ISO/IEC 15045-2

Edition 1.0 2012-07

INTERNATIONAL STANDARD

colour inside

Information technology – Home electronic system (HES) gateway –
Part 2: Modularity and protocol

ISO/IEC 15045-2:2012(E)

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Information technology – Home electronic system (HES) gateway – Part 2: Modularity and protocol

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE P

ICS 35.200

ISBN 978-2-83220-190-9

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INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) GATEWAY –

Part 2: Modularity and protocol

FOREWORD

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International Standard ISO/IEC 15045-2 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

The list of all currently available parts of the ISO/IEC 15045 series, under the general title *Information technology – Home electronic system (HES) gateway*, can be found on the IEC web site.

This International Standard has been approved by vote of the member bodies, and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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INTRODUCTION

As the market has developed for home systems, the number of communications protocols for home networks and for access to the home has increased. This has occurred even while ISO/IEC standards for these networks have been developed and published. Continuing technological progress also suggests that such proliferation will persist, and that no single technology or standard is likely to prevail.

Therefore, standards to enable interoperability among applications implemented on incompatible networks are being written. This standard addresses the gateway, which provides an interconnection between an access network (a wide area network) and one or more home networks (home area networks).

This standard 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 small buildings. ISO/IEC 15045-1, published in 2004, defines a basic model of the residential gateway, including functional requirements.

This standard defines a common framework for implementing gateway platforms to achieve interconnection and interoperability of home system products and applications. The objective is to support products from any manufacturer or provider in a manner that is safe, reliable, predictable and consistent. Service providers such as cable TV companies, Internet service providers and telephone companies are each installing a gateway to deliver digital data and audio/video streams, therefore some houses contain multiple gateways. As a consequence, an optional feature of this standard specifies how to interconnect multiple gateways in one house so that these gateways can co-ordinate service offerings.

A communications gateway provides an interconnection between a wide area network (WAN) and local area network (LAN) where the protocols on each network differ. The gateway is responsible for protocol translation of signals, message formats and timing. The home systems industry has adapted LAN technology for Home Area Networks (HANs). Ideally, each home system would be based on one HAN and all attached devices and appliances would use one communications protocol. In reality, multiple incompatible HAN technologies are being marketed. Also, each service provider is installing a separate gateway (e.g., DSL, cable broadband and satellite). Therefore, it is possible that a user will purchase and install products employing two (or more) dissimilar HANs within the same premises. These HANs may be connected to WANs via separate incompatible gateways. However, the user expects these products and networks to behave as if they were the same logical network in order to deliver home services, such as:

- entertainment (audio/video);
- data/internet access;
- communication (telephony);
- energy management;
- health care and monitoring;
- environmental control (heating and cooling);
- security and safety monitoring;
- appliance telemetry;
- lighting control.

This standard accomplishes interoperability by specifying a modular architecture and set of protocols for interconnecting the modular elements with a common signalling bus. It relies on a common intermediate language to achieve interoperability among applications called the Common Interoperability Framework (HES-CIF), described in this standard. Parts of ISO/IEC 18012 define the network-specific interworking functions needed to provide conforming products.

This International Standard defines a universal gateway system by specifying interfaces between

- 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.

Summing up, this standard shows how to build a gateway out of modular building blocks. This International Standard does not describe or specify gateway applications, service requirements, network topologies, or how gateways are to be applied within home networks and systems. These specifications are left to other home gateway-related standards.

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) GATEWAY –

Part 2: Modularity and protocol

1 Scope

This part of ISO/IEC 15045 specifies a gateway architecture that provides an interconnection between one or more Wide Area Networks (WANs) and one or more Home Area Networks (HANs). This standard is not needed for a "simple gateway" linking one WAN to one HAN where there is no intention of future expansion, as illustrated in Figure 1. The scope of this standard applies to a "distributed gateway," as illustrated in Figure 1 and is also referred to in ISO/IEC 15045-1 as the Complex Modular Gateway. Also, this standard specifies how separate gateways in a single house can interoperate to provide co-ordinated functions.

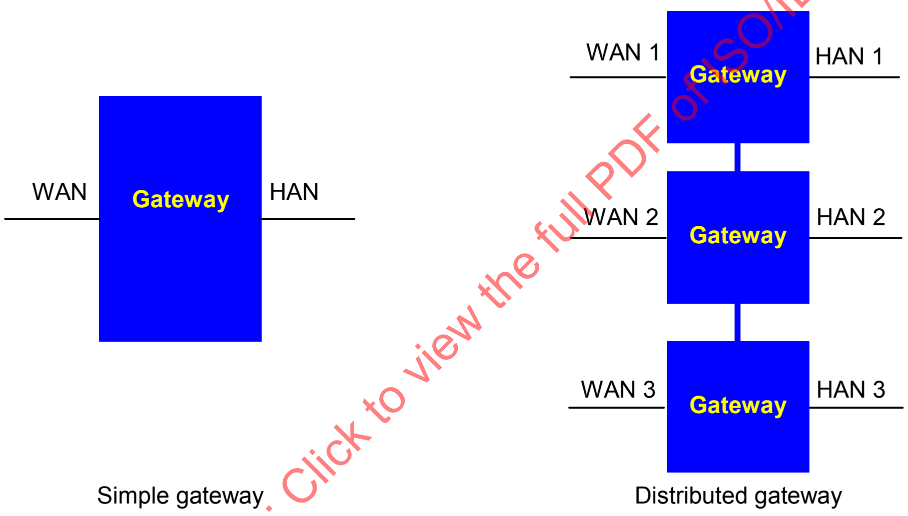

Figure 1 – Options for home-gateway configurations

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 18012-2:—, *Information technology – Home electronic system (HES) – Guidelines for product interoperability – Part 2: Taxonomy and application interoperability model*[1]

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

1 To be published.

3.1.1
appliance
apparatus intended for household or similar use

[SOURCE: IEC 60050-151:2001, 151-11-23]

Note 1 to entry: For example a clothes washer, water heater, television, inverter, etc.

3.1.2
bridge
interface between dissimilar lower layer networks

Note 1 to entry: A bridge may provide services at layer 1 (physical layer) or layer 2 (data link layer).

3.1.3
bus
common or shared communication path or highway

Note 1 to entry: A bus is a means of interconnecting devices under a single administration, such as a LAN comprising devices sharing a common set of pathways.

Note 2 to entry: A distinction may be drawn between "logical" and "physical" buses when bus topologies are considered.

3.1.4
common interoperability framework
CIF
abstract intermediate language expressions for tranlating HAN or WAN-specifid messages

Note 1 to entry: A common interoperability framework includes

a) an HES-AIL (Abstract Intermediate Language) and

b) 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

3.1.5
compatibility
ability of two or more networks within a premises to be mutually tolerant and that do not interfere with one another

Note 1 to entry: The networks are co-existent, but they are not necessarily interoperable.

3.1.6
component
logical subunit of a larger, encompassing concept

Note 1 to entry: For example, the concept of interoperability is subdivided into constituent components such as safety, management and operation. These constituent components are further subdivided 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).

3.1.7
device
distinct physical unit on a network

Note 1 to entry: A device 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).

3.1.8
distributed gateway
HES-gateway implemented as separate but interconnected modular elements

3.1.9
gateway
interface between dissimilar networks

Note 1 to entry: A gateway may provide services up to OSI layer seven and above.

Note 2 to entry: The HES-gateway provides protocol and language translation services above layer seven.

3.1.10
gateway link
GL
full seven-layer protocol stack and the physical bus internal to and specific to the HES-gateway architecture to connect GL modules

Note 1 to entry: The GL is used to communicate the HES-AIL encoded messages (resulting from the GIWF translation process) between HES-link modules and is not intended to link to end user devices. 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".

3.1.11
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

3.1.12
HES abstract intermediate language
AIL
language to represent or express the messages of any HAN or WAN

Note 1 to entry: AIL 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).

3.1.13
HES-gateway
gateway conforming to ISO/IEC 15045-2

Note 1 to entry: The HES-gateway provides protocol and language translation services above layer seven in conformance with this standard.

3.1.14
HES-link module
device that provides the required services for one of the networks of the HES-gateway system

Note 1 to entry: 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.

3.1.15
home area network
HAN
network specifically serving nodes, devices, components and functions within a home or premises

3.1.16
home electronic system
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

3.1.17
interface module
HES-link module that provides an interface to a particular HAN or WAN network

3.1.18
interoperability
ability of logical entities to function together for applications on a network or between multiple networks

3.1.19
management information base
MIB
memory function in some portion of the gateway that stores information useful for various network management functions

Note 1 to entry: No relationship is implied here with Simple Network Management Protocol (SNMP) from which the term "MIB" is borrowed.

3.1.20
network
distinct interconnection or set of nodes or devices that share a common communication protocol and are mutually compatible and interoperable

3.1.21
object
program or unit of software functionality

Note 1 to entry: This definition is similar to that traditionally used in object-oriented programming.

[SOURCE: ISO/IEC 18012-2:–[2], 3.1.27]

3.1.22
product
device or network of devices that may be purchased to make up a home electronic system

3.1.23
router
interface between dissimilar middle layer networks

Note 1 to entry: A router may provide services at layer 2 (data link layer) or layer 3 (network layer).

3.1.24
service module
HES-link module that provides a specific service or process for the home that requires access to one or more networks available to the HES gateway

3.2 Abbreviations

AAA	Authentication, Authorization and Accounting
ATM	Asynchronous Transfer Mode
CIF	Common Interoperability Framework (as specified in 3.1.4)
DBS	Direct Broadcast Satellite
DDS	Data Distribution Service
DG	Distributed Gateway
DGS	Distributed Gateway System
DSL	Digital Subscriber Line
GIWF	Generic InterWorking Function

2 ISO/IEC 18012-2 is planned to be published together with ISO/IEC 15045-2.

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

An HES gateway conforming to this standard 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 6;
- HES-link modules shall implement GL bus interfaces conforming to the requirements identified in 8.3.
- HES-link modules shall implement the GIWF in the manner specified in 7.1.2.

As described in the scope, this standard is not intended to apply to the non-modular “simple gateway” situation where no future expansion is planned (i.e., no future connection to additional WANs or HANs).

5 Architecture

5.1 Architectural model

ISO/IEC 15045-1 specifies the functional requirements and basic framework for the residential gateway. This standard specifies the modular architecture, the interconnection of the modules (employing intermediate busses or HES-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.

The architecture described here allows interconnection of multiple residential gateways, where more than one may be installed in various locations within a home. These gateways may be installed separately by various service providers. An optional feature of this standard specifies how these gateways may exchange messages and function as a single gateway. In other words, this standard anticipates two possible situations, as follows.

a) Simple gateway – one WAN connected to one HAN.

b) Distributed gateway – one or more interconnected gateways operating as one entity.

In case a) and if no of future expansion is planned, this standard need not apply. This standard is only intended to apply to case b).

This standard defines a gateway system of modular expandability employing a set of HES-link modules. Each WAN and HAN connected to a distributed gateway should include an interface, known as an HES-link module, that conforms to this standard, as shown in Figure 2.

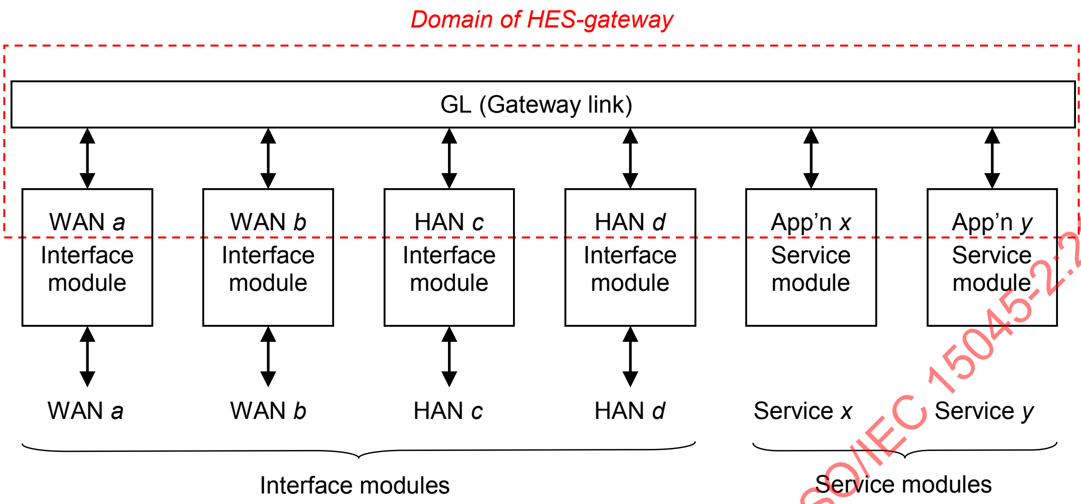

Figure 2 – Interoperating networks and domain of HES-gateway standard

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. The gateway may also provide a place to situate 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 2.

This standard provides a design guideline to create products that can offer interoperable gateway functionalities. It describes all layers (or stacks) of the intermediate protocol, known as the gateway link (GL) protocol, needed to interconnect an interoperable array of HES-Link Modules, which consist of specific WAN Interface Modules, HAN 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) described in 7.1.1. Such CIF includes generic interworking functions (GIWF) that reside above layer seven, (i.e., above the application layer of the ISO reference model, ISO 7498), and interfaces to the HAN/WAN protocol stacks.

The 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 or
- 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.

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. Alternative distributed architectural models are depicted in Figure 3. In this figure, "W" and "H" represent WAN and HAN HES-link modules, respectively. Methods of implementing these alternative models are further described in Annex C. The distributed system may be thought of as simply a combination of smaller centralised systems. These alternative architectural models are referred to in ISO/IEC 15045-1 as the “complex modular implementation”.

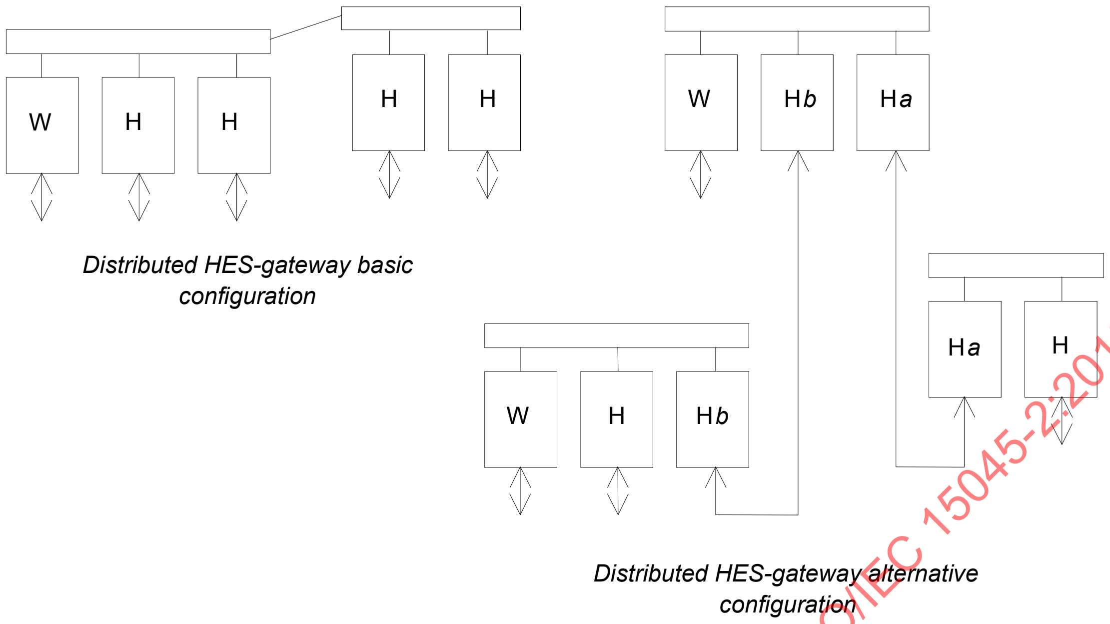

Figure 3 – Alternative distributed modular architectural models

5.2 Design philosophy

5.2.1 General approach

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.

5.2.2 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.

NOTE For example, the most generalised implementation of the DGS would use a distributed computing model consisting of a network of semi-autonomous interfaces and agents running in dedicated embedded microcomputers situated on individual modules (e.g., circuit cards) and interconnected by a "backplane." Multiple backplane units could be linked together to form a single logical 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.

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. Therefore the semantics are transposed from one product/service domain to another by applying the interoperability taxonomy principles described in Clause 7 of 18012-2 of and the object schema described in Clause 8 of ISO/IEC 18012-2. This 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 this 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.

5.2.3 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 principle 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.

NOTE In other words, the HES-gateway does not have to be manufactured in a modular fashion, however, it should be DEFINED here within a modular framework so that CIF operates. This is because the CIF itself is a modular concept. Conformity is assessable by the interchange of modules or by the passing of CIF messages at the modular interface.

In any case (see above), implementations of HES-link modules compliant with this standard shall conform to the modular architecture as specified in Clause 6.

5.2.4 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 described in 7.1.1. 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.

In any case (see above), implementations of HES-gateway modules compliant with this standard shall conform to the modular architecture specified here, including conformance with ISO/IEC 18012-2.

6 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). Each message shall be translated into a common intermediate language, the HES Abstract Intermediate Language (HES-AIL) described in 7.2 of ISO/IEC 18012-2 as application domain. The translation process in the HES gateway is performed by a network-specific Generic Interworking Function (GIWF) specified in 7.1.2. 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 on reference models are provided in Annex A).

NOTE An optional specialised implementation such as the simple gateway (i.e., see A.2.6.2 of ISO/IEC 15045-1:2004) 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 Annex C.

7 HES-gateway system

7.1 Conceptual process model

7.1.1 Common interoperability framework (CIF)

The generalised HES-gateway system model is depicted in Figure 4, known as the CIF (Common Interoperability Framework). The various systems in Figure 4 comprise networks that

- connect the home to service providers via a wide area network and

  (This is the primary objective of the gateway: interconnect WAN and HAN networks.)

- connect HAN to HAN.

  This is a secondary objective of the gateway and is required only if the house includes multiple HANs that do not conform to the same communications protocol. In that case, the HES gateway provides the following additional services

  - linking 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 and
  - interconnecting home applications (e.g., to co-ordinate lighting with turning on lights in case of a fire alarm).

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.

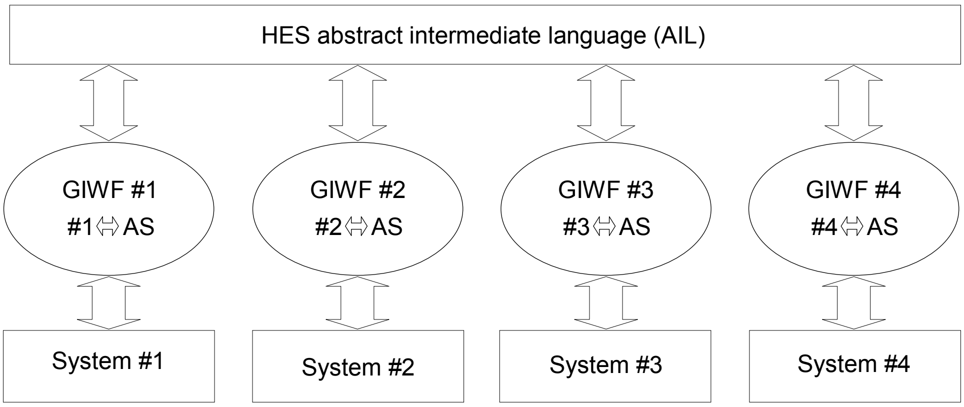

Figure 4 – Common interoperability framework (CIF)

The CIF represents the home electronic system – common interoperability framework described in this standard.

The HES abstract intermediate language (HES-AIL) for enabling interoperability among applications on different networks is specified in 7.2 of ISO/IEC 18012-2:2012[3] as the application domain. The HES-AIL shall be implemented when multiple gateways are combined to a distributed gateway, as shown in Figure 1.

The HES-AIL comprises a 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) described in 7.1.2.

7.1.2 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 an application language. In terms of the seven-layer OSI reference model (ISO/IEC 7498), 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 Clause 8 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 interworking functions and provides other requirements such as those needed to establish a metadata registry for this type of interfaces and interworking functions.

7.2 Physical architecture

The basic physical architecture of the HES gateway including associated architectural domains is shown in Figure 5.

3 To be published. 2012 = estimated year of publication.

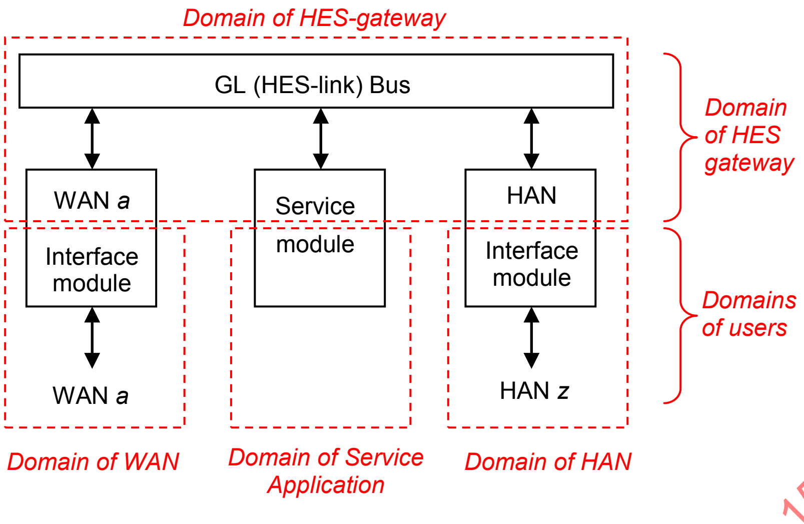

Figure 5 – HES-gateway architectural domains

The HES gateway architecture consists of the domain of the HES gateway specified in this standard and the three user domains of the WAN, the HAN and the Service Application. The upper centre block represents the HES gateway intermediate bus (optionally present) over which the GL/HES-AIL messages are transported (the AIL 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 5 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 18012-2) 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 5 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 (see 7.3.4). The latter two are associated with the domain of HAN.

7.3 Modularity

7.3.1 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 through 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 modules as may be appropriate. The HAN and WAN interface modules shown in Figure 5 may be thought of as HES link modules, as shown in Figure 6.

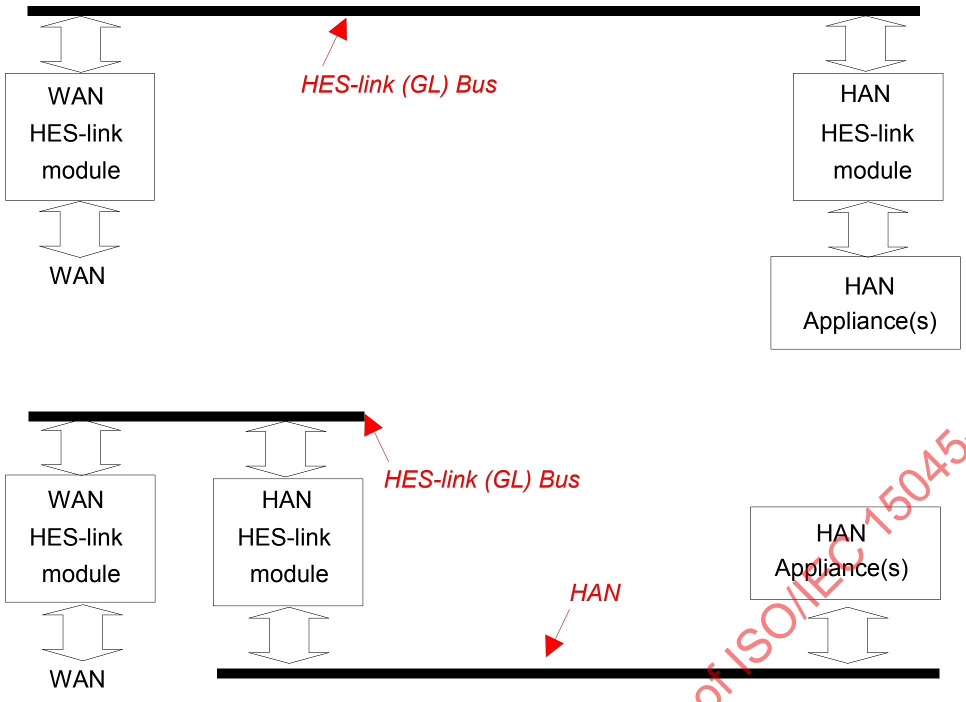

Figure 6 – HES-link module linkage model

Figure 6 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 is physically removed from the HES gateway unit, possibly co-located with a 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). The HES link modules depicted in the following subclauses 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.

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.

7.3.2 WAN access module

The WAN access 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 7. 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 (Local Multipoint Distribution System), MMDS (Multipoint Multichannel Distribution System), IEEE 802.16 (WiMAX, Worldwide Interoperability for Microwave Access), etc.).

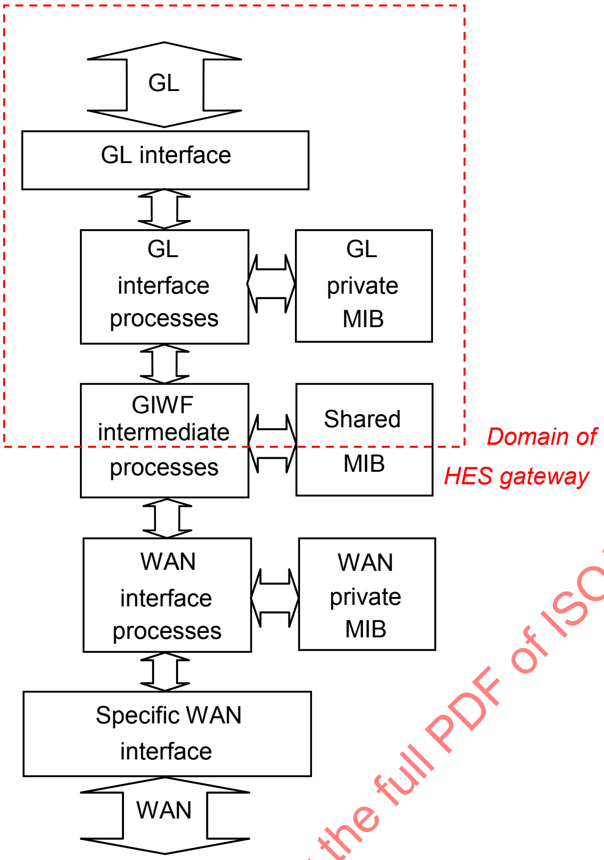

Figure 7 – WAN access module block diagram

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 (Digital Subscriber Line), E1/T1, etc. The elements depicted in Figure 7 are included for illustration purposes only. In practice, they are design matters of manufacturers.

NOTE 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 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 this type of information (e.g., HES-gateway intermediate configuration information, addressing and routing, gateway management information, user preferences, access codes, etc.) within the HES-gateway system.

This subclause describes the architecture of a typical WAN module. The portion of Figure 7 that lies within the domain of HES gateway shall be in conformance with this standard. The structure and content of the remaining portion is entirely up to the specific module manufacturer and is provided here only for illustration purposes.

7.3.3 HAN access module

The HAN access 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 8. 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 ISO/IEC 8802-3, ISO/IEC 14543-3 series, ISO/IEC 14543-4 series IEEE 1394, IEEE 802.11, IEEE 802.15.1, USB etc.

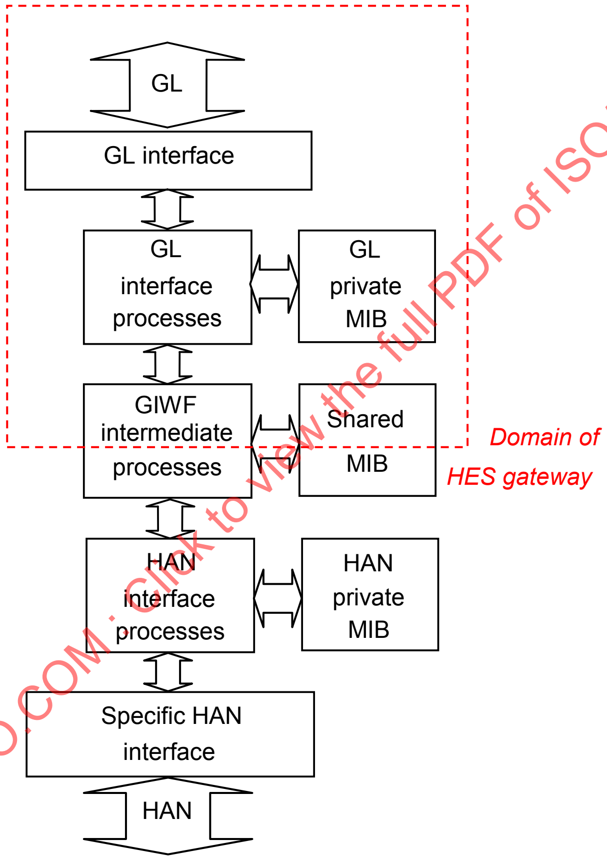

Figure 8 – HAN access module block diagram

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 Figure 8 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.

This subclause describes the architecture of a typical WAN module. The portion of Figure 8 that lies within the domain of the HES gateway shall be in conformance with this standard. The structure and content of the remaining portion is entirely up to the specific module manufacturer and is provided here for illustration purposes only. The HES gateway portion is not responsible for specific knowledge about the HAN configuration or managing its services.

7.3.4 Service module

A third type of module in the HES gateway is the service module, illustrated in Figure 9. The service module resides partly in the domain of the HES gateway and partly in the domain of a private service application process. The service module has no HAN interface but acts as an agent for managing specific services on a HAN or WAN by having access to an intermediate HES gateway (i.e., gateway link) data traffic, and may be associated with specific HAN or WAN services.

NOTE Typical service module applications might include security applications, firewall functions, data encryption, Authentication, Authorisation and Accounting (AAA) energy applications, management (e.g., demand side management, remote meter reading (e.g., “smart meter”), demand response, etc.), entertainment (e.g., iInteractive TV, pay-per-view (PPV), video-on-demand (VOD), etc.), safety and an unlimited number of additional services.

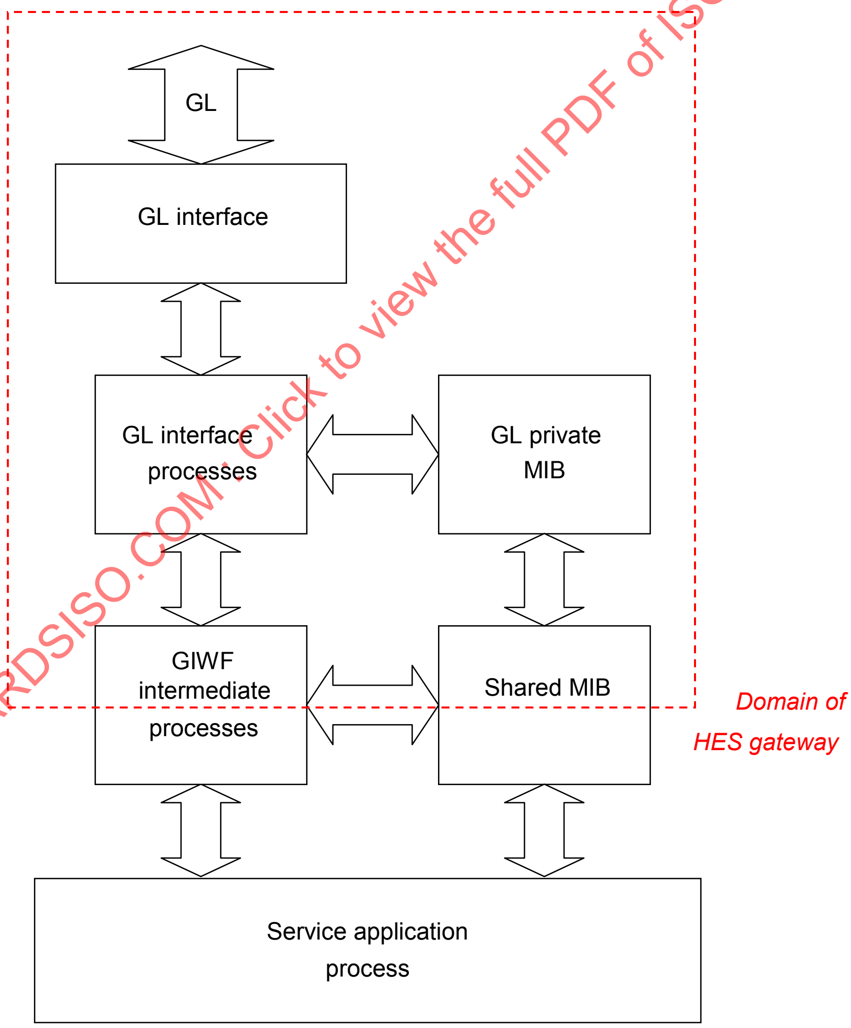

Figure 9 – Service module block diagram

7.4 Data flows

7.4.1 General

The general data flows between the WAN and the HES gateway system are shown in Figure 10, a copy of Figure 7 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.

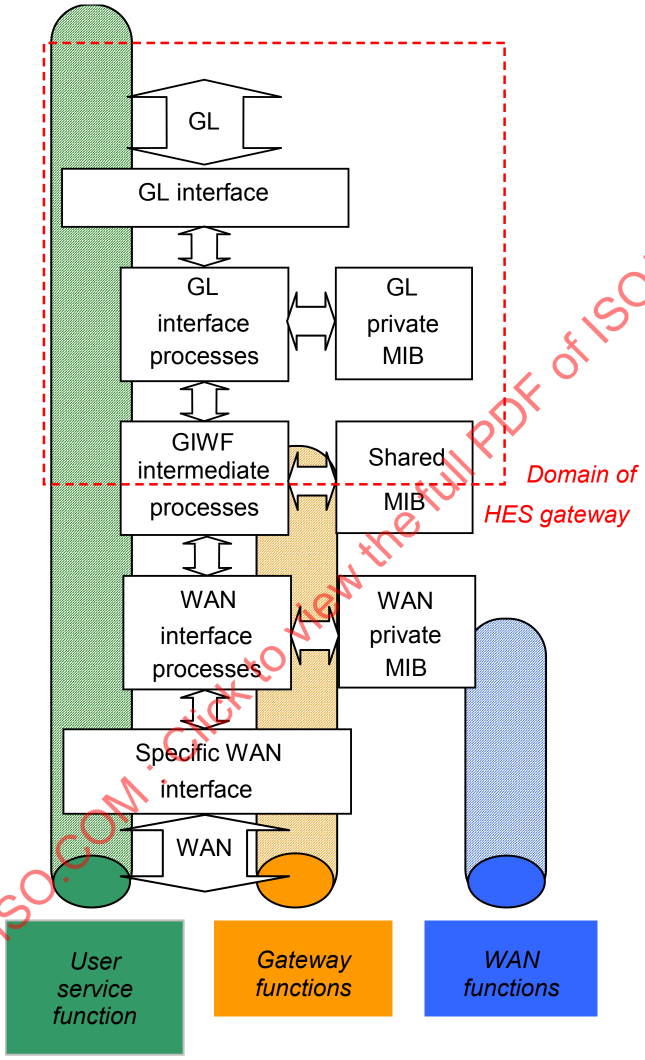

Figure 10 – Data flows

Figure 10 depicts the data flows through a typical module using three vertical "data pipes" inserted into Figure 7 for illustration purposes. In this example, 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.

7.4.2 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.

7.4.3 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).

8 Intermediate processes

8.1 General

The HES-gateway intermediate processes include

a) protocol stacks for both specific networks and the GL meta-protocol,

b) the GL protocol,

c) the GL bus and

d) network management functions.

8.2 Protocol stacks

8.2.1 Generalised model

A generalised model of the HES-gateway protocol stacks is shown in Figure 11. 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 11 apply to either WAN or HAN modules. The GL protocol shall not be confounded 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.

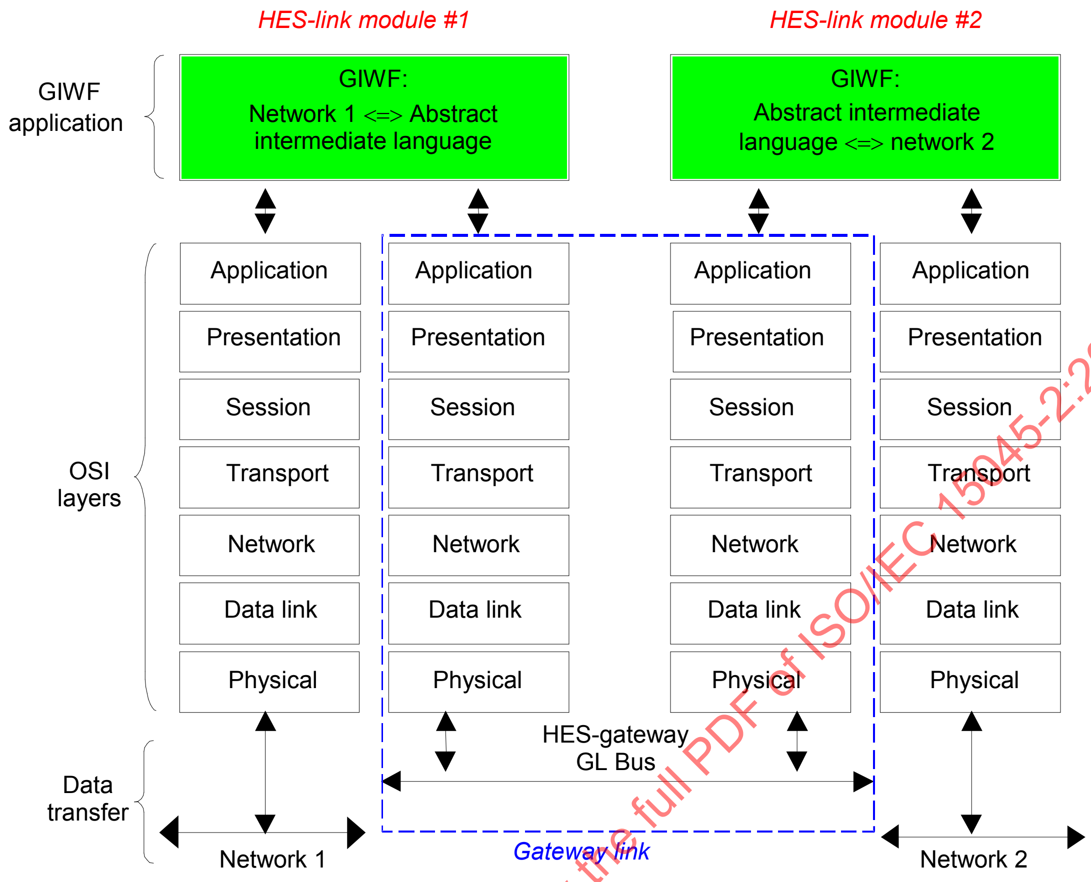

Figure 11 – HES-gateway generalised protocol stack model

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.

8.2.2 Specific model – Simple gateway

The simple gateway protocol stack model (one WAN, one HAN) is depicted in Figure 12. 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 does not use the HES-link modular structure.

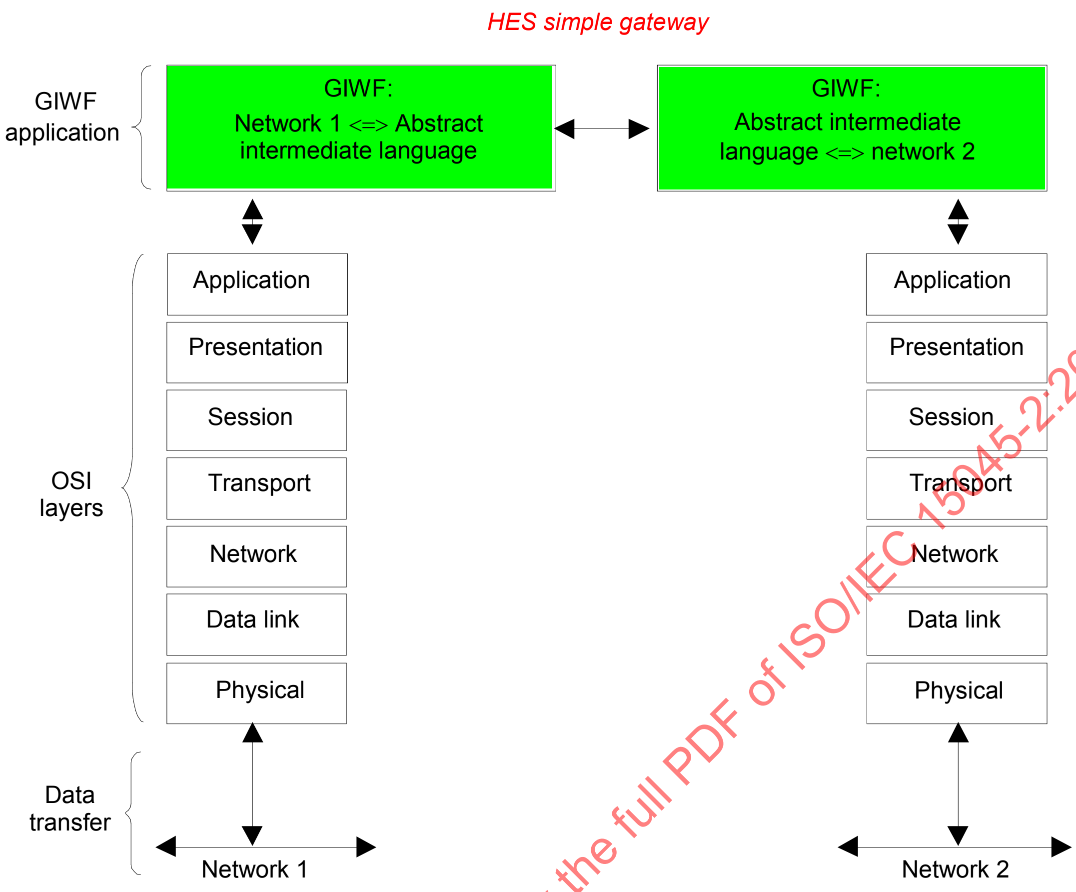

Figure 12 – HES-gateway special case: simple gateway protocol stack model

8.2.3 GIWF application

It is important to note that the GIWF is the **application** and not part of the associated stacks. The HES interoperability guidelines standard ISO/IEC 18012-2 specifies the GIWF. 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.

In the case of the service module, the specific network stacks would be absent and only the GL would be employed.

NOTE For example, typical service agents include those specified by the Open Service Gateway Initiative (OSGi) or The Application Home Initiative (TAHI) consortia.

8.2.4 Data flow control plane signalling

Figure 12, as a generalised model, might be taken to imply that all communications into and out of the HES gateway traverses all seven layers of the ISO stack, see ISO/IEC 7498 series. 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.

8.3 Intermediate bus (GL bus) and protocol (GL protocol)

8.3.1 General

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 on the one hand it will support IP as a network layer protocol and on the other hand 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 the following three levels:

a) lower layer protocol (i.e., physical and data link layers);
b) middle layer protocol (i.e., network layer) and
c) upper layer protocol (i.e., transport, session, presentation and application layer).

8.3.2 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, IEEE 802.11, IEEE 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).

8.3.3 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).

8.3.4 Upper layers

The upper layer GL protocol services interface with the GIWF processes, network interfaces and interworking functions defined in ISO/IEC 18012-2. The upper layer GL protocol shall meet the following requirements, it shall:

a) support the ISO/IEC 18012-2 asynchronous event bus (i.e., the upper layer GL protocol is transparent to the applications that are communicating through the gateway);
b) be designed to run on UDP/IP (see 8.3.3);
c) be a one-to-many communication model (for support of the ISO/IEC 18012 series asynchronous event bus);
d) support for both best-effort and reliable (i.e., guaranteed) delivery communication modes (since UDP/IP is not reliable);

e) have a fault tolerance; there will be no single-node (module) point of failure in the GL protocol services (to support continued operation when one or more modules fail(s) in a multiple, distributed HES-link module configuration);

f) not introduce any blocking operations (such as a blocking send operation) that would cause unpredictable delays when using the GL protocol services;

g) be configurable to allow trade-offs between reliability and time-sensitivity application requirements (one example is the choice between best-effort and reliable delivery, but there may be other possible configuration options in a specific implementation).

NOTE The communication requirement is to support BOTH best-effort AND reliable service. The choice between best-effort and reliable service is application-dependent, and is left to the application implementation.

The following are design considerations for the upper layer GL protocol.

h) Minimal execution memory footprint.

i) Support for multiple senders through a single UDP communication instance (for efficient use of IP stack resources).

j) Designed for time-sensitive applications (e.g., healthcare, distributed energy management).

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

8.4 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 annex 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

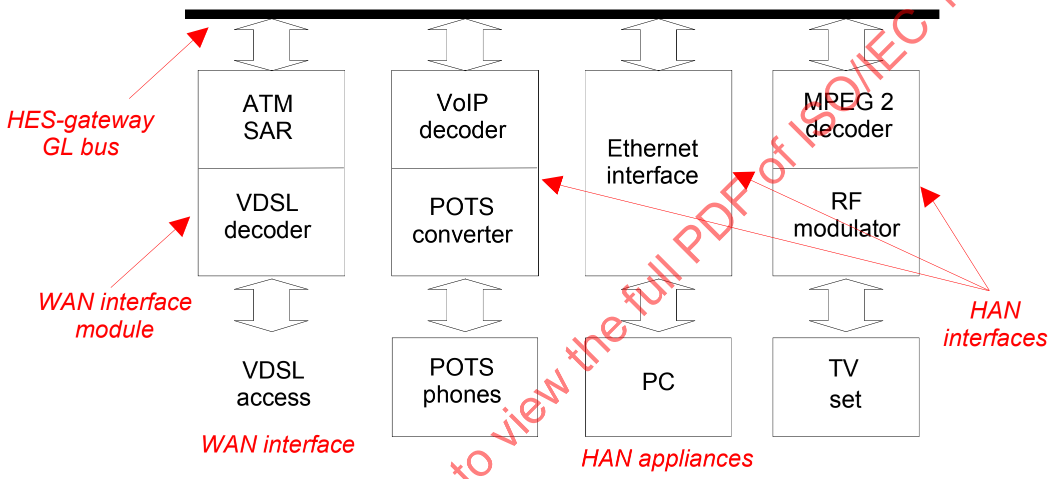

Figure A.1 – VDSL scenario

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

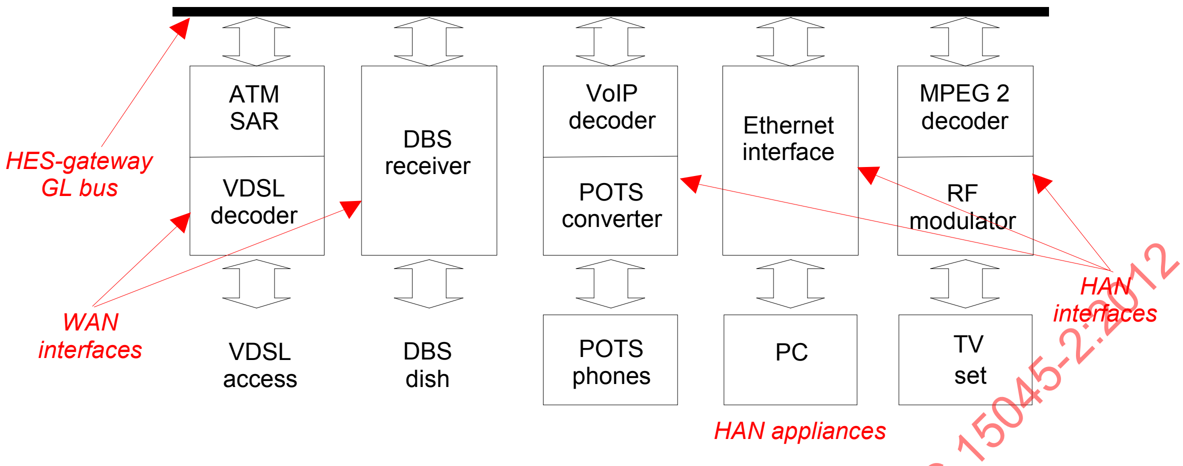

Figure A.2 – DBS/DSL scenario

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, similar to Figure A.1. 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.

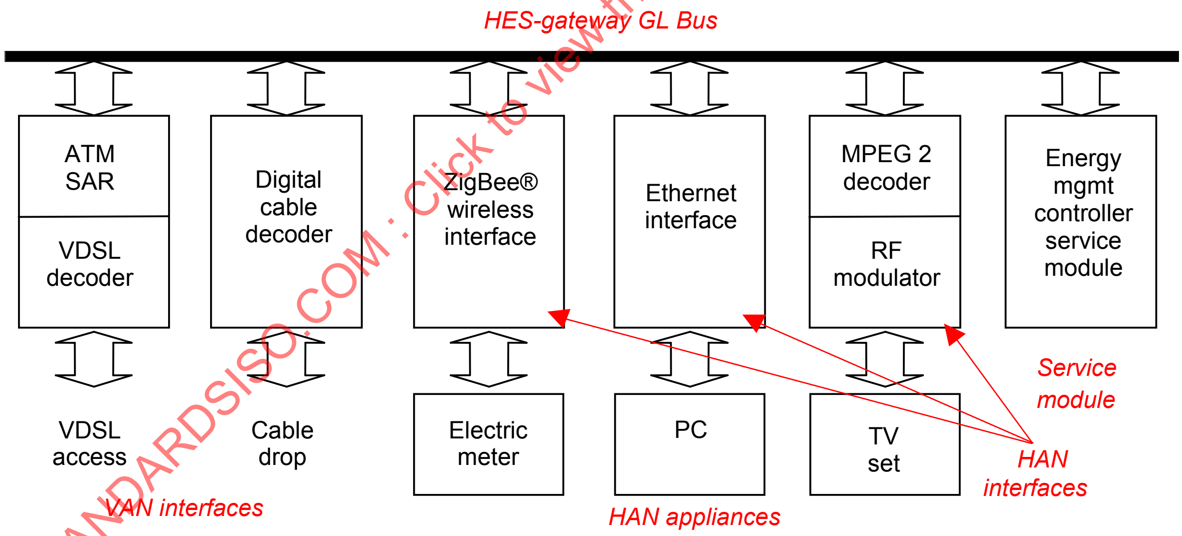

Figure A.3 – Cable/DSL/energy management/ZigBee scenario

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 ZigBee®[4] wireless 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.

4 ZigBee® is a registered trademark of the ZigBee Alliance, San Ramon, CA, USA. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

A.4 Healthcare management scenario

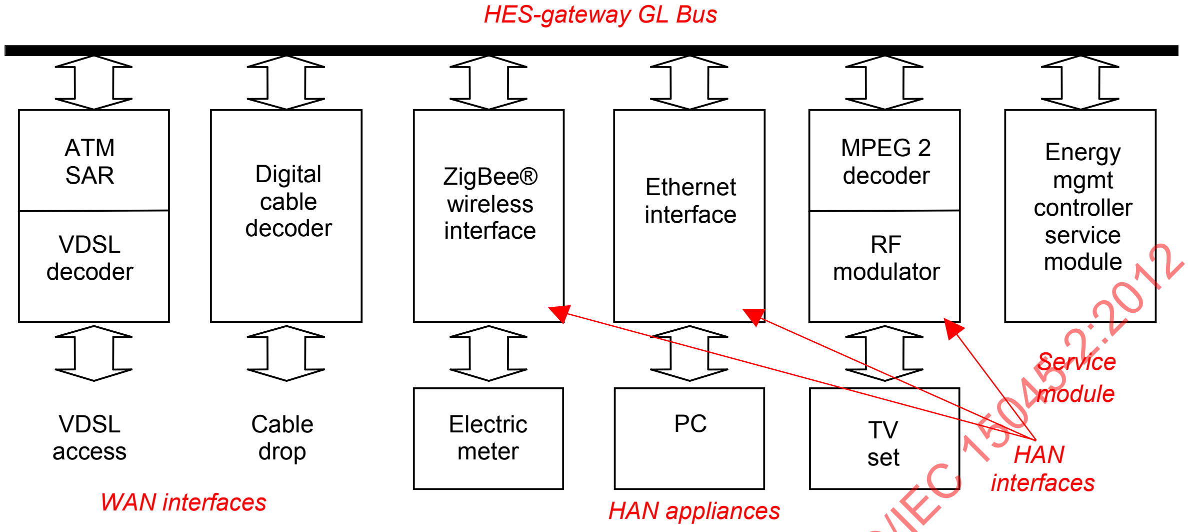

Figure A.4 – Healthcare management scenario

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

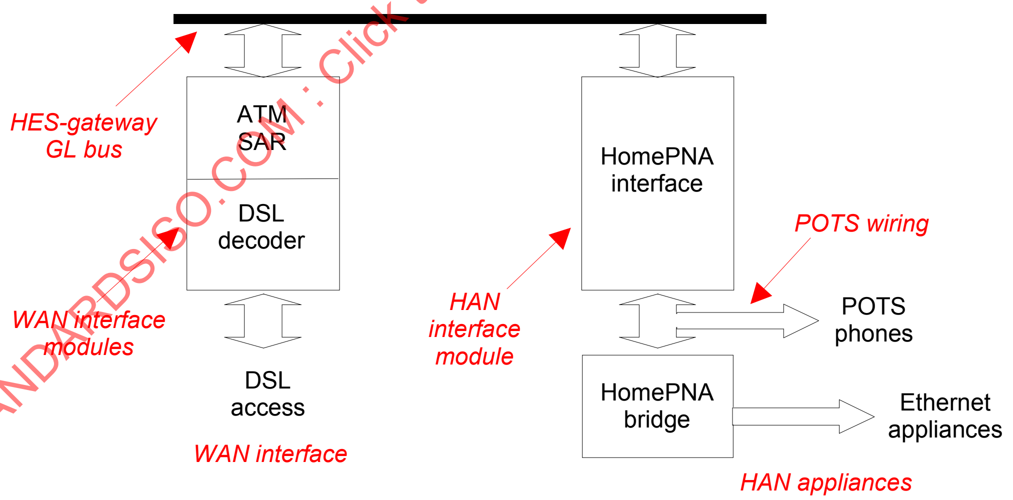

Figure A.5 – DSL/HomePNA Scenario

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.