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ISO/IEC 3rd FCD 15045-2

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Introductory note: **This FCD is distributed for approval as FDIS.**

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3rd FINAL COMMITTEE DRAFT

ISO/IEC 15045-2

Information technology – Home electronic system (HES) gateway

Part 2: Modularity and protocol

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FOREWORD

ISO (the International Organisation for Standardisation) and IEC (the International Electrotechnical Commission) form the specialised system for world-wide standardisation. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organisation to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organisations, 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. 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.

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

ISO/IEC 15045 consists of the following parts, under the general title: Information technology — Home electronic system (HES) gateway.

- Part 1: A Residential gateway model for HES
- Part 2: Modularity and protocol (this standard)

INTRODUCTION

The rapid, unsynchronised development and deployment of numerous standards, specifications, technologies, services, and products for communication within or to the home has created problems of incompatibility, non-interoperability, complexity, and expense for consumers, service providers, and manufacturers. Continuing technological progress also suggests that such problems will continue, and that no single technology or standard may prevail. This situation necessitates a standard for enabling and ensuring co-existence, compatibility, or interoperability among such diverse network standards, specifications, and products from multiple manufacturers or providers.

This document is part of a series of standards and technical reports for the Home Electronic System (HES) that deal with the topic of control and communication networks in homes and other small buildings. Part 1 of ISO/IEC 15045, published in 2004, defines a basic model of the residential gateway, including functional requirements.

This part 2 defines a common framework for implementing distributed gateway platforms to achieve interconnection and interoperability of home system products and applications from any manufacturer or provider in a manner that is safe, reliable, predictable and consistent. It accomplishes such interoperability by defining a standard modular architecture, a common signalling bus and set of protocols for interconnecting the modules. It relies on a common intermediate language for interoperability of applications based on a Common Interoperability Framework (HES-CIF) described in a companion standard, ISO/IEC 18012. ISO/IEC 18012-2 will define the network-specific interfaces and Interworking functions and the application-specific interfaces and Interworking functions needed to provide manufacturable conforming products.

Information technology —
Home Electronic System (HES) Gateway —
Part 2: Modularity and protocol

1 Scope and purpose

1.1 Scope

ISO/IEC 15045-1 specifies the functional requirements and basic framework for the residential gateway. This part 2 specifies the modular architecture, the interconnection of the modules (employing intermediate busses or links), and the overall structural, functional and signalling requirements for interconnecting communications networks inside and outside the house. These specifications describe the network interfaces as a design philosophy for a universal gateway system interconnecting the networks in a manner that allows them to interoperate without modification. This architecture also allows interconnection of multiple distributed residential gateways, where more than one may be installed in a particular home. Subsequent parts will define specific network interfaces and their Interworking functions, specific service application interfaces and their Interworking functions, and other additional gateway and network management services.

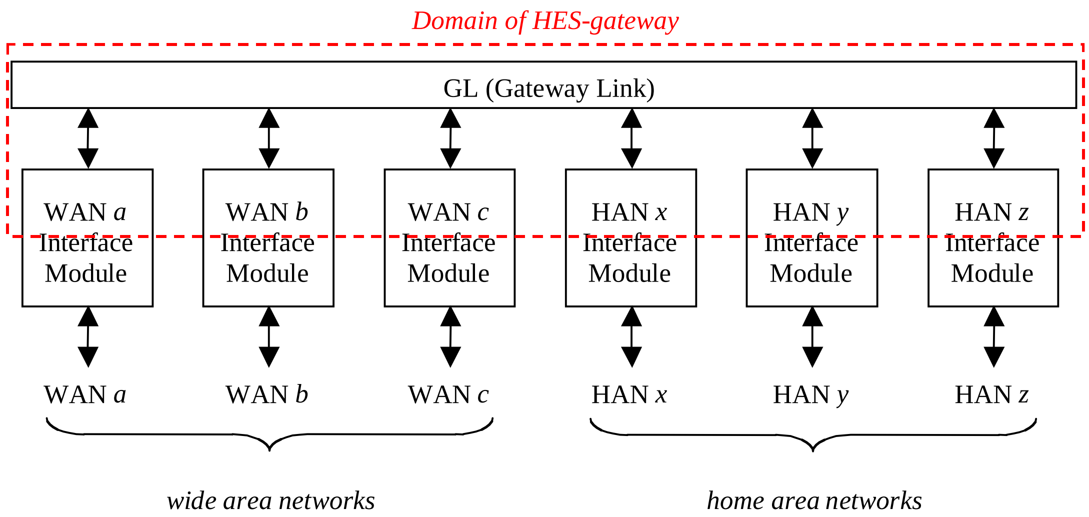


Figure 1 — Interoperating Networks and Domain of HES-gateway standard

This standard provides an open, modular, and expandable framework for the delivery of services to the consumer that can accommodate diverse networks on both the HAN and WAN side. It can also provide a place to situate basic firewall functions that will protect the autonomy, safety, privacy, and security of the consumer, yet enable trusted relationships with preferred service providers. The basic functionality of the HES-gateway system is shown in Figure 1.

This specification, together with its normative references, provides a design guideline to create products that can offer interoperable gateway functionalities. It, together with subsequent parts, specifies all required layers (or stacks) of the intermediate protocol, known as the Gateway Link (GL) protocol, specific network interfaces and Interworking functions needed to interconnect interoperable array of specific Network Interface Modules and specific Service Modules. Required layers of specific WAN or HAN protocols are not specified, but are left entirely to the product manufacturer. The GL and other HAN/WAN protocol stacks implement a Common Interoperability Framework (CIF), including a language (specified in the International Standard, ISO/IEC 18012), that resides above layer seven, (*ie.,* above the application layer of the ISO Reference Model), and interfaces to the aforementioned protocol stacks.

HES-gateway system is intended to provide interconnection and interoperability:

- Where two or more dissimilar HANs are installed or implemented in a premises.
- Where two or more dissimilar HANs are required to interoperate or interwork in a premises.
- Where a product acts as a bridge, router, gateway or residential gateway between two or more dissimilar HANs, or between at least one WAN and at least one HAN, in a premises.

This clause only refers to additional conformance requirements and augments requirements in this document.

1.2 Goals and non-goals

This International Standard defines a universal gateway system by specifying interfaces for:

- Standalone local/Home Area Networks (HANs) and connected devices.
- Multiple implementations of local/home area networks (HANs) and connected devices.
- Wide Area Networks (WANs) (also known as access networks) and applications connected to Home Area Networks (HANs) and connected devices.

This standard establishes a framework for implementation of a general-purpose interoperability platform or “translator” among home area networks or between wide area networks and home area networks. It represents one approach to implementation of the Interoperability standard ISO/IEC 18012. This standard does not attempt to specify a central controller or control system; and does not attempt to improve or resolve disparities or shortcomings among transmission technologies, protocols, or application languages. However, this standard does provide the premises with a platform for supporting any number of specific services and supporting fundamental elements of consumer security (*i.e.,* firewall services), safety, and privacy.

This standard is not a design for a specific gateway, but rather it offers an architecture, and therefore it is necessarily abstract. However, this standard is relevant for many commercial gateway configurations. Examples of such implementations are included for information in Annex A.

1.3 Structure of document

This document comprises the following sections:

- Overview sections that define the scope and purpose of the standard, key terminology, and normative and informative references.
- A conformance section specifying the normative clauses.
- A requirements section that defines functional requirements for the gateway system and associated modules, including modular interface and stakeholder requirements.
- A system model section that describes the abstract HES-gateway system architecture and its concept of modularity, its data flows, and the relationship between the various system parts, including the network interface modules, service modules, the HES-link bus, and the generic interworking function.

- An intermediate process section that explains the protocol stacks, the gateway link bus (HES-link) and its protocols, and network management.

1.4 Purpose

1.4.1 Statement of purpose

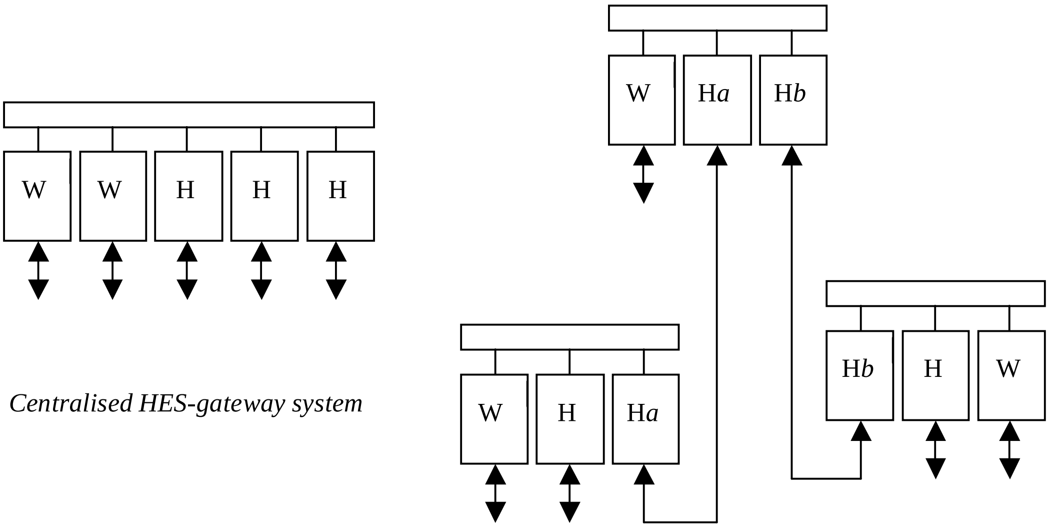
It is possible that a user will purchase and install products employing two (or more) dissimilar networks, known as Home Area Networks (HANs), within the same premises. However, the user will expect these products and networks to behave as if they were logically the same network, Therefore, when linked by some physical means, each network must include an interface that conforms to this standard, as shown in figure 1. Networks (WANs) may wish to exchange information with these HANs. In order to achieve such interoperability, these WANs must also provide an interface that conforms to this standard.

In addition to providing access to WAN based services, this standard can also enable interoperability or interworking of HAN-based appliances, products and services by providing a framework for situating the functions that perform the mappings between disparate, possibly proprietary, HAN systems. The common element among all home systems is that of home services, such as:

- Entertainment/video
- Data/Internet access
- Communication (telephony – video)
- Energy management
- Health care and monitoring
- Environmental control (heating and cooling)
- Security & safety monitoring
- Appliance telemetry
- Lighting control

1.4.2 Architectural model

The HES-gateway architectural model is modular in concept, for purposes of definition and conformity assessment. However, implementation is left to the choice of manufacturers and could be modular or integrated, and could be centralised or distributed. Alternative architectural models are depicted in Figure 2. In this figure, "W" and "H" represent WAN and HAN HES-link modules, respectively. The distributed system may be thought of as simply a combination of smaller centralised systems. These alternative architectural models are described in ISO/IEC 15045-1.



Centralised HES-gateway system

Distributed HES-gateway system

Figure 2 — Architectural models

1.4.3 Design philosophy

1.4.3.1 General

Conventional gateways, e.g. set-top box designs, generally take a “one-size-fits-all” approach tailored to some defined set of services on both the HAN and WAN side. In the quest for low cost and economies of scale in manufacturing, modularity and expandability are sacrificed, along with flexibility that service providers frequently need. Often, the result is a "big box" that tries to accommodate many functions and services, yet frequently fails to provide the key features that are most needed in any particular situation. These big boxes are frequently designed around a powerful central processor and operating system.

1.4.3.2 Distributed Gateway System (DGS)

This standard is based on a model, the Distributed Gateway System (DGS) that seeks to design around the minimum feasible functional unit, rather than the maximum. There is no requirement for a central processor or controller in a DGS. Rather, the most generalised implementation of the DGS uses a distributed computing model consisting of a network of semi-autonomous interfaces and agents running in dedicated embedded microcomputers possibly situated on individual modules (*e.g.*, circuit cards) and interconnected by a “backplane.” Each module may be associated with a single HAN or WAN. This modularity is similar to the "blade server" architecture employed in the commercial computing environment.

1.4.3.3 Common interoperability platform

The HES-gateway accommodates the conventional (simple) gateway (one WAN and one HAN) as a specific case, within a generally defined DGS architectural framework. The DGS is a modular architecture that supports multiple WANs, HANs, and services, and provides a platform for implementing the CIF (Common Interoperability Framework specified in ISO/IEC 18012). It imposes no specific requirements on implementations, although complying with it implies a certain specific choice of modularity that preserves the integrity of the CIF. With respect to protocols and communications services, the DGS model provides a structure that is analogous to the OSI Reference Model for Communications (ISO 7498). In both cases, a specific implementation is not required to include every element (layer) of the reference model.

1.4.3.4 Modularity

The interface to each HAN or WAN might be hosted in a variety of HES-gateway configurations. These HAN and WAN modules might be housed in a common gateway chassis or in multiple gateway chassis that may be directly interconnected over a network. This system of modules is self-configuring and should be "hot-pluggable" so a module may be added or removed while the others are operating. This approach is roughly analogous to the "blade server" architecture widely employed in the commercial networking industry. In more specialised implementations, although the modules might be combined and the intermediate protocol and bus might be collapsed, the principle of modularity at the CIF level shall be preserved.

Modularity in the HES-gateway system represents, more importantly, a functional division rather than a physical one. The main idea is to provide a functional structure within which the CIF can "live." In terms of physical realisation, the entire gateway could end up as a single piece of silicon—that choice is up to manufacturers and the specific set of services they may wish to support (e.g., In the "Simple Gateway," the intermediate bus and protocol are completely collapsed). The modular architecture is simply a framework. The "HES-link module" and the "simple gateway" concepts are introduced in order to clarify this concept. In other words, the HES-gateway does not have to be manufactured in a modular fashion, but it must be DEFINED within a modular framework in order for the CIF to operate.

1.4.3.5 Minimalist approach

Much like the design of the Internet, the HES-gateway seeks simplicity by separating content and application from transport and delivery. Such separation moves as much "intelligence" as possible out of the gateway. Applications and services reside on the periphery of the gateway (*i.e.*, on the respective HANs and WANs or on Service Modules) where they can grow and develop in directions not dependent on the gateway itself. The HES-gateway system design seeks to minimise the information or knowledge that the gateway needs about the products and services residing on each network. It is anticipated that many different commercial gateways will be implemented as subsets of this standard."

This distributed minimalist architecture provides a measure of "future-proofing" by employing intermediate bus and protocol or language elements that are layered and upward compatible with future additions or changes. For example, the language elements may be defined and contained in a metadata registry that can be continuously updated and accessed by product developers. In such case, protocol stacks for an expanding list of WAN and HAN protocols may be maintained in an open-source library that is also available to developers. Such a metadata registry will be specified in subsequent parts of this standard.

2 Normative references

The following referenced document is indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18012-1, *Information technology - Home electronic system - Guidelines for product interoperability - Part 1: Introduction*

ISO/IEC 18012-2, (under consideration), *Information technology - Home electronic system - Guidelines for product interoperability - Part 2: Taxonomy and lexicon*

OMG Document Number: formal/2008-04-09*, The Real-time Publish-Subscribe Wire Protocol – DDS Interoperability Wire Protocol Specification, Version 2.0*
URL: http://www.omg.org/spec/DDS1/2.0/PDF

3 Definitions and abbreviations

3.1 Definitions

For the purposes of this International Standard, the following definitions are applicable.

3.2
Bridge
interface between dissimilar lower layer networks. A bridge may provide services at layer 1 (physical layer) or layer 2 (data link layer)

3.3
Bus
common or shared communication path or highway; a means of interconnecting devices under a single administration, such as a LAN comprising devices sharing a common set of pathways

NOTE A distinction may be drawn between “logical” and “physical” buses when bus topologies are considered.

3.4
Common Interoperability Framework (CIF)
intermediate HES-gateway system that includes 1) an HES-AIL (Abstract Intermediate Language), and 2) a set of network-specific Generic Interworking Function (GIWF) processes to express (*i.e.,* translate) any message to or from any specific HAN or WAN message

3.5
Compatibility
ability of two or more networks within a premises to be mutually tolerant and not interfere with one another; the same as co-existent. Not necessarily interoperable

3.6
Component
logical subunit of a larger, encompassing concept. For example, the concept of Interoperability is broken down into constituent components such as safety, management, and operation. These constituent components are further broken down within their respective sections. In the context of the HES-gateway, the term component is also used to refer to logical subunits of system architecture concepts, such as the components of a networking implementation (*e.g.,* addressing)

3.7
Device
distinct physical unit on a network. It can either be an end node on the network, or an intermediate node (as in the case of a gateway, router, or bridge device connecting two distinct physical networks)

3.8
Gateway
1nterface between dissimilar networks. A gateway may provide services up to OSI layer seven and above. The HES-gateway provides protocol and language translation services above layer seven

3.9
Gateway Link (GL)
full seven-layer protocol stack and the physical bus that may be used to communicate the HES-AIL encoded messages (resulting from the GIWF translation process) between HES-link modules. It is a link in the sense that it transports messages within, or native to, the CIF (*i.e.*, GL and HES-AIL). The GL may also be referred to as the "HES-link"

3.10
Generic Interworking Function (GIWF)
translation function between a specific home network application language and the HES-AIL (Abstract Intermediate Language) used within the HES-gateway system

3.11
HES
collection of devices and components operating within the home and interconnected over one or more networks, and within which such devices and networks are compatible and interoperable according to various ISO/IEC standards

3.12
HES Abstract Intermediate Language (AIL)
language for representing or expressing the messages of any HAN or WAN. It is an intermediate HES-gateway-oriented application language that includes a syntactic structure and semantic definitions comprising a lexicon of terms including objects and methods (actions)

3.13
HES-link module
device that provides the required services for one of the networks of the HES-gateway system. In the context of this standard, the HES-link module provides protocol and language translation services above layer seven and provides an interface to the GL for purposes of connecting by the GL to one or more other HES-link modules serving other networks. Two or more HES-link modules, connected together via a GL, comprise a gateway

3.14
Interoperability
ability of logical entities to function together for applications on a network

3.15
Management Information Base (MIB)
memory function in some portion of the gateway that stores information useful for various network management functions. Note: No relationship is implied here with Simple Network Management Protocol (SNMP) from which the term "MIB" is borrowed

3.16
Network
distinct interconnection or set of nodes or devices that share a common communication protocol and are mutually compatible and interoperable

3.17
Object
unit of software functionality. Something you can do things to. An object has state, behaviour, and identity; the structure and behaviour of similar objects are defined in their common class. The terms *instance* and *object* are interchangeable.” (From “Object-Oriented Analysis and Design with Applications,” by Grady Booch, 2nd Edition, Addison-Wesley, 1994)

3.18
Product
device or network of devices that may be purchased to make up a Home Electronic System

3.19
Router
interface between dissimilar middle layer networks. A router may provide services at layer 2 (data link layer) or layer 3 (network layer)

3.20 Abbreviations

NOTE The abbreviations shown in *italics* below are HES-specific terms.

AAA	Authentication, Authorization, and Accounting
ATM	Asynchronous Transfer Mode
CIF	Common Interoperability Framework (specified in ISO/IEC 18012-2)
DBS	Direct Broadcast Satellite
CEBus	Consumer Electronic Bus
DDS	Data Distribution Service
DG	Distributed Gateway
DGS	*Distributed Gateway System*
DSL	Digital Subscriber Line
GIWF	*Generic InterWorking Function*
GL	*Gateway Link*
HAN	Home Area Network
HES	*Home Electronic System*
HES-AIL	*Home Electronic System Abstract Intermediate Language*
IP	Internet Protocol
IP Sec	IP Security
MIB	Management Information Base
OMG	Object Management Group
OSI	Open Systems Interconnection
PLC	PowerLine Carrier
PNA	Phone Network Alliance
POTS	Plain Old Telephone Service (analogue voice)
RTPS	Real-time Publish-Subscribe
SAR	Segmentation And Re-assembly (of ATM packets)
SNMP	Simple Network Management Protocol
TLS	Transport Layer Security
USB	Universal Serial Bus
VDSL	Very high speed DSL
WAN	Wide Area Network

4 Conformance

4.1 Basic functions and requirements

An HES gateway conforming to this document shall implement the following elements in accordance with the requirements of the indicated clauses of this standard:

- HES-link modules shall conform to the modular architecture described in clause 5.1.
- HES-link modules shall implement GL bus interfaces conforming to the specifications identified in clause 7.2 (all subsections).
- HES-link modules shall implement the GIWF in the manner specified in clause 6.1.2.

5 Requirements

5.1 Modularity requirements

The basic function of the HES Gateway is to translate messages between networks that use different communication protocols and/or application languages. This translation is accomplished by the Common Interoperability Framework (HES-CIF) (specified in ISO/IEC 18012-2). Each message shall be translated into a common intermediate language, the HES Abstract Intermediate Language (HES-AIL). The translation process in the HES Gateway is performed by a network-specific Generic Interworking Function (GIWF). In the case of the DGS where modules (HES-link modules) are physically distributed on an HES-gateway intermediate bus or GL (gateway link), then the translated message may be transported via the GL protocol to the receiving GIWF, which then translates it into the language and protocol of the target network. The GL thus accommodates multiple WANs and HANs without requiring separate translators for each possible combination of networks (e.g., WAN and HAN, or HAN and HAN). A "simple gateway," linking one WAN and one HAN, may incorporate the dual translation process without using the GL, and lies outside of the scope of this standard.

In the most generalised implementation of the HES Distributed Gateway System, network interoperability shall be achieved by a dedicated interface module for each network, known as a "HES-link module," that provides a GIWF linking this network to an abstract HES Common Interoperability System, comprising an abstract intermediate language and (AIL) and intermediate protocol (GL protocol). Alternatively, specific appliances may incorporate such GIWF and AIL/GL interface functions (examples are provided in the section on reference models).

NOTE An optional specialised implementation such as the "simple gateway" (i.e., see A.2.6.2 of ISO/IEC 15045-1) may combine modules into a single unit and collapse the intermediate GL bus entirely, and lies outside the scope of this standard.

Each module may be visualised as a "HES-link module" connected with an intermediate protocol and GL bus. This bus need not be confined to a common chassis, but could be extended throughout the premises using an appropriate bus technology or tunnelling technique. Such distributed HES-link module implementation options further described in later sections.

6 HES-gateway system

6.1 Conceptual process model

6.1.1 Common Interoperability Framework (CIF)

The generalised HES-gateway system model is depicted in Figure 3, known as the CIF (Common Interoperability Framework). The various Systems in Figure 3 comprise networks that:

- Connect the home to service providers. These are usually wide area networks.
- Link components of home applications to form a functional system (*e.g.,* audio/video entertainment, heating and cooling (HVAC), energy management, lighting, and life safety) from multiple local area networks.
- Interconnecting home applications (*e.g,* to co-ordinate lighting with turning on lights in case of a fire alarm event).

There may be multiple home networks with different protocols for each of home service listed above. Since the communications protocols on the external and the various in-home networks may differ, the HES Gateway is responsible for signal, protocol, and language (syntax) translation.

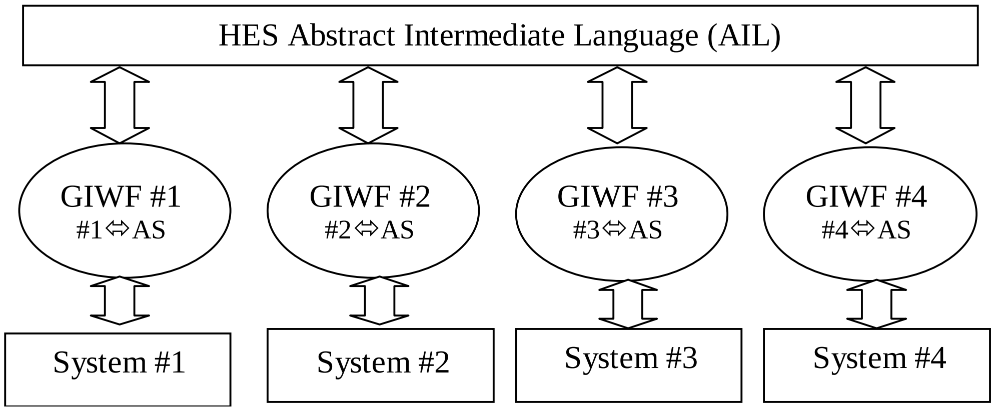


Figure 3 — Common Interoperability Framework (CIF)

The CIF represents the Home Electronic System-Common Interoperability Framework, as defined in ISO/IEC 18012. ISO/IEC 10812 defines the HES Abstract Intermediate Language (HES-AIL) for enabling interoperability among applications on different networks.

The HES-AIL comprises an language for expressing the set of common functions (e.g., objects and methods) served by all home systems. For example, the HES-AIL has representations for lighting system elements such as switches and sensors. Each home system application is defined by a specific subset of the CIF, known as a Generic Interworking Function (GIWF). The HES-AIL and GIWF are specified in ISO/IEC 18012 series of standards.

6.1.2 Generic Interworking Function (GIWF)

The GIWF serves as a translator between any specific system and the abstract (common) system. The abstract HES-AIL language constructs are expressed and conveyed by a GL (Gateway Link) that includes a common meta-protocol and application language. In terms of the seven-layer OSI Reference Model (ISO 7489), the GIWF communicates messages at the top of the protocol stack associated with the interface module process of a particular system. An HES-gateway stack model is described further in a later section on the HES-gateway intermediate processes.

The GIWF resides in modules that may be designed and implemented by manufacturers to perform translation between specific HES implementations of device classes and the interoperability application models device classes. The HES-gateway system provides commercial network system developers and manufacturers the opportunity to specify a specific GIWF for their network protocol to achieve interoperability within the CIF. ISO/IEC 18012-2 specifies network interfaces and interworking functions and provides the requirements to establish a metadata registry for such interfaces and Interworking functions.

6.2 Physical architecture

The basic physical architecture of the HES-gateway including associated architectural domains is shown in Figure 4.

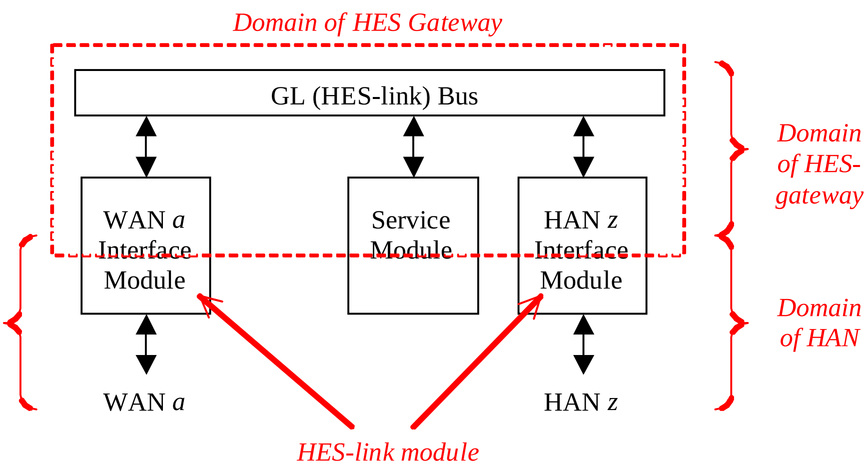


Figure 4 — HES-gateway architectural domains

The HES-gateway architecture consists of three domains, the domain of the HES-gateway standard and the domains of the WAN and the HAN. The centre block represents the HES-gateway intermediate bus (optionally present) over which the GL/HES-AIL messages are transported. (Note: It is “intermediate” in the sense that it transports messages within, or native to, the CIF (i.e., GL and HES-AIL)).

The interface modules shown in Figure 4 are provided by manufacturers seeking to support various WAN or HAN networks. Each such module includes a portion that is in conformance with the interoperable HES-gateway standard and also talks the language of CIF (standardised in ISO/IEC 18012) using specific GIWFs residing on each module. These modules interconnect with each other using the GL protocol and bus. All information processing resides on individual modules and not on the bus or elsewhere. The intermediate GL bus block depicted in Figure 4 represents only a data transfer or switching/arbitration function. There is no specific abstract limit to the number of modules that may be accommodated in any given configuration. However, the physical realisation of the GL protocol and intermediate bus may set a practical limit. Three basic types of modules comprise a HES-gateway: WAN interface modules, HAN interface modules, and Service Modules (Section 6.3.4). The latter two are associated with the domain of the HAN.

6.3 Modularity

6.3.1 General

A useful way of thinking about the HES-gateway architecture is in terms of the “HES-link module”. The HES-link module is a modular unit that provides the services and interface for one of the specific networks served by the HES-gateway. It communicates with the other HES-link modules by use of the HES-gateway GL bus and an associated meta-protocol, the GL protocol. Each HES-link module provides the translation from a specific network to the HES-AIL language. The HES-AIL messages are then transported over the intermediate GL bus to such other specific HES-link module as may be appropriate. The HAN and WAN interface modules shown in Figure 4 may be thought of as HES-link modules.

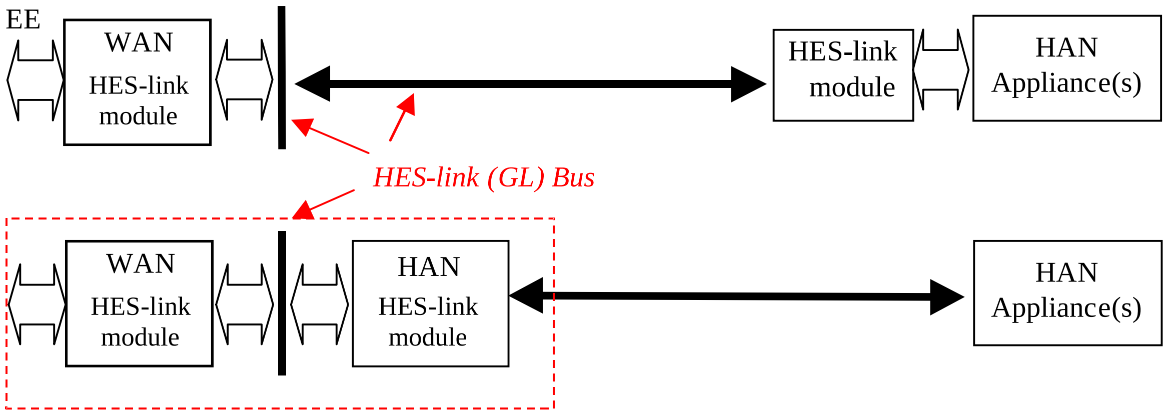


Figure 5 — HES-link module model

Figure 5 depicts the use of two options for a HES-link module. The blocks labelled “HAN” and “WAN” are HES-link modules. The top example represents a case where the HAN HES-link module module is physically removed from the HES-gateway unit, possibly co-located with an HAN appliance, and is linked by an extension of the intermediate bus and protocol. In each case, the translation process takes place in the HES-link module. The bottom example represents a case where the HES-link module employs a transmission facility/protocol that is already interoperable with the end user HAN appliance(s). Note: the HES-gateway Intermediate bus is “intermediate” only in the sense that it transports messages within, or native to, the CIF (i.e., GL and HES-AIL). In some cases, the same bus may be transporting other message traffic as well.

The HES-link modules depicted in the following sections show the distribution of functionality within each module. Only those portions of the drawings located within the “domain of the HES-gateway” are intended to contain normative elements for purposes of this standard.

6.3.2 WAN interface module

The WAN interface module is a unit that provides a complete interface between a specific WAN and the HES-gateway intermediate bus and GL. A generalised block diagram of the WAN interface module is shown in Figure 6. The portion labelled “Domain of HES-Gateway” is outside the WAN domain. For explanatory purposes, the following description will follow the flow of data from WAN to HAN. Typical WANs might include access networks such as cable, xDSL, DBS, optical fibre, or wireless (*e.g.*, LMDS, MMDS, IEEE 802.16 (WiMAX), *etc*.).

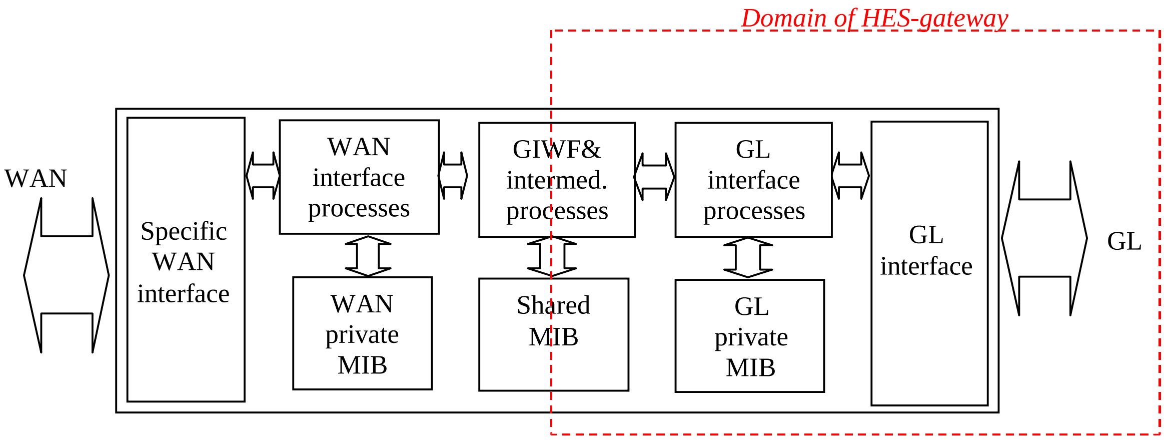


Figure 6 — WAN interface block diagram

The Specific WAN Interface would include physical layer signalling and decoders or demodulators. WAN interface processes would include data processing and any protocol stack necessary to extract the message content meaningful to the application (*i.e.,* up to the application layer (OSI layer seven)) and deliver it to the GIWF and intermediate gateway processes for translation into the GL. The WAN interface processes are determined by the specific manufacturer and could also include any processes necessary for management of the WAN connection, according to the technology it supports, e.g. DSL, E1/T1, etc. The elements depicted in the figure above are included for purposes of illustration only. In practice, they are design matters of manufacturers. A private memory or MIB (Management Information Base) might be needed for such a connection (*e.g.*, such as information relevant to maintaining a customer account relationship, passwords, usage statistics, account codes, *etc.*). The use of the term “MIB” here is borrowed from the IP (Internet Protocol) world, but in this case (unlike IP and SNMP—Simple Networking Management Protocol) it is not intended to imply external access to the MIB by other than a specific service provider. For instance, in the case of WAN modules, a manufacturer may choose to provide a place for storing private information about the WAN connection. This information that would allow a service provider or manufacturer to protect customer-specific data from competitors who may also have WAN modules installed in the same HES-gateway system.

The GIWF and intermediate gateway processes may also have access to a MIB for storage of information that might need to be shared by the WAN and the gateway (*e.g.*, connection status, error, data format or routing information). Once the data have been translated into the GL by the GIWF process, the data are passed to the GL interface processes. The GL includes a protocol stack that passes these data to the intermediate bus and then to the appropriate HAN module(s) where a mirror procedure occurs. The GL private MIB might be used to store information necessary for the proper delivery of such information (*e.g.*, HES-gateway intermediate configuration information, addressing and routing, gateway management information, user preferences, access codes, *etc.*) within the HES-gateway system.

The portion of Figure 6 that lies within the domain of HES-gateway must be in conformance with this standard. The structure and content of the remaining portion is entirely at the option of the specific module manufacturer.

6.3.3 HAN interface module

The HAN interface module is a unit that provides a complete interface between the HES-gateway intermediate bus and GL, and a specific HAN. A generalised block diagram of the HAN interface module is shown in Figure 7. The portion labelled “Domain of HES-Gateway” is outside the HAN domain. Again, the data flow will be traced in the WAN to HAN direction for purposes of explanation. Typical HANs might include IEEE 1394 (Firewire or I-Link), CEBus, USB, Ethernet, IEEE 802.11 (WiFi), IEEE 802.15.1 (Bluetooth), Echonet, ISO/IEC 14543-3 series (Konnex), HomePNA (Home Phone Network Alliance), etc.

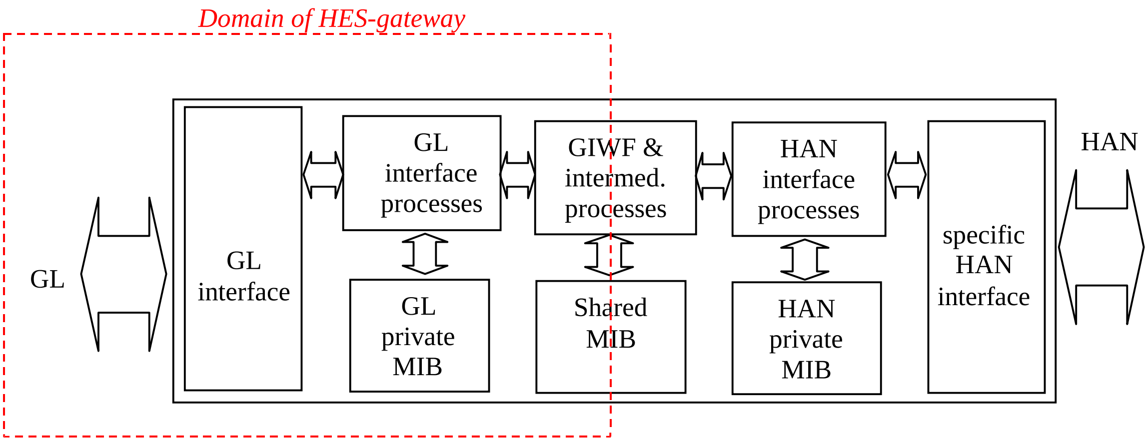


Figure 7 — HAN Interface block diagram

The operation of the HAN interface module follows a complementary pattern to the WAN interface module. The intermediate bus delivers the GL data to a RG bus interface. It is then passed to the GL interface processes where it is extracted up to OSI layer seven and delivered to the GIWF for translation into the specific HAN protocol. The elements depicted in the figure above are included for purposes of illustration only. In practice, they are design matters of manufacturers. The GL private MIB might be used for storing local information such as intermediate configuration information (*e.g.*, addressing and routing, gateway management information, *etc*.). The GIWF and intermediate processes block formats the data and manages the appropriate user processes on the HAN side (*e.g.*, streaming, segmentation, error control, *etc*.), using a shared MIB, if necessary. The translated data are then passed to the HAN interface processes, which actually manage the passing of data to the HAN devices, via the HAN specific interface. The HAN private MIB might be used for HAN configuration or services information, addressing or routing.

The portion of Figure 7 that lies within the domain of HES-gateway must be in conformance with this standard. The structure and content of the remaining portion is entirely at the option of the specific module manufacturer. The HES-gateway portion is not responsible for specific knowledge about the HAN configuration or managing its services.

6.3.4 Service Module

A third type of module in the HES-gateway is the Service Module. The Service Module resides in the domain of the HES-gateway and of the HAN. The Service Module has no HAN interface but acts as an agent for managing specific services on the HAN by having access to intermediate HES-gateway data traffic, and may be associated with specific HAN services. Typical Service Module applications might include security, firewall, data encryption, Authentication, Authorisation, and Accounting (AAA) energy management (*e.g.*, demand side management, remote meter reading, demand response, *etc*.), entertainment (*e.g.*, Interactive TV, pay-per-view (PPV), video-on-demand (VOD), *etc*.), or safety.

6.4 Data flows

The general data flows between the WAN and the HES-gateway system are shown in Figure 8, a copy of Figure 6 with data “pipes” overlaid to illustrate the termination of three kinds of data streams. The various functions in the HES-gateway may be managed remotely or from within the HAN, or by a combination of both. Individual portions of the HES-gateway (HAN or WAN modules) may be managed by separate entities requiring multiple remote management functions.

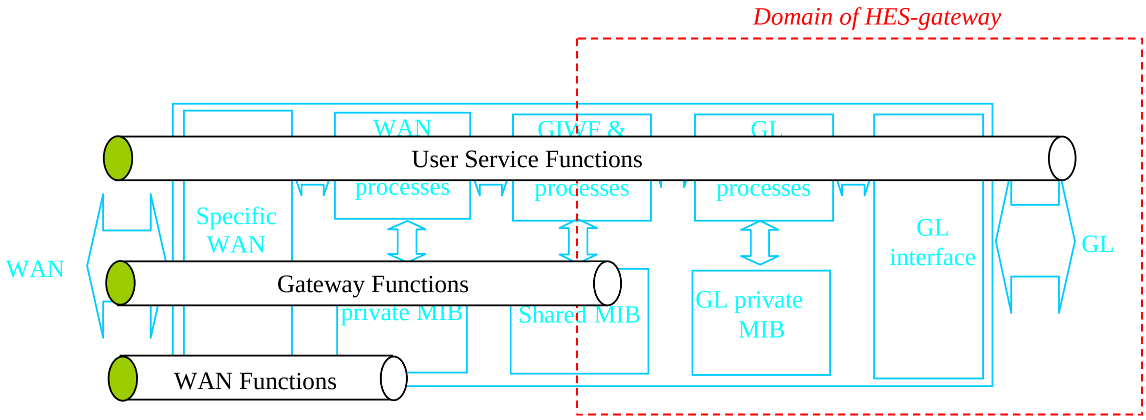


Figure 8 — Data Flows

WAN functions are those that are only intended to manage the specific WAN interface and are the domain of the WAN service provider (*e.g.*, connection establishment signalling, access authorisation, accounting, *etc*.). The gateway functions are those that are shared between the WAN service provider and the gateway, but do not pass through the gateway to the HAN side (*e.g*., resource binding or routing information). User service functions are those that flow through to some application in the domain of the HAN (*e.g.*, a video data stream, user data, *etc*.). Data flows may be generally divided into control plane and content (data) plane flows.

6.4.1 Control plane

GIWF and GL processing are likely to involve a great deal of control plane activity. Control plane flows include short messages that read or write data, inquire, declare device or network states or parameters discover or allocate resources, manage networks (e.g., including safety, privacy, and security) or setup or terminate connections for the management of content flows. An example might be Session Initiation Protocol (SIP), a common control protocol for VoIP (Voice over Internet Protocol) put forward by the Internet community.

6.4.2 Content (data) plane

Content plane flows typically might include digitally encoded video streams, VoIP packet streams, and the like. Once such connected streams are initially set up, they would involve little or no GIWF processing, but they would involve the transfer and routing of packets via the GL (if implemented).

7 Intermediate Processes

The HES-gateway intermediate processes include: 1) protocol stacks for both specific networks and the GL meta-protocol, 2) the GL protocol, 3) the GL bus, and 4) network management functions.

7.1 Protocol stacks

7.1.1 Generalised model

A generalised model of the HES-gateway protocol stacks is shown in Figure 9. These stacks follow the convention of the OSI (Open Systems Interconnection) seven-layer model, which describes communication functions from the physical layer (layer 1) through the application layer (layer 7). The OSI Reference Model is used here for illustrative purposes only and is not intended to be normative. The stack models in Figure 9 apply to either WAN or HAN modules. The GL protocol must not be confused with the specific networking protocols being translated (i.e., being rendered “interoperable”). The GL protocol and bus are unique to the HES-gateway and are an optional method of transporting data between GIWFs.

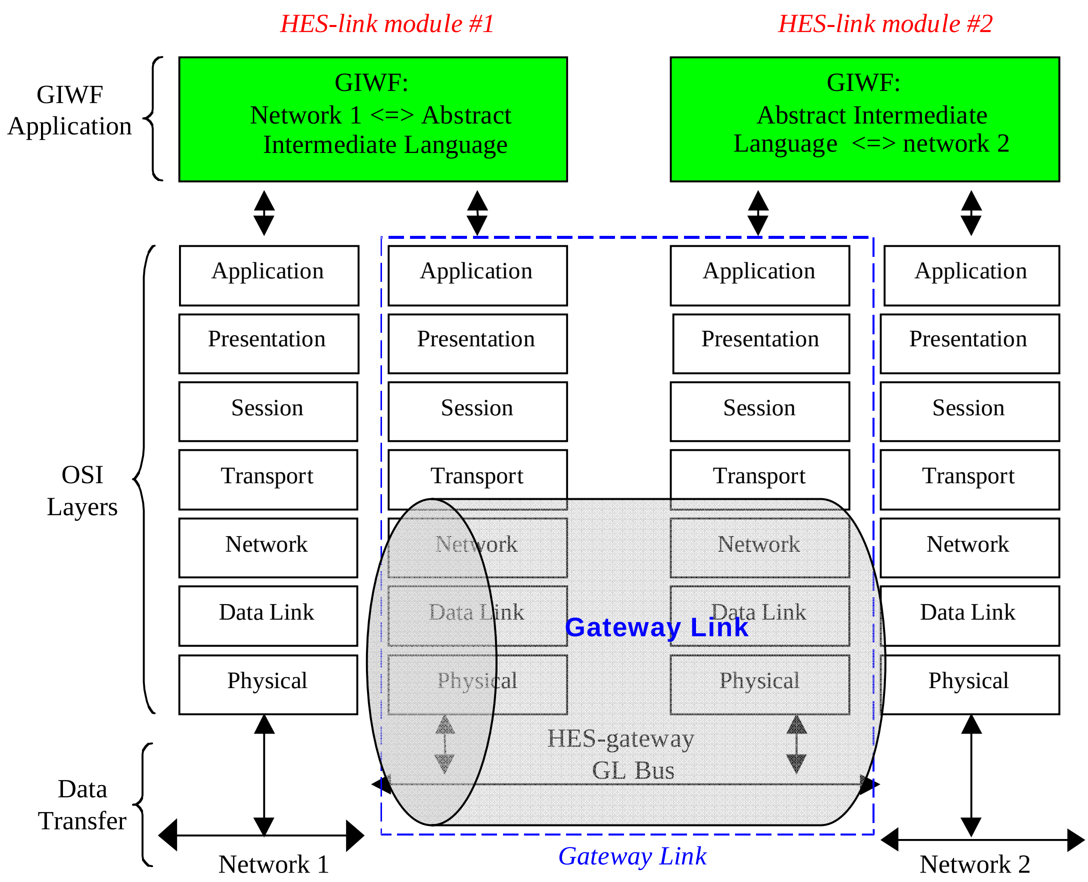


Figure 9 — HES-gateway Generalised Protocol Stack Model

Data transfer from Network 1 to Network 2 would begin by entering the Network 1 HES-gateway module and passing upward to the top of the specific Network 1 stack where the data are then passed to the GIWF, which exists above the application layer. The GIWF translates the Network 1 application language into the GL and then sends it downward through the GL meta-protocol stack to the HES-gateway intermediate bus. The data are transferred by the intermediate bus to the Network 2 HES-gateway module where they are passed upward through its GL stack to the GIWF for translation into the application language of Network 2. The data are then passed down the specific Network 2 stack to Network 2 — and then on to the final destination on Network 2.

The specific network stacks are defined by the specific product manufacturer or by existing standards or other specifications. Many of these stacks may be accumulated and maintained in an open source library for use by those developing HES-gateway modules. Also associated with each of these stacks is a GIWF mapping the specific protocol to the abstract system defined as part of the HES-gateway CIF specified in ISO/IEC 18012-2.

7.1.2 Specific model – simple gateway

The simple gateway protocol stack model (one WAN, one HAN) is depicted in Figure 10. It eliminates the GL and intermediate bus by incorporating both HES-link modules on a single module to form a complete one-to-one gateway. This case is shown for conceptual purposes and is beyond the scope of this standard because it is not use the HES-link modular structure.

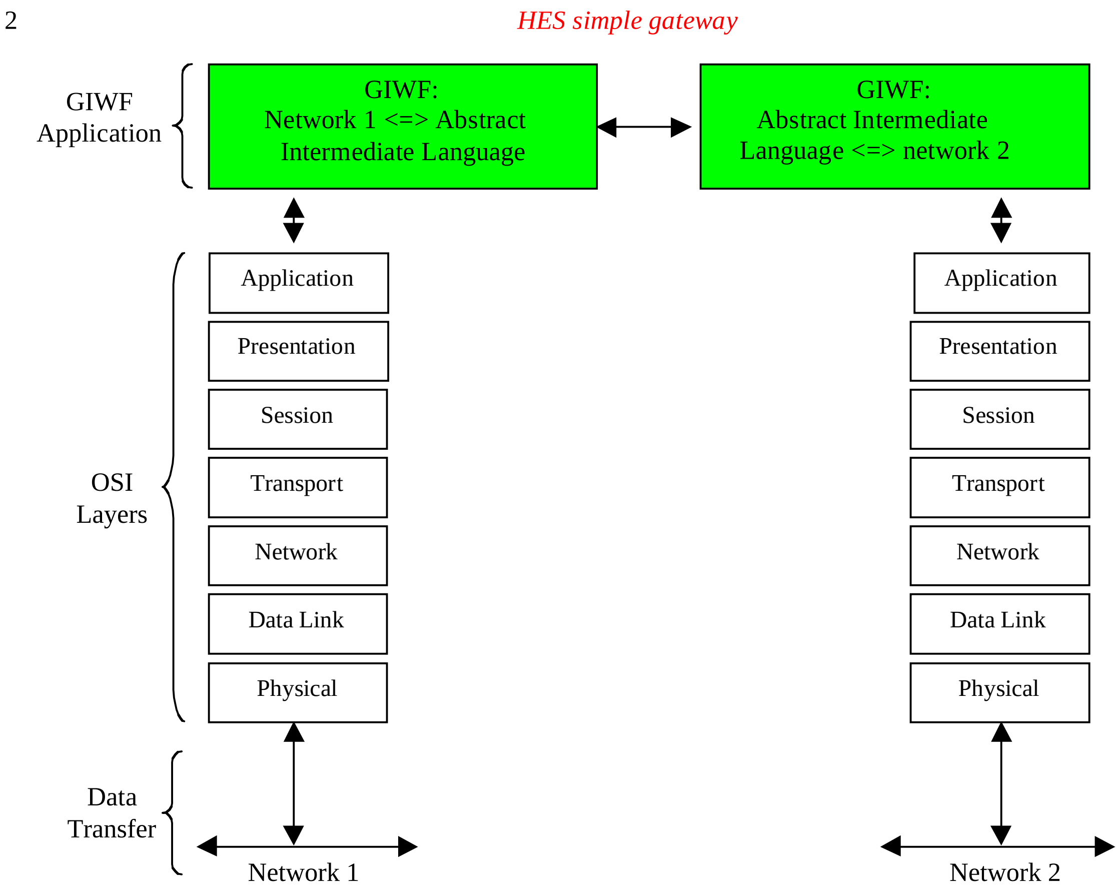


Figure 10 — HES-gateway Special Case: Simple Gateway Protocol Stack Model

7.1.3 GIWF application

It is important to note that the GIWF is the *application* and not part of the associated stacks. The HES-gateway standard ISO/IEC 15045 specifies the GIWF and the GL portions of this model in Part 4 *Network interfaces and interworking functions*. However, there is nothing to preclude additional application functions being added on top of the GIWF, depending on the particular network application being served. For instance, various service agents might reside above the GIWF, monitor the data flow, and modify or control the flow of data, or even initiate data messages, as might be appropriate to any particular application. An example might be the insertion of routing or addressing information, or perhaps to establish or terminate a data-stream connection. GIWF elements for such service functions are specified in Part 5 *Service application interfaces and Interworking functions*.

In the case of the Service Module, the specific network stacks would be absent and only the GL would be employed. For example, typical service agents might include those specified by the Open Service Gateway Initiative (OSGi) or The Application Home Initiative (TAHI) consortia.

7.1.4 Data flow control plane signalling

Figure 9, as a generalised model, might be taken to imply that all communication into and out of HES-gateway traverses all seven layers of the ISO stack. Although this would be true in regard to “control plane” signalling, it would not be strictly true in cases of content (data) plane (or data steam) message traffic. Some traffic will connect at the physical layer, data link layer, or network layer, as perhaps in the case of TLS or IPSec. Some forms of message traffic have no protocol stack, such as analogue TV or Plain Old Telephone Service (POTS). These may need to connect at the physical layer, although they might employ HANs for switching control signalling.

7.2 Intermediate bus (GL bus) and protocol (GL protocol)

The Gateway Link bus, if present, may be implemented in any manufacturer-selected Physical and Data Link Layer communication technology, provided they support the Internet Protocol (IP) as defined in RFC 0791.

The GL bus uses the Internet Protocol (IP) for transmission of information, including both control signalling and content transmission. The GL bus allows distributed gateway implementations (see Annex C).

NOTE Certain characteristics should be taken into account when selecting the appropriate technology to implement the GL bus, namely a common module connector for delivering both data and power and the need to support isochronous communications. As the transfer of isochronous data within the gateway may be frequently needed, it is preferable to support a high data rate and a relatively small number of modules employed to allow for adequate intermediate bandwidth and to avoid congestion. Note that with some standard busses, higher data rates may be anticipated to be available for later implementations that will be upward compatible. The GL bus (including electrical characteristics) is not specified here because (a) it will support IP as a network layer protocol and (b) any interconnection will be done at this layer, as described below.

The Gateway Link (GL), if present, is used here to refer to the set of networking protocols necessary to transfer HES-AIL messages between modules (i.e., HES-link modules) over the GL Bus. HES-AIL is an HES abstract intermediate application language that supports HES product interoperability, specified in ISO/IEC 18012-2. The GL protocol is defined in such a way as to allow the GIWF process to communicate any translated message(s) to or from any specific HAN or WAN-specific subsystem. Existing commonly used networking protocol standards and specifications are specified for the GL. These protocols comprise three levels: 1) lower layer protocol (i.e., physical and data link layers), 2) middle layer protocol (i.e., network layer), and 3) upper layer protocol (i.e., transport, session, presentation and application layer).

7.2.1 Lower layers

The lower layer protocol allowed may include media and standardized data link protocols that support IP; specifically, any from the IEEE 802.3, 802.11, 802.15 suite or protocols (including wired, wireless RF, PowerLine, etc.) that can provide an IP interface to the GL as specified in this standard (see below).

7.2.2 Middle layers

This standard incorporates by reference the Internet Protocol (IP) (RFC 0791) for the GL Network layer. Transport layer functions are provided by UDP/IP (see below).

7.2.3 Upper layers

The upper layer GL protocol services are provided by DDS/RTPS and shall meet the following requirements: 1) support asynchronous, connectionless messaging, 2) provide transport layer functions (i.e., acknowledged or datagram service, QoS, etc.), 3) provide publish-subscribe data delivery mechanisms, 4) support a real-time environment, and 5) be relatively lightweight and modularly configurable according to performance and feature requirements of individual GL modules. OMG DDS/RTPS meets these criteria and is specified for the GL upper layers (see criteria summarized in further detail below). This protocol interfaces at the top of the application layer with the GIWF processes, *network interfaces and interworking functions*, defined in ISO/IEC 18012-2.

a) 1. Only needs to support the ISO/IEC 18012 series event asynchronous event bus (i.e., transparent to the applications that are communicating through the gateway);

b) 2. Requirements for gateway link protocol:

   1) Minimal execution footprint;

   2) Designed to run on UDP/IP (no requirement for TCP/IP between HES-Link modules);

   3) Manage multiple senders through a single UDP communication instance (efficient use of IP stack resources);

   4) One-to-many communication model (for efficient support of 18012 series asynchronous event bus);

   5) eSupport for both best-effort and reliable communication (UDP/IP is not reliable);

   6) Optimized for time-sensitive applications (e.g., healthcare, distributed energy management);

   7) Fault tolerance to support networks without single points of failure (in support of multiple distributed HES-Link modules);

   8) Configurable to allow optimal balancing of reliability vs. time-sensitive requirements;

   9) Does not introduce any blocking or time-outs that would cause unpredictable communication performance.

In regard to the forgoing criteria, the HES gateway environment is not significantly different than an industrial control environment, and the enhanced performance, efficiency, and reliability do not add and possibly reduce unnecessary complexity or redundancy in hardware/software implementations.

NOTE OMG DDS/RTPS on top of UDP/IP was developed for use in industrial control systems. It was developed by the Object Management Group (OMG) as Data Distribution Service (DDS). DDS/RTPS is a standardized connectionless peer-to-peer system that employs a publish-subscribe real time data distribution protocol that rides atop UDP/IP and supports datagram, acknowledged, and multicast modes, and also supports such features as deadline, failover, publisher arbitration, bandwidth control, reliability tuning, QoS, and others.

7.3 Gateway management

The HES-gateway system, if implemented as a Distributed Gateway System, has no central controller. Modules may be installed at any time and a set of basic network management elements provided on each module will allow dynamic self-configuration. Depending on system or service requirements, more advanced network management elements could later be added in the form of a specialised Service Module.

Annex A
(informative)

Case examples

A.1 Overview of case examples

This section includes block diagrams depicting a series of case examples of “typical” or “possible” HES-gateway configurations or scenarios applying the generalised architecture specified in this standard. These case examples are provided for purposes of illustration.

A.2 VDSL scenario

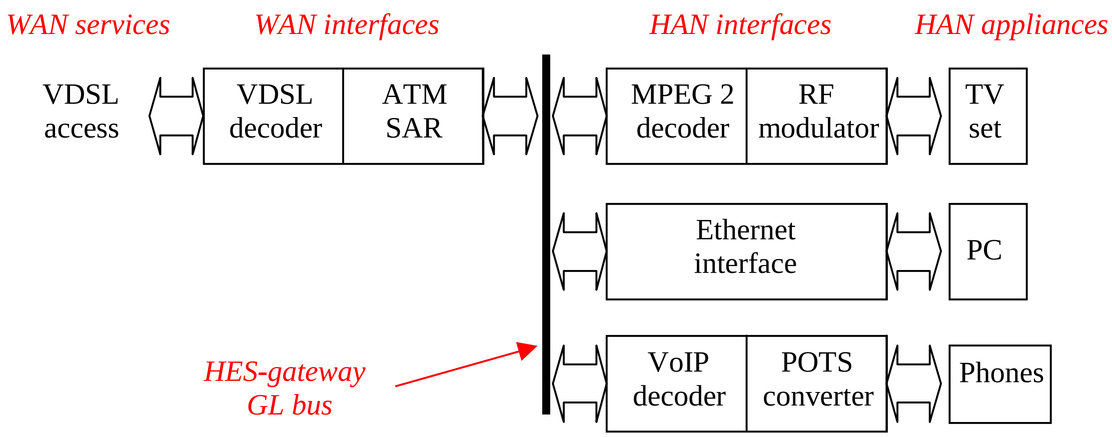


Figure A. 1 — VDSL scenario

Figure A. 1 depicts the use of VDSL (Very-high-speed Digital Subscriber Line) service to provide voice, video and data service to the home. In this particular case, voice, video and data packets are delivered via VDSL (layer 1) service employing ATM (Asynchronous Transfer Mode) packet switching technology. The video packets, using MPEG 2 compression, in this example, are then decoded and converted to conventional RF modulated video and audio signals for display on a conventional TV set. A typical installation might employ more than one MPEG 2 interface module, depending on the capacity of the VDSL access service and the needs of the viewer. The MPEG 2 interface might also include a remote control receiver for initiating data traffic back to the video source to change channels or other purposes. In this example, the VoIP decoder could use a POTS (Plain Old Telephone Service) converter to provide multiple phone lines to the home and allow the use of conventional telephone sets. The Ethernet interface might also provide a hub for multiple PCs or other Ethernet-based appliances.

A.3 DBS/DSL scenario

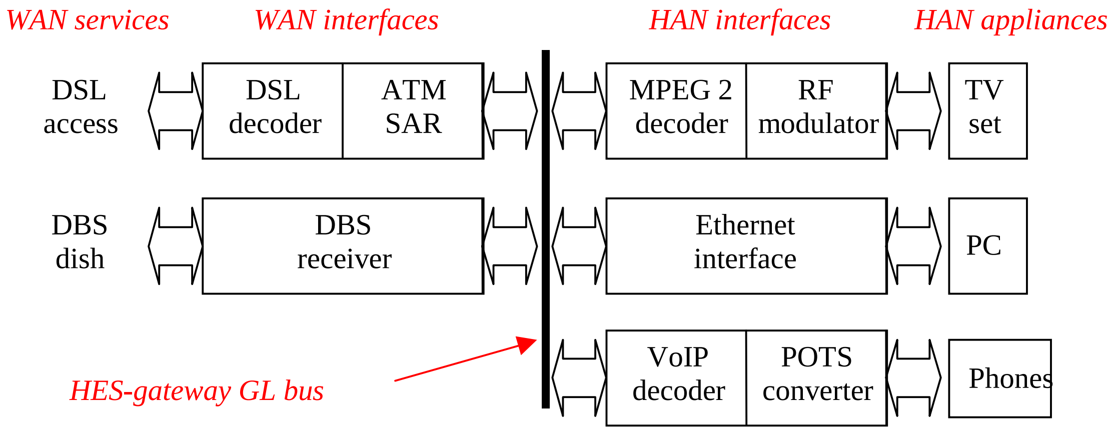


Figure A. 2 — DBS/DSL scenario

Figure A. 2 depicts the use of DBS (Direct Broadcast Satellite) combined with DSL (Digital Subscriber Line) service to provide voice, video and data service to the home, much as in the preceding figure. In this case, video is provided by DBS and voice and data are provided by DSL. This arrangement may be employed where VDSL service is not available, or where DBS delivery is more advantageous. Also, DSL provides a reverse channel for the DBS service for PPV (Pay-Per-View), service provisioning or other interactive applications.

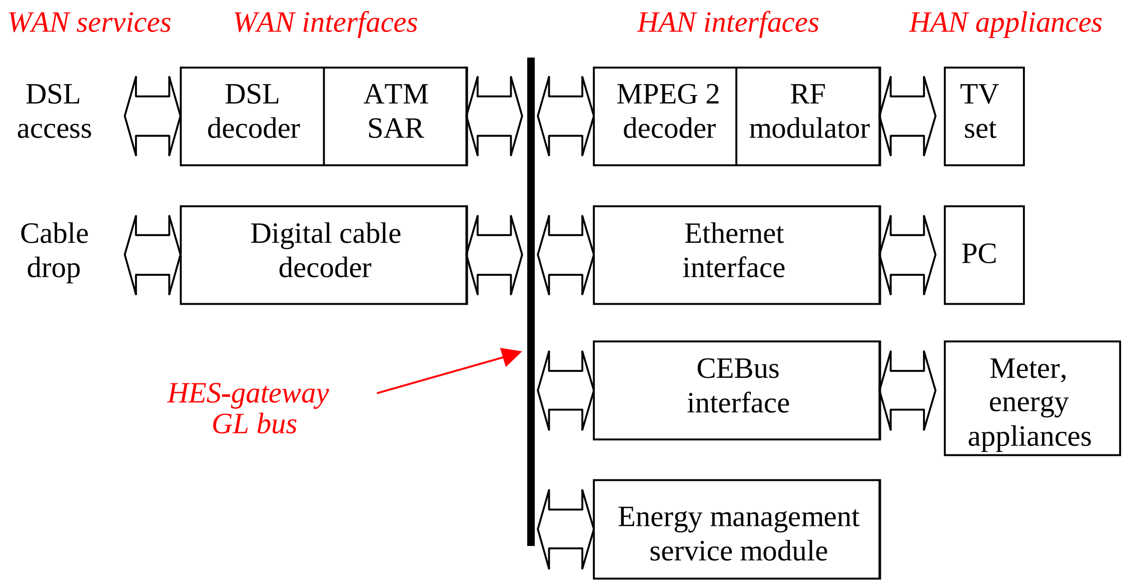


Figure A. 3 — Cable/DSL/energy management/CEBus scenario

Figure A. 3 depicts the use of cable combined with DSL service to provide video and data service to the home. Such an arrangement might be employed when data service over cable is not available or when DSL might also be desirable for certain services. In this example, a Consumer Electronics Bus (CEBus) interface is also shown that might be used for remote meter reading and energy management functions. These functions might be managed by a special Service Module provided by an energy utility or other service provider offering efficiency and cost advantages to the user.

A.4 Healthcare management scenario

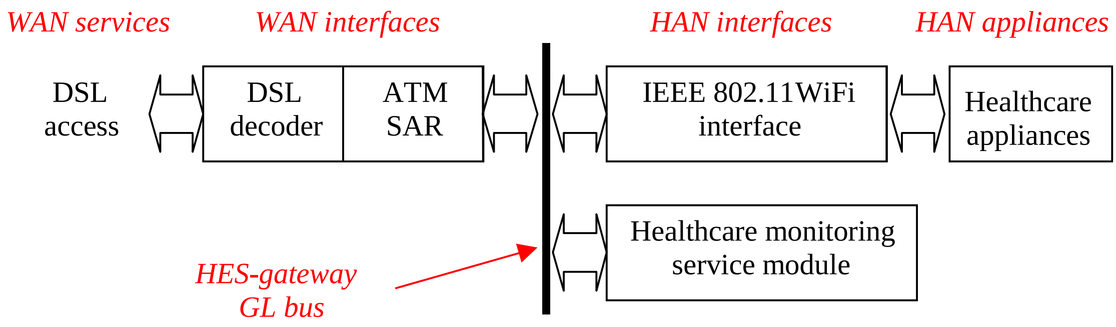


Figure A. 4 — Healthcare management suggestion

Figure A. 4 depicts the use of DSL service to provide data service to specialised healthcare monitoring and management applications in the home. The specific healthcare appliances might employ wireless connections and be managed by a special Service Module provided by medical or healthcare related services. The DSL access could also be shared with other entertainment, data or communication applications shown in the previous figures.

A.5 DSL/HomePNA scenario

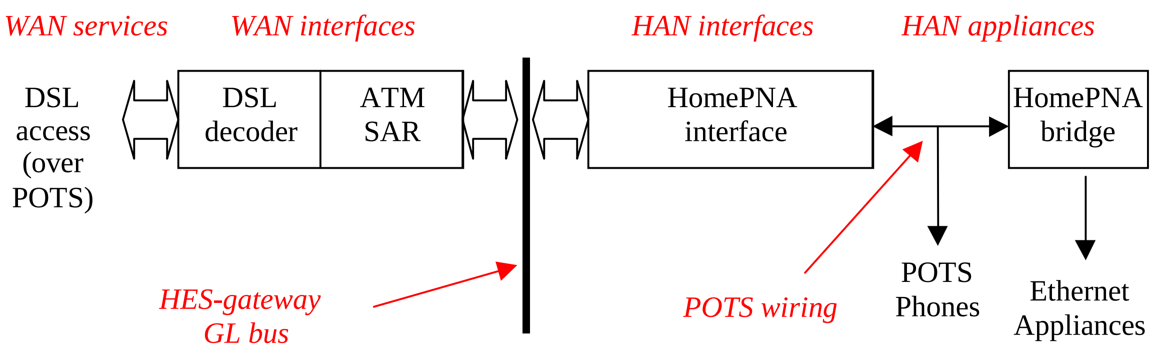


Figure A. 5 — DSL/HomePNA Scenario

Figure A. 5 depicts the use of DSL service and HomePNA (Home Phone Network Alliance) signalling technology utilising the existing POTS wiring and connectors to provide combined conventional voice and Ethernet data services. The HomePNA interface module combines the analogue voice POTS signals with the digital Ethernet signals to convey the voice and data services from the WAN interface. A HomePNA bridge can extract the Ethernet/HomePNA signals or provide other appropriate formats, such as USB (Universal Serial Bus) or PCI (Peripheral Component Interconnect), to be used by various data application terminals.

Note: that if one of the Ethernet Appliances on the HAN is a bridge to another HAN technology, such as 802.11x (wireless) or HomePlug (utilising Power Line Carrier (PLC)), this simple HAN can be expanded with segments based on different HAN technologies. This expansion of the HAN opens the possibility of receiving other WAN services through separate HES-gateways connected to these appended HAN segments.

Annex B
(informative)

Intermediate logical bus topologies

B.1 Overview of intermediate bus topologies

This Annex shows HES-gateway intermediate bus topologies. The intermediate bus may be implemented in either a mesh topology or a star topology; or it may include a combination of both. These topological examples are provided for purposes of illustration.

B.2 Mesh topology

The mesh topology provides a direct, dedicated path from each node to every other node. Packet routing or switching is accomplished by appropriate hardware in each node in order to select a dedicated signal path between each module (node). A single backplane of connected modules (nodes) would require a sufficient number of electrical conductors to provide a separate transmit, receive, common, and ground between each module that might share the common backplane. A diagram of the mesh topology is provided in Figure B. 1.

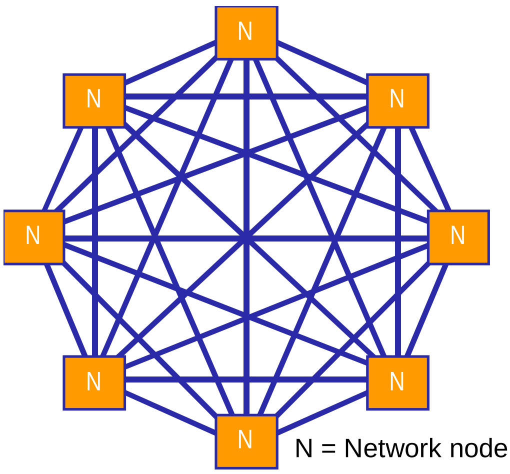


Figure B. 1 — Mesh Topology

B.3 Star topology

The star topology shown in Figure B. 2 provides a shared path between each node in the network. Packet routing or switching is accomplished by a central switch device that reads packet addresses and directs the packet to the appropriate destination node. The star topology is more efficient in the use of connectors and conductors, but requires an additional infrastructure element to provide the switching function. Also, the star topology imposes speed limitations because of the shared nature of the transmission path through the central switch.

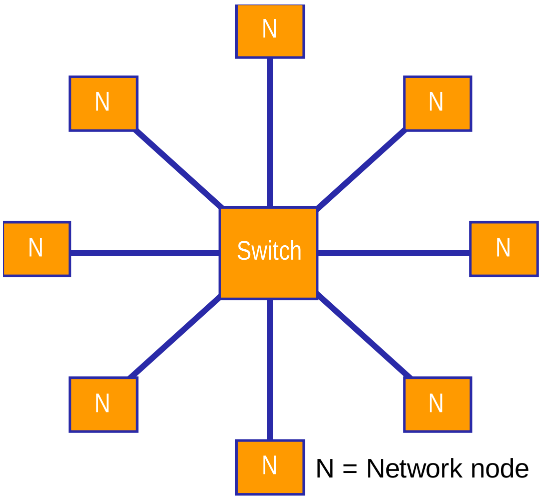


Figure B. 2 — Star Topology

B.4 Combined mesh and star topology

The mesh topology may be combined with a star topology. In this case, one of the mesh nodes routes packets to the switch of the star network. Such a node needs sufficient capacity to avoid creating a “bottleneck” between the two networks. A diagram of the combined mesh and star topology is provided in Figure B. 3.

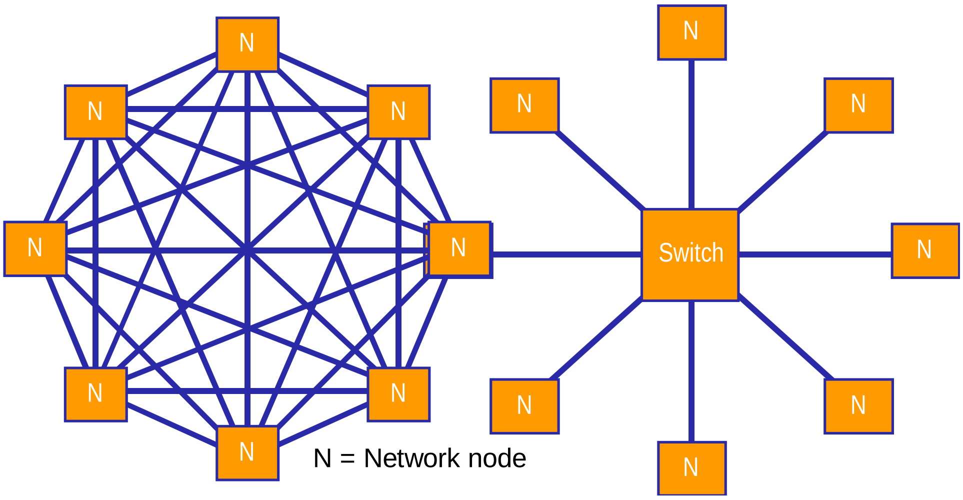


Figure B. 3 — Combined Mesh and Star Topology

Annex C
(informative)

Distributed gateway extension methods

The GL bus allows gateways to be implemented either entirely within a single unit (ie., enclosure) or distributed between multiple units, or even partially within consumer appliances.

The GL bus can be extended by networking between clusters of modules, permitting a distributed gateway, which is possible because each the modules (i.e., HES-link module), if present, are required to support the IP protocol. Such modules can be independently powered or clusters may obtain power separately using modular wall plug power supplies or other means, thus easing the task of expanding the HES-gateway system incrementally.

Alternatively, the intermediate bus can be extended by the use of a tunnelling protocol employing one of the HAN networks common to both clusters. Figure 11 depicts the HES-gateway intermediate bus extension methods described above.

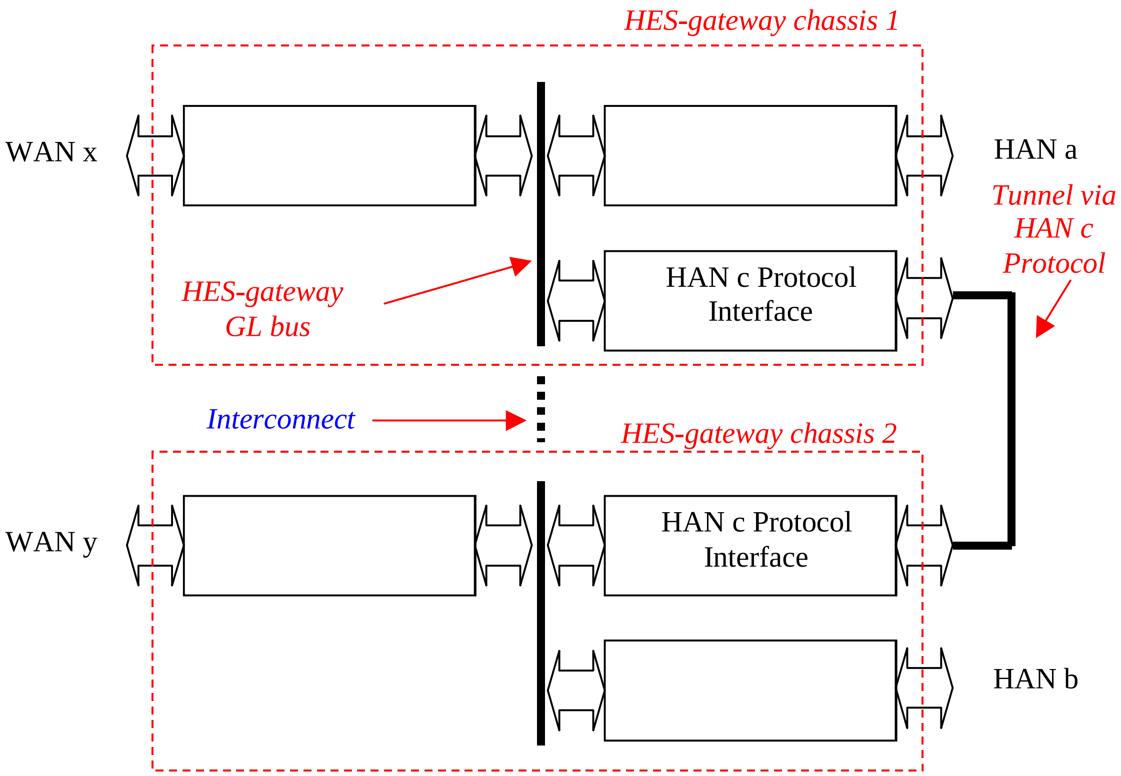


Figure C. 1 — HES-gateway GL Bus Extension Methods

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