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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Access networks – In premises networks

Generic home network transport architecture

Recommendation ITU-T G.9970

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Recommendation ITU-T G.9970

Generic home network transport architecture

Summary

Recommendation ITU-T G.9970 describes the generic architecture for home networks and their interfaces to the operators' broadband access networks.

Source

Recommendation ITU-T G.9970 was approved on 13 January 2009 by ITU-T Study Group 15 (2009-2012) under Recommendation ITU-T A.8 procedures.

FOREWORD

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CONTENTS

Introduction

As the use of electronics and communications equipment proliferates in the home, as well as their technologies and protocols, there have been several proposals for standardization of equipment, transport and networking within the "home network". Recommendation ITU-T G.9970 proposes the generic home network architecture for the transport layer that can become the platform for the development of home networking standards.

Recommendation ITU-T G.9970

Generic home network transport architecture

1 Scope

Considering that, in the future, the home network will be interconnected with the next generation network (NGN), this Recommendation describes the generic home network architecture from the viewpoint of the NGN architecture. [ITU-T Y.2012] defines the transport stratum as well as the service stratum. Considering these, the generic home network architecture can be separately discussed both in the transport layer categorized in the transport stratum and the application layer categorized in the service stratum. This Recommendation references the former model. Note that the latter model is specified in the companion recommendation, [ITU-T H.622]. Its detail will be described in clause 6.

This Recommendation discusses the interfaces between access networks and home networks, including interfaces within home networks as well as legacy interfaces. However, interfaces for off-air broadcast services are not considered in this Recommendation. Interfaces in the home network as well as the interface to the access network are shown as reference points, while proposed demarcation points for the customer and the operator are also shown in this Recommendation. Moreover, this Recommendation identifies key transport technologies for an operator to consider when providing services relevant to home networking.

In summary, this Recommendation addresses layer 3 of the home network architecture, while [ITU-T G.9960] addresses the home network architecture in layers 2 and 1. Moreover, this Recommendation describes the high level requirements for layer 2 and 3 transport technologies from the viewpoint of the interaction between access network and home network, while one of the detailed requirements and specifications for the layer 2 transport technologies within the home network can be found in [ITU-T G.9960]. The detailed description regarding the relationship between this Recommendation and [ITU-T G.9970] can be found in Annex A.

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 G.9954] Recommendation ITU-T G.9954 (2007), *Home networking transceivers – Enhanced physical, media access, and link layer specifications*.

[ITU-T G.9960] Recommendation ITU-T G.9960 (2009), *Next generation home networking transceivers*.

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

[ITU-T H.622] Recommendation ITU-T H.622 (2008), *A generic home network architecture with support for multimedia services*.

[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*.

[ITU-T Y.1541] Recommendation ITU-T Y.1541 (2006), *Network performance objectives for IP-based services*.

[ITU-T Y.2012] Recommendation ITU-T Y.2012 (2006), *Functional requirements and architecture of the NGN release 1*.

[ITU-R M.1450] Recommendation ITU-R M.1450 (2008), *Characteristics of broadband radio local area networks*.

[ITU-R M.1801] Recommendation ITU-R M.1801 (2007), *Radio interface standards for broadband wireless access systems, including mobile and nomadic applications, in the mobile service operating below 6 GHz*.

[ISO/IEC 15045-1] ISO/IEC 15045-1 (2004), *Information technology – Home electronic system (HES) gateway – Part 1: A residential gateway model for HES*.
<http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=26313>

[TR-069 Amd.1] Broadband Forum TR-069 Amendment 1 (2006), *CPE WAN management protocol*.
<http://www.broadband-forum.org/technical/download/TR-069Amendment1.pdf>

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

[TR-098] Broadband Forum TR-098 Amendment 2 (2008), *Internet Gateway Device Data Model for TR-069*.
<http://www.broadband-forum.org/technical/download/TR-98_Amendment_2.pdf>

[TR-104] Broadband Forum TR-104 (2005), *DSLHome™ Provisioning Parameters for VoIP CPE*.
<http://www.broadband-forum.org/technical/download/TR-104.pdf>

[TR-135] Broadband Forum TR-135 (2007), *Data Model for TR-069 Enabled STB*.
<http://www.broadband-forum.org/technical/download/TR-135.pdf>

3 Definitions

The new terminologies are defined in clause 6.

4 Abbreviations

This Recommendation uses the following abbreviations:

AGAF Access Gateway Application layer Function

AGTF Access Gateway Transport layer Function

AGW Access Gateway

ALDF Application Layer Device Function

ASG Application Service Gateway

B-NT Broadband Network Termination

CPE Customer Premises Equipment

DHCP Dynamic Host Configuration Protocol

DSCP Differentiated Services Code Point

EU	End User
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
ICMP	Internet Control Message Protocol
IMS	IP Multimedia Subsystem
IP	Internet Protocol
IPTV	Internet Protocol TeleVision
LANT	Local Area Network side Termination
NGN	Next Generation Network
NP	Network Provider
NW	Network
OSGi	Open Service Gateway initiative
PC	Personal Computer
PLC	Power Line Communication
POTS	Plain Old Telephone Service
PPP	Point to Point Protocol
PS	POTS Splitter
QoS	Quality of Service
RG	Routing Gateway
RMS	Remote Management Server
RSVP	Resource ReSerVation Protocol
SIP	Session Initiation Protocol
SNMP	Simple Network Management Protocol
SP	Service Provider
STB	Set Top Box
TV	Television Set
VDSL	Very high-speed Digital Subscriber Line
VTP/D	VDSL Termination Processing or VDSL Termination Processing and Decoding
WANT	Wide Area Network side Termination

5 Conventions

None.

6 Generic home network architecture

6.1 Application layer generic home network model

Before discussing the generic home network architecture in the transport layer, the application layer architecture is described in this clause. [ITU-T H.622] addresses the home network architecture for the application model, as shown in Figure 6-1.

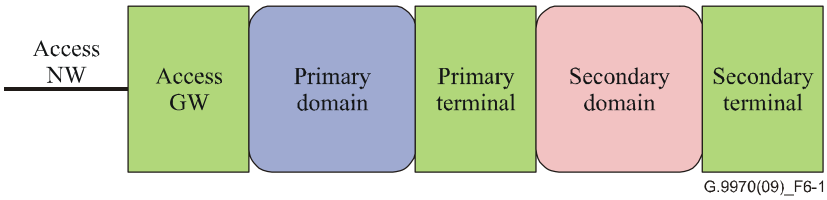


Figure 6-1 – Application model of the home network

– A primary terminal is a terminal device that can interact with the access network or with service functionalities beyond the access network without the assistance of another terminal, and is the service end-point where the service from the service provider is terminated.

– A secondary terminal is a terminal device that has no direct interactive capability with network side entities or needs to rely on another terminal to do so.

– A primary domain is the logically defined area of the home network that interconnects the primary terminal and the access GW.

– 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.

6.2 Transport layer generic home network model

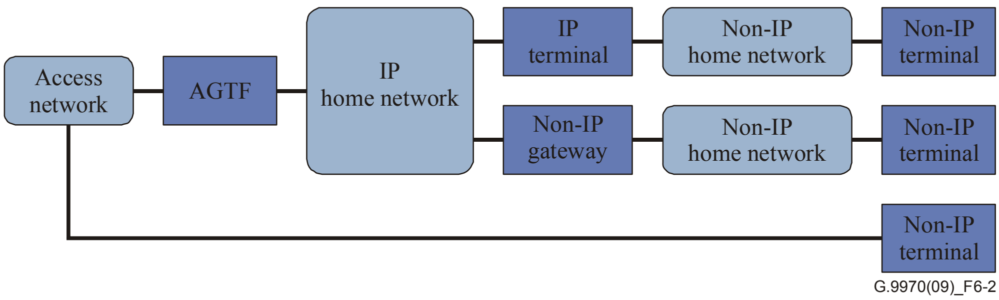


Figure 6-2 – Generic home network functional architecture for the transport layer

In Figure 6-2, the home network is shown as an "IP home network" using IP, and a "non-IP home network" using other specific technologies or protocols. A gateway between the "access network" and the "IP home network" is called the "access gateway transport layer function (AGTF)", while a gateway between an "IP home network" and a "non-IP home network" is called a "non-IP GW". The non-IP terminal at the bottom right of Figure 6-2 is a legacy terminal, such as an analogue CPE, which is directly connected to the access network, bypassing the home network.

The following clauses will describe the terminology relevant to the home network architecture for the transport layer.

Note that this is the functional architecture. For example, both the "IP home network" and the "non-IP GW" can be collapsed in the case that the "non-IP home network" is directly connected to "AGTF"; in this case, the "IP home network" and "non-IP GW" functions are contained in one physical access gateway device. Moreover, one port of the physical access gateway device may serve the "IP home network", while another port of the same physical access gateway device may serve the "non-IP home network".

6.2.1 IP home network

The "IP home network" is the network that carries IPv4 or IPv6 data, i.e., it corresponds to "IPCable2Home domain" in [ITU-T J.190] or to "premises distribution" in [TR-094]. Note that the HB in [ITU-T J.190] can be one of the elements composing the "IP home network".

6.2.2 Non-IP home network

A "non-IP home network" is composed of one or more networks, each of which has its own non-IP technology or protocol. A "non-IP home network" corresponds to the "proprietary domain" in [ITU-T J.190], and also corresponds to the "supplementary application network" or the connectivity between FPD and EUT in [TR-094]. Note that HD in [ITU-T J.190] can be one of the elements composing the "non-IP home network".

6.2.3 IP terminal

An "IP terminal" is a terminal function that is directly connected to an "IP home network", for example an IP-interface-equipped STB or telephone. "IP terminal" corresponds to HC or to a set of HC and HD in [ITU-T J.190].

As shown in Figure 6-3, there are three types of IP terminals, depending on which kind of terminal it resides in: two primary types, a) and b), and one secondary type, c). IP terminal type a) retrieves the payload from the received IP packets (from the left) for the application layer and then sends the non-IP layer 3 packets for the application layer. Similarly, IP terminal type b) sends the IP packets for the application layer. On the other hand, IP terminal type c) just retrieves the payload from the received IP packets for the application layer. In [TR-094], the ASG connects to a non-IP terminal, such as a rendering device, via a non-IP home network, while in [TR-094], the FPD has a point-to-point connection to a non-IP terminal. Since the functional architecture in this Recommendation does not care about the number of interfaces from the IP terminal type a) to a non-IP terminal, both ASG and FPD [TR-094] correspond to IP terminal type a). An [TR-094] FPD/T corresponds to either the combined IP terminal type a) and non-IP terminal or to the combined IP terminal type b) and type c).

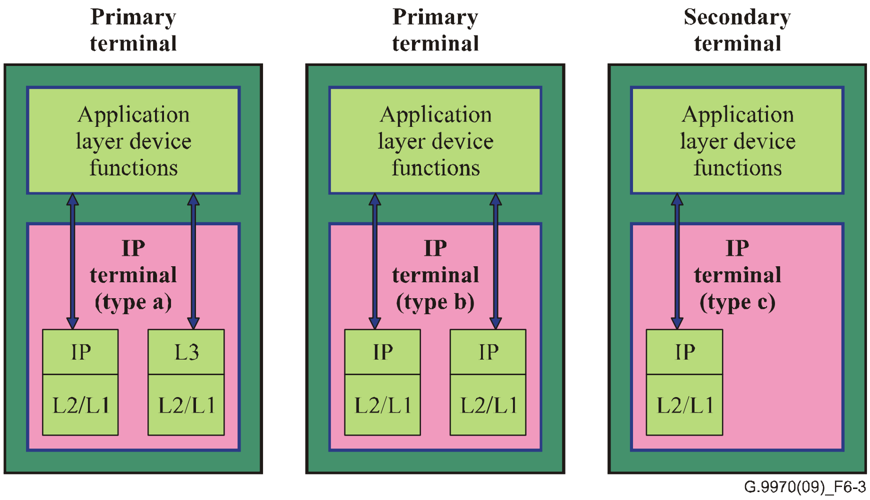


Figure 6-3 – Three types of IP terminals

6.2.4 Non-IP terminal

There are examples of customer premises terminal functions that cannot be directly connected to "IP networks", such as legacy TV, telephone and PC peripheral equipment, like printers. Such terminals are called "non-IP terminals" in this Recommendation. "Non-IP terminal" corresponds to HD in [ITU-T J.190] as well as to EUT in [TR-094].

Moreover, an analogue CPE connected directly to the access network – thus bypassing the home network – supporting legacy non-IP services like POTS or broadcast analogue television, is also a "non-IP terminal".

6.2.5 Non-IP gateway (GW)

A "non-IP GW" connects the "IP home network" and "non-IP home networks".

Contrary to IP terminal type a), a non-IP GW directly converts the received IP packets to the non-IP layer 3 packets without the application layer, which is shown in Figure 6-4. This corresponds to HC in [ITU-T J.190].

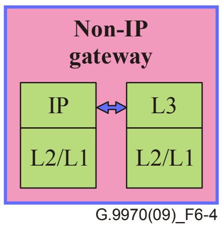


Figure 6-4 – Non-IP gateway

6.2.6 Access network

The access network is terminated by an NT (network termination) function, as shown in Figure 6-5. In general, an IP terminal and a non-IP terminal are each connected to the access network via AGTF. However, some non-IP, or legacy, terminals are sometimes directly connected to the access network for historical reasons. Typical examples are a telephone directly connected to a metallic cable or a STB directly connected to a coaxial cable. In such cases, a non-IP terminal should be connected to the access network via a splitter (see Figure 6-5).

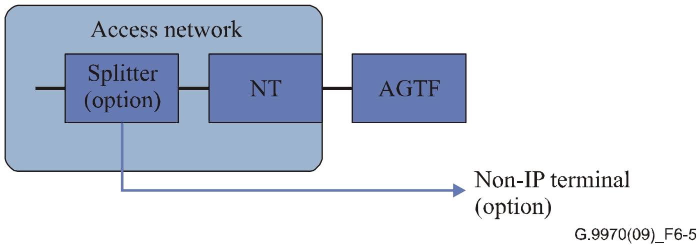


Figure 6-5 – Access network to support non-IP terminal

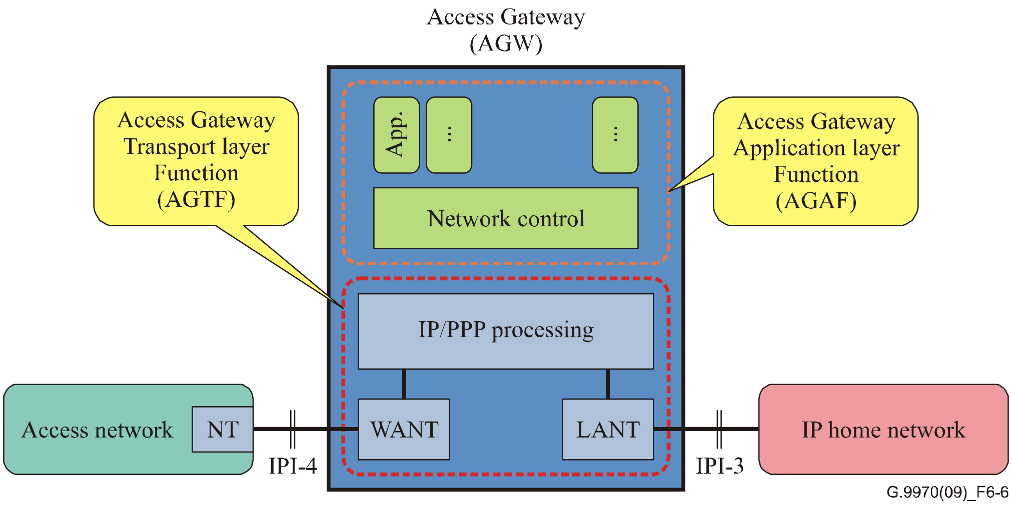
The splitter separates the signals for legacy services from the aggregate signal stream from the central office. A splitter in this Recommendation corresponds to PS in both [ITU-T H.610] and [TR-094]. Moreover, [ITU-T J.190] implicitly shows the signal splitter function that is connected to an STB.

6.2.7 Access gateway transport layer function (AGTF)

The "AGTF" connects the "access network" to the "IP home network". This Recommendation describes the relationship between AGTF and the physical access gateway (AGW) device; how they are handled by some of the referenced documents will be discussed in this clause. The detailed implementation aspects are outside the scope of this Recommendation.

The definition of AGTF is shown in Figure 6-6, while AGAF is addressed in [ITU-T H.622]. Layers 1 and 2 of the access network are terminated at network termination (NT). "Access gateway transport layer function (AGTF)" specified in this Recommendation terminates layers 1 and 2 of the WAN side by using WANT (WAN-side termination), while it terminates layers 1 and 2 of the LAN side by using LANT (LAN-side termination). "IP/PPP processing" may be executed above these WANT and LANT functions. On the other hand, the "access gateway application layer function (AGAF)" specified in [ITU-T H.622] works above AGTF. "Access gateway (AGW)" is a physical device that contains at least AGTF and AGAF, as shown in Figure 6-6. Note that it may also contain an optional NT function. In such a case, the WANT is not needed, because the NT also plays the role of the WANT.

This Recommendation identifies two types of AGW: one is called as "aggregate type AGW" that contains NT, while the other is called as "separate type AGW" that does not contain NT, as shown in Figure 6-6.



NT: Network Termination
WANT: WAN-side Termination function for layers 1 and 2
LANT: LAN-side Termination function for layers 1 and 2

Figure 6-6 – Decomposition of access gateway

Figure 6-7 shows the types of AGW in comparison with common industry standards for the home-access network interface, while Table 6-1 shows the relationship between two types of AGW and the corresponding entities of these documents. As the entities described in [TR-094], B-NT and RG, are logical functions, they can represent the aggregate type as well as the separate type of AGW. On the other hand, VTP/D in [ITU-T H.610] and HA in [ITU-T J.190] represent the aggregate type of AGW.

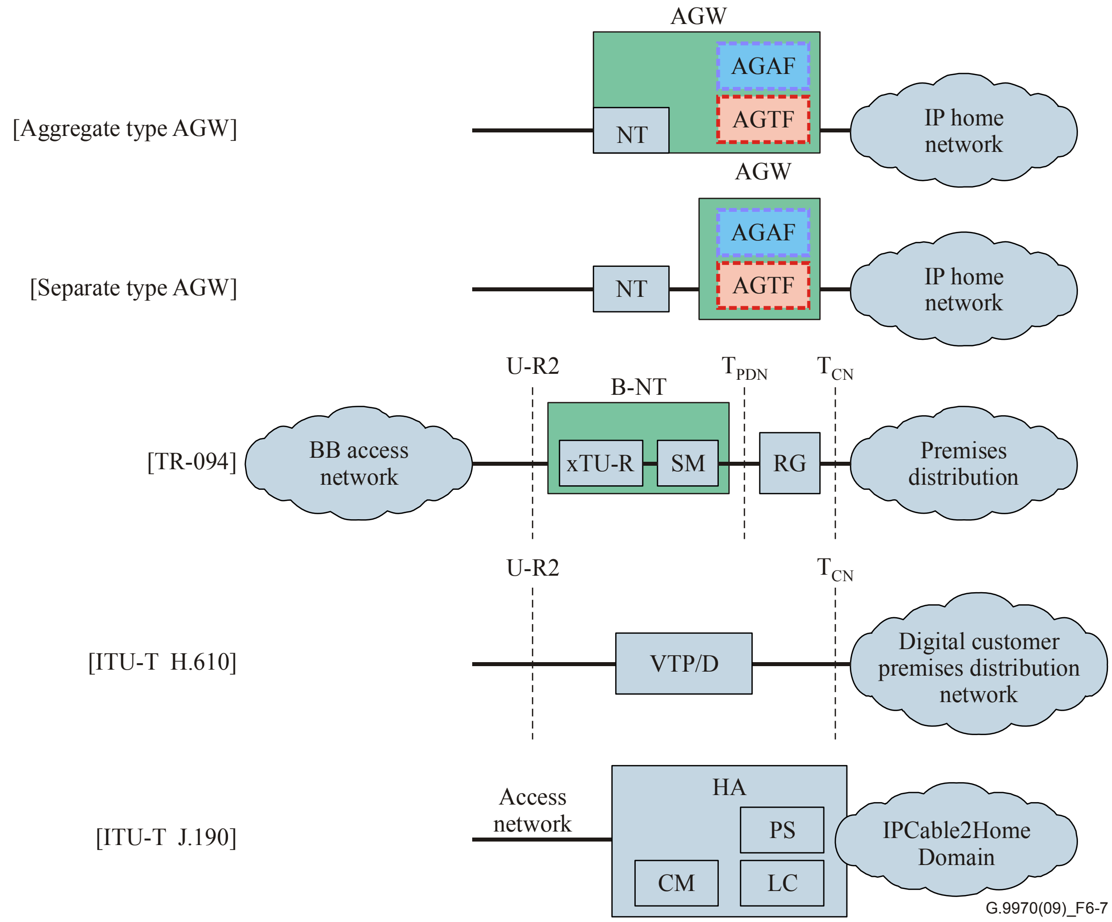


Figure 6-7 – The configuration of AGW in comparison with some documents

Table 6-1 – Relationship between two types of AGW and the corresponding entities in some documents

Type of AGW / Document	Aggregate type AGW	Separate type AGW	
	NT/AGTF/AGAF	**NT**	**AGTF/AGAF**
[TR-094]	B-NT + RG	B-NT	RG
[ITU-T H.610]	VTP/D	–	–
[ITU-T J.190]	HA	–	–

6.3 Relationship between the home network architecture for the transport layer and that of the application layer

The main objective of the home network architecture for the transport layer is to ensure that communication in the application layer can be carried over the transport layer. To better understand the relationship between two home network architectures, one physical configuration is provided in Figure 6-8. This includes the following features.

– The primary terminal contains both an IP terminal type a) and an application layer device function (ALDF), while the secondary terminal contains both a non-IP terminal and an ALDF. AGW, which is the aggregated type in this example, contains NT, AGTF and AGAF.

– AGW terminates the public IP address and interacts with an IP terminal type a) by a local IP address, while IP terminal type a) interacts with the non-IP terminal by a non-IP (L3) protocol. Both the IP terminal type a) and the non-IP terminal lie within the transport layer in the home network.

– On the other hand, ALDF in the primary terminal interacts with functions in the application layer of the carrier's network via the AGAF in the AGW. It also interacts with ALDF in the secondary terminal at the application level.

– The primary domain is provided over an IP home network, while the secondary domain is provided over a non-IP home network.

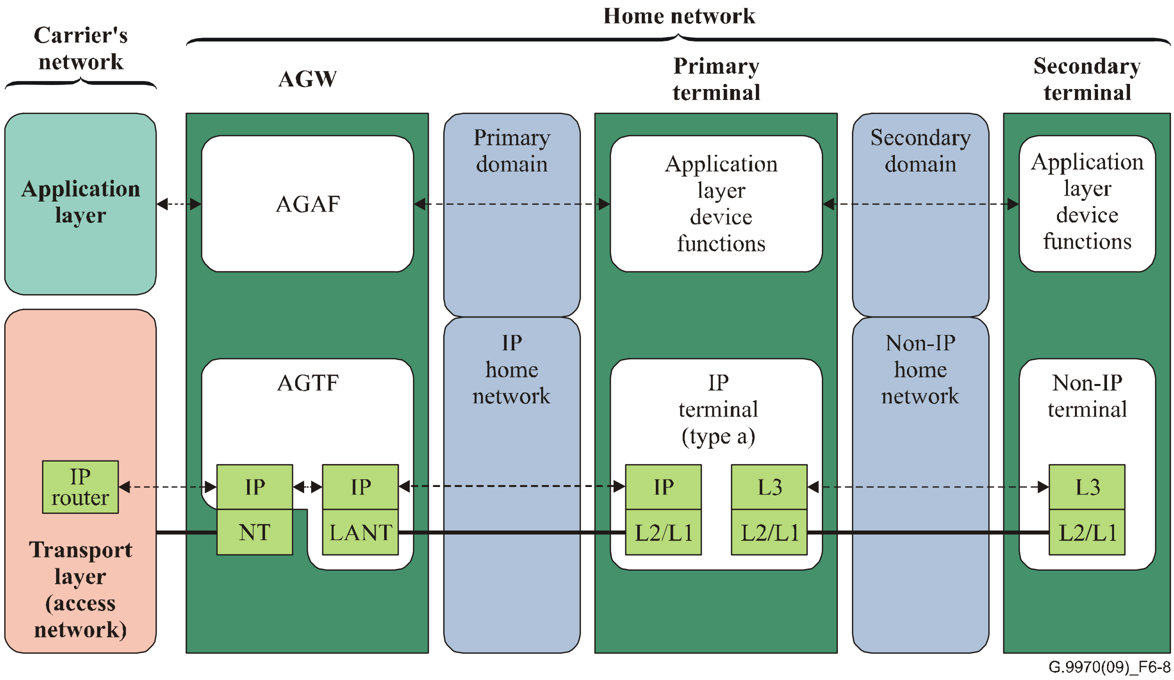


Figure 6-8 – One physical configuration based on two generic home architectures

Considering the above, you can find three typical flows in layer 3, as shown in Figure 6-9. Note that this figure shows a physical configuration; specifically, the AGW is the aggregated type device, while the IP terminal (type a) is the device that contains the IP terminal (type a) function.

– Flow 1: IP terminal (type a) acting as the primary terminal receives packets from the AGW via the IP home network and then distributes them to the non-IP terminal acting as the secondary terminal via the non-IP home network.

– Flow 2: IP terminal (type b) acting as the primary terminal receives packets from the AGW via the IP home network and then distributes them to the IP terminal (type c) acting as the secondary terminal, also via the IP home network. Note that IP terminals type b) and type c) can be combined. In such a case, the IP terminal (types b and c) acts as both primary and secondary terminal.

– Flow 3: The non-IP GW receives packets from the AGW via the IP home network and then forwards them to the non-IP terminal acting as primary terminal via the non-IP home network.

Note that Appendix I shows various cases applying this generic home network architecture for the transport layer in home networks.

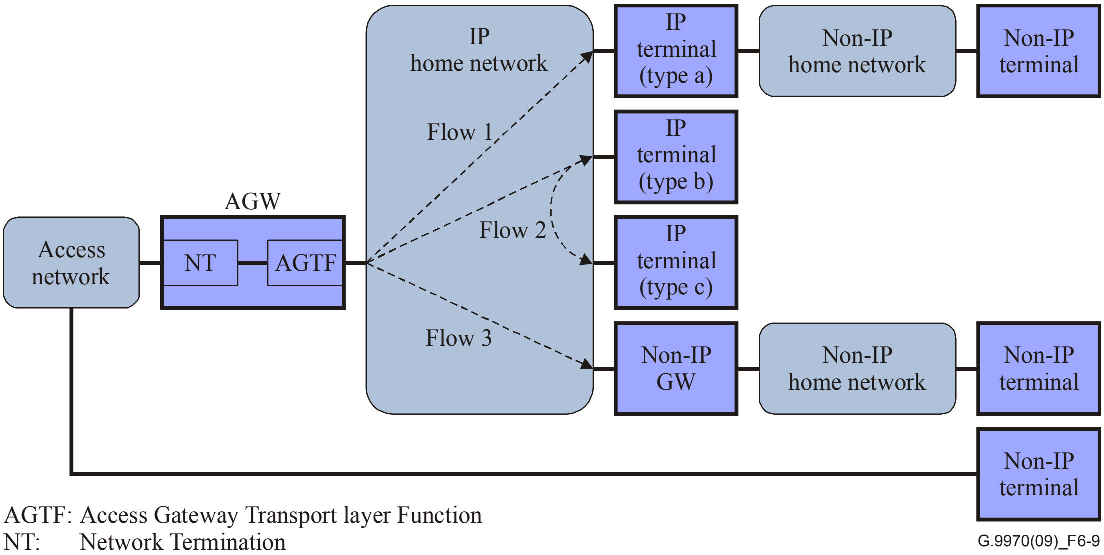


Figure 6-9 – Three typical flows over the generic home network transport physical architecture

Figure 6-10 summarizes the two layered generic home network models. AGW is a physical device that contains at least AGTF and AGAF. Moreover, it may also contain NT function as optional. Both primary terminal and secondary terminal are physical devices that contain application layer device functions as well as transport layer terminal functions, such as IP terminal or non-IP terminal. The primary terminal may contain either IP terminal or non-IP terminal. Similarly, the secondary terminal may also contain either IP terminal or non-IP terminal.

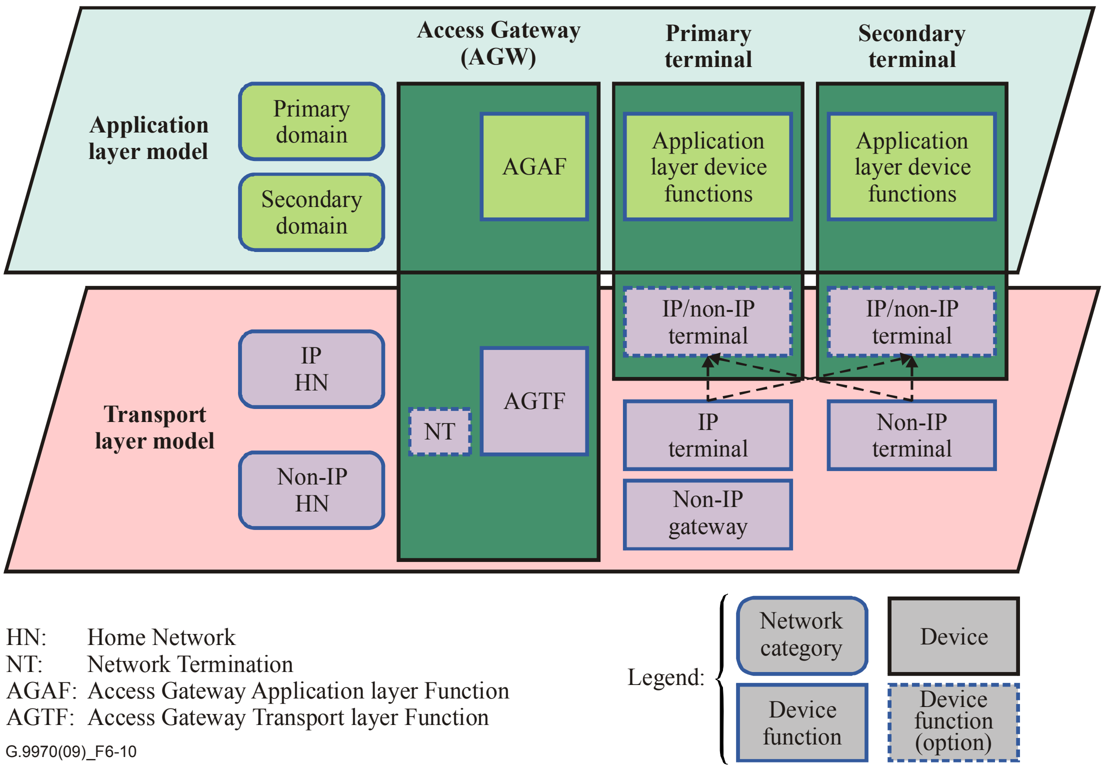


Figure 6-10 – The conceptual diagram of two layered generic home network models

7 Possible demarcation points

As described in clause 6, service is provided to the primary terminal in the application layer, which is supported by either the IP terminal or the non-IP terminal in the transport layer. Therefore, the interfaces to reach each terminal are potential demarcation points between the user and operator domains of responsibility. Possible demarcation points for an IP terminal are described in clause 7.1, while those for a non-IP terminal are described in clause 7.2. One of these demarcation points would be selected by a user and an operator, considering the service model deployed. Moreover, we shall take into account that there are two types of AGW, aggregation type and separate type.

7.1 Possible demarcation points for IP terminals

Points A, B, C, D1 and D2 in Figure 7-1 are the possible demarcation points for an IP terminal (type a) and IP terminal (type b), both of which act as primary terminal. As both non-IP terminal and IP terminal (type c) do not act as primary terminal, the interfaces to reach each terminal are shown as dotted lines in order to indicate that they are not possible demarcation points.

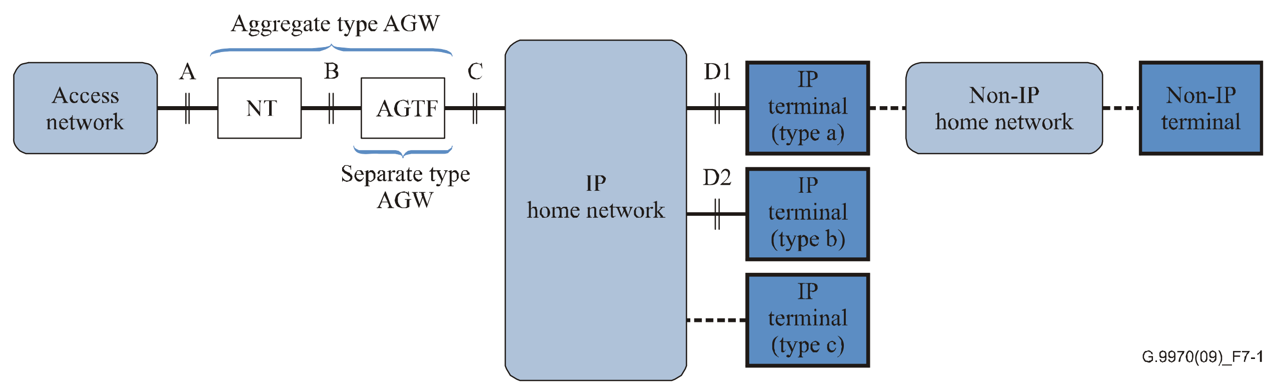


Figure 7-1 – Possible demarcation points for IP terminals

7.2 Possible demarcation points for non-IP terminals

Existing non-IP services should be provided to the non-IP terminals, such as TV, STB, telephone, PC peripherals, etc., that do not have IP capability. Points A, B, C, E, F, G and H in Figure 7-2 are the possible demarcation points for non-IP terminals.

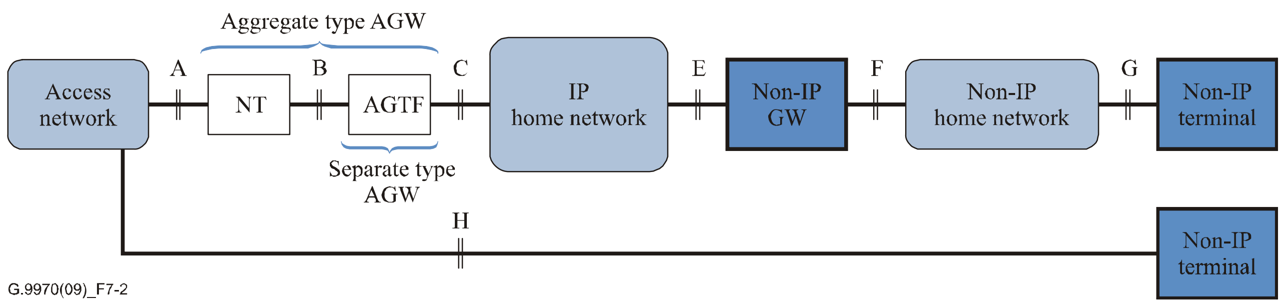


Figure 7-2 – Possible demarcation points for non-IP terminals

8 High level requirements

8.1 QoS control

The functionality to realize QoS control over IP networks is important in order to accomplish stable quality in case of offering streaming-based multimedia services on the IP network. One QoS control domain can be defined, at the edge of which two kinds of QoS services: parameterized QoS and prioritized QoS. [ITU-T Y.1541] specifies IP-based parameterized QoS. Parameterized QoS is realized by some control protocols, such as SIP utilized in NGN, and RSVP mentioned in [ITU-T J.190]. Dynamic parameterized QoS control can be provided by using these protocols, while static parameterized QoS can be provided by management functions. On the other hand, prioritized QoS is realized by DSCP for IP or Ethernet VLAN, which attaches a priority level to each packet. QoS mechanisms described in [TR-094] requirements are all for prioritized QoS. Moreover, [TR-094] includes the configuration of many QoS parameters.

In case of studying the requirements for the access GW (or AGW) to realize end-to-end QoS control between two remote IP terminals in different IP home networks via a network provider's network, we shall consider that they communicate with each other over multiple QoS control domains. We can identify three types of service scenarios in terms of QoS control domains.

– Type 1: One QoS control domain exists for the IP home network, but there is no QoS control domain for the network provider's network including the access network.
– Type 2: QoS control domains exist both for the network provider's network, including the access network, and for the IP home network.
– Type 3: One QoS control domain exists through the network provider's network, including the access network as well as the IP home network.

Type 1 is the non-NGN case, in which the network provider's network, including the access network, provides only best-effort service, which means that it does not provide any QoS control, such as parameterized or prioritized. As QoS control is provided only within each IP home network, end-to-end QoS control between two remote IP terminals cannot be achieved. On the other hand, types 2 and 3 apply to the NGN case.

Figure 8-1 shows type 2. A QoS mapping function is required for the access GW, because the QoS control in one network provider's network including the access network, and the two IP home networks may be different from each other. After QoS mapping, admission control may be performed by the access GW to check whether the network resources are enough to achieve the required QoS. After the communication is established between the two remote IP terminals, some traffic control, such as priority control, policing or shaping, will be also performed by the access GW.

The QoS mapping should be performed, considering the following cases:

– One case is that the access network is IP (layer 3) QoS control domain, while the IP home network is an Ethernet (layer 2) QoS control domain. Another case is the reverse one, with IP QoS in the home network and Ethernet QoS in the access network. In these two cases, layers 3 and 2 QoS mapping should be performed.
– Even if both the access network and the IP home network are either IP (layer 3) or Ethernet (layer 2) QoS control domains, one may be a parameterized QoS control domain, while the other may be a prioritized QoS control domain.
– Even if both the access network and the IP home network are parameterized QoS control domains, each may have different QoS specifications.

Figure 8-1 also shows Type 3. No QoS mapping function is required for the access GW, because one unique QoS control service is provided through the IP home network as well as the network provider's network, including the access network. However, admission control, as well as some traffic control functions, may be needed for the access GW.

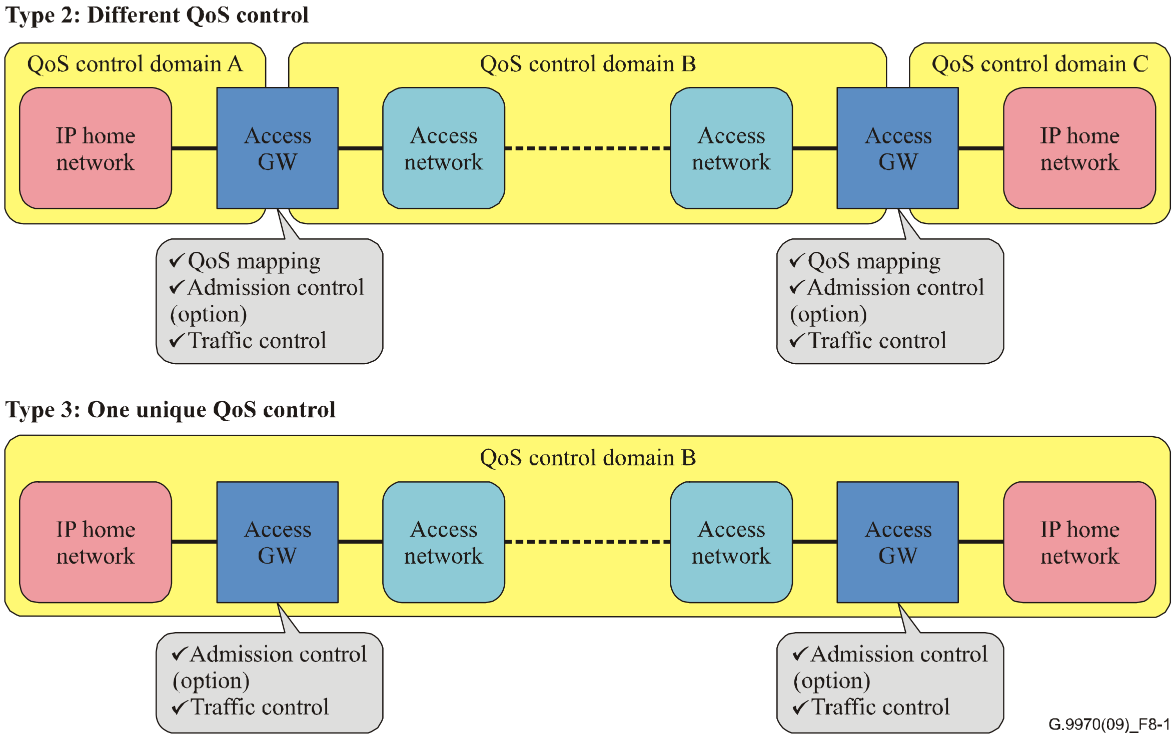


Figure 8-1 – QoS control for network provider's network and IP home networks

8.2 Device management

As described in clause 7, the primary terminal in the application layer, which is the service end-point, is supported by either the IP terminal or the non-IP terminal in the transport layer. Therefore, the devices from the access network communicating with either the IP terminal or the non-IP terminal should be managed by a remote management server (RMS) owned by the network provider or service provider. Management functions include configuration, local monitoring and maintenance.

The AGW will be directly managed by the RMS. The protocols to be used are the standard management protocols based on IP, such as ICMP and SNMP. Moreover, one more promising candidate is [TR-069 Amd.1] specified in Broadband Forum, which provides configuration and performance monitoring functions. Note that [TR-098] is a companion specification to [TR-069 Amd.1] and specifies configuration parameters for AGW.

There will be two schemes to manage end devices, such as IP terminal, non-IP terminal or non-IP GW, as shown in Figure 8-2. Scheme A is the one in which RMS directly manages individual end devices, while scheme B is the one in which RMS only manages an AGW that manages individual end devices instead of RMS. Note that the AGW contains both NT and AGTF in this figure.

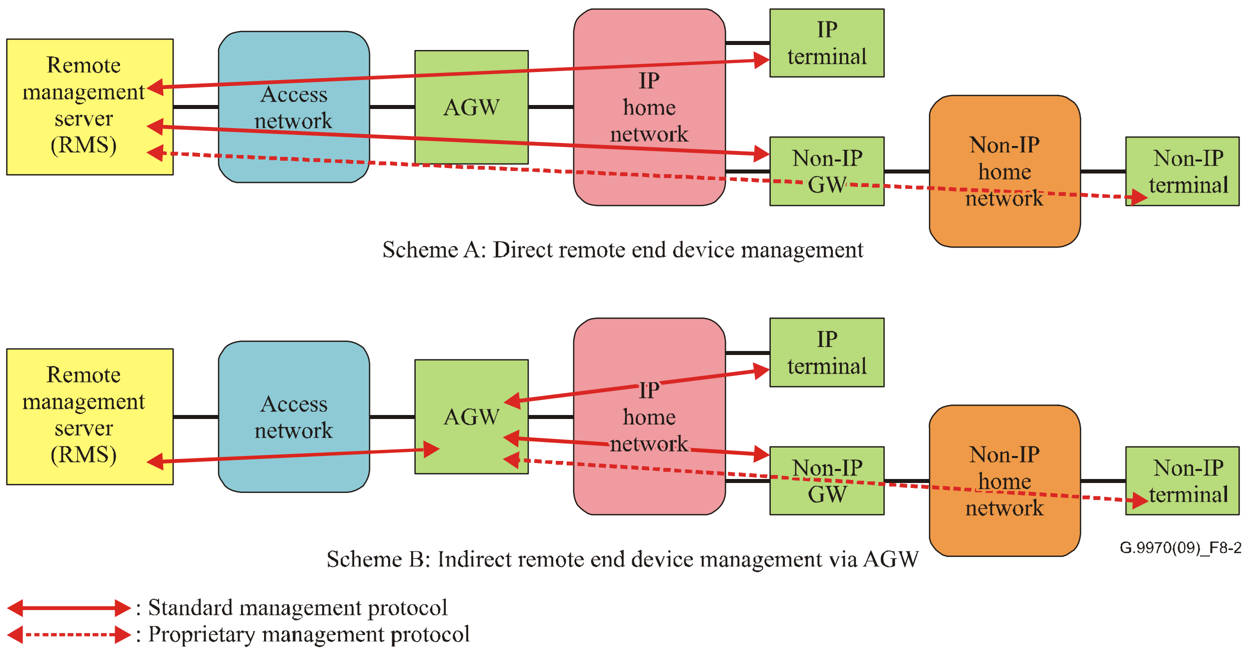


Figure 8-2 – Two schemes to remotely manage end devices

As for scheme A, the protocols to manage IP terminals and non-IP GWs are the same ones used to manage AGW, described above. However, proprietary management protocols are applied for managing non-IP terminals because there is a non-IP home network before it.

Scheme B can also use the standard management protocol based on IP, such as ICMP and SNMP, for the protocol between AGW and IP terminal or non-IP GW. Moreover, since this scheme requires plug and play to enhance usability, the specifications discussed in UPnP™ Forum (http://www.upnp.org) can be applied. However, proprietary management protocols are applied for managing non-IP terminals by AGW because there is a non-IP home network before it. AGW plays the role of adaptation between RMS and end devices in such a way that AGW notifies the RMS of the end device information by using protocols, such as ICMP, SNMP or [TR-069 Amd.1]. Note that this scheme will be also applied to the IP terminal. That is, the standard management protocol may be used for RMS to manage IP terminal, which may manage other individual end devices.

It depends on the situation in the home network which scheme should be deployed, scheme A or scheme B. Scheme A will be useful when the home network contains few end devices. However, when the number increases, the load on the RMS will also increase accordingly, because the end devices in each home network will use various kinds of management protocols. Scheme B will be useful in such a case. It is a more functional distribution to have an AGW manage end devices instead of a RMS, to hide management protocols in each home network. Moreover, even if a new kind of end device is connected to the home network, the interface between the RMS and the AGW will change less, because the AGW hides the new operations that manage it. This is also applied to the proprietary management for non-IP terminals.

In case that the management protocols between the AGW and end devices change frequently due to changes in version and so on, OSGi (http://www.osgi.org) base technology can be applicable for AGW. The software for AGW to manage end devices can be implemented as a software bundle on the OSGi platform, if it is installed in AGW. The OSGi platform provides an open interface for each software bundle, independent of hardware, operating system and other conditions of AGW. Therefore, RMS does not have to care for the specifications of AGW to dynamically download such software bundles managing end devices.

Broadband Forum has other documents like [TR-104] that specifies management of SIP endpoints and [TR-135] which specifies management of set-top boxes (STBs).

8.3 IP addressing

One of the important functions provided by NGN is IP address management. As shown in category A of Figure 8-3, the ports 1a and 1b connected to the access network (referred to as "access network attached port") and the ports 2 and 3 connected to the IP home network (called "IP home network attached port") are identified by IP addresses. Note that IP address types are categorized into IPv4 and IPv6. Within IPv4, there are private and public IP addresses. Within IPv6, there are global addresses, link local addresses, and unique local addresses. Although each has unique characteristics, this Recommendation describes mainly IPv4 and IPv6 for simplicity. The assigners of IP addresses are classified into network providers (NPs), service providers (SPs) and end users (EUs). The SP provides IP connectivity to other networks, such as those of ISPs (Internet service providers) or VSPs (voice service providers). For the purpose of offering its services, each SP has its server in its central office, which sends or receives IP packets to or from IP terminals of EUs. The NP normally sells an access network between the SP's server and the EU's IP terminal. However, there is a case in which the SP resells the access network that the SP had previously bought from the NP. Considering these, we can identify several cases in terms of which port is assigned by which IP address assigner. Category A of Figure 8-3 shows a case that currently exists. NP assigns Port 1a. In order for the SP's server to communicate with Port 3, the SP shall assign an IP address to Port 1b, while the AGTF in AGW shall possess the IP address translation function from the server's port/Port 1b assigned by SP to Port 2/Port 3 assigned by EU. The EU either manually assigns a local IPv4 address to Port 2/Port 3 or uses DHCP in the AGTF, which automatically assigns a local IPv4 address to Port 2/Port 3. This case corresponds to case 1 in Table 8-1, which shows all the possible cases. In case 2, the SP provides the IP addresses to be used on Port 2/Port 3, instead of the EU. This is the typical case where IPv6 is used. Specifically, the SP assigns an IPv6 prefix to AGTF, which provides an IPv6 address to Port 2/Port 3 (through stateful or stateless means). In cases 3 and 4 the SP provides the access network instead of the NP, or NP and SP are the same entity. Ports 1a and 1b can be collapsed into Port 1 in these two cases, because it is only the SP that assigns Port 1.

There are some other cases in which PPP is used in the access network as well as in the home network. Category B of Figure 8-3 shows one typical case. The SP provisions PPP to reach AGW. In order for the SP's server to communicate with Port 3, the SP shall assign an IP address to Port 1, while the AGTF in AGW shall possess the IP address translation function from the server's port/port 1 assigned by the SP to Port 2/Port 3 assigned by EU. This typical case corresponds to case 5, which is similar to case 1. As in case 2, case 6 shows that the SP assigns the IP addresses of Port 2/Port 3 instead of the EU. Category C in Figure 8-3 shows another typical case. SP provisions PPP to reach the IP terminal. The SP just assigns an IP address to Port 3, which corresponds to case 7 in Table 8-1.

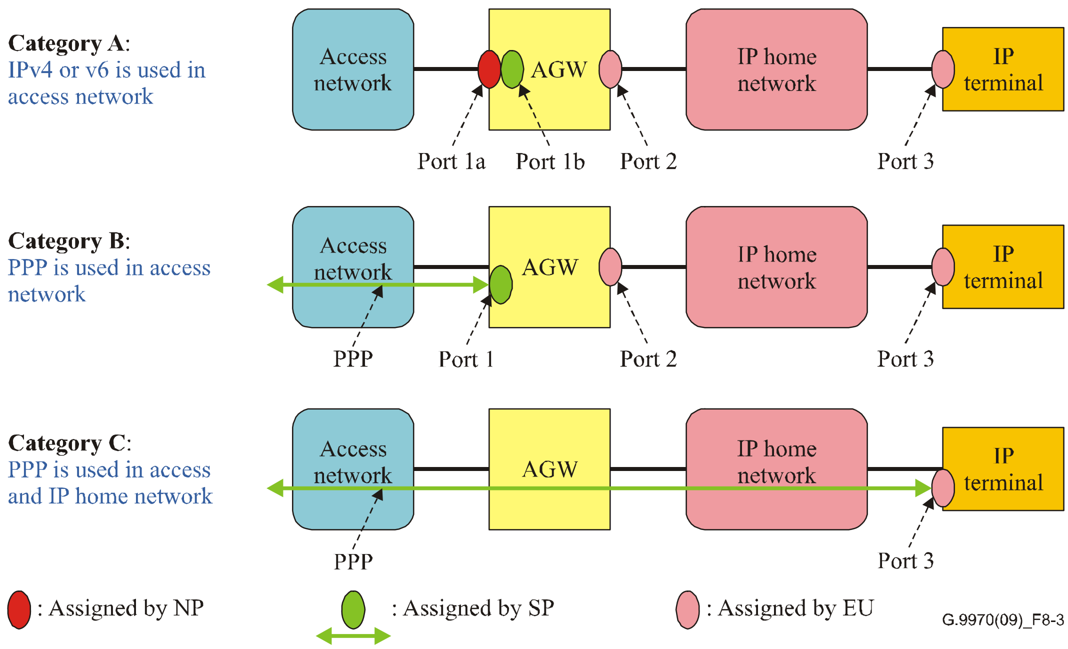


Figure 8-3 – Examples of IP addressing schemes

Table 8-1 – All of the possible cases of IP addressing schemes

Category	Case	Ports 1, 1a, 1b	Port 2	Port 3
A	1	NP assigns port 1a, while SP assigns port 1b.(3)	EU assigns it locally.(1)	EU assigns it locally.(1)
	2		SP assigns it.(2)	SP assigns it.(2)
	3	SP assigns port 1, which is only assigned that one IP address.	EU assigns it locally.(1)	EU assigns it locally.(1)
	4		SP assigns it.(2)	SP assigns it.(2)
B	5	As SP provisions PPP to reach AGW, SP assigns port 1.	EU assigns it locally.(1)	EU assigns it locally.(1)
	6		SP assigns it.(2)	SP assigns it.(2)
C	7	As SP provisions PPP to reach IP terminal, SP assigns only port 3.(4)		

(1) This is the typical case where IPv4 is used. EU either manually assigns a local IPv4 address to port 2/port 3 or uses DHCP in the AGTF, which automatically assigns a local IPv4 address to port 2/port 3.

(2) This is the typical case where IPv6 is used. Concretely speaking, SP assigns IPv6 prefix to AGTF, which provides an IPv6 address to port 2/port 3 (through stateful or stateless means).

(3) This is a case where IPv4/v6 or IPv6/v4 tunnelling is used.

(4) There may be a case where IP is used instead of PPP.

8.4 Security

Security features are categorized into various types, such as establishment of secure communication paths, prevention from attack, and so on. Home networks should be secured from/to the access network. The detailed requirements can be referred to in [ITU-T X.1111] and [ISO/IEC 15045-1]. Moreover, although local security features in every home network may be specified, these features are out of scope of this Recommendation.

Annex A

The relationship between Recommendation ITU-T G.9960 and this Recommendation

(This annex forms an integral part of this Recommendation)

Figure A.1 shows the scope of this Recommendation, [ITU-T G.9960] and some other alien home networks that are out of scope of this Recommendation. Note that the technologies specified, such as power line wiring, are examples. Also, the interaction shown by the arrows, does not indicate the flow of traffic but the traffic control functions, such as QoS mapping.

The scope of [ITU-T G.9960] can be found below:

– As shown in Figure A.1, the scope of [ITU-T G.9960] is G.9960-specific physical layers for each of power line wiring, telephone wiring and coaxial cable. Moreover, G.9960-MAC, G.9960-LLC and G.9960-APC on top of each physical layer are also in the scope of [ITU-T G.9960].

– [ITU-T G.9960] utilizes MAC Bridge [b-IEEE 802.1D] for the interaction between two adjacent G.9960 domains, as shown by the large dark arrow in Figure A.1. Therefore, each G.9960-APC exposes the A-reference point compliant with the MAC part of [b-IEEE 802.3].

  – Each standard or non-standard alien home network also interacts with MAC bridge [b-IEEE 802.1D], as shown by the thin arrow, via the A-reference point, but this is out of the scope of [ITU-T G.9960].

  – There may be the case that G.9960-APC exposes the A-reference point directly to IP without MAC bridge [b-IEEE 802.1D]. However, such an A-reference point is not currently defined in the current [ITU-T G.9960].

– In summary, [ITU-T G.9960] studies layers 1 and 2 technical requirements and specifications, which are derived from the interaction between the devices within one G.9960 home network domain. Moreover, [ITU-T G.9960] studies some specific requirements for MAC Bridge [b-IEEE 802.1D] implementation, which are derived from the interaction between the devices of the different G.9960 home network domains, although inter-domain bridging is out of scope of [ITU-T G.9960].

The scope of this Recommendation can be found below.

– As shown in Figure A.1, the scope of this Recommendation is IP as well as MAC bridge/VLAN layers.

– This Recommendation studies layer 2 and 3 high level requirements, which are derived from the interaction between access network and home network, concretely speaking.

– The IP layer interaction, as shown by the large white arrow, is the main traffic control function to study. QoS mapping is an example, such as when two IP layers use different QoS specifications. Note that there is no IP layer interaction in case that the IP layer in the access network directly reaches the IP terminal in the home network.

– The interactions between IP and MAC Bridge/VLAN layers, as well as between MAC Bridge/VLAN layers, also shown by the large white arrow, are also the traffic control functions to be studied in order to guarantee the end-to-end IP layer communication. For example, when IP packets enter the right-hand-side IP layer from the access network, QoS mapping will be executed from the IP layer to MAC Bridge/VLAN layer in the middle. Similarly, the QoS mapping will be also executed from the IP layer to MAC bridge/VLAN layer in the most right-hand-side. These are shown by the two vertical large white arrows.

On the other hand, in case that the QoS mapping cannot be executed from the IP layer to MAC bridge/VLAN layer in the most right-hand-side, the QoS mapping will be executed between two MAC bridge/VLAN layers, which is shown by the horizontal large white arrow.

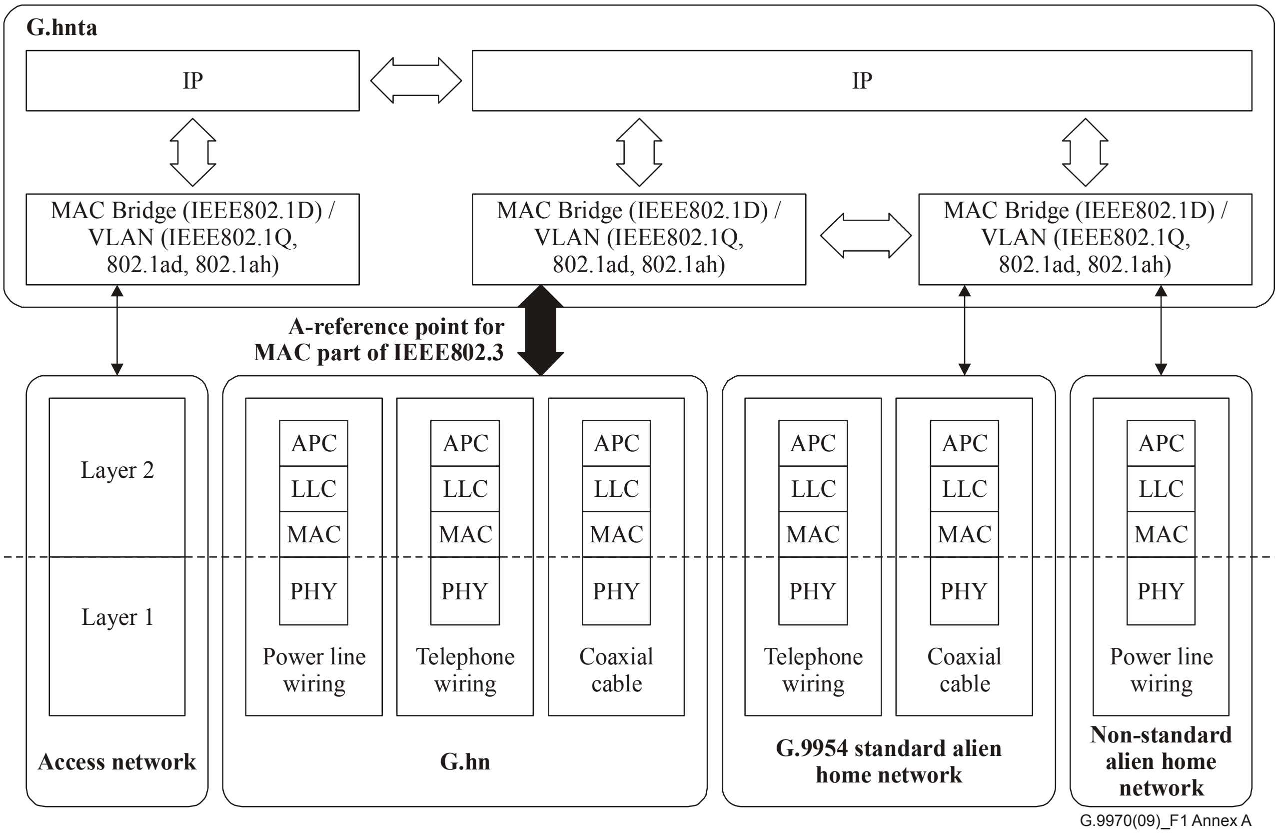


Figure A.1 – Overview of the scope of G.9960 and G.9970

Appendix I

Example applications of the generic home network architecture

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

IPTV traffic is first stored in a primary terminal by its interaction with an IMS or an IPTV head end system and then distributed to a secondary terminal. The following cases use this as an example.

Case 1 shown in Figure I.1: The figure shows flow 1 of Figure 6-9. The AGTF of the AGW terminates the public IP address and then translates it into local IP addresses. While the IP terminal (type a) of the primary terminal terminates the local IP traffic, its application layer device functions (ALDF) terminate IPTV traffic. This IPTV traffic can be distributed to ALDFs of the secondary terminal over a non-IP L3 protocol.

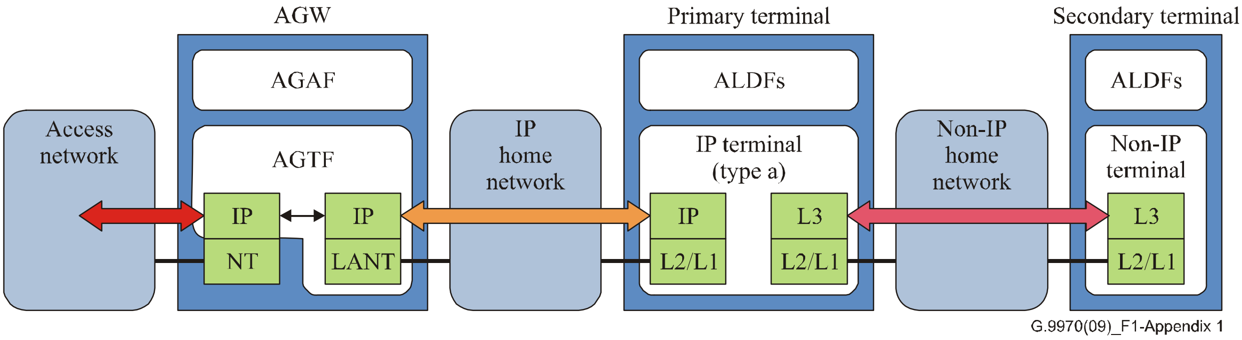


Figure I.1 – Generic home network architecture: Case 1

Case 2 shown in Figure I.2: The figure shows flow 2 of Figure 6-9. This case focuses on the interaction between the two IP terminals, IP terminal (type b) of the primary terminal and IP terminal (type c) of the secondary terminal. The two IP terminals may interact directly with each other in the IP home network, but it is preferable for this interaction to take place via the AGTF, because the AGTF can control the QoS of each IP flow. Specifically, it is assumed that the flow from the head end system travels downstream to other IP terminals, which are not shown in this figure. This downstream flow may be affected by the flow from IP terminal (type b) to IP terminal (type c), unless this latter flow is controlled. The AGTF may control the QoS in such a case, where QoS control may be either IP level or Ethernet level.

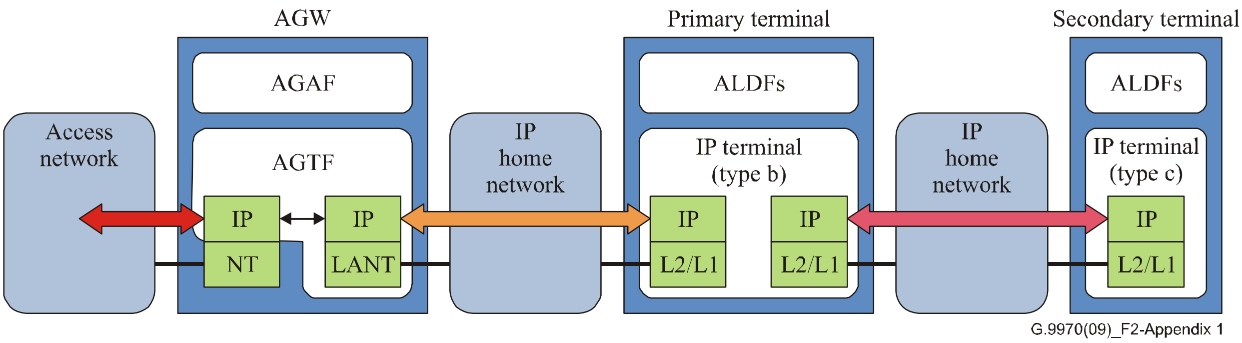


Figure I.2 – Generic home network architecture: Case 2

Case 3 shown in Figure I.3: The figure shows flow 3 of Figure 6-9. As in case 1, the AGTF of the AGW terminates the public IP address and then translates it into local IP addresses. However, a non-IP GW terminates the local IP address and then directly translates it into a non-IP L3 protocol. Therefore, IPTV traffic is terminated at the non-IP terminal of the primary terminal.

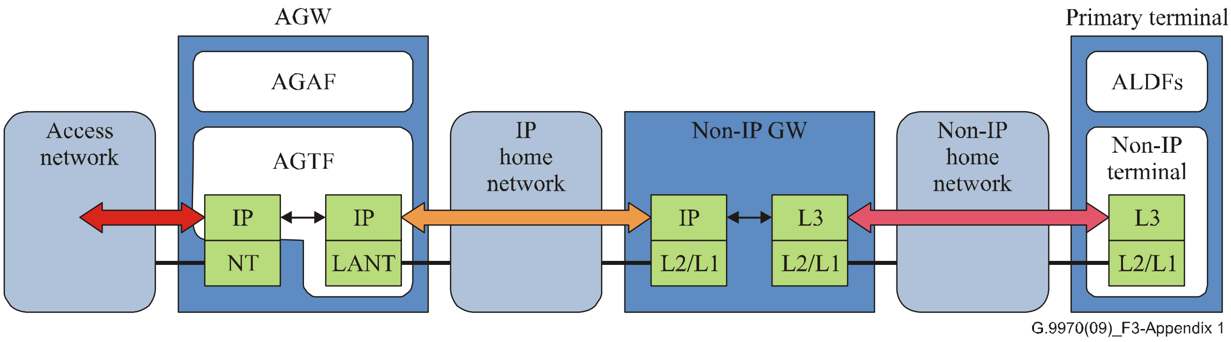


Figure I.3 – Generic home network architecture: Case 3

Case 4 shown in Figure I.4: This is different from case 1 in that the IP terminal (type a) terminates the public IP address rather than the AGTF of the AGW. Note that this case represents case 1 of Table 8-1, where the network provider (NP) assigns IP addresses of the AGW as well as the primary terminal.

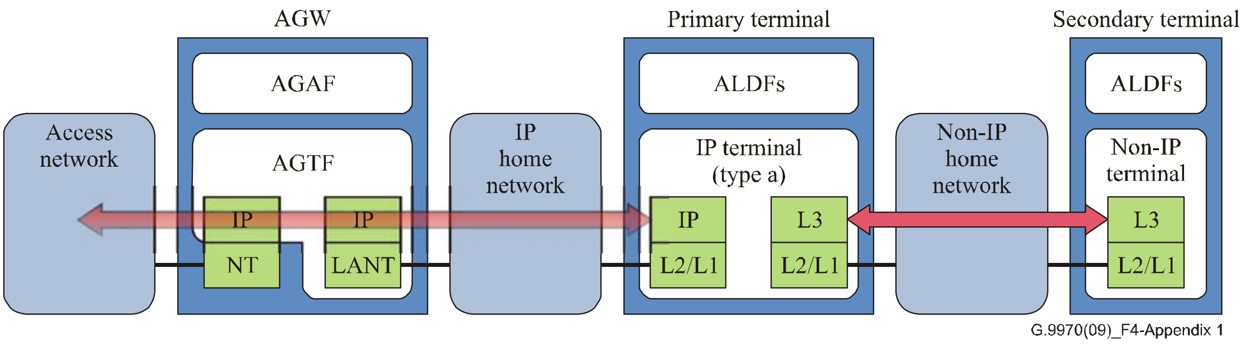


Figure I.4 – Generic home network architecture: Case 4

Case 5 shown in Figure I.5: This is different from case 1 in that the AGTF of the AGW terminates PPP. Therefore, IP packets with local IP addresses in the IP home network are en-/de-capsulated in this PPP. Note that this case represents the cases 5, 6 and 7 of Table 8-1.

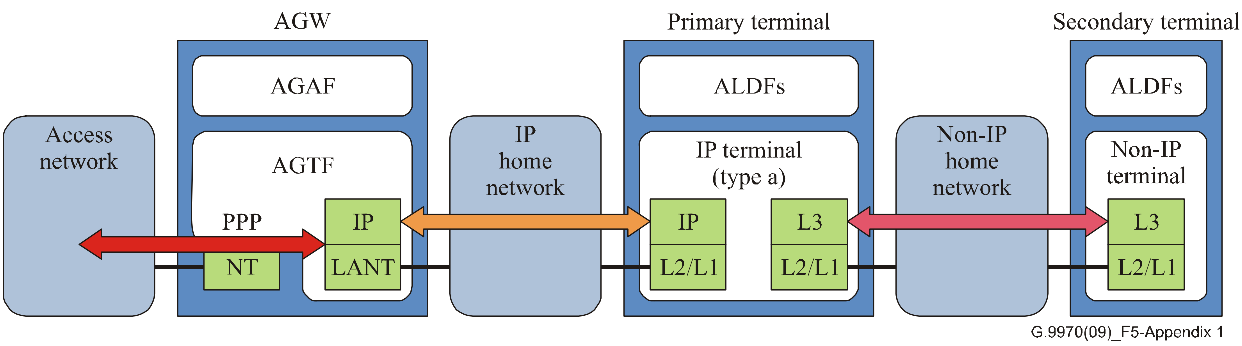


Figure I.5 – Generic home network architecture: Case 5

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