International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.622

(06/2008)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Broadband, triple-play and advanced multimedia services – Advanced multimedia services and applications

A generic home network architecture with support for multimedia services

Recommendation ITU-T H.622

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	H.220–H.229
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
Mobility interworking procedures	H.550–H.559
Mobile multimedia collaboration inter-working procedures	H.560–H.569
BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619
Advanced multimedia services and applications	**H.620–H.629**
IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV	
General aspects	H.700–H.719
IPTV terminal devices	H.720–H.729
IPTV middleware	H.730–H.739
IPTV application event handling	H.740–H.749
IPTV metadata	H.750–H.759
IPTV multimedia application frameworks	H.760–H.769
IPTV service discovery up to consumption	H.770–H.779

For further details, please refer to the list of ITU-T Recommendations.

Recommendation ITU-T H.622

A generic home network architecture with support for multimedia services

Summary

Recommendation ITU-T H.622 describes the architectural framework of a home network that supports multimedia services. Definitions of home network elements such as access gateway, domains, terminals and interfaces are introduced with explanations. This Recommendation also provides a comparison with related documents.

Source

Recommendation ITU-T H.622 was approved on 13 June 2008 by ITU-T Study Group 16 (2005-2008) under Recommendation ITU-T A.8 procedure.

Keywords

Access gateway, domain, home network, terminal.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g. interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

Introduction

The home network is recognized as an important element of multimedia services. Considering the configuration of typical broadband services, the home network has two major roles; an extension of the access network and a transmission medium for data distribution among home devices. A fundamental difference can be found between these two roles. As an extension of the access network, the home network should provide characteristics similar to those of the access network, quality of service (QoS) for example. The home network also inter-connects consumer electronic devices in the same home. For this purpose, this part of the home network may not need to work with the functional entities in the network or service provider.

To clarify these two different roles of the home network, Recommendation ITU-T H.622 introduces the concept of primary and secondary domains. The primary domain is defined as that part of the home network that works as an extension of the access NW, while the secondary domain is defined as the rest of the home network. Primary and secondary terminals are introduced in the same way. Some key features of the home network such as QoS and management that are defined in other documents are described in this context.

Since the home network includes various technical areas from physical data transmission to multimedia capability, it is difficult for any single document to cover all issues. This Recommendation and Recommendation ITU-T G.9970, which is an accompanying Recommendation, share the same layered model that consists of transport and application models. This Recommendation mostly focuses on the issues related to the application model. For better understanding of the home network, users of this Recommendation are encouraged to consider Recommendation ITU-T G.9970.

Recommendation ITU-T H.622

A generic home network architecture with support for multimedia services

1 Scope

This Recommendation describes a generic home network architecture that is applicable to, including but not limited to, fibre-to-the-home (FTTH), xDSL and cable television (CATV). The architecture is designed to support a wide range of multimedia services such as Internet Protocol television (IPTV), IP-telephony and video telephony as well as legacy services, if needed. The goal of the architecture is to define functionalities and interfaces that support these services with the demanded level of quality of service (QoS), security and management capability in the home network domain based on [ITU-T J.190].

The home network specific to each access network can be defined based on functional entities and interfaces defined in this Recommendation.

This Recommendation uses the transmission functionality and demarcation point between the access network and the home network defined in [b-ITU-T G.9970] that contains more details about these aspects. Users of this Recommendation are encouraged to consider both Recommendations for complete understanding of the generic home network architecture.

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 H.610] Recommendation ITU-T H.610 (2003), *Full service VDSL – System architecture and customer premises equipment*.

[ITU-T J.190] Recommendation ITU-T J.190 (2002), *Architecture of MediaHomeNet that supports cable-based services*.

[ITU-T X.1111] Recommendation ITU-T X.1111 (2007), *Framework of security technologies for home network.*

[ATIS 0800002] ATIS 0800002 (2006), *IPTV Architecture Requirements*.
<https://www.atis.org/docstore/default.aspx>

[DSL TR-094] DSL Forum TR-094 (2004), *Multi-Service Delivery Framework for Home Networks*.
<http://www.broadband-forum.org/technical/download/TR-094.pdf>

[HGI] HGI (2006), *Home Gateway Technical Requirements: Release 1*.
<http://www.homegatewayinitiative.org/publis/HGI_V1.0.pdf>

3 Definitions

This Recommendation defines the following term:

3.1 home network: A home network is the collection of elements that process, manage, transport and store information, thus enabling the connection and integration of multiple computing, control, monitoring, communication and entertainment devices in the home.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AGAF Access Gateway Application layer Function

AGTF Access Gateway Transport layer Function

AGW Access Gateway

AN Access Network

ASG Application Service Gateway

ASP Application Service Provider

AV Audio Visual

B-NT Broadband Network Termination

CM Cable Modem

CODEC COder-DECoder

DHCP Dynamic Host Configuration Protocol

DNG Delivery Network Gateway

DNGF Delivery Network Gateway Function

DRM Digital Rights Management

DSCP Differentiated Services Code Point

EPG Electronic Programme Guide

EUT End User Terminal

FPD Functional Processing Device

FPD/T Functional Processing Device and Terminal

GW Gateway

HA Home Access

HB Home Bridge

HC Home Client

HD Home Decoder

HE Head-End

HN Home Network

HNS Home Network Segment

IGMP Internet Group Management Protocol

IP Internet Protocol

IPCP Internet Protocol Control Protocol

IPI	Internet Protocol Infrastructure
ISP	Internet Service Provider
ITF	IPTV Terminal Function
LC	Layer-1/2 Converter
MLD	Multicast Listener Discovery
NAT	Network Address Translation
NID	Network Interface Device
NSIS	Next Steps In Signalling
NT	Network Termination
ONT	Optical Network Termination
PC	Personal Computer
PLC	Power Line Communications
PS	Plain old telephone service Splitter
QoS	Quality of Service
RG	Residential Gateway
RQoS	Relative Quality of Service
RSVP	Resource ReserVation Protocol
SM	Service Module
STB	Set-Top Box
TCP	Transmission Control Protocol
ToS	Type of Service
TTL	Time To Live
TV	Television set
UPnP	Universal Plug and Play
VLAN	Virtual Local Area Network
VTP/D	VDSL Termination Processing or VDSL Termination Processing and Decoding
XSP	Service Provider
xTU-R	xDSL remote terminal unit

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 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 "**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 not recommended**" indicate a requirement which is not recommended but which is not specifically prohibited. Thus, conformance with this Recommendation can still be claimed even if this requirement is present.

– 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.

6 Model of the home network

6.1 Concept of layered model

The home network is an integrated technology ranging from physical transmission to service support. It is difficult to encompass all the aspects of a home network in a single architectural model. This Recommendation adopts a layered model as shown in Figure 6-1.

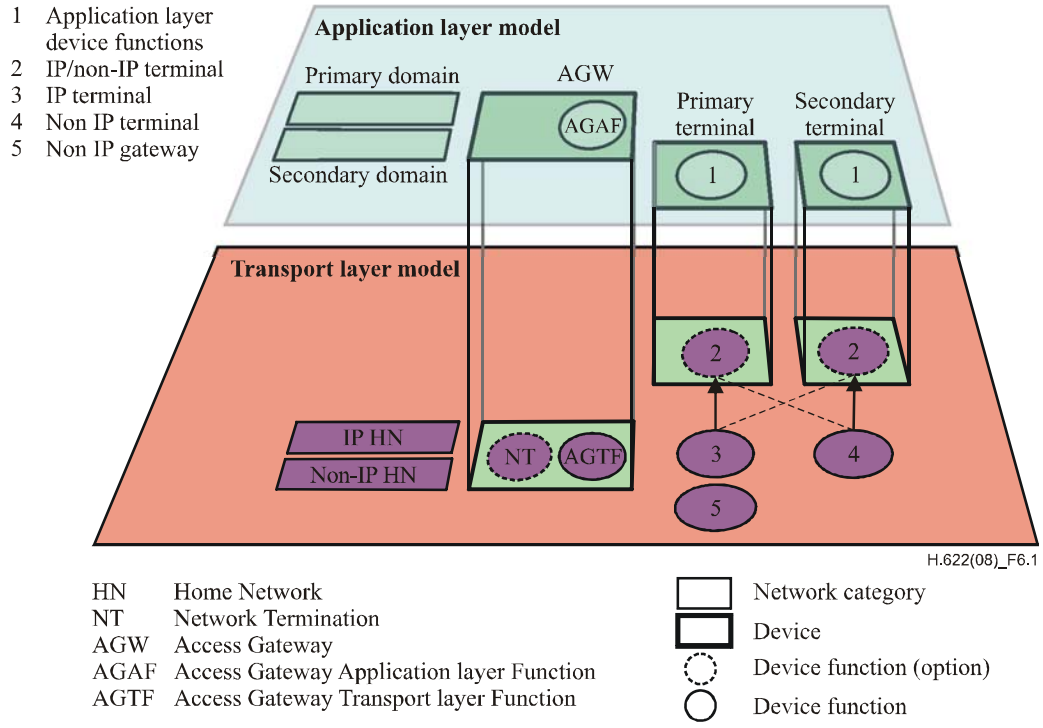


Figure 6-1 – The conceptual diagram of layered model

The layered function architecture includes two layers: transport function layer and application function layer. The detailed descriptions are presented as follows:

a) The **transport model** describes how the network links clients together and transfers the data packets across the network. The transport model corresponds to three layers: network, data link and physical. That is to say, the functions of physical connection, data link connection and choice of packet switching are realized in this model.

b) The **application model** describes the features that allow users to interact with the networks, including defining data formats, designing services and designing interfaces. There are

many services at present, such as TV gaming, TV education and linear TV. Providing more multimedia services may help drive the widespread adoption of multimedia capabilities, so it is necessary to design more types of services. The data formats of different services vary widely, so data format identification is an important component of the application function model.

6.2 Transport model of the home network

As shown in Figure 6-2, the home network is composed of IP home network segments using IP and non-IP home network segments using the specific technologies or protocols designed for short-range communication. The gateway between the access network and IP home network segment is called the access GW, while that between the IP home network segment and non-IP home network segment is called the non-IP GW. The terminal may be wireless or wired.

Refer to [b-ITU-T G.9970] for details of the transport model.

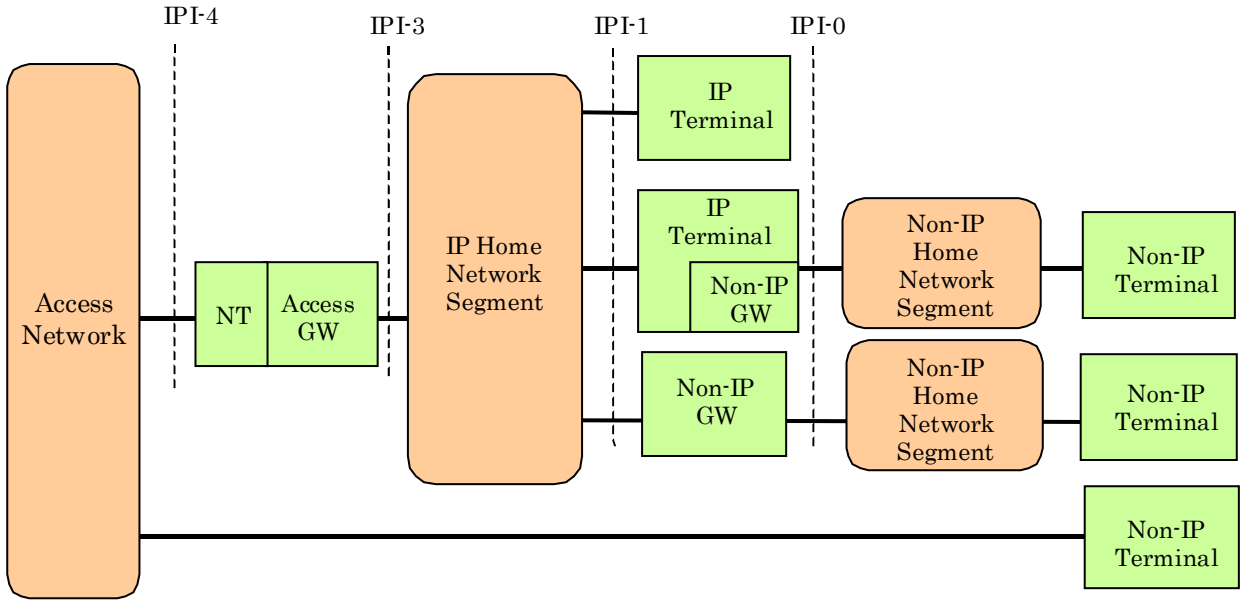


Figure 6-2 – Transport model of the home network

NOTE – The interface "B" between the NT and AGTF is presented in [b-ITU-T G.9970].

6.3 Application model of the home network

6.3.1 Home network service functional structure

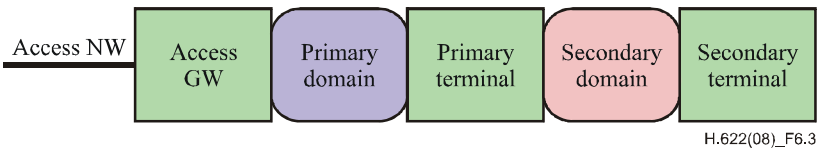


Figure 6-3 – Application model of the home network

For multimedia services on the broadband access network, the service is presented at the terminal device. Usually, this device lies within the home network. Considering that typical multimedia services require network management features such as QoS and security, the same or similar level

of management and transmission characteristic as the public network such as NGN are required for the network portion connecting terminal devices to the access network. In other words, this portion of the home network, defined as the primary domain, is expected to work as an extension of the access network.

Many types of consumer electronics devices will also be connected to the home network for exchanging information with other devices or creating services together with other devices; such devices do not need to be considered as a part of the managed public network. For such devices, the home network can be seen as being less integrated with the public network.

Considering these two cases, there are two major roles for the home network; extending the access network and interconnecting devices in the home network. The portion working as an extension of the access network must be aligned with the technical aspects of the network provider. This Recommendation introduces the concepts of primary and secondary domains to describe these roles. The home network contains two types of terminal devices and network domains as well as the gateway functionality called the access GW. The definition of each device and domain relies on its role rather than its physical configuration. A definition for and explanation of each entity are provided below.

6.3.1.1 Device

A device is a physical entity that implements one or more functions and is sometimes referred to as a "box". There are several types of devices in the home network such as terminal, bridging device and access gateway.

6.3.1.2 Terminal

A terminal is a type of device that can provide a visible service and application, such as presenting content, accepting commands and so on. There are two types of terminals: primary terminals and secondary terminals. The key difference between them is that the former can interact with outside functional entities through the access gateway; the latter needs the support of the former to interact with outside entities.

6.3.1.2.1 Primary terminal

A primary terminal is a terminal device that can interact with the access network or service functionality beyond the access network without being assisted by any other terminal; it is the service end-point where the service from the service provider is terminated. It may present the service to the end user. A primary terminal is required to provide communication capability with a device or function outside the home, thus a set of IP-based protocols is a basic requirement. However, primary terminals need not have IP capability if its communication with outside entities is done through a bridging device that offers protocol translation between IP and non-IP. A terminal device can be categorized as a primary terminal device as long as it has at least application-level transparency and offers synchronized operation with outside functions.

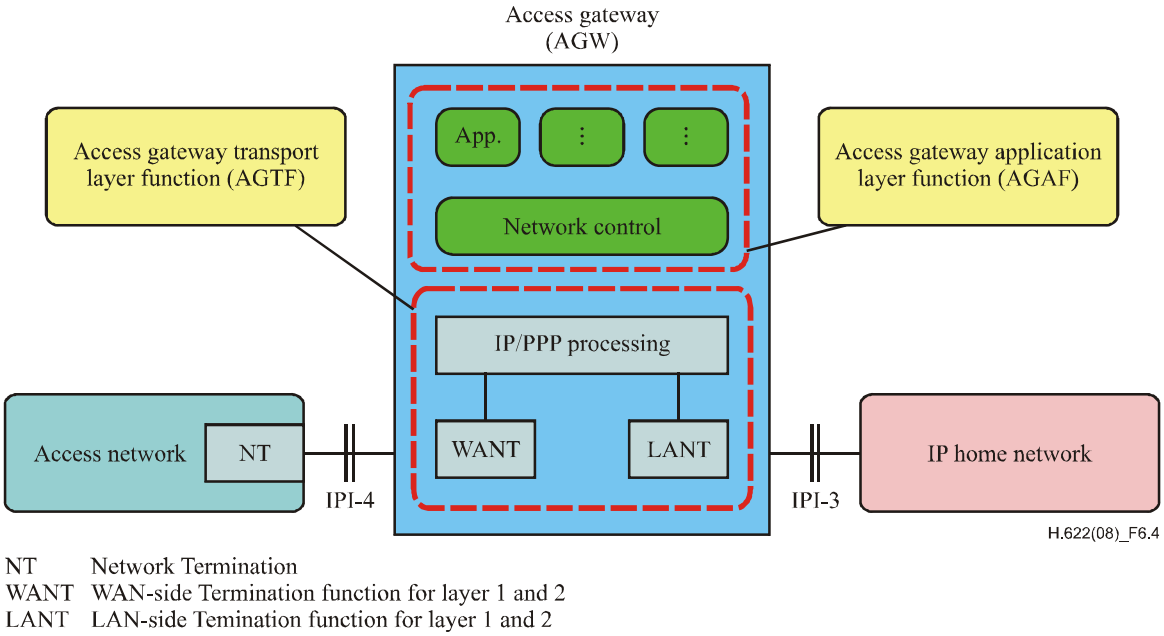
6.3.1.2.2 Secondary terminal

A secondary terminal is a terminal device that has no direct interactive capability with network side entities or needs to rely on a primary terminal to do so. Examples of a secondary terminal are TV displays and cordless telephones. These devices are typically installed by the end user and connected to a primary terminal such as an IPTV-TD and VoIP terminal.

Even if a secondary terminal does not have IP communication capability, it can communicate and interact with outside functional entities if a primary terminal provides a relay function that bridges the signal between the secondary terminal and the outside function. An AV device that has a digital interface to receive content from IPTV-TD connected to IPTV-NW is an example of this type of interaction with an outside device.

6.3.1.3 Access gateway

An access gateway (AGW) is a device that handles traffic to/from the access network as well as transit traffic within the home network. An AGW can optionally terminate or transfer protocols on either side (of the AGW). Some packet header fields such as source/destination address/port, ToS and TTL, can optionally be changed due to, for example, security reasons and/or QoS management at the AGW.



NT Network Termination
WANT WAN-side Termination function for layer 1 and 2
LANT LAN-side Temination function for layer 1 and 2

Figure 6-4 – Definition of access gateway and its component functions

Some functions that are typically incorporated into an AGW but not related to traffic handling are not included as access GW functions. A local DHCP server, which provides a local IP address to devices placed in the home network, is an example of this kind of function.

Since an AGW is typically placed around the demarcation point between the access and home network, it can be implemented as a single device in combination with a network termination. This type of implementation requires the AGW to have the relevant network interface for the access network and makes it difficult to connect the gateway to another access network due to the differences in access network technologies. On the other hand, an AGW can be implemented as a stand-alone device separate from the network termination. While this implementation allows the gateway to be used with various access networks, if the layer 2 and 3 specifications at the user network interface are well harmonized, two separate devices, network termination and AGW, need to be installed in the home.

Furthermore, the implementation of an AGW could have an impact on the definition of the user network interface. For the AGW combined with the network termination, the position of the user network interface may be limited. Refer to Appendix I and [b-ITU-T G.9970] for more details.

6.3.1.4 Bridging device

A bridging device handles traffic within the home network. Since the functionalities of the bridge device are limited below layer 3, a bridging device is almost invisible from the service functional perspective.

6.3.1.5 Device function

As defined in this Recommendation, a function is a logically distinguishable entity typically residing within a device, while a device is a physically distinguishable implementation. See Figure 6-5. A device such as a terminal and AGW contains one or more functions. Each function is responsible for a specific layer or category of function such as decoding, security, network control, and so on.

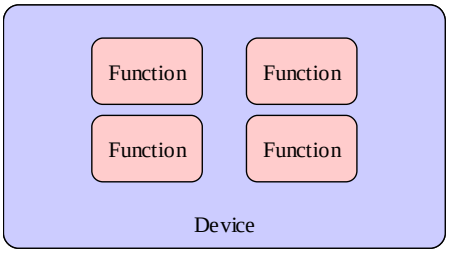


Figure 6-5 – Device function model

Figure 6-6 shows an example of interaction among the functions within the home network. Each function communicates with a similar function in another physical device.

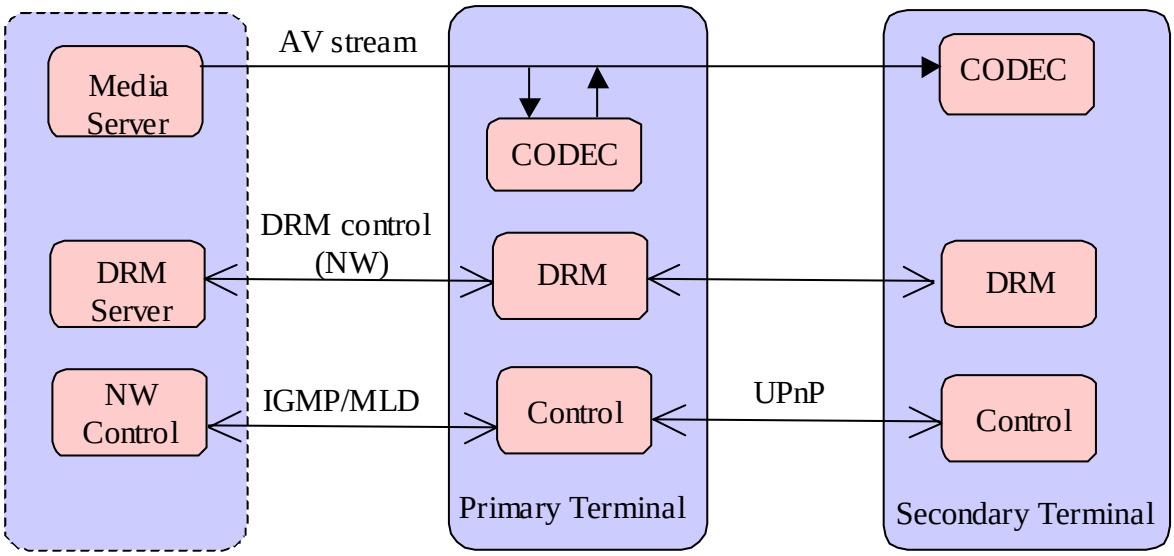


Figure 6-6 – Example of a device function in the home network

A physical device can be defined as a collection of functions. Figure 6-7 shows some devices from this view point.

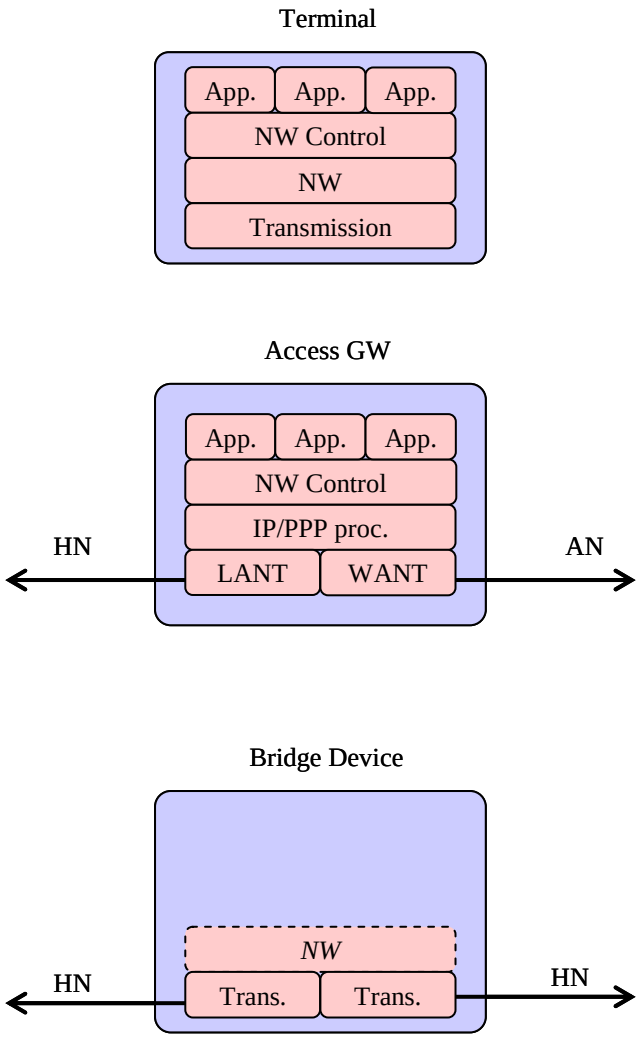


Figure 6-7 – Some device configurations

6.3.1.5.1 Function decomposition

Figure 6-8 shows an example of device function decomposition.

It is not necessary for a function to be the minimum unit within a device. For example, in the case of IPTV, ITF is a comprehensively defined function for IPTV terminal devices. ITF can, however, be divided into more basic functions such as DRM, decoder and EPG. A browser, typically an independent function for Internet services, can be a part of EPG.

The appropriate level of function granularity may depend on the service. It may be desirable to define more basic functions for some types of services and devices. In other cases, more comprehensive definitions would be better.

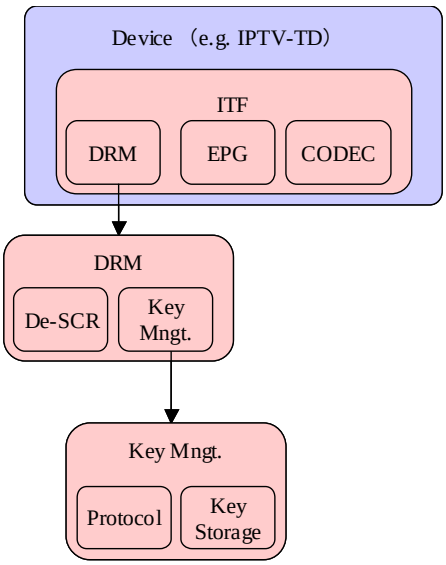


Figure 6-8 – An example of device function decomposition

This Recommendation allows a function to be divided into one or more basic functions. The following are examples of device function decomposition:

– Comprehensive function: ITF and DNGF.

– Intermediate level of function: DRM.

– Basic functions: Browser and CODEC.

The function hierarchy may depend on the service. The detailed structure of function hierarchy is for further study.

6.3.1.6 Domain

A domain is a logically defined area of the home network. There are two kinds of domain; primary domain and secondary domain, in this model. Each domain can be decomposed into IP sub-domain and non-IP sub-domain, if necessary.

6.3.1.6.1 Primary domain

A primary domain is the logically defined area of the home network that interconnects the primary terminal and the access GW. Traffic on the primary domain is associated with traffic to/from the access GW.

The devices and traffic related to the primary domain are required to be configured to be reachable to/from the access network, directly or indirectly (via NAT).

The general and fundamental requirement placed on the primary domain is to provide the same level of transmission performance and characteristics such as QoS, security and manageability as provided by the access network, since the primary domain is expected to work as an extension of it. A well-managed and configured network is an important aspect of the primary domain.

6.3.1.6.2 Secondary domain

A secondary domain is a logically defined area of the home network that interconnects terminals.

The devices and traffic dedicated to the secondary domain do not need to be configured to be reachable to/from the access network. For example, local assignment or generation of IP addresses, if IP is used for network transmission, is enough for this domain.

6.3.1.6.3 Domain overlap

It is not necessary to physically isolate the domains from each other. Combining domains into the single physical network segment may mitigate the complexity of wiring and cost of deployment, and hence benefit the end users. In particular, considering the proliferation of IP technologies in the area of broadband infrastructure, adopting IP for both primary and secondary domains may be the most likely situation. For this reason, it may be useful to consider the possibility of domain overlap where the same transmission medium and bridging device are shared by the two domains. In this definition, it is not necessary that the domains overlap completely.

This Recommendation defines domain overlap. Figure 6-9 shows the logical concept of domain overlap.

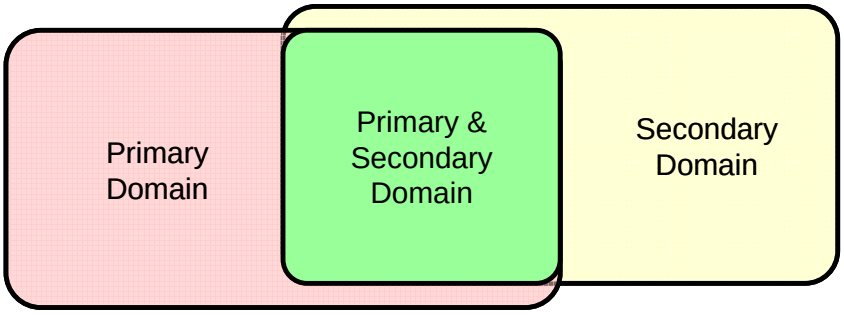


Figure 6-9 – Definition of domain overlap

Figure 6-10 shows an example of domain overlap. The access GW, primary terminal and secondary terminal are connected via a bridging device. The data flow between the access GW and primary terminal (the blue arrow in the figure) is considered to be a part of the primary domain. The data flow between the primary and secondary terminals (the red arrow in the figure) is considered to be a part of secondary domain. In this example, both data flows share the same network link between the bridging device and primary terminal. This part of the network belongs to an overlapped domain, the overlap of primary and secondary domains.

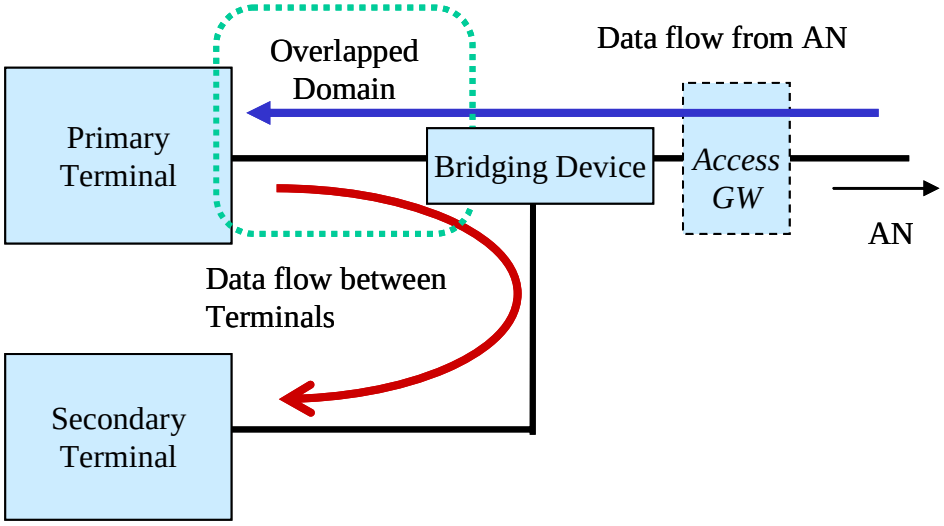


Figure 6-10 – An example of domain overlap

Therefore, placing two domains on the single physical network segment could cause resource contention between traffic belonging to the domains and introduce complexity to the network devices. The performance degradation due to resource contention is one of the issues to be addressed.

6.3.2 Operational model

There are some cases where functionalities in both primary and secondary domains interact with each other. For example, a secondary terminal is defined to interact with functional entities with the help of a primary terminal. This clause provides three operational models as shown in Figure 6-11.

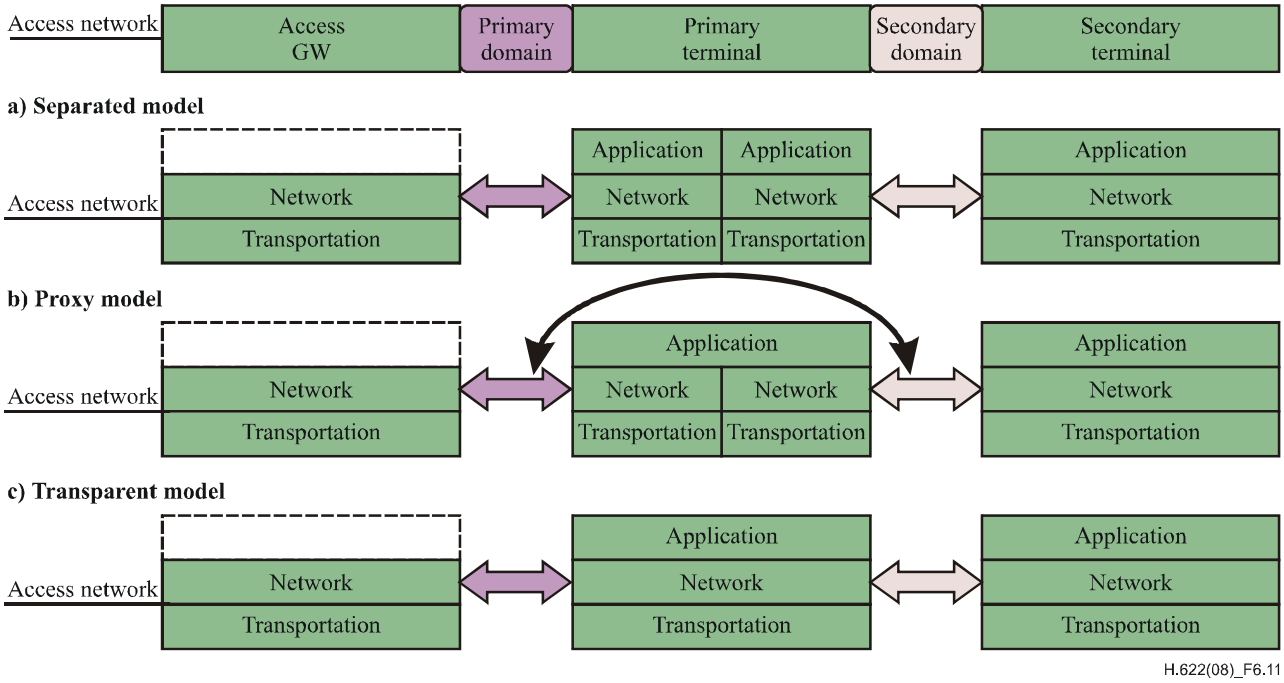


Figure 6-11 – Interaction of primary and secondary domains

6.3.2.1 Separated model

In the separated model, the protocol operations in primary and secondary domains run independently.

6.3.2.2 Proxy model

In the proxy model, the protocol operations in primary and secondary domains are closely related, but technically run independently. The operations in both domains are synchronized, but the actual protocols are different. This model allows both terminal devices to use their own protocols and terminals, particularly secondary terminals, to interact with functional entities beyond the access network. In this operation, the primary terminal acts as a proxy device to the secondary terminal. The secondary terminal is not required to have global reachability.

6.3.2.3 Transparent model

The protocol operations in primary and secondary domains are closely related. For example, primary terminals act as a relay device for secondary terminals or primary terminals simply transfer a protocol to/from secondary terminals.

6.3.3 Interfaces with outside networks

The home network is generally expected to work with outside networks for establishing communication with outside devices or acquiring contents from outside sources. As shown in

Figure 6-12, there are two kinds of outside network that are expected to work with the home network.

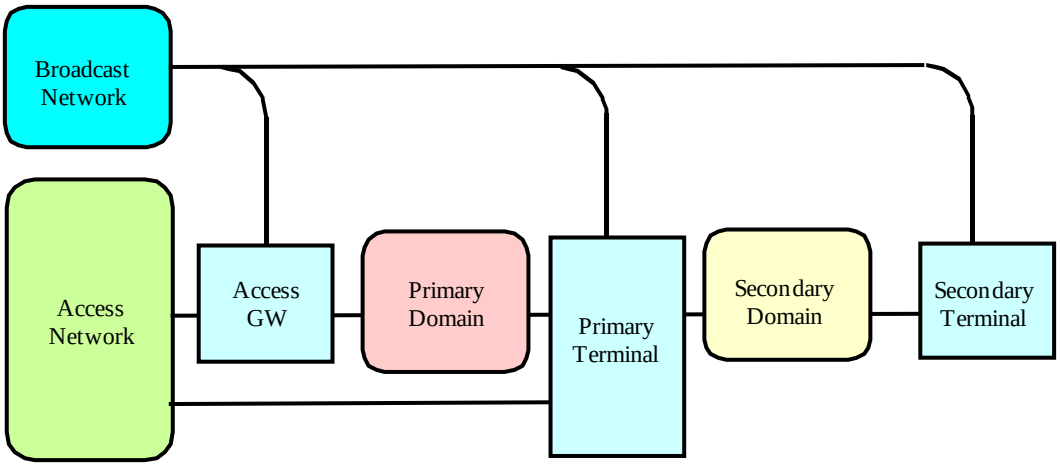


Figure 6-12 – Interfaces with outside network

The access network provides basic communication services between the home network and service nodes/functions provided by network operators or service providers. The boundary between the access network and home network is outside the scope of this Recommendation. All traffic coming from/going to the access network shall be transferred through the access GW function.

The broadcast network includes terrestrial and satellite. These networks provide one-way transmission of broadcast signals into the home network. Since the radio signal is available almost anywhere in the home, a broadcast network can be connected to the access GW function, as well as the primary and secondary terminal functions.

7 QoS

The functionality that realizes QoS on the IP network is important to accomplish stable quality for the case of offering streaming-based multimedia services on the IP Network. Two methods to provide QoS can be identified: class-based QoS and session-based QoS. [ITU-T J.190] describes UPnP, a kind of session-based QoS mechanism, while [DSL TR-094], [b-DSL TR-133] and [HGI] describe class-based QoS. The applicability of these QoS mechanisms in the IP home network segment needs consideration of application requirements as well as network functions of the access and home network.

NOTE – It is known that at least [ITU-T J.190] and [DSL TR-094] use different QoS technologies at the time at which this Recommendation was created. Therefore, it is not appropriate to specify a common QoS mechanism without first confirming its necessity. Further study on this issue is needed for the purpose of specifying unique QoS mechanism in the common home network architecture.

In addition to the above QoS solutions described in existing documents, there may be some emerging solutions as listed below that might be applicable to QoS in the home network:

– NSIS QoS NSLP.

– UPnP QoS.

7.1 Class-based QoS

7.1.1 Overview of class-based QoS

Traffic is aggregated into a small number of classes, typically 4-8 classes. The packets belonging to the same class are given the same treatment at the network devices. This means that each packet experiences the same transmission characteristic regardless of the application data contained in it.

Class-based QoS introduces less complexity to the home network than the session-based QoS mechanism. It can work without signalling among the terminals and network devices. Each device is not required to have QoS signalling capability. Also, no network device is required to maintain application status such as call set-up and teardown. Less complexity helps to minimize the costs of traffic management not only by the network provider but also by the end user. The key features of class-based QoS are summarized below.

- Less complexity

  Class-based QoS does not require any signalling mechanism to operate. Packets are sent with relevant marking. The network devices read the information and transfer the packet with relevant priority. Eliminating the signalling mechanism increases the possibility for interoperability with other systems. For example, if there is a network device that is unable to understand the priority information, the packet can be transferred on the best effort basis and it remains possible for other devices to transfer the same packet with appropriate priority. This situation slightly degrades the packet transmission quality; however impacts on the other network segments are limited.

- Scalability

  Unlike the session-based QoS, the network devices running the class-based QoS mechanism are not required to maintain the session status of each application such as call set-up and teardown. Instead of maintaining each session status, the network devices are simply required to classify packets based on the attached information.

  This is an advantage for the network devices placed in the core network since they must deal with a huge number of traffic flows. It is also attractive for the home network in which complicated multimedia applications will transfer many packet streams.

- Priority-based mechanism

  Class-based QoS can define relative priority among several applications. This means that the traffic given a higher priority can experience better treatment than the traffic with lower priority. Relative priority is reasonable since it is difficult to guarantee the bandwidth requested by an application. In other words, it is sufficient to establish relative priority and have a clear policy or consensus on the service priorities among the applications.

7.1.2 Number of classes

The number of classes is one of the key parameters of class-based QoS. Standards exist for class-based QoS mechanisms and the typical number of classes ranges from 4 to 8. Among these classes, traffic such as VoIP and streaming video is typically given a higher priority than conventional data service such as Internet and e-mail. Some standards state that some data services are to be given better treatment than best effort traffic.

The complexity of the home network configuration increases the demand for classes. For example, the home network that handles a number of different types of application needs to have more traffic classes than the home network that handles a single application. In the same way, the home network that handles both downstream traffic from the access network and in-home traffic that circulates only in the home network needs to differentiate the priorities of the two traffic types.

The number of classes is related to the physical implementation of network devices. The network device assigns packets to its queues according to the priority. For example, higher priority class packets are assigned to queues with higher priority.

7.1.3 Priority marking methods

The service class of each packet is expressed by the information placed in the header field of the packet. This can be done either in layer 2 or layer 3.

Layer 2 marking schemes can use techniques such as VLAN priority defined in [b-IEEE 802.1Q]. Transmission technologies such as PLC and wireless LAN have their own technique (Note). DSCP is a layer 3 level technique defined in [b-IETF RFC 2474], [b-IETF RFC 2597] and [b-IETF RFC 2598]. L2 and L3 schemes can be used in combination. This allows network devices that are blind to layer 3 headers to apply the relevant policy.

There are some discussions about the use of these marking techniques. Refer to documents such as [HGI] and [b-DSL TR-133] for further information.

NOTE – There is an informative annex describing user priorities and traffic classes in [b-IEEE 802.1D]. It also provides an example of class-based QoS marking.

7.2 Session-based QoS

In session-based QoS, every terminal or application is required to reserve the necessary resources by the signalling mechanism. RSVP [b-IETF RFC 2205] is a typical example of such a mechanism.

NOTE – [b-UPnP-QoS] also provides a session-based QoS mechanism.

It is possible that the terminal or application knows whether the requested resource is available or not. In other words, if the resource reservation process has succeeded, the transmission quality of associated service is guaranteed. Session-based QoS has the following problems:

– Some network devices are unaware of signalling protocol.

– Network devices need a complicated mechanism.

– Additional session set-up time introduced by the resource reservation process.

7.3 QoS in primary and secondary domains

Since the primary domain works as an extension of the access network, a QoS mechanism is recommended to be provided for the primary domain. This will help to provide a level of transmission quality as provided in the access NW. Some applications in the secondary domain may require priority higher than best effort traffic. In this case, the secondary domain is recommended to have a relevant QoS mechanism.

As described in clause 6.3.1.6.3, it is possible that primary and secondary domains share the same physical infrastructure. This means that traffic belonging to these two different domains could compete for network resources, such as bandwidth. This situation causes a problem with QoS management. It is generally believed that a certain type of service (e.g., VoIP) has priority over other services (e.g., data services) in the QoS managed network. In this concept, traffic differentiation for the same service category is not meaningful. In the case of domain overlap, resource management is also necessary between services belonging to different domains even if these services have the same basic characteristics. [HGI] has some requirements on service differentiation based on types of traffic such as downstream, upstream and transit. Among these traffic types, downstream and upstream correspond to the primary domain, while transit corresponds to the secondary domain. These requirements may be applicable to the situation of the overlapped domain.

The possibility of domain overlap depends on the implementation as well as practice. If domain overlap is likely, each domain is recommended to operate so as not to negatively impact the other.

NOTE – The relative priority of traffic in primary and secondary domains is an issue that needs to be addressed in future.

8 Management Functionality

Customer premises equipment in the home network is recommended to be appropriately managed by the network operator, service provider and end user.

There are two types of devices in the home network, managed device and unmanaged device, if the devices are categorized by the management feature. Managed devices are defined here as devices managed by the network or service provider using a remote management protocol; unmanaged devices are defined as the other devices. In this context, a device managed only by its IP address by the network provider is considered to be an unmanaged device. For managed devices, the type of device managed and management items depends on the case.

It is recommended that the access GW and primary terminal be managed by the network provider or service provider because these devices are closely related to the network provider or service provider. Since the secondary domain is a more independent part of the home network relative to the access network, it is likely to be managed by the end user rather than the network provider or service provider.

There are several management protocols and mechanisms available in the industry. [b-DSL TR-069] and SNMP are examples of the remote management protocols. Refer to the related documents for details.

NOTE – Some different management mechanisms have been identified between [ITU-T J.190] and [DSL TR-094] at the time of creating this Recommendation. Therefore, it is not appropriate to seek a common set of management functions without first identifying the necessity for this.

8.1 IP address management

IP address management is the foundation of IP communication. If a device is to be IP-reachable from the access network, its address must be managed by the network provider. The IP address of the device is assigned by the network provider directly or by the access GW locally. In the latter case, IP datagrams from the device are translated by the NAT/NAPT functionality in the access GW.

The secondary domain devices can organize a network segment that is independent of other network segments. Such network segments are isolated from the access NW. In this case, IP address assignment from the access NW is not expected.

All the equipment/devices, including access GW and non-IP GW connected to IP home network segment, are assigned unique IP addresses.

8.1.1 Network-assigned IP addresses

In this scheme, the server located in the network provider assigns an IP address to the terminal devices. Indirectly assigned IP address such as RA for IPv6, in which the network provider provides a block of addresses instead of an individual address to the terminal device, is also included in this scheme. The following address assignment mechanisms are available for this scheme:

– DHCP (IPv4).

– IPCP.

– RA.

Figure 8-1 shows the network assigned IP address scheme.

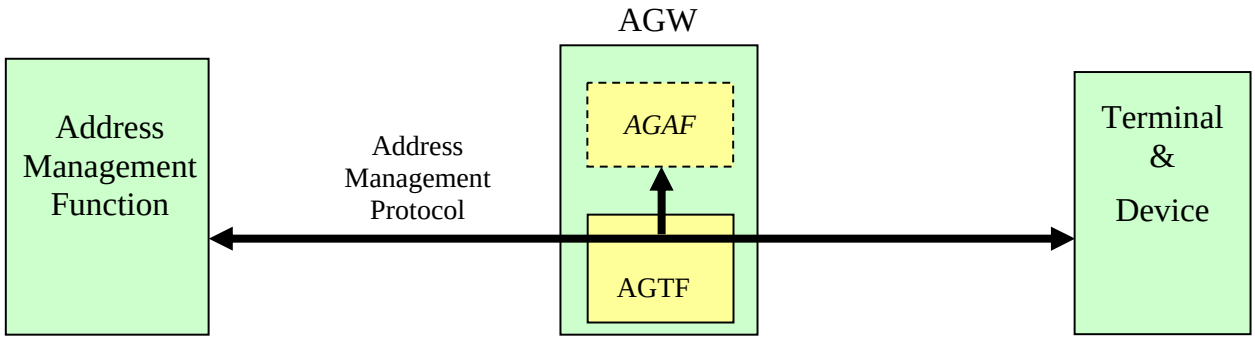


Figure 8-1 – Network assigned IP address

The address management function in the network provider provides an IP address to each terminal or device in the HN. At the AGW, the AGTF handles the address management protocol. It is also possible for the AGAF to handle this assignment if necessary.

NOTE – The AGW's functions related to these mechanisms, such as the relay agent, are for further study.

This Recommendation does not recommend static IP address assignment by the user. For applications that require static IP address assignment, the above dynamic mechanisms are recommended to be used.

8.1.2 Locally-assigned IP addresses

The server installed in the customer premises assigns IP addresses in the locally-assigned IP address scheme. The following address assign mechanism is available for this scheme:

– DHCP

This DHCP can optionally be installed within the access GW. If the access GW assigns a local IP address to a terminal or device in the HN, the access GW is required to provide NAT/NAPT functionality to the device.

This mechanism can be used for assigning private IP addresses but is not recommended to be used for assigning public IP addresses.

Figure 8-2 shows the locally-assigned IP address scheme.

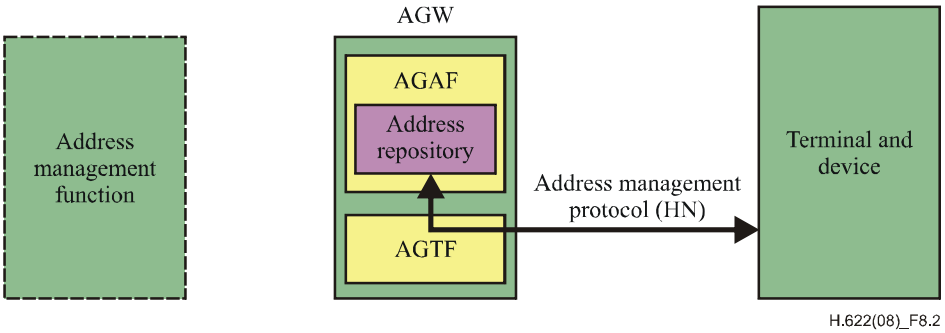


Figure 8-2 – Locally-assigned IP address

IP addresses assigned to the terminals and devices are stored or generated in the address repository in the AGW. Such IP addresses usually fall within the local administration scope.

9 Security

The access GW is recommended to provide security functionality, i.e., a firewall, in order to prevent external illegal access to the home network. Moreover, it will improve the security of the customer premises to install NAT in the access GW.

[ITU-T X.1111], which defines the framework of home network security, identifies security threats and requirements. Please refer to [ITU-T X.1111] and related documents for details.

Appendix I

Components in home network documents

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

I.1 Introduction

Home network standards/Recommendations have already been published by ITU-T SGs and SDOs. The different terminologies, which are sometimes defined or used for the same or similar device/network segment/interface, complicate any comparison of home network architectures and functional components.

This appendix provides a comparison of these standards/Recommendations and the relevant interpretation of components.

I.2 Access GW

A list of devices corresponding to the AGW as defined in other documents is shown in Tables I.1 and I.2. Figure I.1 gives the comparison of these devices. Table I.3 gives the internal functional entities placed in AGW.

Table I.1 – List of devices corresponding to AGW combined with a network termination

Device	Document where defined	Note
VTP	[ITU-T H.610]	–
VTP/D	[ITU-T H.610]	Combined with terminal functionality called FPD.
HA	[ITU-T J.190]	–
Secure home gateway	[ITU-T X.1111]	–
HG	[HGI]	–

Table I.2 – List of devices corresponding to AGW not combined with a network termination

Device	Document where defined	Note
DNG	[ATIS 0800002]	DNG is connected to NID, in case of DSL, or ONT, case of optical access network.
RG	[DSL TR-094]	RG is connected to B-NT for DSL access network. [DSL TR-094] allows implementation of a combination of B-NT and RG as a single device.

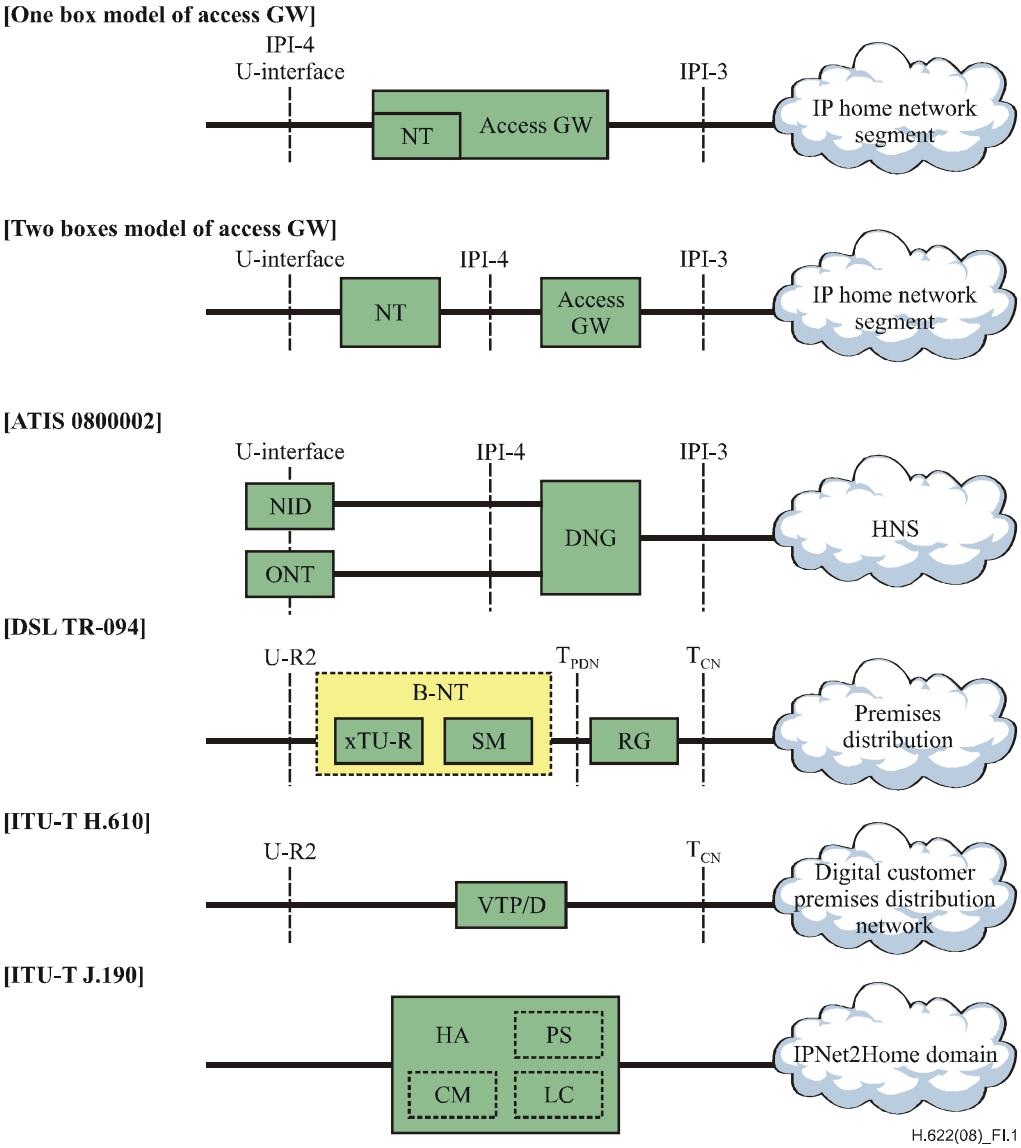


Figure I.1 – Configuration of home gateway in other documents

Table I.3 – Internal functional components related to access GW and NT

Internal functional component	Document where defined	Note
DNGF	[ATIS 0800002]	Internal function contained in DNG (access GW).
xTU-R	[DSL TR-094]	Network termination function for DSL access network.
SM	[DSL TR-094]	–
VTU-R	[ITU-T H.610]	Network termination function for VDSL access network.
ATM Proc.	[ITU-T H.610]	–
Functional processing	[ITU-T H.610]	–
CM	[ITU-T J.190]	Network termination function for cable access network.
PS	[ITU-T J.190]	This function includes security, management, provisioning and addressing functions.
LC	[ITU-T J.190]	Bridging function for IPNet2Home.

I.3 Terminal

This Recommendation defines two types of terminal, primary and secondary terminals, according to the role and function in the home network. This clause categorizes terminal devices defined in other documents into these two types. Tables I.4 and I.5 are lists for primary and secondary terminals, respectively.

Table I.4 – List of terminals that can be primary terminals

Terminal	Document where defined	Note
HNED	[ATIS 0800002]	–
FPD	[DSL TR-094]	FPD needs to have IP communication capability.
FPD/T	[DSL TR-094]	–
FPD	[ITU-T H.610]	–
VTP/D	[ITU-T H.610]	Combined with gateway functionality called VTP.
HD	[ITU-T J.190]	–
Type A	[ITU-T X.1111]	Controlling capability for type B or C.
Type B	[ITU-T X.1111]	Bridge to type C.

Table I.5 – List of terminals that can be secondary terminals

Terminal	Document where defined	Note
HNED	[ATIS 0800002]	–
EUT	[DSL TR-094]	–
Home appliance	[ITU-T H.610]	–
HD	[ITU-T J.190]	–
Type A	[ITU-T X.1111]	Controlling capability for type B or C.
Type C	[ITU-T X.1111]	Provide services to other devices.

I.4 Other devices

Device types are not limited to AGWs and terminals. A typical home network consists of other types such as a gateway device connecting IP and non-IP network segments. Table I.6 gives a list of devices not categorized as either AGW or terminal.

Table I.6 – List of other devices

Terminal	Document where defined	Corresponding device	Note
ASG	[DSL TR-094]	Non-IP gateway	It is possible to implement an ASG in a physical device as an RG.
HB	[ITU-T J.190]		Bridging device within IPNet2Home (IP-based home network segment).
HC	[ITU-T J.190]	Non-IP gateway	–

I.5 Network domain

This Recommendation defines two types of domain, primary and secondary domain, according to the role and function in the home network. This clause categorizes network segment/domain defined in other documents into these two types. Tables I.7 and I.8 are lists for primary and secondary domains, respectively.

Table I.7 – A list of network segments/domains that can be primary domains

Domain/segment	Document where defined	Note
Premises distribution	[DSL TR-094]	–
SP managed (M) domain	[DSL TR-094]	M domain can overlap with U domain.
Premises distribution	[ITU-T H.610]	–
IPNet2Home domain	[ITU-T J.190]	–
Proprietary domain	[ITU-T J.190]	–
GSD	[ITU-T J.190]	A network segment that ensures QoS for streaming services by [b-UPnP QoS].
ASD	[ITU-T J.190]	A network segment in which devices are required to be authenticated by the network operator.
AOD	[ITU-T J.190]	A network segment for the contents on portable/mobile equipment.
BED	[ITU-T J.190]	A network segment for non-QoS sensitive contents.
M-Domain	[ITU-T J.190]	The set of elements compliant with IPNet2Home provisioning and management specifications.
Q-Domain	[ITU-T J.190]	The set of elements compliant with IPNet2Home QoS specifications.
S-Domain	[ITU-T J.190]	The set of elements compliant with IPNet2Home security specifications.
MP-Domain	[ITU-T J.190]	–
QP-Domain	[ITU-T J.190]	–
SP-Domain	[ITU-T J.190]	–

Table I.8 – A list of network segments/domains that can be secondary domains

Domain/segment	Document where defined	Note
Supplementary application network	[DSL TR-094]	[DSL TR-094] allows the use of premises distribution for this purpose.
Customer managed (U) domain	[DSL TR-094]	U domain can overlap with M domain.
Proprietary domain	[ITU-T J.190]	–
GSD	[ITU-T J.190]	A network segment that ensures QoS for streaming services by [b-UPnP QoS].
ASD	[ITU-T J.190]	A network segment in which devices are required to be authenticated by the network operator.

Table I.8 – A list of network segments/domains that can be secondary domains

Domain/segment	Document where defined	Note
AOD	[ITU-T J.190]	A network segment for contents on portable/mobile equipment.
BED	[ITU-T J.190]	A network segment for non-QoS sensitive contents.
MP-Domain	[ITU-T J.190]	–
QP-Domain	[ITU-T J.190]	–
SP-Domain	[ITU-T J.190]	–

I.6 Interfaces

Table I.9 gives a list of interfaces defined in home network documents.

Table I.9 – List of interfaces

Interface	Document where defined	Corresponding device	Note
U	[ATIS 0800002]	IPI-4	–
IPI-4a/b/c/d	[ATIS 0800002]	IPI-4	IPI-4a: Defined for copper access network (DSL). IPI-4b: Defined for optical access network. IPI-4c: Defined for optical access network with coaxial interface. IPI-4d: Defined for wireless access network.
IPI-3a/b/c/d/e	[ATIS 0800002]	IPI-3	IPI-3a: Defined for PLC-based home network. IPI-3b: Defined for Ethernet. IPI-3c: Defined for copper home network (HomePNA). IPI-3d: Defined for coaxial home network. IPI-3e: Defined for wireless home network.
IPI-1a/b/c/d/e	[ATIS 0800002]	IPI-1	IPI-1a: Defined for PLC-based home network. IPI-1b: Defined for Ethernet. IPI-1c: Defined for copper home network (HomePNA). IPI-1d: Defined for coaxial home network. IPI-1e: Defined for wireless home network.
IPI-0	[ATIS 0800002]	IPI-0	–
U-R	[DSL TR-094]	IPI-4	U-R and U-R2 are distinguishable only when the access network supports both broadband and POTS service.
U-R2	[DSL TR-094]	IPI-4	U-R and U-R2 are distinguishable only when the access network supports both broadband and POTS service.

Table I.9 – List of interfaces

Interface	Document where defined	Corresponding device	Note
T_{PDN}	[DSL TR-094]	–	This interface is visible only when the RG and B-NT are implemented in separate devices.
T_{CN}	[DSL TR-094]	IPI-3	–
R	[DSL TR-094]	IPI-0	–
U-R	[ITU-T H.610]	IPI-4	–
U-R2	[ITU-T H.610]	IPI-4	–
T_{CN}	[ITU-T H.610]	IPI-3	–
R	[ITU-T H.610]	IPI-0	–

Bibliography

[b-ITU-T G.9970] Recommendation ITU-T G.9970 (2009), *Generic home network transport architecture*.

[b-DSL TR-069] DSL Forum TR-069 (2004), *CPE WAN Management Protocol*.
<http://www.broadband-forum.org/technical/download/TR-069.pdf>

[b-DSL TR-133] DSL Forum TR-133 (2005), DSLHome™ TR-064 Extensions for Service Differentiation.
<http://www.broadband-forum.org/technical/download/TR-133.pdf>

[b-IEEE 802.1D] IEEE 802.1D (2004), *IEEE Standard for Local and metropolitan area networks Media Access Control (MAC) Bridges*.
<http://ieeexplore.ieee.org/servlet/opac?punumber=9155>

[b-IEEE 802.1Q] IEEE 802.1Q (2005), *IEEE standard for local and metropolitan area networks virtual bridged local area networks*.
<http://ieeexplore.ieee.org/servlet/opac?punumber=10905>

[b-IETF RFC 2474] IETF RFC 2474 (1998), *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*.
<http://www.ietf.org/rfc/rfc2474.txt>

[b-IETF RFC 2205] IETF RFC 2205 (1997), *Resource ReSerVation Protocol (RSVP) – Version 1 Functional Specification*.
<http://www.ietf.org/rfc/rfc2205.txt>

[b-IETF RFC 2597] IETF RFC 2597 (1999), *Assured Forwarding PHB Group*.
<http://www.ietf.org/rfc/rfc2597.txt>

[b-IETF RFC 2598] IETF RFC 2598 (1999), *An Expedited Forwarding PHB*.
<http://www.ietf.org/rfc/rfc2598.txt>

[b-UPnP-QoS] UPnP (2006), *UPnP QoS Architecture:2*.
<http://www.upnp.org/specs/qos/UPnP-qos-Architecture-v2-20061016.pdf>

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	**Audiovisual and multimedia systems**
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2009