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Information technology – Home electronic system (HES) architecture – Part 2-1: Introduction and device modularity

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CONTENTS

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 2-1: Introduction and device modularity

FOREWORD

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International Standard ISO/IEC 14543-2-1 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

ISO/IEC 14543-2-1 cancels and replaces ISO/IEC TR 14543-1 and ISO/IEC TR 14543-2, published in 2000. It constitutes a complete revision of the principles outlined in ISO/IEC TR 14543-1 and ISO/IEC TR 14543-2 and provides the specifications essential for an international standard.

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 title page.

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

INTRODUCTION

Various electrically controlled devices are used in homes and similar environments for many different applications. Examples of such applications are lighting, heating, food preparation, washing, energy management, water control, fire alarms, blinds control, different forms of security control and entertainment (audio and video).

When several such devices are able to interwork via a common internal network (in this document called a home network), the resulting total system is called a home control system. When a home control system follows all the specifications in the ISO/IEC HES Standards, it is called a Home Electronic System (HES).

Three different classes of HES are defined. Class 1 has transport capabilities for telecontrol applications only. Class 2 includes Class 1, but also supports switched medium bandwidth data channels. Class 3 includes Classes 1 and 2 and, in addition, supports high bandwidth switched data channels.

A home network may be based on one or more different media (for example power line, balanced cables, infrared or radio) and may also be connected to outside networks (for example telephone, cable television, power and alarm networks).

The implementation of a specific Home Electronic System will typically be assembled by a consumer by adding one application at a time, starting from single applications like lighting control, security control or audio and video control, to develop into an integrated multi-application system. The cost of adding an application depends on whether rewiring of the house is needed and whether existing cables and prefitted ducts or other media can be used. Hence the HES standards and supplementary technical reports will also give guidance to architects and builders as well as to users on how to share such resources.

Currently, ISO/IEC 14543, *Information technology – Home Electronic System (HES) architecture*, consists of the following parts:

Part 2-1:	*Introduction and device modularity*
Part 3-1	*Communication layers – Application layer for network based control of HES Class 1*
Part 3-2:	*Communication layers – Transport, network and general parts of data link layer for network based control of HES Class 1*
Part 3-3:	*User process for network based control of HES Class 1 (under consideration)*
Part 3-4:	*System management – Management procedures for network based control of HES Class 1 (under consideration)*
Part 3-5:	*Media and media dependent layers – Power line for network based control of HES Class 1 (under consideration)*
Part 3-6:	*Media and media dependent layers – Twisted pair for network based control of HES Class 1 (under consideration)*
Part 3-7:	*Media and media dependent layers – Radio frequency for network based control of HES Class 1 (under consideration)*
Part 4:	*Home and building automation in a mixed-use building (technical report)*
Part 5-1:	*Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Core ptotocol*
Part 5-2:	*Intelligent grouping and resource sharing for HES Class 2 and Class 3 – Device certification*
	Additional parts may be added later.

ISO/IEC 18012, “Guidelines for product interoperability,” specifies how applications can co-operate across different protocols. To facilitate interoperability of various protocols, amendments to published standards may be needed.

INFORMATION TECHNOLOGY – HOME ELECTRONIC SYSTEM (HES) ARCHITECTURE –

Part 2-1: Introduction and device modularity

1 Scope

This part of ISO/IEC 14543 specifies the general features and architecture of the HES.

The object is to

- define new terms for use in the ISO/IEC 14543 series,
- give general information and advice on the required HES features and its architecture,
- specify the HES model,
- specify the basic functional structure of an HES with its interfaces.

2 Normative references

The following referenced documents are 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 7498-1, *Information technology – Open systems interconnection – Basic Reference Model – Part 1: The Basic Model.*

ISO/IEC 10192-1, *Information technology – Home electronic system (HES) interfaces – Part 1: Universal interface class 1*

3 Definitions and abbreviations

For the purpose of this standard the following definitions apply.

3.1 Definitions from ISO/IEC 7498-1

3.1.1
application entity
active element, within the application process, ambodying a set of capabilities which is pertinent to OSI and which is defined for the application layer, that corresponds to a specific application-entity type (without any extra capabilities being used)
[ISO/IEC 7498-1, 7.1.1.1]

3.1.2
application process
element within a real open system which performs the information processing for a particular application
[ISO/IEC 7498-1, 4.1.4]

3.1.3
connection-mode transmission
(N)-data-transmission in the context of an (N)-connection

[ISO/IEC 7498-1, 5.3.1.17]

3.1.4
connectionless-mode transmission
(N)-data-transmission not in the context of an (N)-connection and not required to maintain any logical relationship between (N)-service-data-units
[ISO/IEC 7498-1, 5.3.1.18]

3.1.5
(N)-service-data-unit, (N)-SDU
amount of information whose identity is preserved when transferred between peer-(N+1)-entities and which is not interpreted by the supporting (N)-entities.
[ISO/IEC 7498-1, 5.6.1.4]

3.1.6
flow control
function which controls the flow of data within a layer or between adjacent layers
[ISO/IEC 7498-1, 5.8.1.8]

3.1.7
OSI environment, OSIE
abstract representation of the set of concepts, elements, functions, services, protocols, etc., as defined by the OSI reference model and the derived specific standards which, when applied, enable communications among open systems
[ISO/IEC 7498-1, 4.1.5]

3.1.8
segmenting
function performed by an (N)-entity to map multiple (N)-service-data-unit into multiple (N)-protocol-data-units
[ISO/IEC 7498-1, 5.8.1.9]

3.1.9
(N)-service access point, (N)-SAP
point at which (N)-services are provided by an (N)-entitiy to an(N+1)-entity
[ISO/IEC 7498-1, 5.2.1.8]

3.2 Additional definitions

3.2.1
application
field of use of an HES

NOTE An HES may support more than one application.

3.2.2
application object
an HES object located within the HES device application process

3.2.3
application process
an element within an HES which performs the information processing for a particular application

3.2.4
application protocol
standardized protocol for the exchange of information between application processes in an HES; it is transported without interpretation by the home network resources

3.2.5
connection
association established between functional units for data transmission across a network (or part of a network) for the purpose of communication between the units; the association is explicitly established at some point in time and exists until explicitly ended

NOTE Data transmission includes, in this context, audio, video and other information in either analogue or digital form.

3.2.6
control channel
communication channel that is established between two or more entities for the primary purpose of exchange of HES control and monitoring messages

3.2.7
device
physical implementation of functions belonging to one or more functional groupings providing a service directly for an end-user

3.2.8
device application process
element within a device that performs information processing for a particular application; device application processes can represent manual, automated, computerised or physical processes

3.2.9
device modularity
property of devices that specifies the extent to which they have been composed out of separate parts called modules

3.2.10
domain
range of validity

NOTE When the term is used for a more specific concept, it should be qualified. Two examples are the application domain (the range including OSI layer seven and above) and the user domain (the range above OSI layer seven).

3.2.11
HES-application
field of use of an HES

NOTE An HES may support more than one application.

3.2.12
HES application object
an HES application object is an HES-object located within the HES device application process

3.2.13
device application process
an element within a device which performs information processing for a particular application; it can represent a manual, automated, computerised or physical process

3.2.14
HES class 1
HES with transport capabilities for telecontrol applications such as:
- Control,
- Monitoring,
- Measurement,
- Alarm,
- Low speed data transfer

NOTE These capabilities are typically provided for by the single packet-mode low bandwitdth channel and the digital transmission.

3.2.15
HES class 2
HES with capabilities for switched voice or other information transfer with similar bandwidth

NOTE These capabilities are typically provided for by a class 1 system, enhanced with multiple switched medium bandwidth channels and analogue or digital transmission or both. In principle, all class 2 capabilities may be supported by a single class 2 channel.
For practical reasons, however, HES class 2 may contain a separate channel or use a separate medium to support class 1 capabilities.

3.2.16
HES class 3
HES with capabilities for switched high quality sound and video transfer and high speed data transfer

NOTE These capabilities are typically provided for by a class 2 system enhanced with multiple switched medium bandwidth channels and analogue or digital transmission or both.
In principle all class 3 capabilities may be supported on a single class 3 channel. For practical reasons, however, HES class 3 may contain a separate channel or use a separate medium to support class 1 and class 2 capabilities.

3.2.17
HES device application process
the part of a device application process which is accessible through the HES communication network

NOTE 1 An HES device application process is built up with application objects.

NOTE 2 The functionality of the HES device application process is defined in this series of standards or in the appropriate product standards.

3.2.18
HES-object
set of data with associated functions applicable to it

NOTE An HES-object can be implemented in various ways.

3.2.19
HES user process
the part of the HES device application process belonging to the user domain of the HES

3.2.20
home electronic system (HES)
various electronic devices are used in homes, buildings and similar environments (including their immediate surroundings) for several applications relevant to the home and/or building

NOTE The expression “Home Electronic System” (HES) covers any combination of electronic devices linked via a digital transmission network. The HES includes a specification for this communication network. There are three classes of HES, depending on the transmission throughput capabilities.

3.2.21
home network
internal network for digital and analogue information transport in a home or on business premises of similar complexity, providing defined access points and using one or more media in any topology

3.2.22
information channel
a communication channel established between two or more entities for the primary purpose of exchange of information other than HES control and monitoring messages

NOTE Examples of such information are audio or video data, facsimile data and analogue speech signals.

3.2.23
interface
shared boundary between two implementations of functions belonging to one or more functional groupings

3.2.24
interoperability
the ability of devices to exchange information via the higher layers resulting in meaningful actions; this includes aspects of the application domain which, by definition, is beyond the OSI domain

3.2.25
local application process
the part of an application process within a device which is not accessible through the HES communication network, it is located inside the user domain

3.2.26
network access unit (NAU)
piece of equipment which comprises the mechanical, electrical and communicational functions for an HES connection

NOTE The NAU corresponds to one network service access point (NSAP) and can be uniquely identified by one or more network addresses.

3.2.27
network segment
part of an HES network that is within the domain of a single link layer instance

3.2.28
reference model
model that describes the general principles of interconnections in a system and the network architecture resulting from those principles

3.2.29
repeater
unit that regenerates or amplifies signals in order to extend the range of transmission between medium attachment points or to interconnect two network segments that use the same protocols

3.2.30
topology
the structure of the communication paths between the medium attachment points

NOTE Examples of topologies are: bus, ring, star, tree.

3.2.31
user process
the part of a device application process belonging to the real system environment, that is the user domain

3.2.32
transmission medium
a physical medium that conveys signals

NOTE Often referred to as medium.

3.2.33
unit
piece of equipment

3.2.34
universal interface (UI)
standardized interface, placed on top of the network layer, between a home network and the devices to be connected to it; the specification of the UI includes the necessary mechanical, electrical, functional and procedural characteristics of the interface

3.2.35
user domain
the part of an HES above layer 7

3.3 Abbreviations

AME	application management entity
CX	coax
FO	optical fibre
HES	home electronic system
HES/RM	HES / reference model
LME	layer management entities
IR	infra-red
NAU	network access unit
NSAP	network service access point
OSIE	OSI environment
OSI/RM	OSI / reference model
PL	power line
RF	radio frequency
RSE	real system environment
SME	system management entity
TP	twisted pair (balanced cable)
UI	universal interface

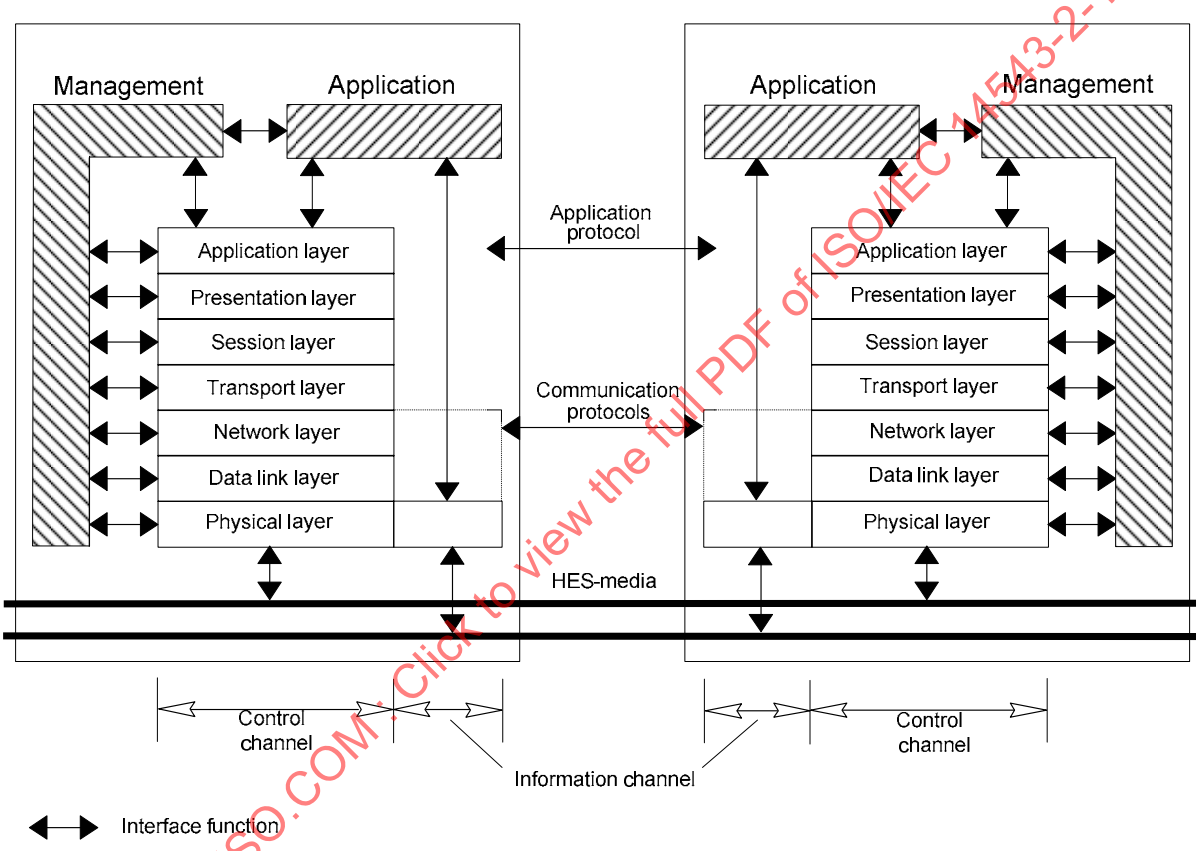
4 Conformance

An entity of operational exchange conforms to this International Standard if documentation is available stating how all elements of clauses 5 and 6 are implemented.

5 HES reference model

5.1 Architecture

The HES shall be designed in accordance with the OSI reference model (OSI/RM). The functionality of the OSI/RM is very general and not all of this functionality is needed in the HES reference model (HES/RM). For this reason, and also for reasons of protocol efficiency, some of the layers may be null in some implementations of HES. In particular, some implementations have little or no functionality at one or more of the layers: network, transport, session and presentation layer. If a layer has no functionality of its own, then it is regarded as present, merely to map between the layer below and the layer above. This imposes no overhead on any implementation. Figure 1 depicts the overall structure of the HES/RM. The power feed service is not shown in this figure.



NOTE The control channel and information channel(s) may be on the same or different media (which may be of different types).

Figure 1 – Overview of the home electronic system reference model

In some implementations all layers are contained within one piece of equipment. It is also possible to split the implementation across two (or more) pieces of equipment. To facilitate this, standardized interfaces are defined in later parts of this standard. The two standardized interface points are the medium interface and the universal interface (between network and transport layer).

The overall HES/RM consists of three parts, see description in 5.2 to 5.4:

- communication;
- application;
- management.

5.2 Communication

5.2.1 General

The HES/RM defines layers which correspond to the general OSI reference model and in addition a management function.

In the HES/RM a distinction is made between information and control channels. These channels are distinguished from an application point of view. For the control channel each layer identified within the communication part of the HES/RM has a standardized functionality, whereas for information channels only the Physical Layer may have a standardized functionality.

There is a need for the HES to specify the methods to be used to feed power for entities connected to the different media.

HES is a multimedia system in the sense that it may use one or more transmission media. Since different transmission media have different characteristics, the Physical Layer and Data Link Layer services can be distinct for optimization for different media. Above the Data Link Layer the services provided are medium independent. The performance characteristics may differ according to the medium used. For instance, the transfer capacity of power line is less than that of a twisted pair.

This subclause gives an overview of the functions of each layer. Other parts of the ISO/IEC 14543 series will define the layers in more detail.

5.2.2 Physical layer

The Physical layer provides mechanical, electrical, functional and procedural means for physical communication between data link entities. A network may contain repeaters. Physical layer entities are interconnected by means of a physical medium.

5.2.3 Data link layer

The data link layer provides functional and procedural means for connectionless-mode service. It transfers information between network entities and optionally establishes, maintains and releases data link connections among network entities. A data link connection uses one or more physical connections. It is expected that all data link layer implementations will be connectionless.

The data link layer shall detect errors and shall offer error correction functionality. Uncorrected errors may be reported to the network layer. The data link layer provides the means to access the medium, handling, when necessary, contention for access.

The data link layer may also implement flow control to manage the rate of information transfer and sequence numbering to manage the ordering of data link service data units.

The data link layer shall provide recognition of data link addresses and may provide to the network layer confirmation of the success or non success of services requested by the network layer.

A data link layer implementation may make use of bridges to link transparently several data links in tandem to provide a data link service.

5.2.4 Network layer

The network layer provides the functional and procedural means for connectionless-mode service. It gives the transport entities independence of the route and of the topology of the

network segment. This includes the case where several network segments are used in tandem or in parallel.

It makes invisible to transport entities how underlying resources such as data link connections are used to provide network services. The network layer may provide notification to the transport layer of errors which have been reported by the data link layer and also of protocol errors which may occur in the network layer.

The network layer may also implement flow control to manage the rate of information transfer and sequence numbering to control the ordering of network service data units.

The network layer shall provide recognition of network addresses and may provide to the transport layer confirmation of the success or non success of services requested by the transport layer.

The network layer services are optional.

5.2.5 Transport layer

The transport layer provides transparent transfer of data between session layer entities and relieves them from any concern with the detailed way in which reliable transfer of data is achieved.

All protocols defined in the transport layer have end-to-end significance, they are carried transparently across the network.

The dual purposes of the transport layer are

- to provide a connection-mode transport service over the connectionless network service,
- to provide data segmentation.

The transport layer services are optional.

5.2.6 Session layer

In the HES the session layer in general has null functionality.

5.2.7 Presentation layer

In the HES the presentation layer in general has null functionality.

5.2.8 Application layer

The application layer provides a means for the HES device application processes to access the HES communication resources. Each HES device application process is represented to its peer by the application entity. The application entity contains the user process and a set of application service access points. The application service access points may call upon each other and on the presentation services to perform their function.

5.2.9 Medium aspects

A medium may be open either allowing free propagation of electromagnetic waves or guided by, for example, an electrical conductor, wave guide or optical fibre. The following media have been identified for HES use:

- twisted pair (TP)
- power line (PL)
- coax (CX)

- infra-red (IR)
- radio frequency (RF)
- optical fibre (FO)

But this list is not exclusive. Physical characteristics will be defined in another part of ISO/IEC 14543 (Media dependent layers). That part will cover aspects such as installation, regulatory factors, topology, distances and signal confinement, connectors and EMC.

NOTE The physical characteristics of balanced copper cables are specified in ISO/IEC 15018.

Twisted pair and power line may provide a power feed service, which allows devices to draw power supply current from the medium. For other appropriate media the power feed service is optional. The specification of each medium will define the power feed service (if available).

5.3 Application

One of the main characteristics of an HES is that most of its application processes are distributed. This is shown in Figure 2 for only one application process to keep the figure simple. Of course devices may belong to more than one application process.

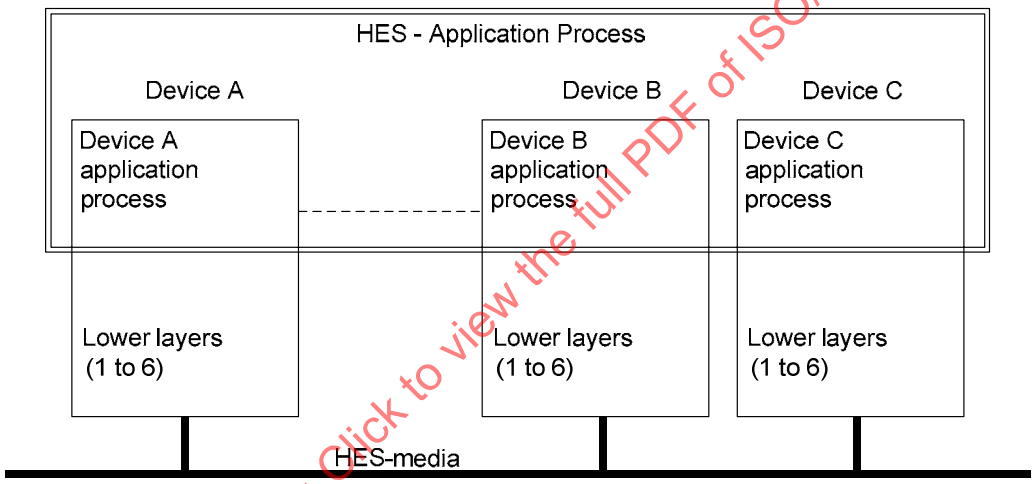
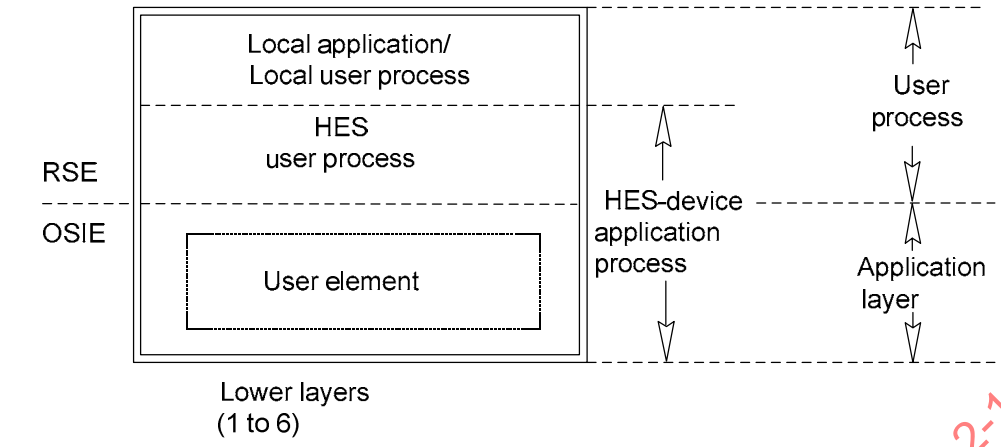


Figure 2 – Application process of an HES

The application process whose structure is shown in Figure 3, consists of the HES device application process and an optional local application process. The part belonging to the real system environment (RSE, that is the user domain) is named user process. A user process may consist of user programmes, physical processes or user interactions. The HES device application process only partly belongs to the OSI environment (OSIE). This part is the application layer. The other part belonging to the RSE is named HES user process. This means that user process and application process are overlapping each other. The RSE interfaces to the OSIE via the user process which is located inside the application layer.



Device application process

OSIE Open system interconnection environment

RSE Real system environment

Figure 3 – HES device application process structure

As shown in Figure 4 the HES device application process is constructed of application objects. The user process and the associated application service access points (AL-SAPs) allow the HES-user process to communicate via the HES communication system (see Figure 5). An HES-user process may use more than one application service access point for this communication.

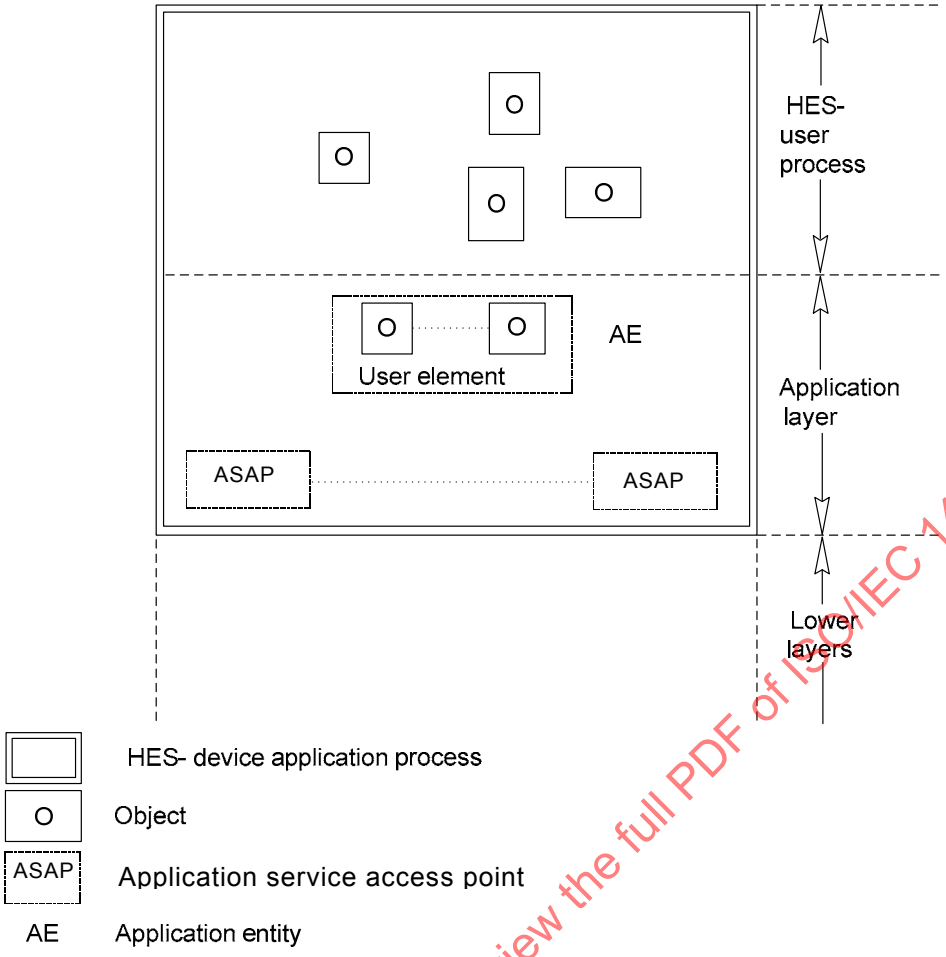


Figure 4 – HES device application process model

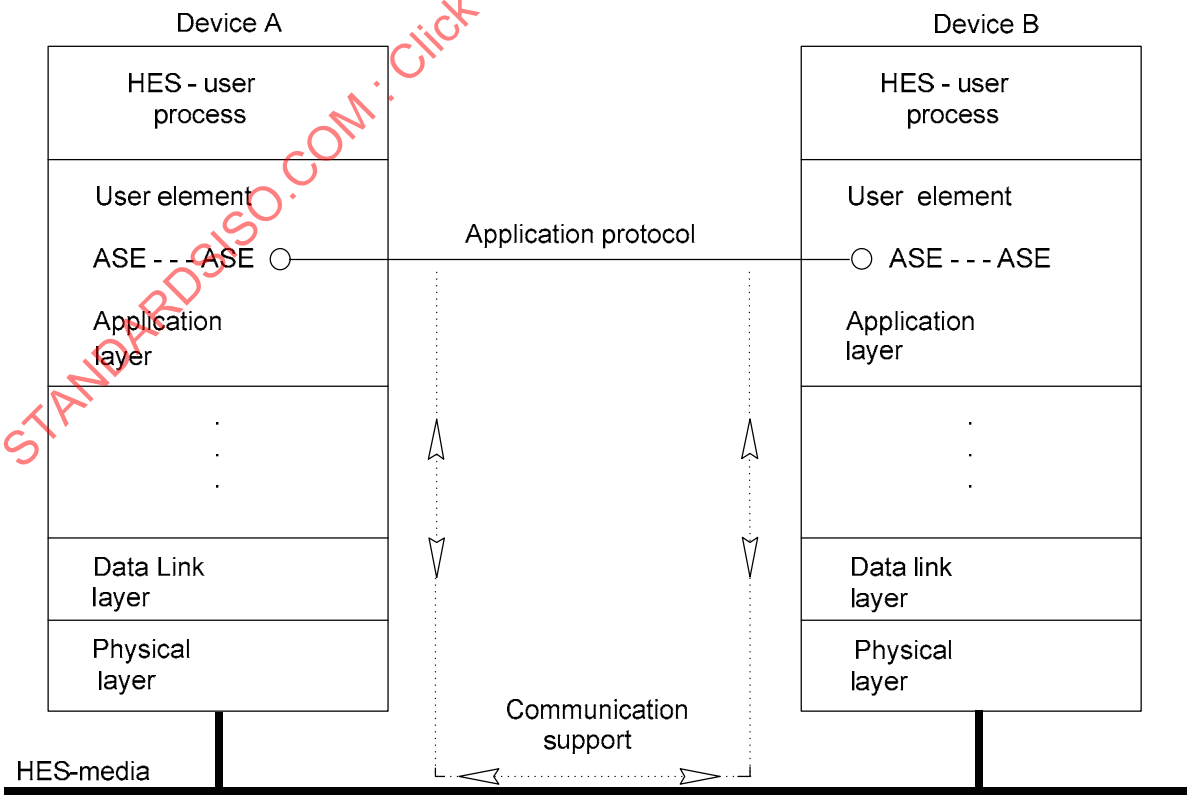


Figure 5 – Link of user processes

5.4 Management

5.4.1 General

The management aspects of the HES concern the problems of initiating, testing, terminating and monitoring the HES activities and assisting in their harmonious operations, as well as handling abnormal conditions.

Typical management activities are:

a) activation/deactivation
   - activation, maintenance and termination,
   - parameter initialization and modification;

b) monitoring
   - status and status change registration,
   - statistics registration and reporting;

c) error control
   - error detection,
   - diagnostic functions,
   - reconfiguration and restart.

From a functional point of view the management aspects of the HES can be divided into two main parts:

a) SYSTEM MANAGEMENT, concerned with management of communication resources;

b) APPLICATION MANAGEMENT, concerned with management of application processes.

5.4.2 System management

The system management entity (SME) is in charge of the management of communication resources.

Inside this system management, layer management entities (LMEs) interface to each layer.

Examples of system management entity (SME) activities are given in Table 1 and Table 2.

Table 1 – Layer Management functions

Activity	Example
1.1	Control of (N)-layer operation(s) (enable/disable/reset/etc.)
1.2	Modification of parameters general for a specific type of (N)-layer operation
2.1	Registration of status of (N)-layer operation(s): reporting to SME
2.2	Quality of (N)-layer operation(s) (number of successful transmissions per time-unit)
3.1	(N)-layer operation(s) error detection to identify the demand for error control
3.2	(N)-layer operation(s) error diagnostics to identify needed error control activities
3.3	(N)-layer operation(s) reset

Table 2 – General management functions

Activity	Example
1.1	Set mode of operation (normal/test/maintenance/etc.) for single device/group of devices/whole system
1.2	Initialization and modification of system parameters (communication relations)
2.1	Status of single device/group of devices/whole system, remote error indication to user
2.2	Registration and reporting of performance for single device/group of devices/whole system
3.1	Single device/group of devices/whole system error detection to identify the demand for error control
3.2	Single device/group of devices/whole system error diagnostics to identify needed control activities
3.3	Single device/group of devices/whole system reset

The general management structure of communication resources for a device is illustrated in Figure 6.

The SME uses the services available on the layer 7 service boundary.

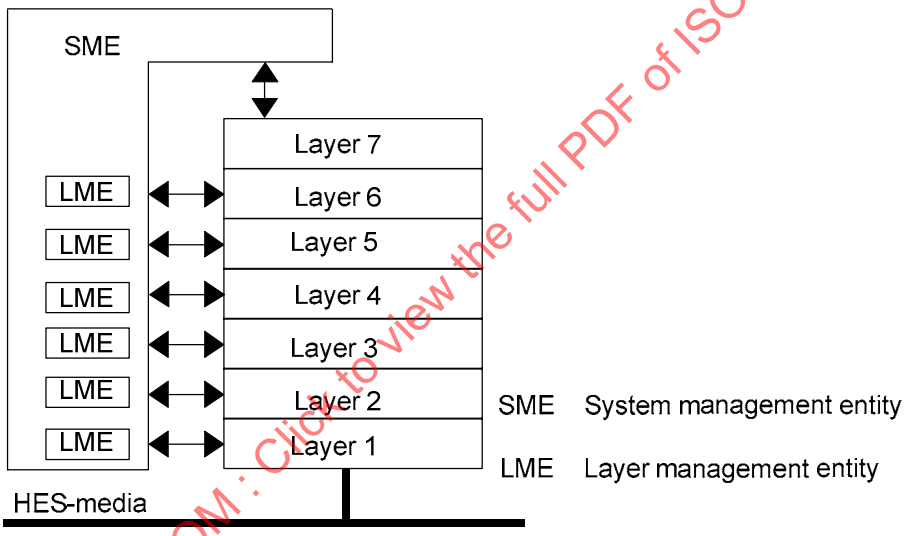


Figure 6 – Management of communication resources

The user (which may be a human) of the communication resources has interfaces to the user process as well as to the system management. The user may also provide some system wide management capability. This is illustrated in Figure 7.

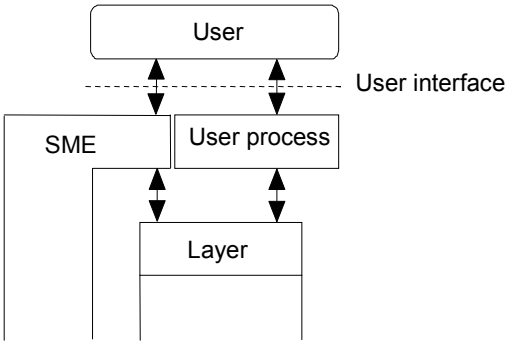


Figure 7 – User interface of the communication resources

The management of the communication resources by the layer management entities (LMEs) is strictly a layer function. LMEs do not have direct human or user access.

All HES devices shall have a defined minimum functionality of the SME.

One or more devices may have additional management functionality to assist a human user.

This HES specification allows implementations in such a way that the lower layers are implemented in a network access unit (NAU) separate from the upper layers. This is particularly related to the universal interface (UI) defined in ISO/IEC 10192-1. In such a case, the lower layer unit needs functionalities of the upper layers as well as reduced HES/SME functionality for its own management. Figure 8 shows an example where the UI is placed between layers 3 and 4.

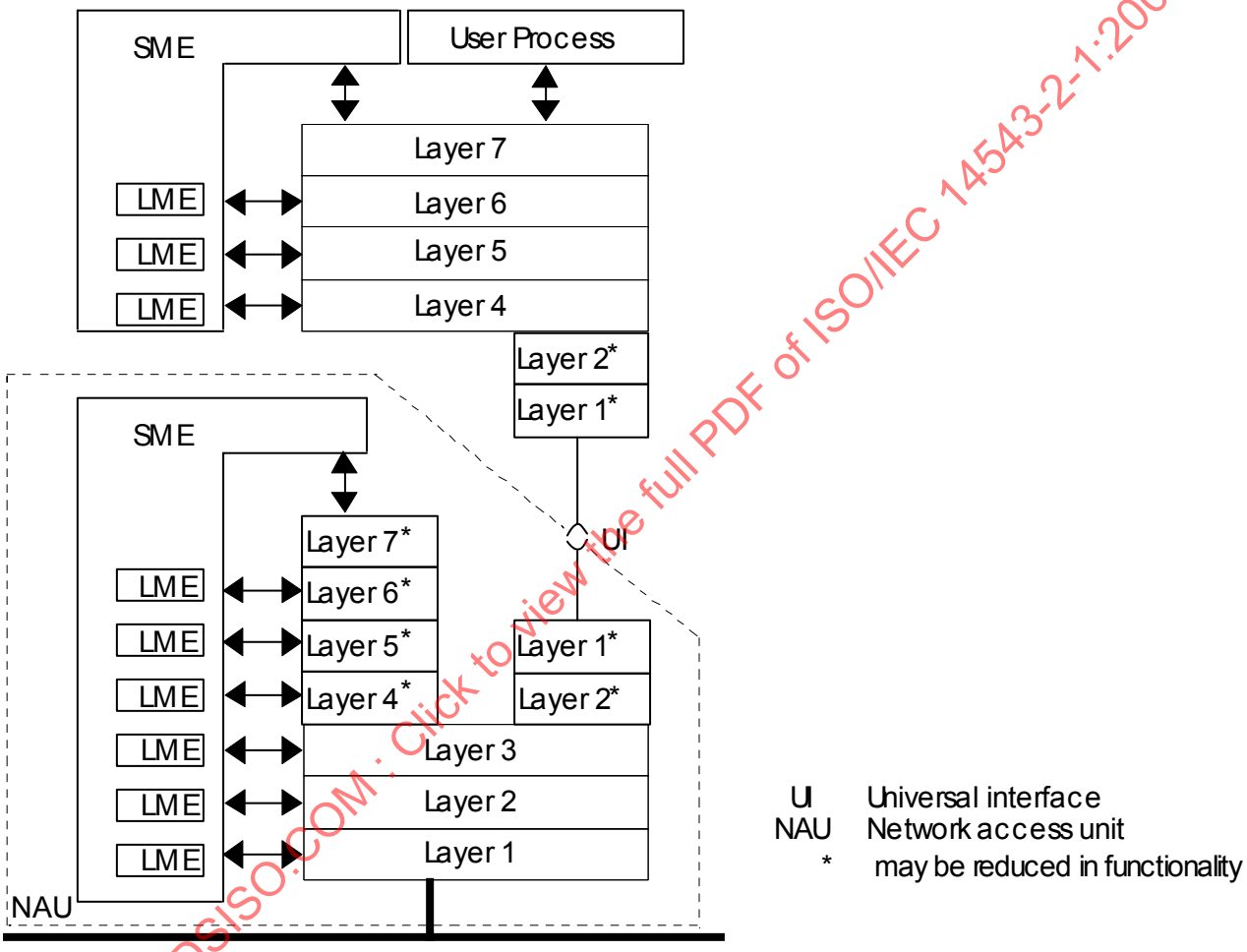


Figure 8 – Example of management functions of a device using the universal interface

5.4.3 Application management

Management of the application processes is responsible for managing priority conflicts and synchronization between application processes, including proper initiation, monitoring and termination of application processes. For this purpose an application management entity (AME) is defined.

Table 3 – Examples of application management entity (AME) functions

Activity	Example
1.1	Control of application process operation
1.2	Initialisation and modification of application process parameter(s)
2.1	Status of application process operation(s)
2.2	Registration and reporting of application process performance
3.1	Application process operation(s) error detection to identify the demand for error control
3.2	Application process operation(s) error diagnostics to identify needed control activities
3.3	Application process operation(s) reset

The general management structure of an HES device application process is illustrated in Figure 9. The device application process may use the control channel (7 OSI layers) as well as one or more information channels (at least OSI layer 1).

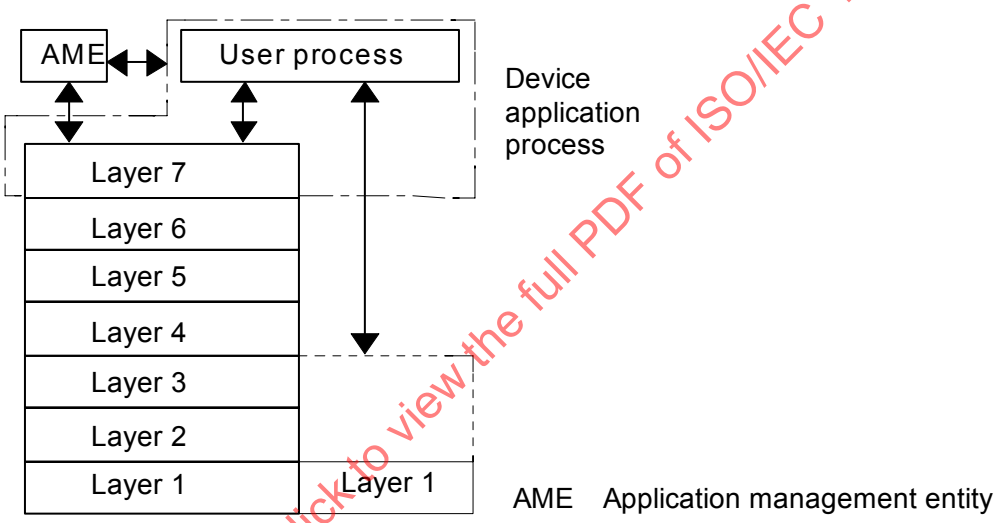


Figure 9 – Management of application process

The user of the application process resources interfaces to the AME as well as to the application process. The user may also provide some system wide management capability. This is illustrated in Figure 10.

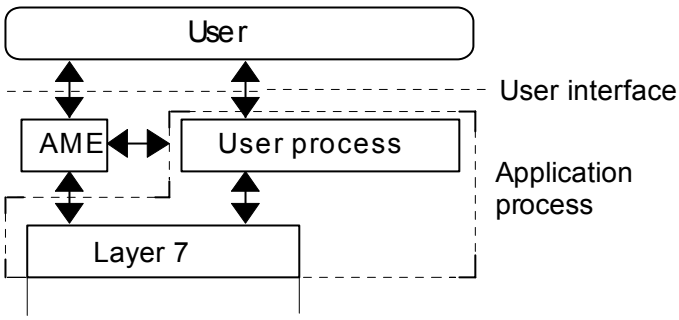


Figure 10 – User interface of the application process resources

All HES devices shall have a defined minimum functionality of the AME.

One or more devices may have additional management functionality to assist a user.

6 System aspects

6.0 General

Communication takes place between devices, application objects, systems and subsystems. Depending on the views of different kinds of users, installers, planning and maintenance engineers some system aspects are more important than others. The description of those aspects is suitable for clarification of these different views and may be used as references in later parts of the standard. The following aspects are dealt with:

- network topology;
- interapplication;
- grouping;
- system access.

This list is not exhaustive.

6.1 Network topology

The interoperability between different devices which may be connected to different media is independent of network topology. Physically the different media, subsystems or HES network segments are connected by gateways. In the case of HES network segment interconnection the gateway shall include layers 1 to 3. A network segment shall have no special restrictions related to its implemented hierarchical position compared with the other segments. When connecting gateways to external networks it should be taken into account that the position of the connection may have a strong influence on the overall system performance. There may be functional constraints related to individual media characteristics.

At the wiring level, for the basic media, twisted pair and power line, all topologies such as bus, tree, star, loop and any combinations thereof shall be possible.

6.2 Interapplication

The HES is intended to be used for a broad range of applications. Applications can be categorised into application domains. The application domains may be distributed or centralized. This depends on the practical implementations. If devices belong to more than one application domain, additional interapplication support may be needed to co-ordinate system activities. Therefore the HES shall allow interapplication co-ordination.

Figure 11 shows the HES domain as the total home application domain. The HES allows domain specific functions, such as "all lights off".