for reference and for further study.

5.4.1.3 Service domain

In addition to Q-domain described in clause 5.4.1 and QP-domain in clause 5.4.1.2, the following service domains SHOULD be added to Q- and QP-domains as its sub-layer domains in order to assure the service quality in end-to-end basis.

Guaranteed service domain (GSD)

GSD is the domain for streaming contents such as voice, video-on-demand or game for which customer requires highest service quality. The network operator cannot control the rights of contents itself. The devices within GSD MUST be able to receive the fully-guaranteed QoS contents such as packets of VoIP, TV conference, VoD stream and Game, etc. in accordance with QoS grade. Some DRM information outside the domain MAY be contained in the contents. All the devices in the GSD MUST implement home networking technology that meets network operator requirements for the GSD. Such technology is called as GSD Technology. All the devices in the GSD MUST implement UPnP QoS specifications. The GSD Manager logical entity is responsible for managing QoS on the GSD. The GSD Bridge functionality bridges devices with different GSD home networking technologies.

Authorized service domain (ASD)

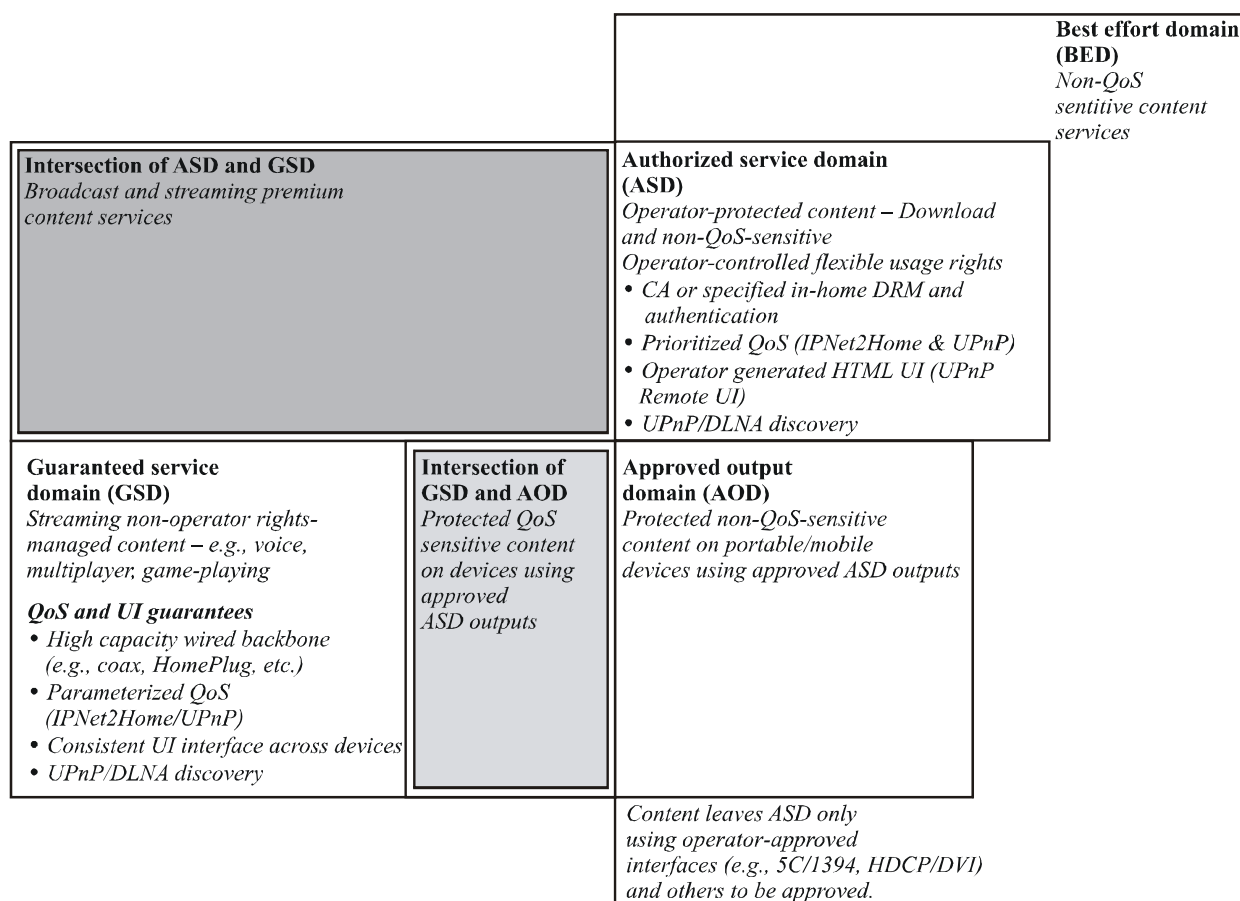
ASD is mainly for the contents downloading with operator protection. The devices in ASD MUST have device authentication function to receive the contents that are compliant with the policy of network operator. All the devices in ASD MUST have discovery mechanism defined by UPnP/DLNA specification.

Approved output domain (AOD)

AOD is the domain for the contents on portable/mobile equipment with non-QoS sensitive environment. The devices in AOD SHOULD be connected to ASD with the interface approved by network operator. It is required to protect the contents by means of DRM mechanism when the contents are transferred from ASD to AOD. The DRM mechanism implemented by devices in the AOD SHOULD respect the requirements identified in [b-ITU-T J.197] in conjunction with capability of redistribution control assigned by content providers.

Best-effort domain (BED)

BED is the domain for non-QoS sensitive contents. The devices in BED do not satisfy the requirements of the GSD. Devices residing in the BED are connected to the devices in the GSD using the BED Bridge. The BED Bridge is responsible for protecting the integrity of the GSD by policing the traffic flowing into the GSD that is originated from devices in the BED.



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Figure 5-2a – Service domains

5.4.1.4 Higher layer domain

The higher layer domain contains the end-to-end messaging to the EPs that are above layer-3. Service providers may communicate parameters and data to the EPs. The higher layer domain is for reference and for further study.

5.4.2 Logical elements

As shown in Figures 5-1 and 5-2, the MediaHomeNet architectural framework introduces the concept of logical elements. There are four distinct classes of logical elements defined by the MediaHomeNet architecture framework; these are referred to as portal services (PS), layer-1/2 converters (LC), boundary points (BP) and endpoint (EP).

LCs, PSs, and BPs are logically bounded functional entities that can generate and respond to IPNet2Home-compliant messages. They include the ability to gather and communicate information as needed to manage and deliver services over IPNet2Home networks. They also contain the functionality necessary to carry out IPNet2Home-defined control of network traffic. IPNet2Home logical elements operate at the network protocol layer and above, thus remaining independent of any particular physical Layer-1/2 network technology.

As shown in Figure 5-3, layer-1/2 converters, portal services, boundary points and endpoints are used to extend the MediaHomeNet Domain, provide local MediaHomeNet services or terminate the IPNet2Home Domain.

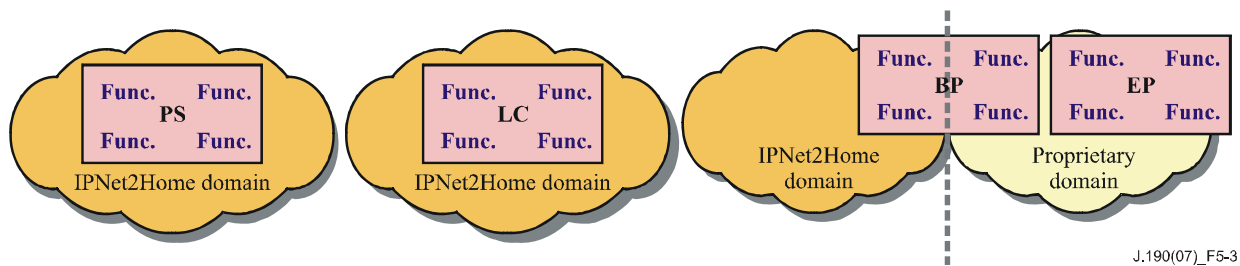


Figure 5-3 – MediaHomeNet logical elements

A **LC** is a logical element that interconnects IPNet2Home-compliant IP capable Layer-1/2 technologies. A LC also terminates and initiates management messages (such as to control interface packet forwarding rules, provisioning, gathering statistics, etc.) for itself. Packet forwarding between interfaces may occur at layer 2 (bridging), layer 2.5 (selective forwarding) or layer 3 (routing).

A **PS** is a logical element that provides in-premise and aggregated security, management, provisioning, and addressing services for logical elements within a compliant IPNet2Home network. In other Recommendations, sometimes this functionality is called "Residential Gateway".

A **BP** is a logical element that interconnects non-compliant home networks, devices and applications to a compliant IPNet2Home network.

An **EP** is a logical element that provides services to users based on IP or proprietary protocols. An EP terminates the Higher Layer control network.

LC and BP may be collectively referred to as LAN IP devices.

5.4.2.1 Logical elements are the MediaHomeNet network

The EP, BP, PS and LC logical elements form the foundation of the MediaHomeNet architecture and they fully define a MediaHomeNet network within the home. While Domains (introduced in clause 5.4.1) and device classes (introduced in clause 5.4.3) are structural aides only, IPNet2Home logical elements completely supply the in-home functionality defined by the IPNet2Home specifications. Each BP, PS and LC logical element is assigned a unique IP address that is used for provisioning and managing the element. An IPNet2Home network can be conceptualized as a set of PSs, BPs and LCs that are discovered and managed, and that interact with each other and with the IPNet2Home support infrastructure as needed to deliver services. The thrust of the IPNet2Home effort is the specification of logical element interfaces.

5.4.2.2 A closer look at boundary points and endpoints

The IPNet2Home boundary point (BP) is a key concept that warrants further discussion. As mentioned before, a BP connects an IPNet2Home network to non-compliant entities known as proprietary endpoints (EP). Proprietary endpoints may source or sink data content, but they reside outside of the IPNet2Home Domain. As such, a proprietary EP knows nothing about IPNet2Home layer-3 messaging and no IPNet2Home requirements can be placed on them. These entities may range from simple analog audio and video presentation devices to complex proprietary networked devices. Since the BP may provide a protocol conversion function, it is possible, in some instances, for the IPNet2Home layer-3 messaging to be extended to the proprietary EP. However, the conversion function is proprietary and outside the scope of IPNet2Home. Proprietary EPs can also send/receive higher layer control messages.