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Technical Report, Type 2

xTR 15045-1: Information technology Architecture for Residential Gateways (ARG)

Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75% of the national bodies casting a vote.

Technical Report 15045-1 was prepared by Joint Technical Committee ISO/IEC JTC 1, Information technology, Subcommittee SC 25, Interconnection of Information Technology Equipment.

Architecture for Residential Gateways (ARG)

1 Scope

The Architecture for Residential Gateways (ARG) is being standardized by ISO/IEC JTC1 SC25.

The ARG provides a framework for identifying critical interoperability interfaces for Home Electronic Systems. The ARG is intended as a "future-proof" architecture for residential gateways and their devices. This Technical Report presents these critical interoperability interfaces from a variety of perspectives:

- Architecture Overview: General discussion of residential gateways.
- Architecture Boundaries: Technical scope, as viewed from several perspectives.
- System Description: Main components of a residential gateway.
- System Addressing Characteristics: How components refer to and communicate with each other.
- Bus Interface Architecture and Layering: A layering approach that supports future capabilities.
- Information Security and Privacy: Security services and components.
- Physical Configuration Architecture: The physical components and connections.

The Technical Report is the first part of a multipart standard.

2 Normative References

This Technical Report incorporates by dated or undated reference, provisions from other publications These normative references are cited at the appropriate places in the text and the publications listed hereafter. For dated references, subsequent amendments to, or revisions of any of these publications apply to that standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

CCITT V.41 Code-independent error-control system

EN 300 402 ISDN - DSS1 protocol - Data link layer

EN 300 403 ISDN - DDS1 protocol - specification for ISDN signalling network layer for circuit mode basic call control.

EN 301 240 Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Point-to-Point Protocol (PPP) interworking for internet access and general multi-protocol datagram transport

EN 50083-1 Cabled distribution systems for television, sound and interactive multimedia signals - Part 1 : Safety requirements

EN 50090-2-2 Home and Building Electronic Systems (HBES) Part 2-2 : System Overview General Technical Requirements

EN 50173 Information Technologies. Generic cabling

EN 60603-7 Connector for frequencies lower than 3 MHz for use with printed circuit boards

ETR 328 Transmission and Multiplexing (TM); Asymmetric Digital Subscriber Line (ADSL); Requirements and performance

ETS 300 001 Attachment to PSTN - General technical requirements for equipment connected to an analog subscriber interface in the PSTN

ETS 300 007 ISDN - Support of packet mode terminal by an ISDN (SAPI 16)

ETS 300 701 Digital Enhanced Cordless Telecommunications (DECT); Data Services Profile (DSP); Generic frame relay service with mobility (service types A and B, class 2)

IEC61883 Consumer audio/video equipment - Digital interface

IEEE1394 IEEE Standard for a High Performance SerialBus", IEEE Std 1394-1995

ISO 8802.3 Information technology -- Telecommunications and information exchange between systems -- Local and metropolitan area networks -- Specific requirements -- Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications

ISO 8802.5 Information technology -- Telecommunications and information exchange between systems -- Local and Metropolitan Area Networks -- Specific requirements -- Part 5: Token ring access method and physical layer specifications

ISO/IEC 8482 :1993/12 Standard for Electrical Characteristics of Generators and Receivers for user in Balanced Digital Multipoint Systems

prEN 301 145 ISDN - DSS1 protocol - Teleaction Bearer Service - protocol (SAPI 12)

prENV 50090-6-4 Home and Building Electronic Systems, HBES : Part 6-4 : Interfaces - Gateway between HBES and Wide Area Communication Networks

RFC 791 Internet Protocol

TBR21 Terminal Equipment (TE); Attachment requirements for pan-European approval for connection to the analog Public Switched Telephone Networks (PSTNs) of TE (excluding TE supporting the voice telephony service) in which network addressing, if provided, is by means of Dual Tone Multi Frequency (DTMF) signalling

TBR3 Integrated Services Digital Network (ISDN); Attachment requirements for terminal equipment to connect to an ISDN using ISDN basic access

TS GSM 02-63 GSM data - Packet data on signalling channel service (PDS)

UTE C 15-100 Low-voltage electrical installations

3 Definitions

3.1 application

Software the runs on the operating system.

3.2 bus

A communication path connects several bus members.

3.3 bus address

An identifier associated with a bus member.

3.4 device

A consumer device in the Home Electronic System (HES).

3.5 device driver

Operating system software for interacting with a device.

3.6 operating system

Controlling software within the Home Electronic System.

3.7 user

Any person who has access to to a home automation system (including service providers).

3.8 Acronyms

- ADSL: Asymetric Digital Subscriber Loop - a high bandwidth service superimposed on analog PSTN lines to the premise
- CLIP: Calling line identification Presentation
- ERG: European Residential Gateway
- GI GIP: Interface - Specific interface to the GIP to which LGI and WGI modules must conform
- GIP: Gateway Internal Protocol - Protocol, Addressing and Data format for interchanging data between the LGI and WGI
- GSM: Global Systeme Mobile - Mobile phone standard
- HAB Home Automation Bus - Any electronic networking system that interconects equipment and devices in the home
- HAE: Home Automation Equipment - Appliances and/or domestic equipment capable of being interfaced to a Home Automation Bus Such equipment may be capable of requesting addresses in the WAN or of being addressed from the WAN via the ERG
- HAI: Home Automation Interface - Interface between the LGI and HGM
- HAI/HAI-RF: Home Automation Interface/Radio Frequency Home Automation Interface
- HBES: Home and Building Electronic System - Any electronic networking system that interconects equipment and devices in the home
- HGM: Home Automation Bus Gateway Module
- HHU: Hand Held Unit - Hand Held computer used to initialise equipment
- ISDN: Intergrated Services Digital Network
- ISN: Interface to Specific Local Area Network
- LAN: Local Area Network capable of carrying voice, data and entertainment services within the premise. LANS may utilise existing mains cabling, telephone wiring, RF or wide bandwidth services such as Fibre Optical Cables, Coax, TP using standard protocols as IEEE1394, ISO 8802.3 etc...
- LGI: LAN Gateway Interface - Functional Module which interfaces the ERG to a Local Area Network
- LI: LAN Interface - Generic interface between LGI and HAI
- LLC: Link layer Control
- MAC: Medium Access Protocol
- MMI: Man Machine Interface

- OSI: Open System Interconnection
- PC: Protocol Conversion
- PIU: Pulse Interface Unit
- PLC: Power Line Carrier
- PSTN: (analog) Public Switched Telephone Network
- PSU: Power Supply Unit
- RU: Remote User
- SIU: Serial Interface Unit
- SLI: Specific Lan Interface
- SP: Service Provider - any organisation or operator which provides a service to or via equipment in the premise (often) from the WAN
- STB Set Top Box - Equipment which allows a TV to receive cable, satellite and digital broadcasts
- SWI: Specific WAN Interface
- TP: Twisted Pair
- WAN: Wide Area Network capable of carrying voice, data and entertainment services to and from the premise. WANs are external to the premise and may be telecommunication networks, data networks or entertainment networks such as Cable, or Satellite.
- WGI: WAN Gateway Interface - Functional Module which Interfaces the ERG to a Wide Area Network

4 Architectural Overview

The Residential Gateway (RG) is a physical or logical device that provides a common, secure, intelligent interface between the service access distribution networks and the consumer's in-home networks and devices. The interface and mediation capabilities of the RG should enable independent evolution of the technologies and physical media used in the distribution network and in the home. This attribute of the RG should make evolution and innovation in both the service delivery and consumer arenas feasible. It should enable service providers and application vendors to offer a variety of multimedia services while masking the complexity of the service access from the consumer.

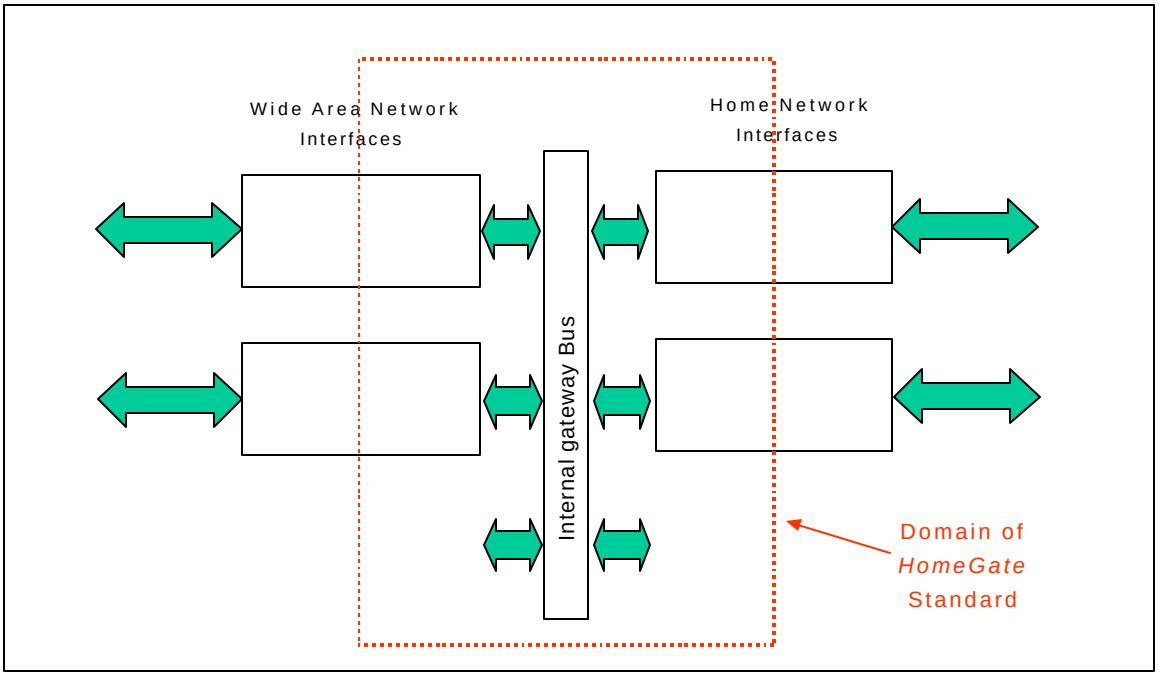
One approach torwards residential gateways is commonly called a "centralized" residential gateway, which contains the bulk of its functionality in a single box. However, many of the features, functions, and operational parameters would also be directly applicable to a "distributed" residential gateway, which distributes the functionality of the residential gateway across a number of boxes in physically separate locations such as in the attic for broadcast antenna signals and the garage or basement for telephony and cable TV.

The Residential Gateway is an internetworking device that provides a common termination interface, mediation facility, and enabling mechanism between the service access distribution networks and those of the consumer's in-home networks and devices. The intelligent termination interface of the RG uncouples the technologies and physical media of the access networks from those used in the premises and vice versa. Through an open-ended architecture that is processor controlled and uses plug-in devices for services and features, the RG provides a platform upon

which service providers and application vendors can offer a variety of new and creative services while masking the complexity of the service from the consumer. In addition, the RG provides an opportunity for remote management and maintenance. Residential Gateways isolate home networks from the details of access systems' physical layer through network layer details.

5 Architecture Boundaries

The following diagrams illustrate the boundaries of the Architecture for Residential Gateways.



Perspective #1: Internal Gateway Bus.

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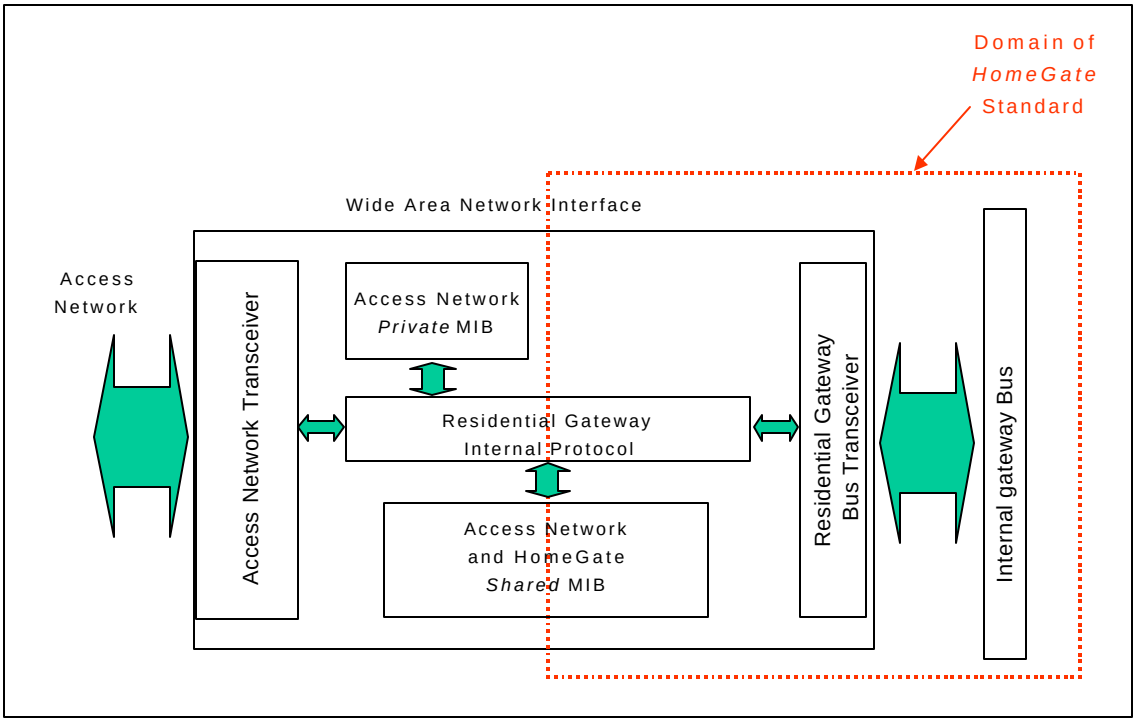

Perspective #2: Interfaces to the Internal Gateway Bus.

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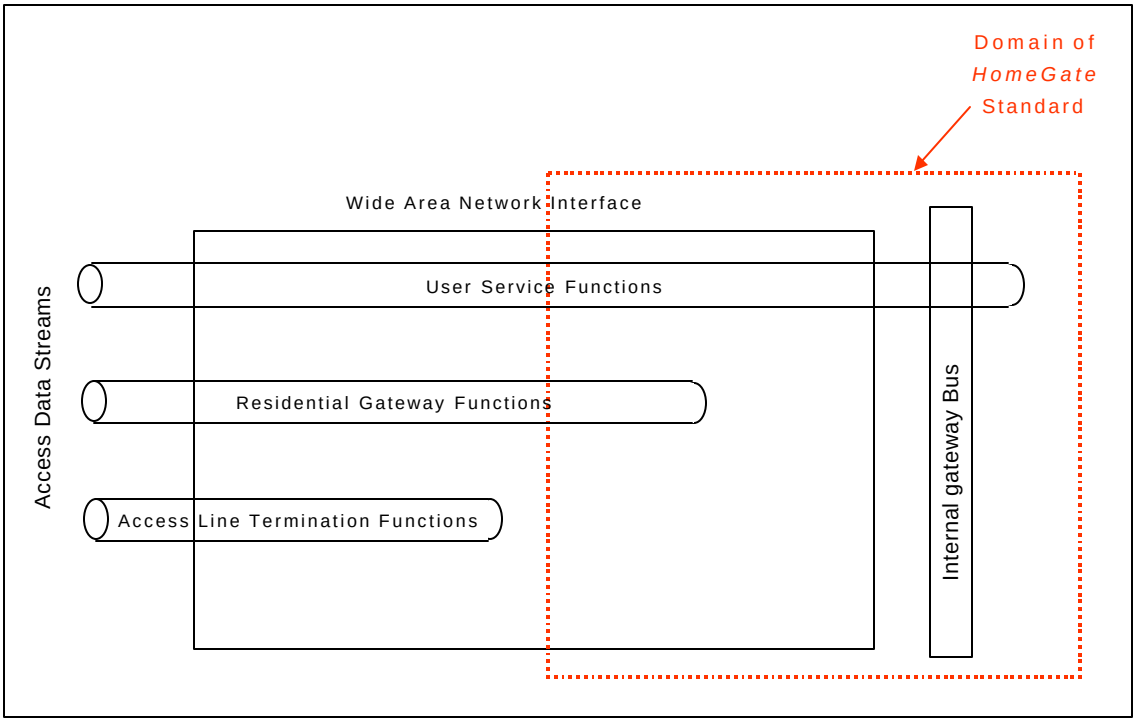

Perspective #3: data stream terminations.

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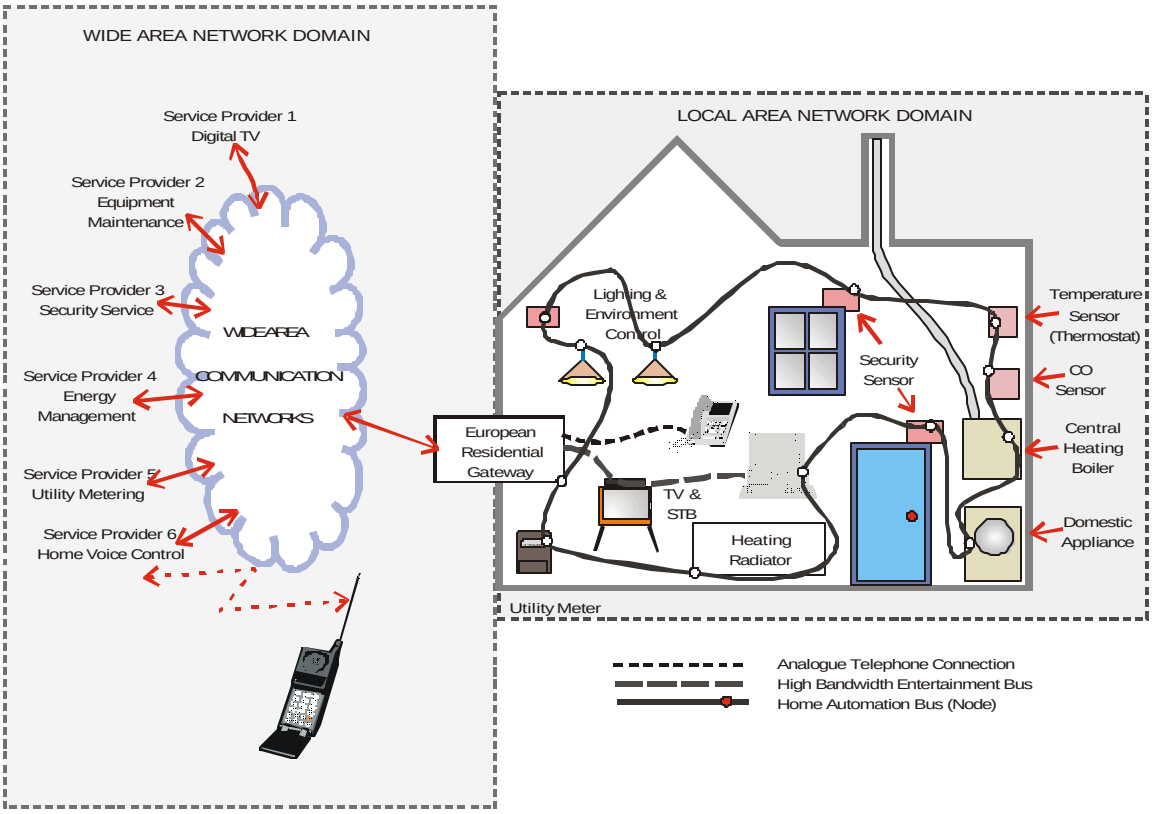
6 System Description

6.1 Service Description

The Residential Gatway (RG) is a necessary component of the Home Electronic System. It allows communication between devices within the premise and systems, service providers, operators and users in the external environment outside the premise. The RG enables Service providers to provide teleservices such as telecare, home appliance control and pre-emptive maintenance, remote metering and security monitoring; other service providers may provide energy management, entertainment services or information. The RG connects the remote user with the equipment, appliance or service in the home.



Service provision for home automation systems.

6.2 Gateway Functions

The RG acts as a connection between the external world outside the premise and networks within it. Operators, service providers and other systems communicate with appliances, equipment and systems attached to local networks within the home over wide area communication networks and through the gateway. Thus the gateway must

- Route data and voice communication securely between the WAN and LAN
- Ensure only the correct data is allowed in and out of the premise (Firewall property)
- Convert between internal and external addresses
- Convert protocols and data
- Interface to one or more WANs
- Interface to one or more LANs

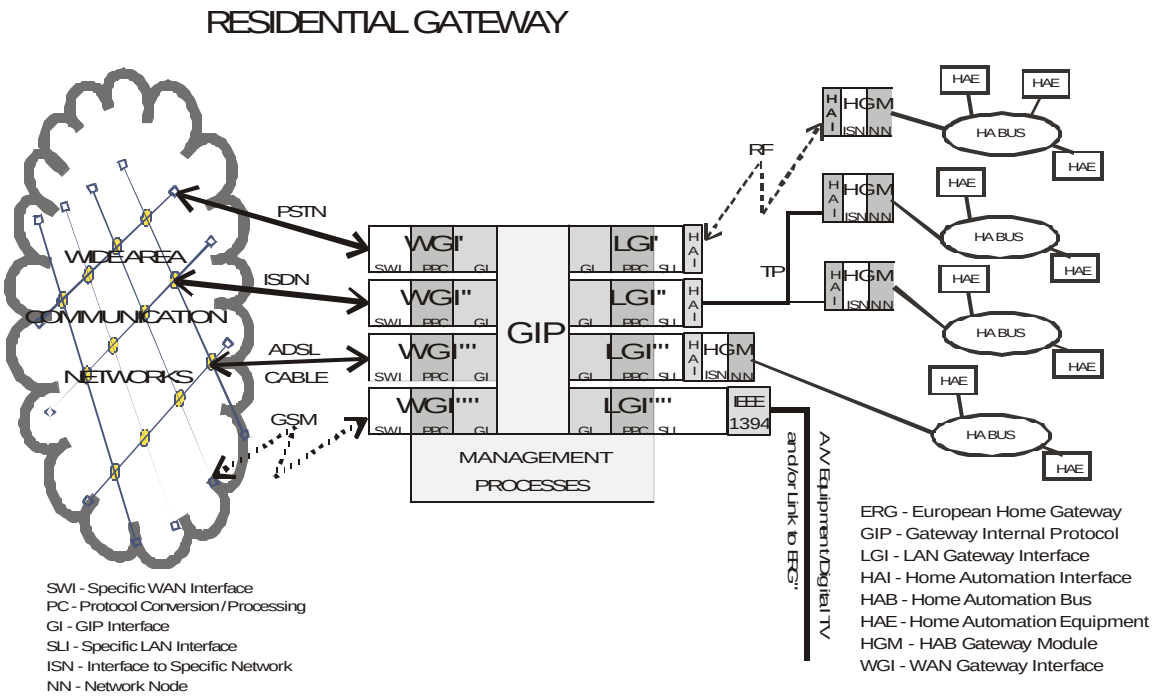


Diagram of the Residential Gateway

6.2.1 Standardized Elements of Gateway

Within the domains of the Residential Gateway, although in many cases the use of particular elements may be optional, some elements are to be fully compliant to this standard where they are used.

Particular elements which must be standardised by this standard are: the Interfaces to the GIP which include the information within the WGI and the LGI to ensure a standardised presentation to the GIP interface, the bus of the GIP, and certain management processes of the GIP.

In almost all cases where the WGI and LGI interface to WANs and LANs it will be the responsibilty of the manufacturer to ensure that these interface provide presentation to the standards of that WAN or LAN.

6.3 Elements of Gateway

A gateway consists of an interface to a WAN and an interface to a LAN between which there is necessary conversion of protocols, addressing and data handling. The RG has the following major elements:

- WAN Gateway Interface (WGI)
- Gateway Internal Protocol (GIP)
- LAN Gateway Interface (LGI)
- Management Processes

These elements may be modular and provided in software as full implementations or as subsets of the full implementation or as physical interchangeable modules in which case the interfaces to and of the GIP must conform to the standard specification of the GIP.

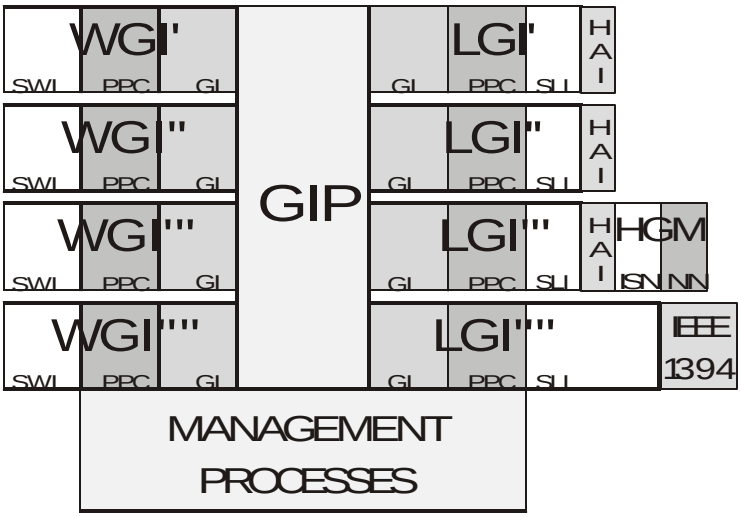


Diagram of components of Residential Gateway.

6.4 Details of Elements

6.4.1 WAN Gateway Interface (WGI)

The WAN Gateway Interface (WGI) consists of the following elements:

- An interface to a Specific WAN (SWI) which conforms to the standards and requirements for connection to that wide area network for the communication of voice, data or entertainment. It shall conform to the protocols, data structures and addressing conventions of that network.
- A system for processing and converting the voice or data to and from the WAN into a format which conforms to the protocols defined for the interface to the Gateway Internal Protocol. In order to do this the Processing and Protocol Converter (PPC) will access tables and data which are specific to the WAN and for the GIP such that it has knowledge of addressing and formats of that WAN. It is the responsibility of the PPC to ensure that data, protocols and addresses are presented to the WAN and the GIP in the correct format.
- An Interface to the GIP (GI) which conforms to the requirements (or a subset of the requirements) of the GIP Common Interface

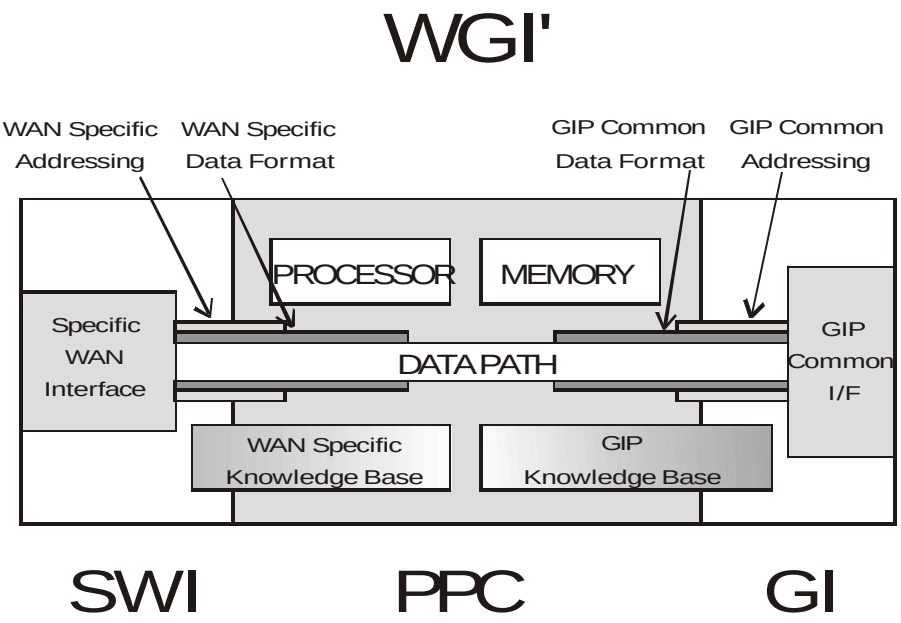


Diagram of WAN Gateway Interface showing subcomponents and functions.

6.4.2 Gateway Internal Protocol (GIP)

The Gateway Interface Protocol may consist of the following elements:

- A common interface to WGI modules
- A bus connecting interfaces to WGI modules to LGI modules
- A common interface to LGI modules
- A mechanism for routing data between WGI and LGI modules (and between LGI and other LGI modules)
- Management processes to control the activity of the GIP and of modules attached to it.

Optionally:

- A Firewall to prevent unauthorised access or egress of data to or from the premise
- Security or encryption

Note: the GIP may function in the European Residential Gateway at a number of levels. The level illustrated is the fully specified modular version and may be realised in hardware, firmware and software. Subsets of this version are allowable where the GIP is realised in firmware and software alone or even where there is direct connection between elements of WGI and LGI.

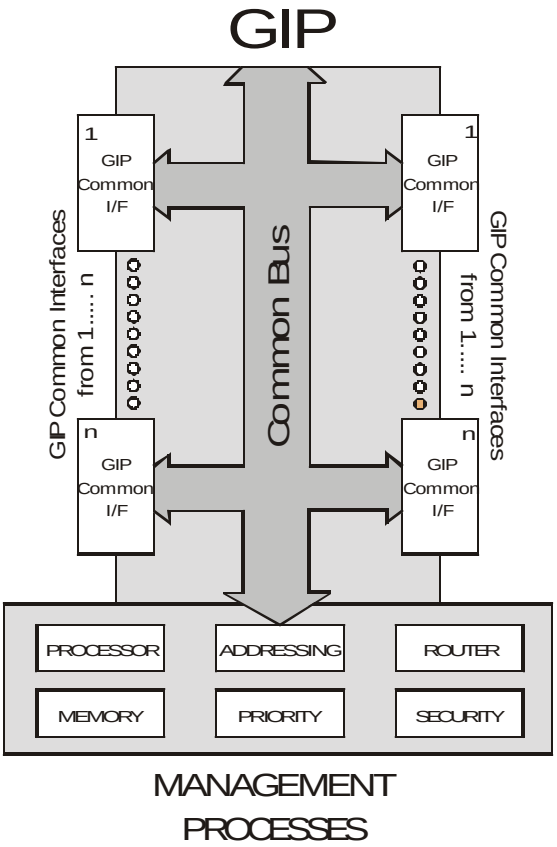


Diagram of Gateway Internal Protocol showing its subcomponents.

6.4.3 LAN Gateway Interface (LGI)

The LAN Gateway Interface (LGI) consists of the following elements:

- An Interface to the GIP (GI) which conforms to the requirements (or a subset of the requirements) of the GIP Common Interface
- A system for processing and converting the voice or data to and from the LAN into a format which conforms to the protocols defined for the interface to the Gateway Internal Protocol. In order to do this the Processing and Protocol Converter (PPC) will access tables and data for the GIP and the specific LAN such that it has knowledge of addressing and formats of that LAN. It is the responsibility of the PC to ensure that data, protocols and addresses are presented to the LAN and the GIP in the correct format.
- A Specific LAN Interface (SLI) which conforms to the standards and specifications for the communication of voice, data or entertainment service for that LAN. It shall conform to the protocols, data structures and addressing conventions of that network.

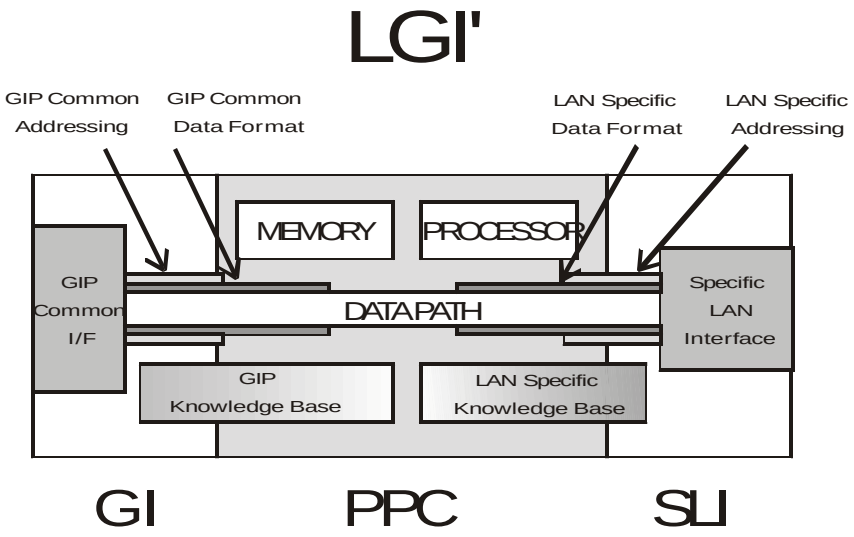


Diagram of LAN Gateway Interface and subcomponents.

6.4.4 Home Automation Interface (HAI)

For this standard an interface is defined to interchange data, protocols and addresses between the LGI and the HGM which directly connects to the HBES Home Bus. This interface defines the message format, priorities and addresses for equipment on the Home Bus required to communicate with addresses in the WAN and for addresses in the WAN to address equipment on the Home Bus. The HAI may be a direct connection with the HGM, may use a standard cabling method to connect with the HGM or may use RF. The specification for the HAI defines each of these options.

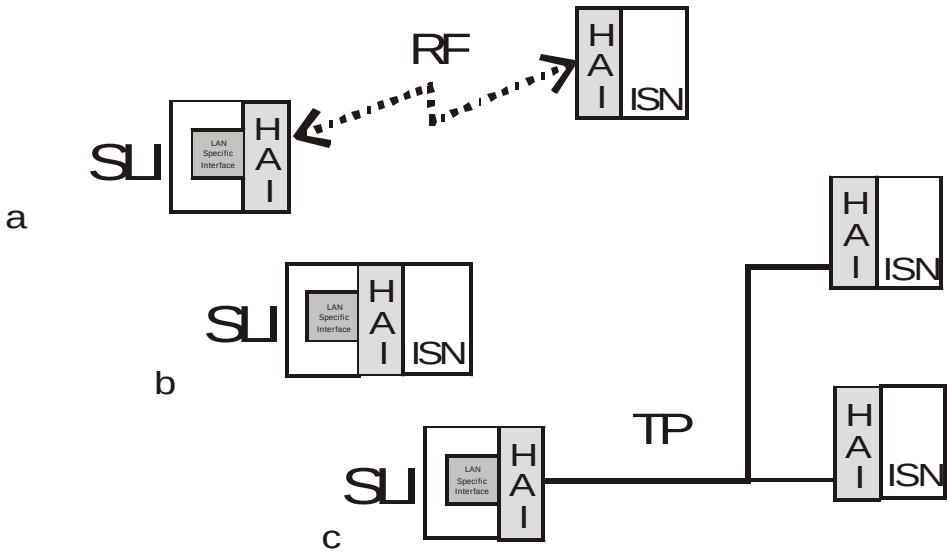


Diagram of HAI with subcomponents. Element A: HAI-RF using RF for communication with HBES. Element B: HAI direct coupling to HBES. Element C: HAI using TP to node on HBES.

6.4.5 Home Automation Bus Gateway Module (HGM)

For this standard a module is defined which interfaces the HAI to a node on a specific home automation network type. It consists of two parts:

- An Interface to Specific Network (ISN) which ensures that the protocols, addresses of the Home Automation Network are presented to the HAI in the correct format and vice versa.
- A Network Node (NN) which is a standard node for that Home Network.

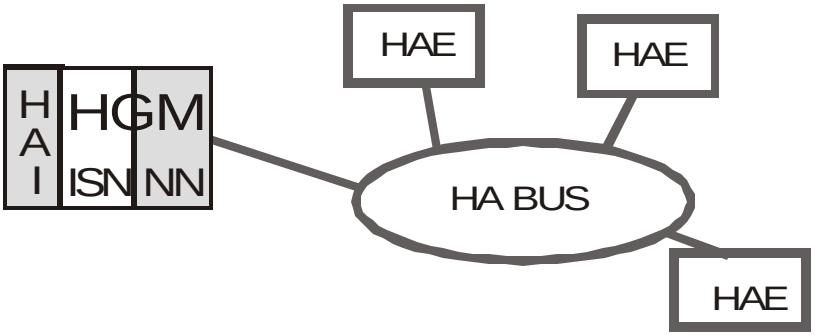


Diagram of HGM with subcomponents.

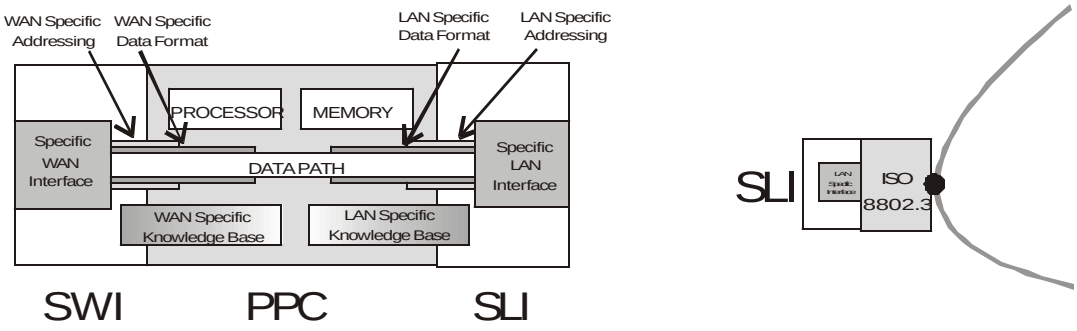
6.4.6 Configurations of RG

The RG may consist of a simple 1:1 integral box configuration to an Many WAN to Many LAN modular configuration and may interface to any Local Network such as Ethernet, IEEE1394 or any of several Home Busses

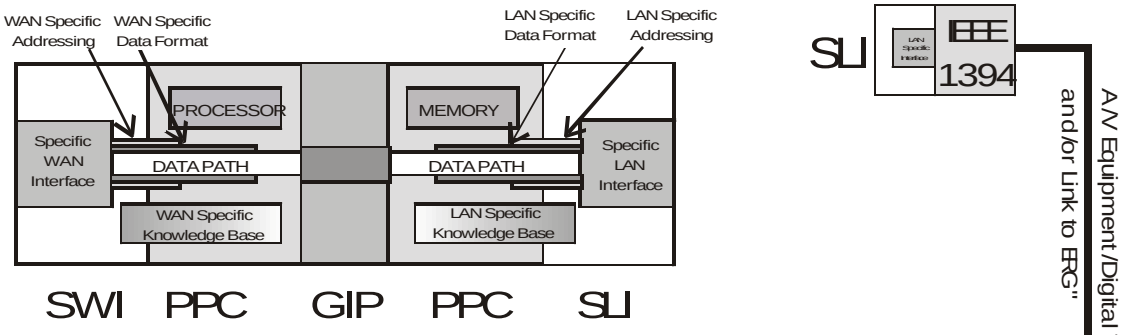
It is intended that the RG standard shall be modular and that elements such as the WGI and LGI can be merged (as in the case of a simple WAN:LAN gateway) and elements can be selected as required as the complexity of the gateway increases.

Wherever elements are used, they and their interfaces must conform to the protocols, addressing and data formats specified in the standard.

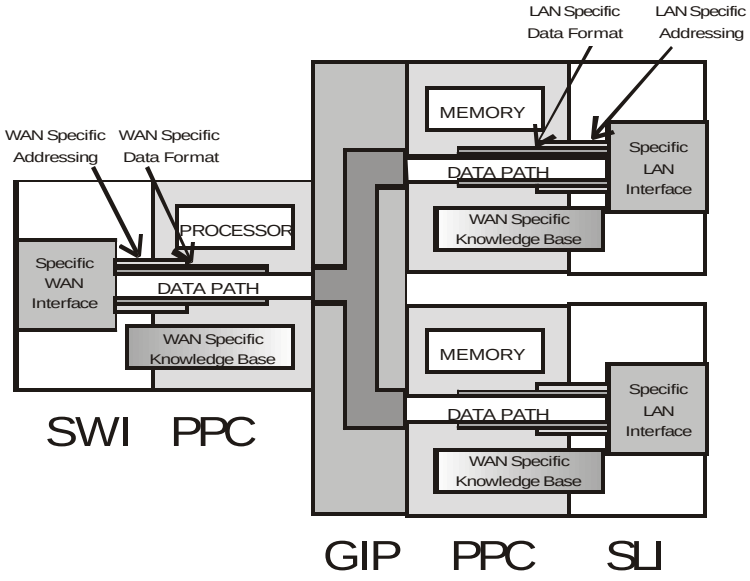
Some examples of gateway configuration are shown below.



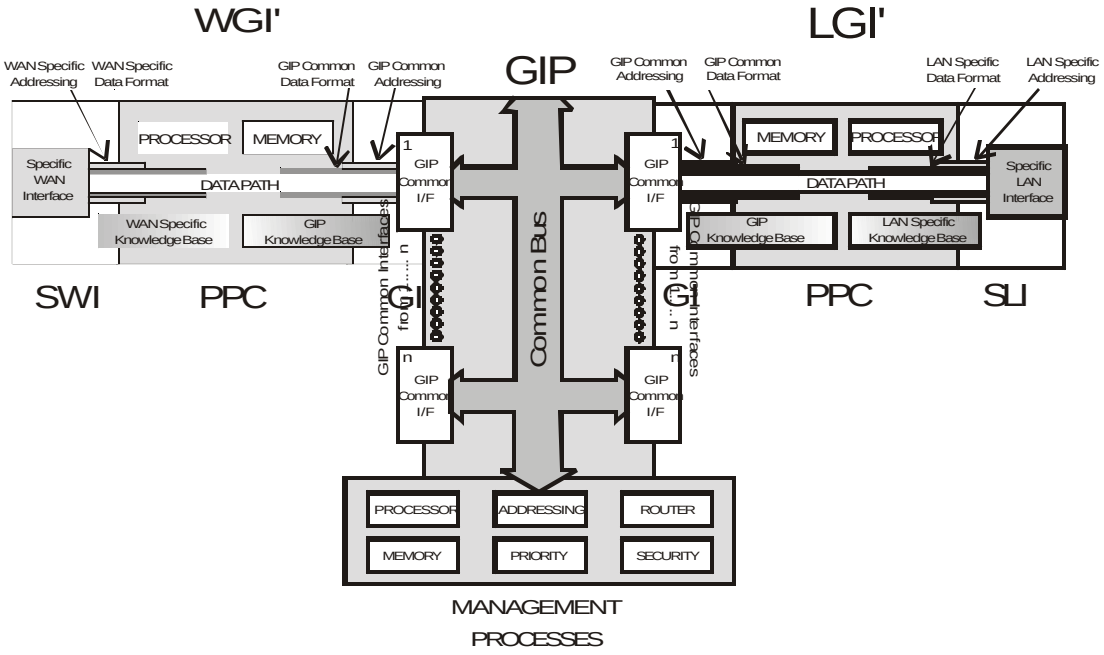
Simple 1:1 configuration direct conversion
GIP not implemented



Simple 1:1configuration with GIP



1:Many configuration GIP required

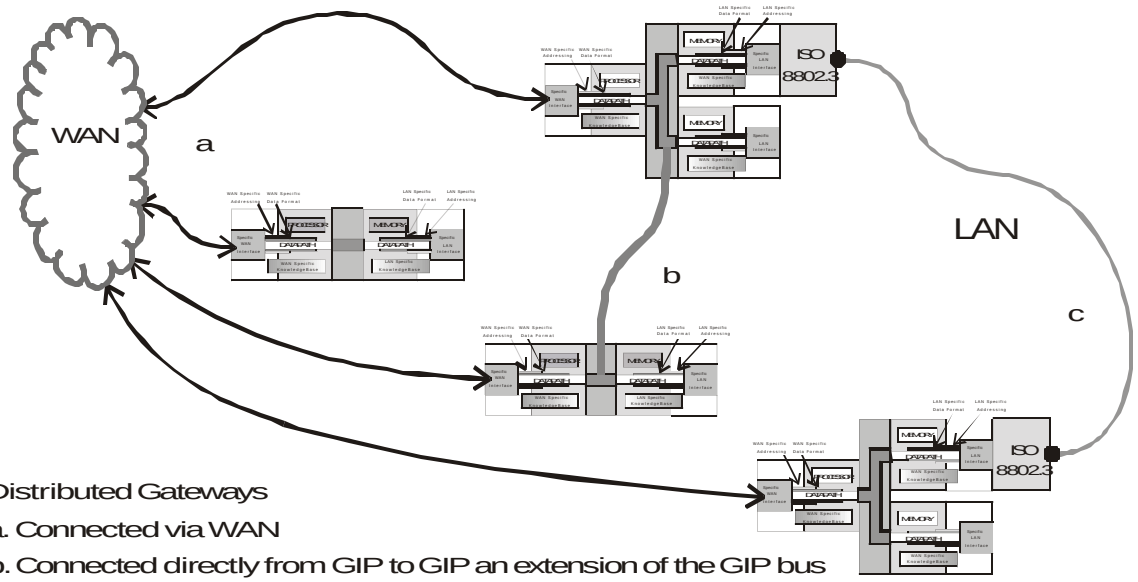


Many:Many modular configuration

Some configurations of the European Residential Gateway and potential connections to other LAN networks

6.5 Gateway Types

Although a gateway may be designed, manufactured and used as a dedicated device, it is entirely possible for it to be part of entertainment or computing equipment; thus a RG could form part of a TV Set Top Box (STB) or be integrated into a Personal Computer or alternatively the RG could be a centralised STB or have the functions of a PC. This is because these types of equipment are likely to be connected to Wide Area Communication Networks and they have significant processing power to carry out the functions of a gateway or vice versa.



Distributed Gateways

a. Connected via WAN

b. Connected directly from GIP to GIP an extension of the GIP bus

c. Connected via LAN (Ethernet or IEEE1394 or Home LAN

Diagram of distributed gateways.

6.6 Domains Of Gateway

For the purposes of definition and documentation the RG is divided into domains which correspond to the major functional elements of the gateway and the documents of this standard See Figure 10.

Note: It is not a requirement of this standard that all domains be applied to gateways conforming to the Residential Gateway, but where they are used, the specifications, requirements and definitions must comply with the those set out in this standard.

6.7 Home Network

A home network may be described as any electronic system in the premise where two or more devices are interconnected and are to some extent interdependent on each other through the use of the interconnection.. Thus a network can consist of: a meter which can provide data of which tariff applies currently and an appliance which will use this data to optimise the cost of its operation, or: it can have many nodes which control security systems, the level of lighting, the white goods and entertainment systems in the home. Since many devices in a complex home network will require to communicate with the wide area a home gateway is a necessary node for such a network.

6.8 Wide Area Networks

Wide area networks are characterised by being in the public domain and being operated by professional organisations such as telecommunications operators. Examples are:

- The (analog to the premise) Public Switched Telephone Network.
- The Integrated Services Digital Network
- Cable Networks
- The Internet
- Mobile Networks

and services carried by public service telecommunication operators such as ADSL or Cable Modems. From the viewpoint of home networked equipment, service providers and their systems are attached to Wide Area Networks.

7 System Addressing Characteristics

For the purpose of this Technical Report, it is necessary to define the way in which voice, data and messages are routed between sytems, service providers and devices in wide area networks and systems, appliances and equipment in local area networks.

7.1 Messaging Requirements

Messages, frames or packets of data which pass through the gateway need to be identifiable and must carry information which enables the gateway to direct them to the correct network and for the network to to deliver them to the correct address in that network. This applies to messages travelling, both from the WAN and from the LAN. Therefore, for any combination of networks a packet of data must have:

- Information which delivers it to the gateway (the address of the gateway in terms of the WAN or of the LAN - i.e. a telephone number, IP address etc.. or a node address on the LAN).
- Information which allows the gateway to recognise it as a valid message to be transferred through the gateway. i.e. a valid telephone number (which is recognised by an addressing table at the HGM or LGI) or a valid originator's address and valid LAN node address (which is recognised by an addressing table at the WGI or GIP)
- Information which instructs the WGI or LGI to open a connection path through the gateway to the address on the network.
- Information which allows the GIP to route the information to the correct network and to ensure that the information satisfies the requirements of any firewall or priority within the RG.

Although the requirements are identical for messages travelling in either direction, the way in which they are handled is dependent on the characteristics of the networks either side of the RG.

Typically messages can be graphically represented by the following diagram:

*** INSERT DIAGRAM HERE ***

7.2 WGI Functional Description

This document describes the functions and architecture of the Interface to Wide Area Networks (WGI) It consists of three functions. Interfacing to a specific Wide Area Network. Conversion of protocols, data format and addresses to conform to the specification of the Residential Gateway (and in particular the GIP) (Note: Until the GIP has been defined, this document will also describe how this interface will interface to the HAI).

7.3 GIP Functional Description and Specification

This document describes the functions, architecture, protocols and addressing required for the Gateway Internal Protocol. This element of the RG provides a common interface between software, firmware or hardware external interface modules incorporated or attached to the RG. This common interface is responsible for routing, addressing, and security functions of the gateway.

7.4 LGI Functional Description

This document describes the functions and architecture of the Interface to Local Area Networks (LGI) It consists of three functions. Interfacing to a specific Local Area Network. Conversion of protocols, data format and addresses to conform to the specification of the Residential Gateway (and in particular the GIP) (Note: Until the GIP has been defined, the WGI document will cover the interfacing to the HAI).

7.5 HAI Specification Document

This part defines an API between HBES and telecommunications networks. The API has to allow for the data transfer and addressing procedures between the bus protocols and the support network protocols to be described. It shall be precise enough to serve as a specification in the development of the RG (LGI/GIP/WGI) and home automation appliances (Note: when the GIP and LGI documents are completed, the HAI will interface with the LGI and for the purposes of this standard, will view the WGI/GIP/LGI elements as a single block).

7.6 HGM Functional Description

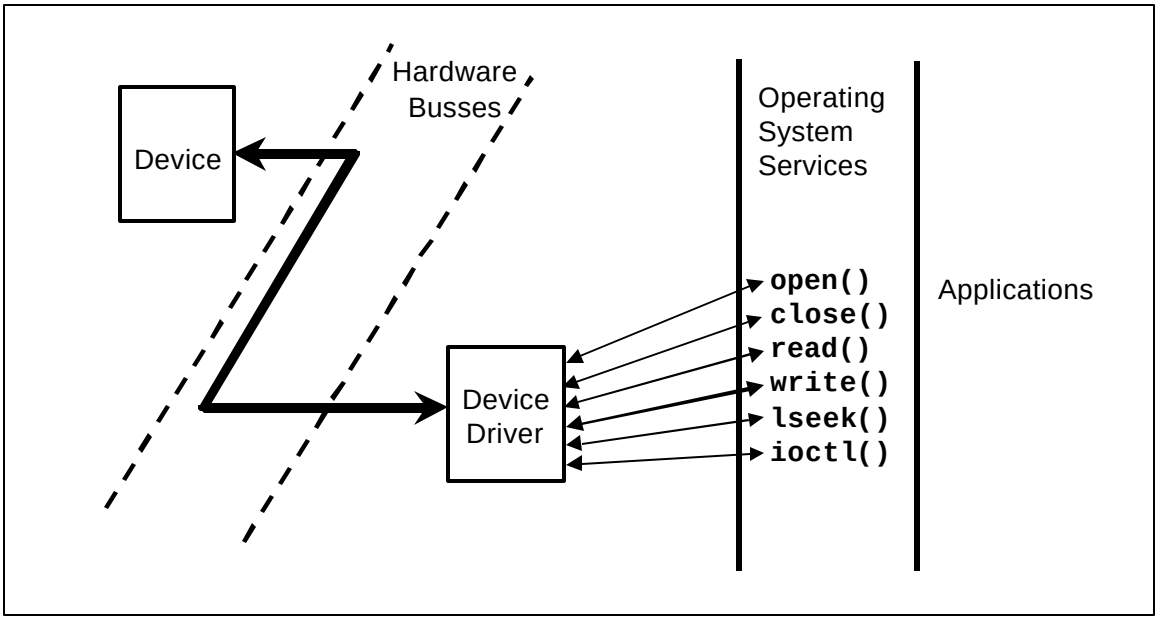
The HGM interfaces to specific equipment connected to the HBES and connects to the HAI.

8 Bus Interface Architecture and Layering

The Bus Interface Architecture is defined as five layers:

- Layer 1: Device. A consumer device in the Home Electronic System.
- Layer 2: Hardware Busses. One or more communication busses that interface the Device to the Residential Gateway.
- Layer 3: Device Driver. The operating system software that interfaces the Operating System Services to the hardware interface (usually, Hardware Busses).
- Layer 4: Operating System Services. The services provided by the operating system that are common to all Devices accessible by the Residential Gateway.
- Layer 5: Applications. Software applications that perform some function, including accessing one or more Devices.

The following diagram depicts the five layers of the architecture.



8.1 Layer 1: Device

The Device is connected to the Residential Gateway via one or more communication busses. The Device is operated via Device Messages. The Device Messages, their timing, and their interactions may vary from Device to Device. Device Messages may flow to or from the Device.

8.2 Layer 2: Hardware Busses

The Hardware Busses are or more communication busses that communicate Device Messages to/from the Device. If there is more than one Device attached to the Residential Gateway, the Hardware Busses may provide shared access (a traditional "bus"), exclusive access (e.g., a "switch" or private connection), some combination, or some other type of access. Hardware Busses that support more than one Device shall provide an Address mechanism to distinguish one Device from another.

8.3 Layer 3: Device Driver

The Device Driver is the software interface to the operating system. Typically, Device Drivers are specialized for or specific to the Device. the Device Drivers shall use the Uniform Device Interface (UDI), as specified in "http://www.sco.com/udi".

8.4 Layer 4: Operating System Services

The following services shall be provided as Application Programming Interfaces (APIs).

8.4.1 Open service

The "rg_open" service associates a handle with the device for further communication.

8.4.1.1 C binding

```
int rg_open(const char * name, int mode)
```

A Device named by name is opened according to mode mode (e.g., read-only, write-only, read-write). A handle shall be returned that describes the newly established connection to the Device.

8.4.2 Close service

The "rg_close" service disassociated a handle with the device.

8.4.2.1 C binding

```
int rg_close(int handle)
```

The connection to a Device that is described by handle is terminated.

8.4.3 Read service

The "rg_read" service receives messages or octets from the device(s) associated with the handle.

8.4.3.1 C binding

```
ssize_t rg_read(int handle, void *buffer, size_t octet_count)
```

Reads data from the connected Device handle to the buffer pointed to by buffer for up to octet_count octets.

8.4.4 Write service

The "rg_write" service sends messages or octets to the device(s) associated with the handle.

8.4.4.1 C binding

```
ssize_t rg_write(int handle, void *buffer, size_t octet_count)
```

Writes data to the connected Device handle from the buffer pointed to by buffer for up to octet_count octets.

8.4.5 Seek service

The "rg_seek" service performs device positioning operations.

8.4.5.1 C binding

```
off_t rg_seek(int handle, off_t offset, int whence)
```

Changes the current read/write position of the Device to offset. If whence is 0, offset is relative to the beginning of the Device (i.e., an absolute position). If whence is 1, offset is relative to the current position. If whence is 2, offset is relative to the end of the Device.

8.4.6 Ioctl service

The "rg_ioctl" service performs device controling operations.

8.4.6.1 C binding

```
int rg_ioctl(int handle, int request, ... /* args */)
```

Performs the I/O control operation request on the connected Device handle. Some operations may require additional parameters (arguments).

8.4.7 Relationship to POSIX

The Operating System Services are intended to conform to open, close, read, write, lseek, and ioctl in the POSIX.1 standard (ISO-IEC 9945-1).

8.5 Layer 5: Applications

The Applications use the Operating System Services for accessing the Devices. No other requirements are imposed on Applications.

9 Information Security and Privacy

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10 Physical Configuration Architecture

This section contains specifications pertaining to the physical attributes and low-level electrical characteristics of the residential gateway.

10.1 Components

The Residential Gateway is comprised of an enclosure, plug-in modules, and an Internal Digital Interface (IDI), all arranged to accommodate the plug-in modules. The Internal Digital Interface (IDI) shall be based on the Peripheral Component Interconnect (PCI) local bus. Figure 1 shows the logical arrangement of these components. These specifications focus on the centralized residential gateway, which houses all of the logical components in a single physical enclosure. However, ther is no intention of precluding distributed residential gateway architectures. The RG components may be physically located in separate locations, and then they are only logically arranged as shown in Figure 1.

The plug-in modules shall, at a minimum, comprise:

- Access Gateway Modules (AGMs) designed to terminate and mediate the associated external access networks. The AGMs implement the functions of the network interface units.
- Premises Network Modules (PNMs) designed to terminate the in-home networks technologies and services.

Additional plug-in modules called Service Modules (SMs) may be supported to provide specialized services or to supplement the features and capabilities of the RG. The functionality and interoperability of the plug in units and the core processes and integrity of the RG are to be controlled by an operating system (OS) and one or more central processing units.

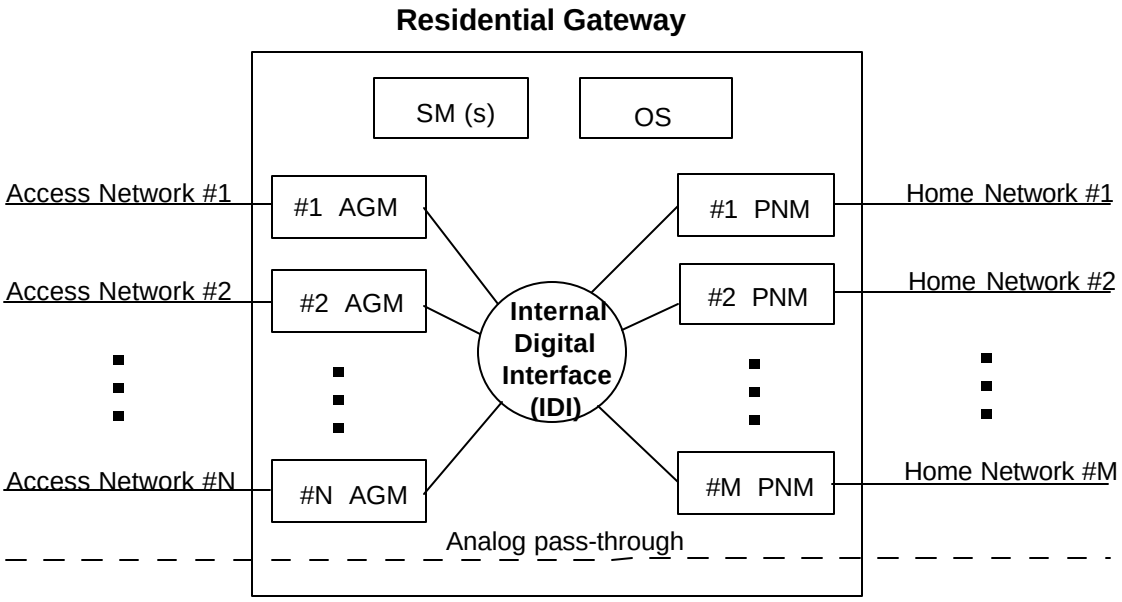

Figure x. Logical configuration of a Residential Gateway, showing the relationship among it's components: Access Gateway Module (AGM), Premises Network Module (PNM), Service Module (SM), Operating System (OS), and Internal Digital Interface (IDI).

10.2 Internal Digital Interface (IDI)

The residential gateway's internal digital interface (IDI) shall conform to the The Peripheral Component Interconnect (PCI) Local Bus Specification Revison 2.2, as written by the Peripheral Component Interconnect Special Interest Group (PCI SIG).

Either the Personal Computer Memory Card International Association (PCMCIA) "PC Card" standard for hot insertion and removal; or the PCI Hot-Plug specification as defined in the PCI Local Bus Specification Revison 2.2, shall be supported by the residential gateway's IDI. PCI Hot-Plug provides the ability to insert and remove PCI adapter cards without having to shut the system down. PCI Hot-Plug allows for several implementations, including Hot Replace, replacing adapter cards in “hot systems”; Hot Upgrade, upgrading existing adapter cards with new versions of cards and drivers; and Hot Expansion, adding previously uninstalled cards and associated driver software into the system.

The PCI specification supports bus mastering. There may be more than one bus master, but there is only one bus arbiter who decides which of all the requesting bus masters will be granted use of the PCI bus. The residential gateway shall contain the functionality of a PCI bus master and a bus arbiter.

10.3 Plug-in Modules

The plug-in modules (AGMs, PNMs and SMs) provide the necessary flexibility to address the ongoing technology evolution in the service delivery and consumer products arena. Because the plug-in modules may be installed by a low-level technician or by the resident, the form factor for the devices should be rugged, consumer friendly, and plug-n-play capable. The plug-in modules shall be based on open industry standards to insure interoperability of modules provided by a number of suppliers. All plug-in modules shall be connected by a connector such that they can be inserted and removed without undue effort and with no special tools. Plug-in modules may require the use of a cable or dongle to interface with external associated media or ancillary apparatus.

10.3.1 Access Gateway Modules

The Access Gateway Modules (AGM) shall be specific to each service delivery technology and shall terminate the access at standard physical and electrical interfaces. Some AGMs may incorporate special equipment (e.g., antennas, transceivers) needed on customer premises; and some may be physically divided between internal and outdoor chassis elements for environmental or service delivery reasons. In order to locate an RG indoors, simple network interface (NI) functions such as legal demarcation and electrical protection are allowed at locations other than in the RG. The NI may be located outdoors with the RG located indoors. A short cable can connect the NIs to the RG.

The types of service delivery technologies foreseen at this time include but are not limited to:

- Twisted pair, carrying POTS, ISDN, or digital subscriber line (DSL) modulations.
- One or two-way analog or digital coaxial cable, frequency divided into channels. Currently this medium is primarily used for video broadcast and may also be used for high-speed data, voice, and digital video.
- Fixed wireless loop, narrowband media using analog or digital technology related to cellular, PCS, MMDS and others.
- Direct broadcast satellite, including a satellite dish and other special video reception equipment including satellite or terrestrial uplinks.
- Broadband microwave systems such as multi-Gigahertz, terrestrial or satellite cellular technologies.
- Optic fiber networks, carrying high-bandwidth, multi-wavelength analog and digital applications.
- Powerline networks, including energy management and information services.

10.3.2 Premises Network Modules

The Premises Network Modules (PNMs) shall be specific to each in-home network and shall terminate the associated network at standard physical and electrical interfaces. Some PNMs may incorporate special equipment (e.g., antennas, transceivers) needed on customer premises.

The kinds of customer premises systems/networks foreseen at this time include but are not limited to:

- Twisted pair, carrying voice and information services, as well as LAN and home automation applications.
- Coaxial cable, carrying one- or two-way, analog or digital services, frequency-divided into channels. Currently this medium is primarily used for video broadcast and may also be used for high-speed data, voice, and digital video.
- In-home fixed wireless network, narrowband media using analog or digital technology related to micro-cell and 900 MHz.
- Infrared networks, carrying services such as home security, remote control and gaming.
- Optical fiber networks, carrying high-bandwidth analog and digital applications.
- Powerline networks, including control, energy management, and information services.

The premises network modules should employ technology and form factors as specified in the Personal Computer Memory Card International Association (PCMCIA) "PC Card" standard. Premises network modules that support relatively high bandwidth services should comply to the

PC Card CardBus standard. CardBus uses PCI's 32-bit data path, and operates at PCI local-bus speeds of up to 33 MHz.

10.3.3 Service Modules

The Service Modules (SMs) are application specific to expand Residential Gateway services. As such they are developed to meed the requirements of these applications. Applications envisioned at this time include:

- Enhanced RG management
- In-home network management
- Directory services
- Data storage
- Specialized services such as TDD and calling number ID display.
- Residential "PBX"
- Master set-top box adjunct
- Net TV adjunct
- Security system adjunct

10.4 Enclosure

The enclosure of a centralized RG shall house the internal digital interface and a minimum of 4 plug-in modules. The enclosure shall provide an adequate environment for the operation of the RG, including any internal power supplies, ventilation, and mechanical protection from the elements.

Connectors located in the RG housing shall be designed such that mounting and mating stresses transmitted to the connector contacts, mechanical, or soldered connections do not affect interconnection reliability, e.g., surface mount solder joints shall not be subjected to shear or tensile stress that could result in creep failures.

The RG enclosure should be designed so that it can be mounted on outside or inside walls, or in the interior of a single family structure The RG enclosure shall be esthetically pleasing and the materials and finishes of the RG shall meet all fire resistance and toxicity requirements. The RG enclosure shall be conductive to allow grounding.

Certain RG components may be located in separate compartments within the RG or may be external to it. There may be two separate sections: one accessible only by network service providers, and one that is also accessible by the subscriber. The subscriber, customer, or resident should be allowed access to some portion of the RG. This access should only be possible by using a typical tool, such as an allen wrench, so that people who cannot use tools also cannot perform modifications on an RG. The subscriber or resident should not be allowed easy access to portions of the RG that are soley owned by a network service provider.

Any portion of the RG exposed to the outside environment shall be adequately protected to resist corrosion. This includes protection from salt fog and spray in areas where it is commonly encountered. It also includes protection from typical environmental pollutants. If the RG is located outdoors, then its enclosure shall prevent the entry of water when mounted in its normal position and sealed as per supplier instructions. Plastic materials used in the RG enclosure that may be directly exposed to ultraviolet light should not degrade as a result of exposure to ultraviolet light. Polymeric materials used in the RG enclosure should not degrade as a result of ozone exposure.

If the RG is located outdoors, then its housing and critical components should not support fungus growth, and the enclosure should show no degradation after being exposed to chemicals typically used by technicians, such as oil and wasp and hornet spray. The RG enclosure should be able to resist attacks by rodents. The RG enclosure should be able to withstand handling, transport, and reasonable impacts and vibrations.

10.5 Operating Environments

There are basically two types of environments in which an RG may be located: indoors or outdoors. The indoors environment is preferred and it is suggested that the RG should be located under a roof, at least, and in a climate-controlled environment if possible. However, it is recognized that a service provider who wishes to have complete access to a network-owned RG may locate it outdoors.

RGs placed outdoors are subject to large temperature variations. These variations depend on the ambient air temperature, heat due to solar load, and heat generated by the power consumption of the RG electronics. The exact temperature range encountered by RGs will vary depending on if it is indoors or outdoors, what the local climate is, if its in full sunlight, etc. Therefore the temperature ranges are not specifically enumerated here, since it is not possible to specify all options at all locations with a single temperature range. The RG should not be located in very hot locations such as unventilated attics.

If a back-up battery for the RG is also located outdoors, then it may require a special vented or cooled environment since battery life generally decreases exponentially as the temperature increases. Thus, outdoor RGs with integral battery back-up may need to contain a vented and thermally-isolated battery compartment. Batteries may also be very sensitive to low temperature extremes, which may cause them to lose their capacity and become damaged. Thus, RG batteries may need to be heated in some cases to prevent them from being damaged by low temperatures.

The RG shall function reliably at all temperatures and humidity levels that it is designed to encounter throughout its lifetime.

10.6 Power Requirements

10.6.1 Primary Power

The RG may be network-powered, or it may be locally powered, or its power may be drawn both from the network and locally. A likely scenario is to power lifeline POTS service with 48 VDC network power, with other services powered by local commercial utility 120 VAC power. The RG shall be capable of obtaining primary power from a 120 VAC commercial utility power by a standard cord or plug. The RG and its plug-in cards shall be designed to have low power consumption.The RG and its back-up power source shall not be damaged by primary power outages.

10.6.2 Back-up Power

If analog lifeline POTS service is provided through the residential gateway, then a power failure pass-through function shall be incorporated into the RG. This function shall allow the lifeline POTS service to be network powered.

Back-up power, provided by a battery or other energy storage device located near the RG, can significantly enhance the availability of all other services supported by the RG. However, battery back-up can also increase costs. For this reason battery-back-up is not specifically mandated for the RG. Instead, battery back-up in, or explicitly with, the RG is a recommended option.

The RG design should allow it to have an external back-up power connection. Such a connection may serve for providing back-up power from the house and thus placing batteries in a controlled environment. Any batteries used should be commercially available for consumers.

The RG should be capable of having back-up battery power supplied by an external UPS that can be connected in series with 120 VAC commercial utility power using a standard plug. The RG should continue to operate if its back-up batteries are taken out or if the back-up power is disconnected.

If there is battery back-up in or with the RG, then the batteries should provide a minimum of 8 hours of back-up while powering telecommunications and video services. The back-up batteries, should provide at least 5 years of service under normal service conditions, except for in hot desert locations and locations South of 30 degrees North latitude where the back-up batteries should provide at least 3 years of service under normal service conditions. The back-up battery should not require any periodic maintenance other than replacement.

Back-up power should automatically supplant loss of primary power without service interruption. When the RG is running on back-up power and the primary power is restored, then the RG should return to normal operation without manual intervention or service interruption. If the primary power was disabled, and the RG has completely exhausted all back-up power, then it should resume normal operation after the power is restored without requiring manual intervention.

10.6.3 Electrical Protection

Metallic facilities entering an RG may consist of copper pairs, coaxial cables, and cables providing electrical power. Providing electrical protection to control the currents and voltages brought into the RG by these metallic facilities is necessary to ensure the reliability and availability of the RG. In particular, the RG must be properly grounded and bonded. The RG shall meet all grounding and bonding requirements stated in applicable national standards.

Surges caused by lightning and power faults may enter metallic facilities connected to the RG. Therefore, surge protection devices are typically used at the terminations of the metallic facilities so that the energy of incoming electrical surges is reduced before reaching the electronics in the RG. This reduces the possibility of damage to the RG and enhances its reliability. The surge protection devices may be located in a NI external from, but close to, the RG; particularly if the RG is located in an indoors environment. Surge protection devices may not be needed at the RG for service drop facilities that are shielded and grounded at the RG and are less than 500 feet in length. There shall be a surge protector on copper pairs that carry POTS before they enter the RG. This surge protector may be at a NI located near, but not in, the RG.

Regulations generally only require the bonding of a coaxial cable shield to an approved ground for electrical protection of coaxial cable entrance facilities. However, since the RG may contain sensitive electronics, it is highly recommend that a surge protector be used on any external coaxial interface.

The RG enclosure shall be properly grounded. If metallic cables entering the RG are shielded, then the shields shall be bonded to the RG enclosure. If the RG is located outdoors, then provisions for connecting the metallic housing of the RG via at least a 6 AWG copper grounding conductor to an approved grounding electrode shall be provided.

Discharges of electrostatic voltages on or near equipment assemblies can be a significant cause of failures or malfunctions. Failure or malfunctions occur when ESD effects extend to the device level and cause device damage. Protective circuitry, isolated ground paths and similar features designed into equipment help reduce ESD effects below the damage threshold at the device level

and allow equipment to withstand a certain amount of ESD on external surfaces without affecting its ability to function. The RG should be able to withstand typical low levels of ESD with no failures or malfunctions.

10.7 Physical Security

The RG should be resistant to vandalism and it should be difficult to surreptitiously disable any alarm services that the RG provides. If the RG is located outdoors, then it should be equipped with a locking mechanism. Alarm mechanisms should be built into RGs located outdoors.

10.8 Reliability

Customers will perceive the reliability of a residential gateway in terms of the availability of the services that are provided through it. From the customers' viewpoint, the availability of services is independent of the network and equipment architectures. Service availability contrasts with equipment downtime criteria, which depend on network technology and architecture. For consumer-oriented services, a customer services approach to reliability is necessary in addition to the more traditional approach based on technology considerations.

Customers expect different services to have different levels of availability. For example POTS should be highly reliable, while video and data services may be less critical. Thus it is reasonable to specify different classes of service availability and reliability. Services may be put into different classes such as POTS, security systems, video, data, etc. Requirements are only explicitly stated here for lifeline POTS and emergency services.

10.8.1 Reliability of Lifeline POTS and Emergency Services

For lifeline POTS and emergency services the unavailability caused by failures in the RG shall not exceed 26 minutes per year on average. The MTBF of any service-specific, or network specific, devices in the RG should be a minimum of 5 years. The MTBF of any critical components of the RG, including any backplanes and any components required for lifeline POTS, should be a minimum of 10 years.

10.8.2 Fault Monitoring

One of the primary potential advantages of an RG is its ability to serve as a single maintenance point for access services. The RG can monitor its own functions for faults, and can isolate faults between those caused by the outside network and those caused by in-home networks and devices. By providing automatic fault monitoring, the availability and reliability of services provided through an RG can be significantly enhanced.

- Where practical the Access Gateway Modules should provide a loopback functionality that can be remotely activated to enable the location of faults.
- The RG should provide a "health check" function that reports any failures (including low battery charge) periodically. The reporting period may be as often as once or more a day. The system should be capable of remotely activating this capability.
- The RG should provide a power source alarm which is activated in the event of a power outage.
- The RG design should provide a means to notify of unauthorized access by activating remote alarms.

Annex X: Sample Usage (informative)

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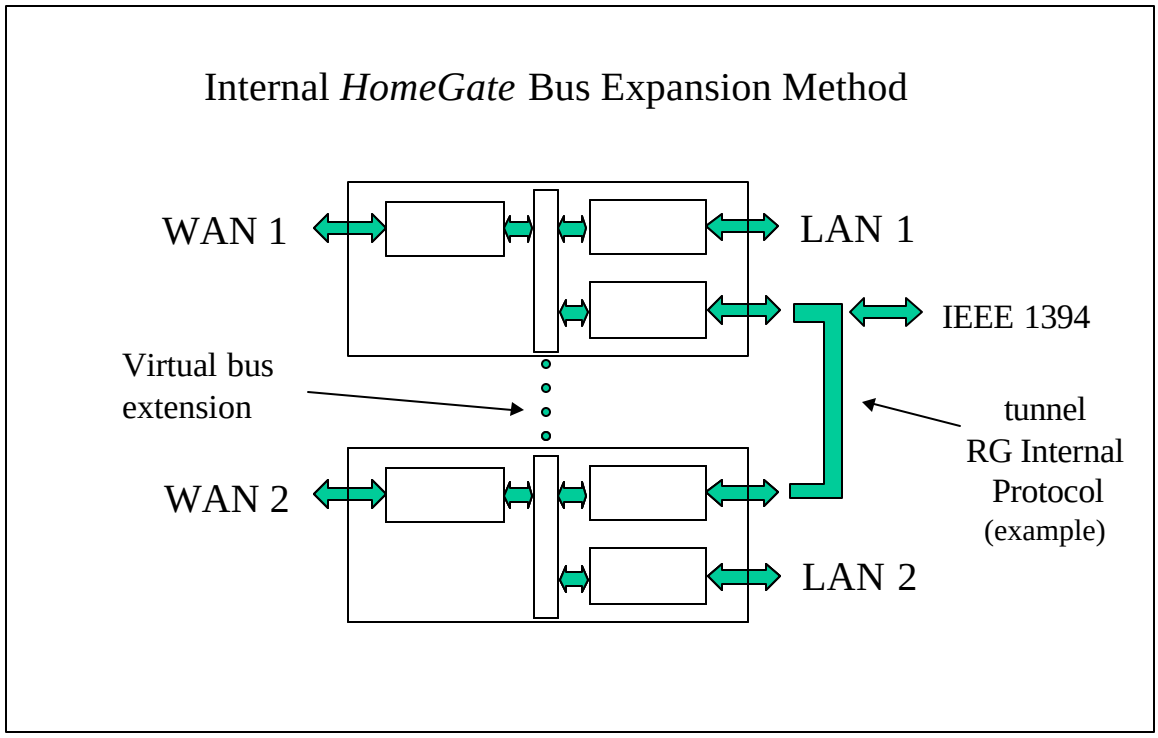
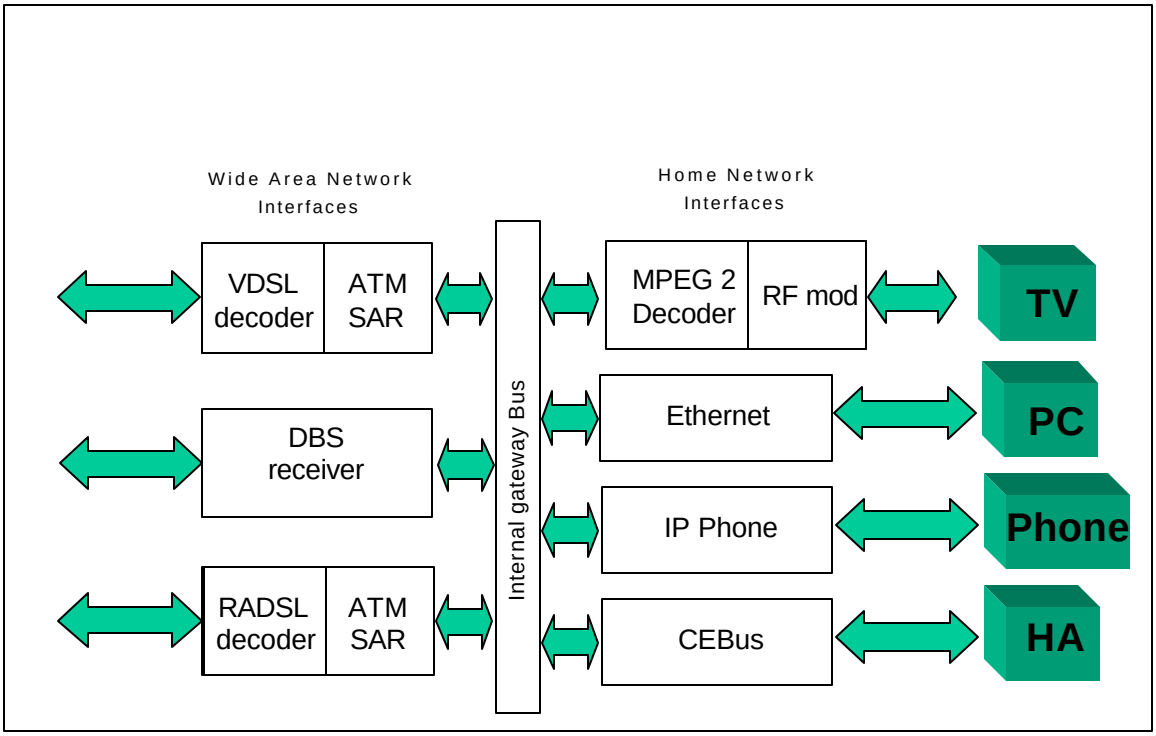


Internal HomeGate Bus Expansion Method.



DBS/DSL Architecture Example.

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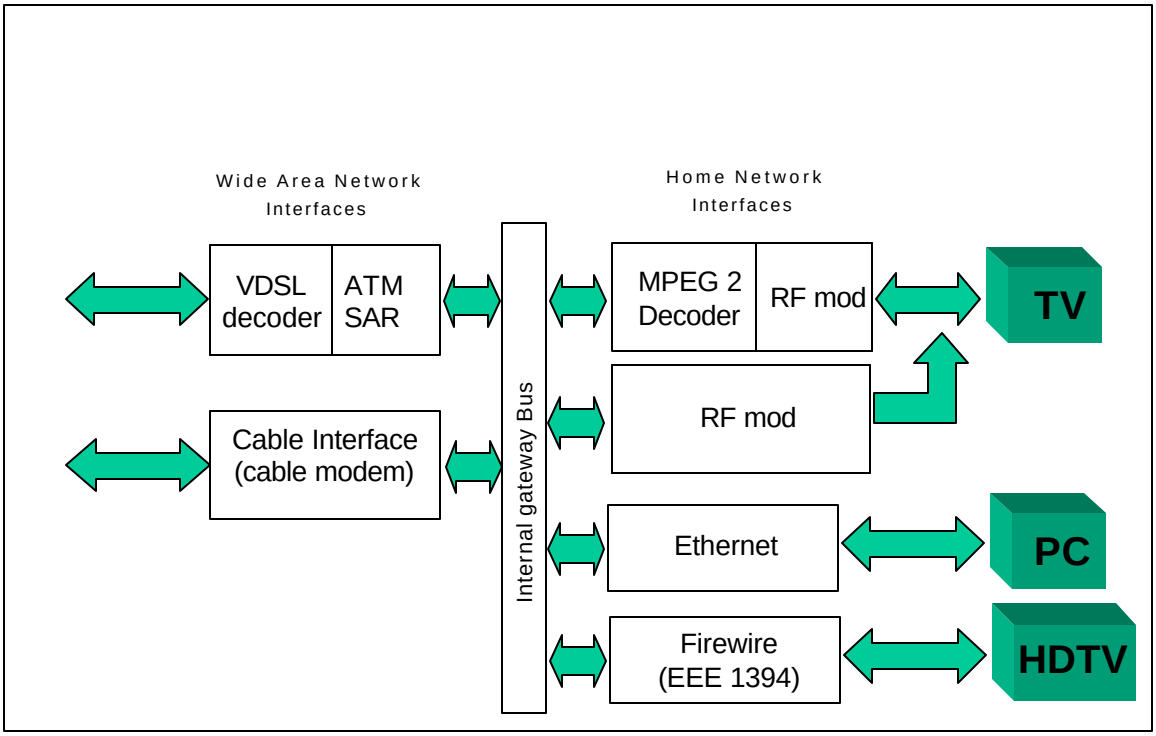

Cable/DSL example.

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