

BS EN 62457:2008



BSI British Standards

Multimedia home networks — Home network communication protocol over IP for multimedia household appliances

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

raising standards worldwide™



National foreword

This British Standard is the UK implementation of EN 62457:2008. It is identical to IEC 62457:2007.

The UK participation in its preparation was entrusted to Technical Committee EPL/100, Audio, video and multimedia systems and equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© BSI 2009

ISBN 978 0 580 57233 3

ICS 33.040.01; 33.160.01; 35.110

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2009.

Amendments issued since publication

Amd. No.	Date	Text affected
----------	------	---------------

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 62457

March 2008

ICS 33.040; 33.160.01

English version

**Multimedia home networks -
Home network communication protocol over IP
for multimedia household appliances
(IEC 62457:2007)**

Réseaux résidentiels multimédia -
Protocole de communication
de réseau résidentiel sur IP destiné
aux appareils domestiques multimédia
(CEI 62457:2007)

Multimedia-Heimnetzwerke -
Heimnetzwerk-Kommunikationsprotokoll
über IP für Multimedia-Haushaltsgeräte
(IEC 62457:2007)

This European Standard was approved by CENELEC on 2008-02-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in two official versions (English and German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

© 2008 CENELEC - All rights of exploitation in any form and by any means reserved worldwide for CENELEC members.

Ref. No. EN 62457:2008 E



Documents
Document Sharing Hub

Foreword

The text of document 100/1197/CDV, future edition 1 of IEC 62457, prepared by technical area 9: Audio, video and multimedia applications for end-user network, of IEC TC 100, Audio, video and multimedia systems and equipment, was submitted to the IEC-CENELEC parallel Unique Acceptance Procedure and was approved by CENELEC as EN 62457 on 2008-02-01.

The following dates were fixed:

- latest date by which the EN has to be implemented
at national level by publication of an identical
national standard or by endorsement (dop) 2008-11-01
- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2011-02-01

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62457:2007 was approved by CENELEC as a European Standard without any modification.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEEE Std 802.15.1	2005	IEEE Standard for Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 15.1: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPANs)	-	-

CONTENTS

INTRODUCTION.....	8
1 Scope.....	10
2 Normative reference	11
3 Terms, definitions and abbreviations	11
3.1 Terms and definitions	11
3.2 Abbreviations	15
4 TCP/IP interface and requirements	15
4.1 Overview	15
4.2 Topology	16
4.3 UDP interface	19
4.4 Packet format of Home Network frame	19
4.4.1 General	19
4.4.2 Home Network transmission frame transfer	21
4.4.3 MAC/IP address resolution request/response	22
4.4.4 IP/MAC address resolution request/response	23
4.4.5 Hardware/MAC address resolution request/response	24
4.4.6 MAC address initialization request/response	25
4.4.7 MAC address server initialization response/MAC address allocation response	26
4.4.8 MAC address confirmation request/response	27
4.4.9 MAC address request to all nodes/response	28
4.4.10 MAC address server detection request/response, MAC address server notification	29
4.4.11 Network control message (destination invalid)	30
4.4.12 Network control message (NMa overlap)	31
4.5 Basic communication sequences	32
4.5.1 General	32
4.5.2 MAC/IP address resolution request/response (resolution of the NMa into the IP address)	32
4.5.3 IP/MAC address resolution request/response (resolution of IP address into NMa)	33
4.5.4 Hardware/MAC address resolution request/response	35
4.5.5 MAC address request/response to all nodes	36
4.5.6 Network control message (destination invalid)	37
4.5.7 Special case pertaining to packets with invalid destination values	38
4.5.8 Network control message (NMa overlap)	39
4.6 NMa acquisition booting sequence	40
4.6.1 Overview of NMa acquisition booting sequence	40
4.6.2 Overview of the processing after acquisition of IP Address	40
4.6.3 Booting node	41
4.6.4 MAC address server	45
4.6.5 Operating nodes	45
4.7 MAC address server	47
4.7.1 Requirement of MAC address server	47
4.7.2 Processing sequence for MAC address server booting	47

4.7.3	Processing by operating MAC address server	48
4.8	Time period parameters	50
4.9	Provision for updating data after NMa acquisition	51
5	TCP/IP and requirements	51
5.1	IP	51
5.1.1	Protocols to be used	51
5.1.2	IP Address	51
5.1.3	Multicast address	51
5.1.4	DHCP	51
5.1.5	Method for obtaining IP Address by manual setting, etc.	52
5.1.6	Routing	52
5.2	UDP	52
5.2.1	Protocols to be used	52
5.2.2	Port Number	52
6	Lower-layer medium-specific interface and requirements	52
6.1	Interface and requirements on lower-layer medium	52
6.2	Software internal status transition	52
6.2.1	Overview	52
6.2.2	Stop status	54
6.2.3	Cold start status	54
6.2.4	Warm start status	55
6.2.5	Communication suspension status	55
6.2.6	Normal operation status	56
6.2.7	Error stop status	57
6.2.8	Temporary stop status	58
Annex A (informative)	Basic booting sequence	59
Annex B (informative)	Basic MAC address server booting sequence	66
Annex C (normative)	Requirements on IEEE 802.15.1	68
Bibliography		74
Figure 1	– Grouping of relationship between household appliances and audiovisual equipment, PCs and PC-related equipment	9
Figure 2	– Examples of data communication between household appliance and audiovisual equipment, PCs and PC-related equipment	9
Figure 3	– The composition of the Home Network layer and the specified portions	10
Figure 4	– Encapsulation of Home Network frame	16
Figure 5	– Example of a subnet using Layer 2 bridges	17
Figure 6	– Example of a subnet connection using Home Network routers	17
Figure 7	– Relationship between IP subnet and Home Network subnet	18
Figure 8	– Home Network frame packet format	19
Figure 9	– Notation for bits in the flag field	21
Figure 10	– IEEE 802.15.1 Address described in bits	21
Figure 11	– Basic MAC/IP address resolution sequence	33
Figure 12	– Basic IP/MAC address resolution sequence	34

Figure 13 – Basic Hardware/MAC address resolution sequence	35
Figure 14 – Basic “MAC address request/response to all nodes” sequence	37
Figure 15 – Basic “destination invalid” processing sequence	38
Figure 16 – Basic sequence for handling detected NMa overlap	39
Figure 17 – Flowchart for determining provisional NMa to be used	42
Figure 18 – Check for NMAs in use by other nodes	43
Figure 19 – Example of duplicated provisional NMa	44
Figure 20 – Format for UsedMAC	46
Figure 21 – Example of UsedMAC	46
Figure 22 – Internal software status transitions	53
Figure A.1 – A-MODE booting, NMAs not retained (with MAC address server)	60
Figure A.2 – SR-MODE booting, NMAs not retained (with MAC address server)	61
Figure A.3 – A-MODE booting, NMAs not retained (without MAC address server)	62
Figure A.4 – SR-MODE booting, NMAs not retained (without MAC address server)	63
Figure A.5 – A-MODE booting, NMAs retained (with MAC address server)	64
Figure A.6 – A-MODE booting, NMAs retained (without MAC address server)	65
Figure B.1 – Booting of a single MAC address server	66
Figure B.2 – Near-simultaneous booting of two or more MAC address servers	67
Figure C.1 – Layer structure	68
Figure C.2 – Basic form of subnet	69
Figure C.3 – Example of a subnet connection using Home Network routers	69
Figure C.4 – Example of an unacceptable subnet connection (scatternet)	70
Figure C.5 – Example of a connection using a home network gateway	70
Figure C.6 – Example of a subnet using Layer 2 bridges	71
Figure C.7 – Examples of Home Network communication software implementation	72
Figure C.8 – Packet structure	73
Table 1 – Packet type numbers of the Home Network frame	20
Table 2 – Hardware type	20
Table 3 – Format for “Home Network transmission frame transfer” packets	22
Table 4 – Format for “MAC/IP address resolution request” packets	22
Table 5 – Format for “MAC/IP address resolution response” packets	23
Table 6 – Format for “IP/MAC address resolution request” packets	23
Table 7 – Format for “IP/MAC address resolution response” packets	24
Table 8 – Format for “hardware/MAC address resolution request” packets	24
Table 9 – Format for “hardware/MAC address resolution response” packets	25
Table 10 – Format for “MAC address initialization request” packets	26
Table 11 – Format for “MAC address initialization response” packets	26
Table 12 – Format for “MAC address server initialization response” packets	27
Table 13 – Format for “MAC address allocation response” packets	27
Table 14 – Format for “MAC address confirmation request” packets	28
Table 15 – Format for “MAC address confirmation response” packets	28
Table 16 – Format for “MAC address request to all nodes” packets	28

Table 17 – Format for “MAC address response to all nodes” packets	29
Table 18 – Format for “MAC address server detection request” packets.....	29
Table 19 – Format for “MAC address server notification” packets.....	30
Table 20 – Format for “MAC address server detection response” packets	30
Table 21 – Format for “network control message (destination invalid)” packets	31
Table 22 – Format for “NMa overlap” network control message packets.....	31
Table 23 – Address Relation table	32
Table 24 – Booting modes	40
Table 25 – Sample for storing allocated NMas	48
Table 26 – Time period parameters.....	50

INTRODUCTION

By enabling standalone-type household appliances (household appliances other than audiovisual equipment, PCs and PC-related equipment) such as white appliances (e.g. air conditioners, refrigerators), sensors, health, exercise and fitness equipment to connect to and work in conjunction with audiovisual equipment, PCs and/or PC-related equipment, it becomes possible to deliver multimedia application services, such as displaying a “washing completed” message of a washing machine on a TV screen or operating an air conditioner via a TV screen, that otherwise would not be possible (see Figure 1).

To achieve these services, a home network standard for networks of standalone-type household appliances and network standards for audiovisual equipment, PCs and PC-related equipment are needed. It is also necessary to establish a system that allows equipment belonging to a network to exchange data with other equipment of different types of networks. A commonly used approach to allow networks of different types to exchange data with each other is to use Gateways.

Because data transferred within, into and out of networks of standalone-type household appliances are control data, which are much smaller in volume than data similarly transferred for networks of audiovisual equipment, PCs and PC-related equipment, and because standalone-type household appliances have longer service lives than audiovisual equipment, PCs and PC-related equipment, home network standards for networks of standalone-type household appliances have been established separately from network standards for audiovisual equipment, PCs and PC-related equipment, and many different protocol standards have been in use for a long time in different countries¹).

On the other hand, recent advances in device and software technology have made it possible to implement TCP/IP (which has been adopted worldwide for audiovisual equipment, PCs and PC-related equipment) in certain standalone-type household appliances, and so establishing a home network standard for networks of standalone-type household appliances in the form of a standard for layers above TCP/IP would allow data to be directly exchanged between household appliances and audiovisual equipment, PCs and PC-related equipment via TCP/IP (see Figure 2 example1, example2). In turn, this would allow the creation of multimedia application services that enable household appliances to work in conjunction with audiovisual equipment, PCs and PC-related equipment.

The advantages of applying this standard are:

- it can be applied to many types of Home Network standards.
- both Home Network nodes with TCP/IP Layer and without can coexist under the same Home Network middleware.
- Household appliances can communicate with audiovisual equipment, PCs and PC-related equipment, and vice versa, without requiring any gateway.
- Household appliances can handle text and audiovisual data.
- Audiovisual equipment, PCs and PC-related equipment can handle Household appliances data.
- Household appliances can freely select a suitable lower-layer medium from various lower-layer media below TCP/IP.

¹ CEBus, ECHONET, Konnex, LonTalk, others.

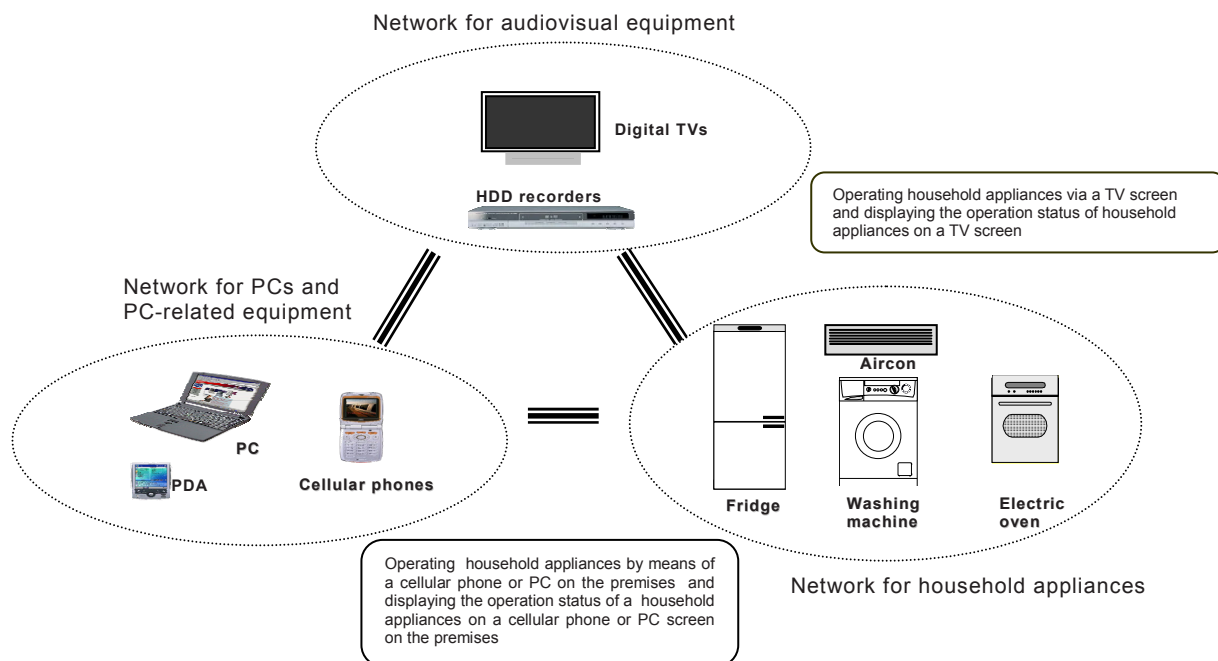


Figure 1 – Grouping of relationship between household appliances and audiovisual equipment, PCs and PC-related equipment

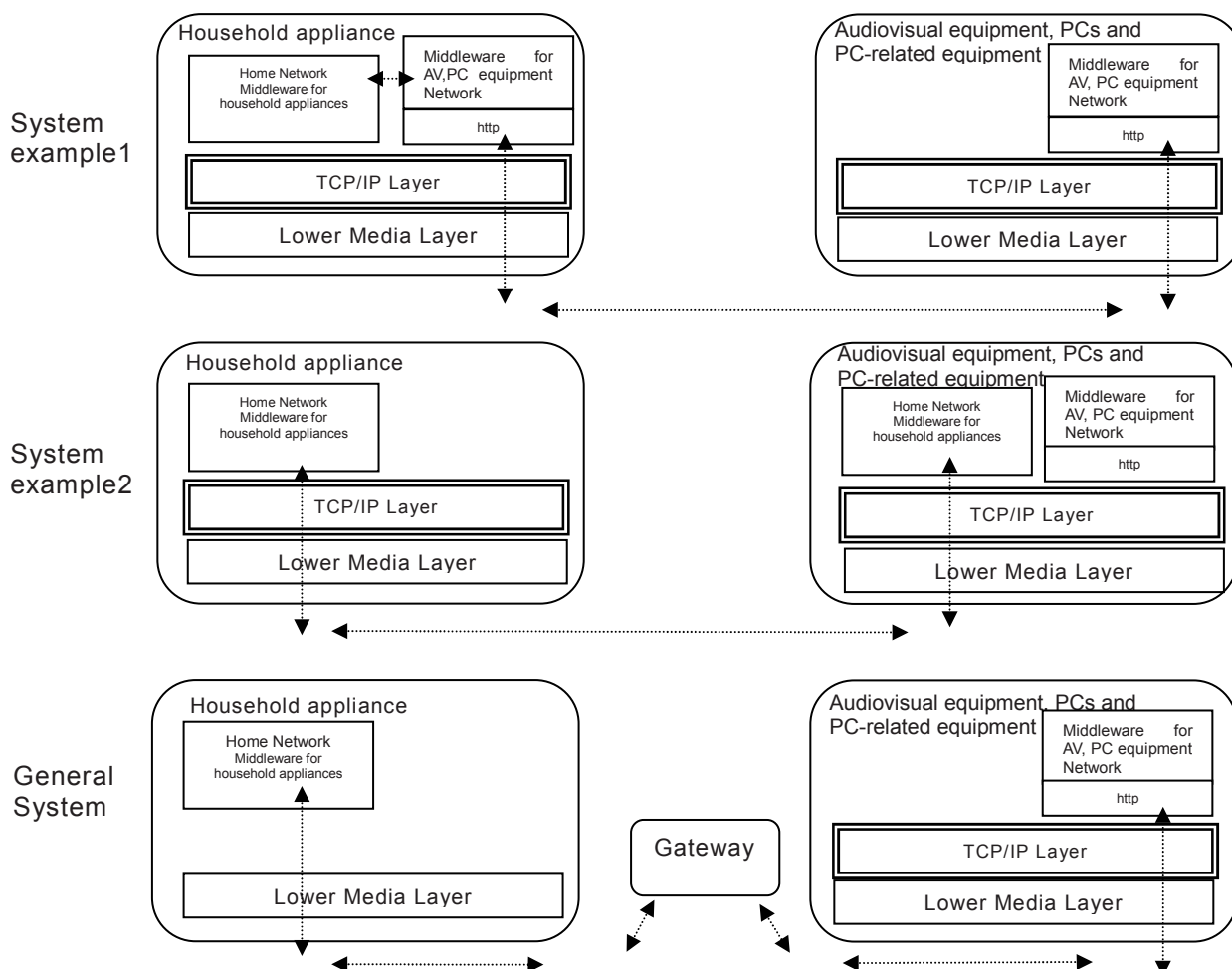
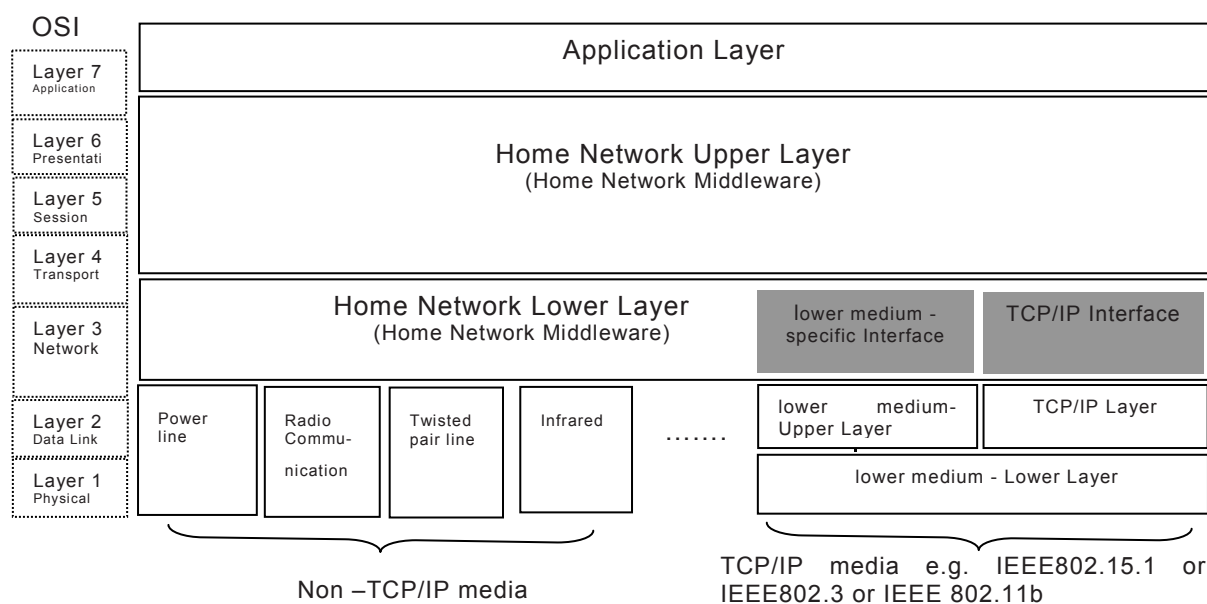


Figure 2 – Examples of data communication between household appliance and audiovisual equipment, PCs and PC-related equipment

MULTIMEDIA HOME NETWORKS – HOME NETWORK COMMUNICATION PROTOCOL OVER IP FOR MULTIMEDIA HOUSEHOLD APPLIANCES

1 Scope

This International Standard specifies the requirements for the interface between the Home Network Lower Layer for a country's home network of standalone-type household appliances and the TCP/IP Layer for cases where it is intended to introduce a TCP/IP Layer to each of the nodes comprising such home network of standalone-type household appliances. The specified interface in the Home Network Lower Layer consists of 2 portions, the TCP/IP Interface and the lower medium-specific Interface. Figure 3 shows the composition of the Home Network Layer and the standardized portions. In Annex C, this standard specifies the requirements for the lower medium-specific Interface One of these layers shall be IEEE 802.15.1, short-distance radio standard additional layers can be added in the future).



NOTE 1 Grey coloured portions are standardized.

NOTE 2 TCP/IP Interface is the same even if the lower medium is different, however the lower medium-specific Interface is different.

NOTE 3 Home Network Lower Layer and Home Network Upper Layer are prepared for CEBus, ECHONET, Konnex, LonTalk, others respectively.

NOTE 4 Each OSI Layer is roughly mapped to each Home Network Layer.

Figure 3 – The composition of the Home Network layer and the specified portions

2 Normative reference

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.

IEEE Std 802.15.1-2005, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 15.1: Wireless medium access control (MAC) and physical layer (PHY) specifications for wireless personal area networks (WPANs)*

3 Terms, definitions and abbreviations

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

3.1 Terms and definitions

3.1.1

Bluetooth

wireless technology that is a worldwide specification for a small-form factor, low-cost radio solution providing links between mobile computers, mobile phones, other portable handheld devices, and connectivity to the Internet

NOTE The specification is developed, published and promoted by the Bluetooth Special Interest Group (SIG). Main specifications are adopted as IEEE Std 802.15.1. In this standard, Bluetooth means IEEE 802.15.1.

3.1.2

Bluetooth Network Encapsulation Protocol

BNEP

protocol specified in Bluetooth. IP packet is encapsulated according to this protocol

3.1.3

cold start

method for starting the Home Network node by starting initial setting processing while abandoning previous information related to network addresses

3.1.4

Group ad-hoc Networks

GN

Piconet which comprises a master and a slave as defined in IEEE 802.15.1 and which is not connected to any outside network or node

3.1.5

Hardware address

Ha

address based on a medium-specific addressing scheme

3.1.6

Home Network

generic name for various equipment-type Home Network standards mainly for household appliances

NOTE Specifically, it refers to CEBus, Konnex, ECHONET, LonTalk, etc.

3.1.7

Home Network device

a home device, home electric product, or building/store device, such as lighting, air conditioning, refrigeration, power equipment, ordinary home appliances, sensors, actuators, etc.

NOTE A Home Network node provided with a communication interface and system compatible function conforming to the Home Network standard. A Home Network node provided with a controller function for the centralized control unit with functions to monitor, control, and operate them or an operating unit (remote control, etc.).

3.1.8

Home Network domain

a range on the network within which information transmission is logically guaranteed by the Home Network

NOTE Property and security control, including homes and stores, are generally thought to use the same range as a domain, but the domain is not limited by any standard.

3.1.9

Home Network frame

frame which is generated in the Home Network lower layer as specified in this standard;. the frame consists of a Home Network transmission frame or an associated managing packet

3.1.10

Home Network gateway

a Home Network node which connects a home network domain to an external system (including other Home Network domains)

NOTE Multiple Home Network gateways may exist in the domain depending on differences in the external system(s) to be connected.

3.1.11

Home Network lower-layer

interface between Home Network upper layer and the lower medium upper-layer

NOTE Some parts depend on the medium characteristics. This standard is contained in this layer. This layer mainly consists of OSI Layer 3, 4, and 2.

3.1.12

Home Network master router

a router that acquires a Net ID at the time of initialization and stores it; there is one Home Network master router in each Home Network subnet

3.1.13

Home Network node

communication node conforming to a Home Network standard, referred to as “node” herein unless otherwise specified

NOTE In a Home Network, a Home Network node is a Home Network communication function which is uniquely identified by a Network address. There is no distinction between the application functions of nodes. The term node is used to describe the function of one communication terminal of the Home Network.

3.1.14

Home Network router

a Home Network node used to connect Home Network subnets

NOTE A Home Network router connects the subnets of different lower-layer communication protocols (for different protocols, regardless of transmission media type) or divides the same protocol into subnets. The lower-layer communication protocol is connected seamlessly on the system using routing processing based on Network addresses as a function.

3.1.15

Home Network subnet

a group of nodes in the Home Network domain, using the same media or different media connected by layer 2 bridges, referred to as a “subnet” herein unless otherwise specified

NOTE Each subnet has a Net ID. Different subnets can be connected by a Home Network router.

3.1.16**Home Network transmission frame**

frame that is generated in the Home Network upper layer and transmitted between nodes via the Home Network lower layer

NOTE Each Home Network has its own frame format, but a Home Network transmission frame normally contains headers, address information, acquisition and setting information for other nodes.

3.1.17**Home Network upper layer**

processing block of the Home Network communication middleware

NOTE The Home Network upper layer performs the communication protocol processing to simplify the processing performed when the application software remotely controls or monitors devices, stores the information necessary for that purpose, and manages various pieces of information including that on the status of the device itself and of other devices. This layer mainly consists of OSI Layers 4, 5, 6, and 7.

3.1.18**IPme****IP multicast address**

this address is used for IP multicasting. The specific number is assigned to this standard

3.1.19**layer 2 bridge**

device used to store and transfer packets

NOTE Layer 2 bridges cover up to OSI Layer 2 (the data link layer). Layer 2 bridges are classified into several types by function including transparent bridges that discard or transfer packets based on MAC address values, converter bridges that perform MAC header conversions and source routing bridges with the additional capability to handle destination path information. Layer 2 bridges are defined in IEEE Std 802.1D.

3.1.20**MAC address server**

server which allocates Network MAC addresses in a subnet

3.1.21**net ID**

a subnet identifier; it is also a component of a Network address

3.1.22**Network Access Points****NAP**

an access point connected to the Internet which acts as a IEEE 802.15.1 master. IEEE 802.15.1 slaves are connected to a IEEE 802.15.1 master to form a Piconet and thus are connected to the Internet

3.1.23**Network address****Na**

an address permitting unique identification of a Home Network node in the domain

NOTE This address enables the Home Network communication processing block and the application software to disregard differences in the lower-layer communication software. A Network address is a logical address that is defined separately from the Hardware address to lower-layer communication software; it consists of at least a Net ID and a Node ID.

3.1.24**Network MAC address****NMa**

a unique Home Network lower layer address that allows Layer 2 communication (transmission medium) to be performed

NOTE This address for each Home Network node is uniquely assigned in the Home Network subnet by the Home Network lower layer of the Home Network node itself or MAC address server.

3.1.25

node ID

an identifier used to identify a Home Network node uniquely within the Home Network subnet.

NOTE A node ID is a logical address converted from the NMa by the Home Network upper layer. This is a component of a Network address.

3.1.26

park mode

a low power consumption mode defined in the IEEE 802.15.1 specification

NOTE Upon entry into this mode, two different addresses are given by the master and synchronization is maintained thereafter by periodic beacon pulses from the master. While in Park mode, a negotiation to cancel Park mode can be made within the preset window period.

3.1.27

Personal Area Networking Profile

PAN

specified in Bluetooth

NOTE This profile is for IP communication over IEEE 802.15.1. IP Packet is encapsulated by BNEP and behaves like Ethernet networking.

3.1.28

Personal Area Networking Profile User

PANU

slave nodes specified in Personal Area Networking

3.1.29

Piconet

a network that has a single master and two or more slaves as specified in the IEEE 802.15.1.

3.1.30

profile

profiles specify Bluetooth communication functions and protocol requirements by purpose to maintain interconnectivity

NOTE In the Bluetooth specification version 1.1, Generic Access Profile, Serial Port Profile, etc. are defined.

3.1.31

scatternet

network that looks like two or more Piconets connected together because of the “time-series” manner in which a node belongs to one of the two or more Piconets

3.1.32

Service Discovery Protocol

SDP

upon establishment of a link between two nodes, this protocol (which is defined in IEEE 802.15.1) is used to acquire service records (service class, protocol, etc.) held by the nodes

3.1.33

warm start

method of starting the Home Network node by starting initial setting processing while keeping previous Network addresses and initial setting information

3.2 Abbreviations

BNEP	Bluetooth Network Encapsulation Protocol
DHCP	Dynamic Host Configuration Protocol
GN	Group Ad-hoc Networks
Ha	Hardware address
IP	Internet Protocol
Ipme	IP multicast address
LSB	the Least Significant Bit
MAC	Media Access Control
MSB	the Most Significant Bit
Na	Network Address
NAP	Network Access Point
Nma	Network MAC address
OSI	Open System Interface
PAN	Personal Area Networking Profile
PANU	Personal Area Networking Profile User
SDP	Service Discovery Protocol
TCP	Transmission Control Protocol
UDP	User Datagram Protocol

4 TCP/IP interface and requirements

4.1 Overview

When introducing lower layer media into Home Networks, some Home Networks require a definition on an Internet Protocol (IP) network whereas others do not; the selection should be made according to the application requirements. This standard provides International Standards for protocols that operate on IP. In the case where Home Networks operate in an IP network, each Home Network subnet is mapped onto an IP subnet and the Home Network frames (Home Network transmission frames or associated control packets) are encapsulated into IP packets and transferred over the IP network (see Figure 4). IP networks are classified into IPv4 and IPv6 networks; this standard uses IPv4. Each Home Network node shall have an IP address, which shall be either a unique global IP address or a private IP address, in addition to a Hardware address. Although this standard does not specify a method for acquiring IP addresses, the operation of a node as a Home Network node is premised on the acquisition of an IP address. The IP network transfer protocol used to transfer a Home Network frame shall be the connectionless User Datagram Protocol (UDP). When transferring a Home Network frame, the UDP shall permanently use the port number specified in this standard. Each Home Network frame is encapsulated into one UDP packet. Each Home Network node shall also have a Network Address (Na) in the Home Network Upper Layer and Network MAC address (NMa) in the Home Network Lower Layer, in addition to the IP address. For destination addresses and sender addresses for Home Network transmission frames, Na shall be used. For destination addresses and sender addresses for Home Network frames, for IP headers, IP addresses shall be used. All Home Network nodes operating on an IP subnet shall be capable of using the IP multicast addresses assigned for the Home Network. A Home Network frame to be broadcast or group-broadcast is mapped onto IP multicast packets addressed to the specified IP multicast address. Because there are many media other than IEEE 802.15.1, IEEE 802.3, etc. that have been defined as lower layer media, they have their own layer structures, functions, addressing schemes and topologies. This standard also defines interfaces as medium-specific interfaces that are separated from the TCP/IP interface.

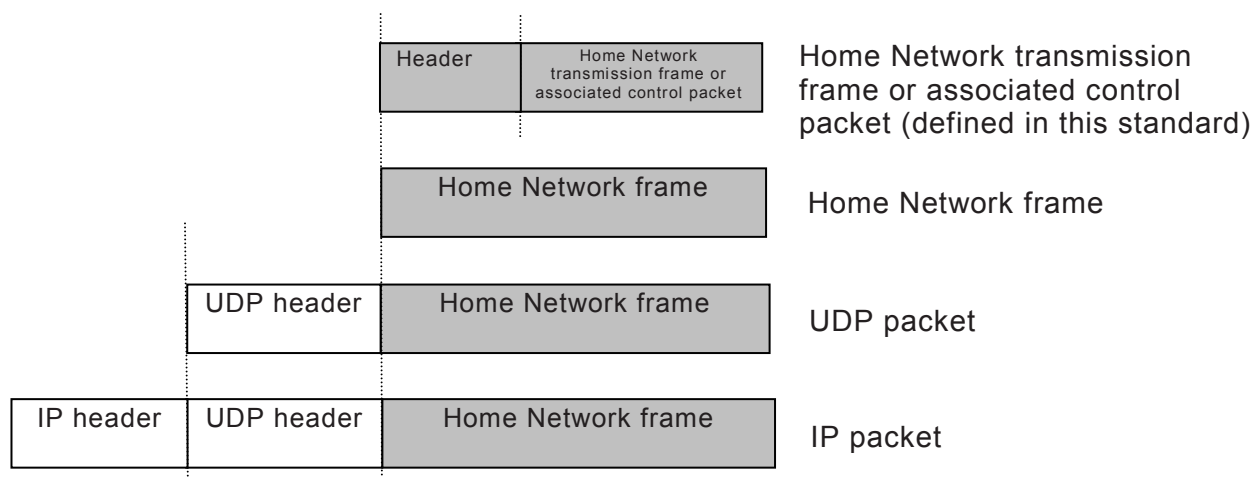


Figure 4 – Encapsulation of Home Network frame

NMa Acquisition Booting Sequence is specified in this standard. Each Home Network node has a unique Na which is held by the Home Network upper layer to allow the node to be identified regardless of the types of media or with IP or with non-IP. Each of the components of a Na corresponds uniquely to a NMa set by the Home Network lower layer at the time of initialization. This standard stipulates three NMa setting methods: the MAC Address Server Method, the Distributed Method that does not use any MAC address server, and the Manual Setting Method. In this standard, three address setting modes are acceptable: a) the “Server Required Mode” (SR-MODE), where a MAC address server shall always be used for NMa setting under some administrator; b) the “Automatic Mode” (A-MODE), where no MAC address server exists in which the NMa setting mechanism is operated in a distributed manner; and c) the “Manual Mode” (M-MODE), in which NMAs are defined manually.

4.2 Topology

The common accommodation requirements for all IP medium types are as follows:

- A single IP subnet that contains nodes using different media connected by means of Layer 2 bridges shall be treated as a Home Network subnet. That is, node sets using different Home Network media but connected using Layer 2 bridges are defined as a single Home Network subnet. This allows node sets using different media to be connected without using a Home Network router and eliminates Net ID changes during node transport within the subnet. When a Layer 2 bridge is to be used, the Home Network packet timeout requirement specified in this standard shall be satisfied. Figure 5 shows an example of a bridge connection Network A, B, C in this figure are basic networks with the same lower media and IP layer.
- Home Network nodes shall be connected by Home Network routers on a subnet-by-subnet basis regardless of whether the IP layer exists. An example is shown in Figure 6.
- In a network comprising two or more IP subnets connected by means of an IP router or IP routers, the Home Network subnets shall be contained in the respective IP subnet. That is, it is not allowed to use an IP network comprising two or more IP subnets connected by means of an IP router or IP routers as one Home Network subnet. Connection between Home Network subnets shall be made by means of a Home Network router or Home Network routers. Home Network communication via an IP router is not allowed. Figure 7 shows an example of this type of connection.

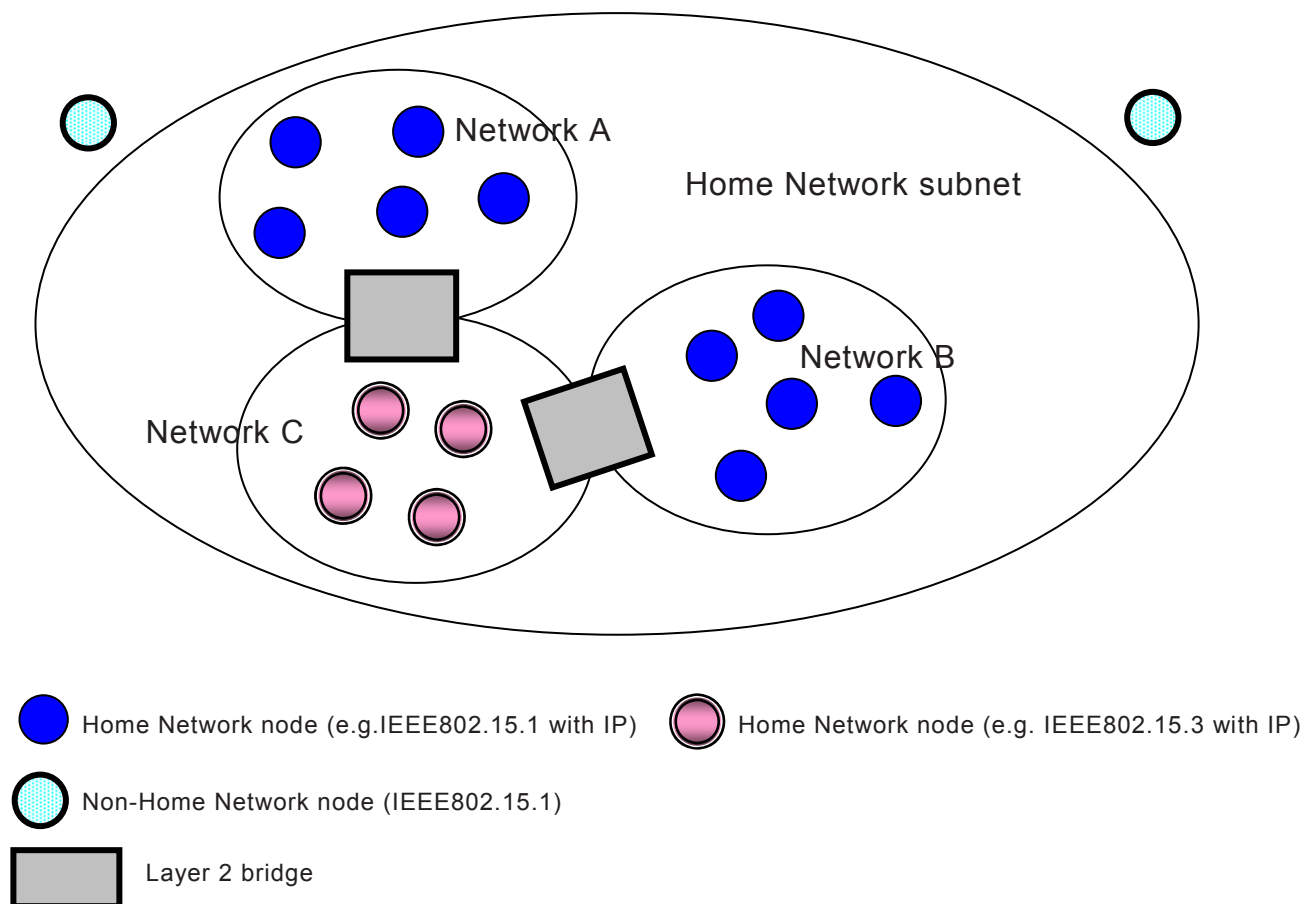


Figure 5 – Example of a subnet using Layer 2 bridges

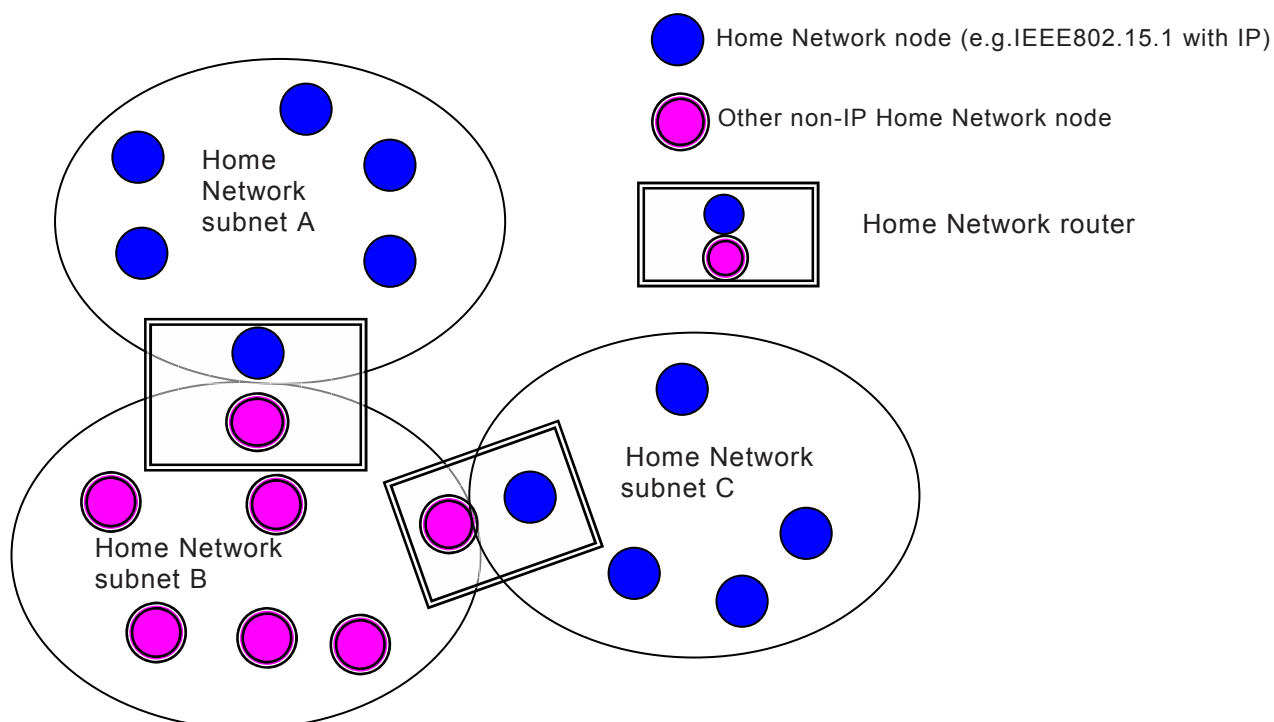


Figure 6 – Example of a subnet connection using Home Network routers

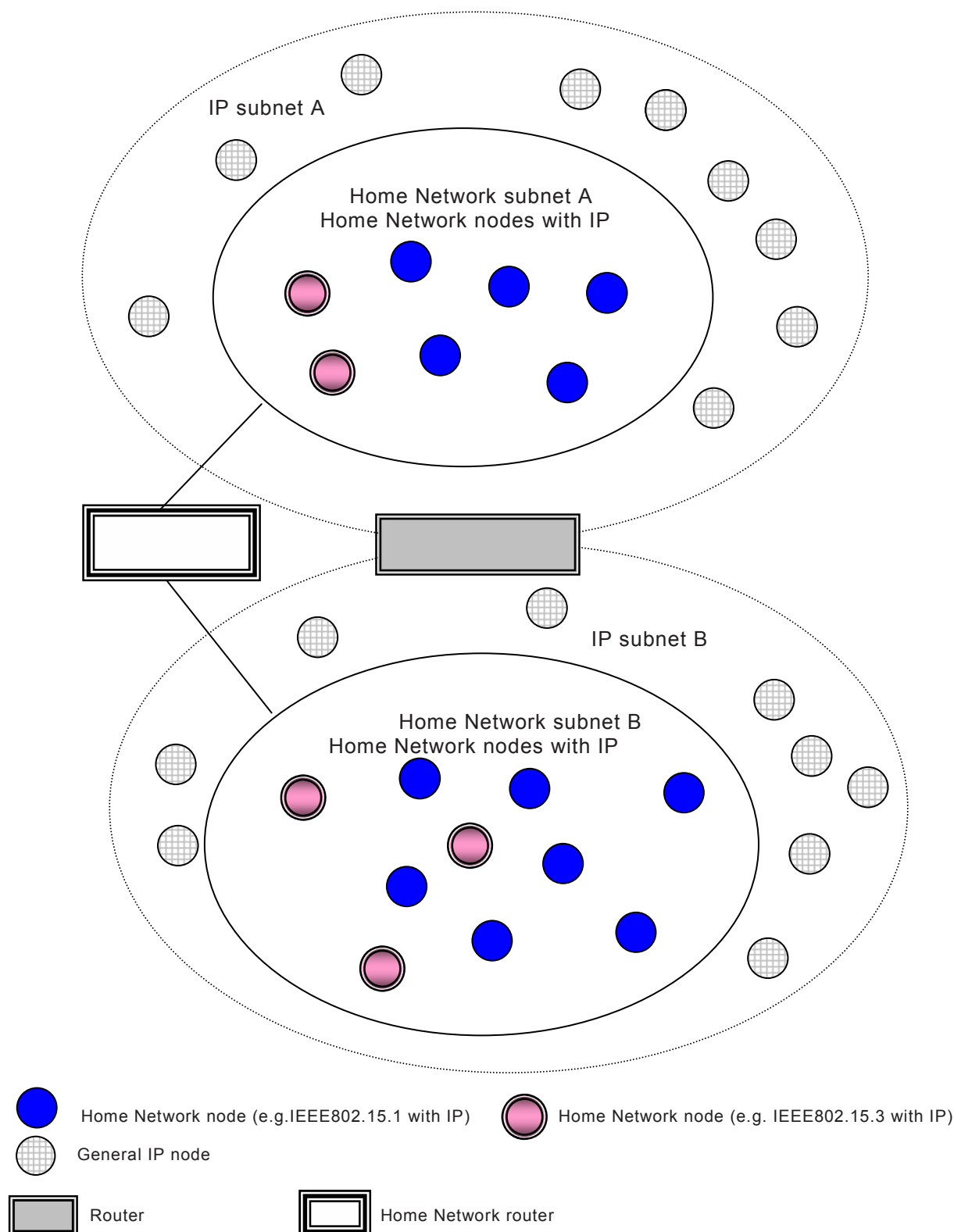


Figure 7 – Relationship between IP subnet and Home Network subnet

4.3 UDP interface

For access to UDP/IP by a UDP/IP application, a socket interface or equivalent interface is normally used. These interfaces depend on the operating system and development environment. For details, see the UDP/IP interface standards for the specific development platform.

4.4 Packet format of Home Network frame

4.4.1 General

Home Network frames which are generated by a TCP/IP Interface shall be encapsulated into UDP packets when transferred over the Internet. These packets shall be transferred with the UDP port number 3610 attached. This number shall be for the receiving port. The port number shall be the same regardless of packet type (unicast, multicast, or broadcast).

One Home Network frame packet prepared for a Home Network transmission frame and 9 types of Home Network frame packets for network management are specified as follows:

- Home Network transmission frame transfer
- MAC/IP address resolution request/response (resolution of IP address from NMa)
- IP/MAC address resolution request/response (resolution of NMa from IP address)
- Hardware/MAC address resolution request/response (resolution of NMa from Ha)
- MAC address initialization request/response, MAC address server initialization response
- MAC address allocation response
- MAC address confirmation request/response
- MAC address request/response to all nodes
- MAC address server detection request/response, MAC address server notification
- Network control message(destination invalid/NMa overlap)

Because all these packet types are multiplexed onto the same UDP port, it is necessary to use packet type numbers for multiplexing. Therefore, these packets are multiplexed onto UDP packets using the format shown in Figure 8 below. The entry in the “version number” section shall always be 0x01.

Version number (0x01)	Packet type number	Packet type number-dependent
-----------------------	--------------------	------------------------------

Figure 8 – Home Network frame packet format

Packet type numbers are shown in Table 1. “Mandatory for all nodes” in the “Support” column means that all Home Network nodes shall support packets having the packet type number shown. “Mandatory only for address servers” means that only those nodes that may become a MAC address server are required to support packets having the packet type number shown

Table 1 – Packet type numbers of the Home Network frame

Packet type number	Packet type	Support
0	Home Network transmission frame transfer	Mandatory for all nodes
1	MAC/IP address resolution request	Mandatory for all nodes
2	MAC/IP address resolution response	Mandatory for all nodes
3	IP/MAC address resolution request	Optional for all nodes
4	IP/MAC address resolution response	Mandatory for all nodes
5	Hardware/MAC address resolution request	Optional for all nodes
6	Hardware/MAC address resolution response	Mandatory for all nodes
7	MAC address initialization request	Mandatory for all nodes (not required for manual setting mode-only nodes)
8	MAC address initialization response	Mandatory for all nodes
9	MAC address server initialization response	Mandatory only for address servers
10	MAC address allocation response	Mandatory for all nodes (not required for manual setting mode-only nodes)
11	MAC address confirmation request	Mandatory for all nodes (not required for manual setting mode-only nodes)
12	MAC address confirmation response	Mandatory for all nodes
13	MAC address request to all nodes	Mandatory only for address servers
14	MAC address response to all nodes	Mandatory for all nodes
15	MAC address server detection request	Mandatory only for address servers
16	MAC address server notification	Mandatory only for address servers
17	MAC address server detection response	Mandatory only for address servers
18	Network control message (destination invalid)	Optional for all nodes
19	Network control message (NMA overlap)	Optional for all nodes
Other than above	Reserved for future use	

In this standard, the term “multicast” means “multicast to all Home Network nodes in the Home Network subnet” unless otherwise specified. Multicast packets are encapsulated into an IP packet addressed to the assigned IP multicast address (also referred to as “IPme”) and sent to the Home Network nodes.

The “Hardware type” and “Hardware address length” follow Table 2.

Table 2 – Hardware type

Hardware type	Hardware name	Hardware address type	Hardware address length
0x00	IEEE 802.15.1	IEEE 802	48 bit
0x01	Ethernet or IEEE 802.3	IEEE 802	48 bit
0x02	IEEE 802.11	IEEE 802	48 bit
Other than above	Reserved for future use		

For fields with the comment “Enter null” or “Padding,” “0x00” shall be used throughout the remainder of this standard. In the explanation of packet formats in this standard, MSB shall refer to the leftmost bit and LSB to the rightmost bit. In the Flag field in some packet format tables, bit 7 shall refer to MSB and bit 0 to LSB as shown in Figure 9. Multi-byte fields shall be transmitted with the MSB first and LSB last (Big-endian).

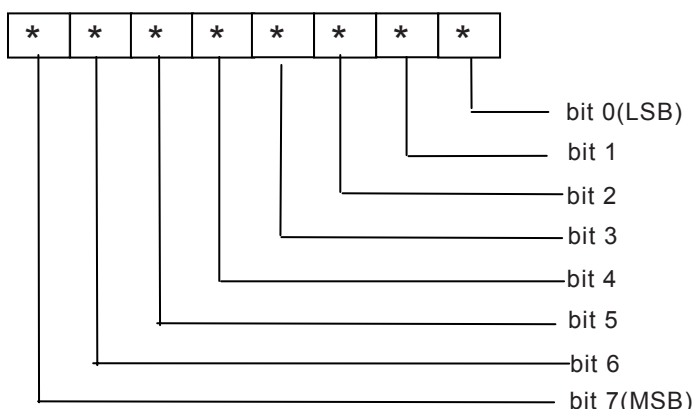


Figure 9 – Notation for bits in the flag field

The unit of size used in this standard is Octet.

A bit ordering example in case of the IEEE 802.15.1 address used as the Ha is shown in Figure 10. In this case, 0x “acde48000080” is entered into the packet.

MSB		LSB	
company_id		company_assigned	
NAP	UAP	LAP	
1010110011011110	01001000	000000000000000010000000	

Figure 10 – IEEE 802.15.1 Address described in bits

IP addresses represented in dotted decimal notation are treated similarly. For example, “192.168.10.5” is entered into the packet as “0xc0a80a05”.

4.4.2 Home Network transmission frame transfer

The definition and the format are described below.

- Stores a Home Network transmission frame, which was received from the Home Network upper layer or UDP Layer.
- The node that transmits the Home Network transmission frame shall be referred to as the transmission node and the node that receives the Home Network transmission frame shall be referred to as the receiving node.
- The Home Network transmission frame shall be transferred with the transmission node's Hardware type, Ha length, Ha, NMa, and the receiving node's NMa attached.
- When the Home Network transmission frame to be transmitted is a broadcasting or group-broadcasting frame, the transmission node's NMa value shall be entered in the column for the receiving node's NMa.

NOTE The detection of the frame from the protocol (CEBus, ECHONET, Konnex, LonTalk, others) is out of the scope of this standard.

Table 3 below shows the format for “Home Network transmission frame transfer” Packets.

Table 3 – Format for “Home Network transmission frame transfer” packets

Item	Size(octet)	Explanation
Version	1	Enter “0x01” (Version 1)
Type	1	Enter “0x00” (Home Network transmission frame transfer)
DMAC	1	NMa of receiving node
SMAC	1	NMa of transmission node
SHType	1	Hardware type of transmission node
SHLen	1	Ha length of transmission node
SHAddr	SHLen	Ha of transmission node
Msg		Direct storage of Home Network transmission frame

4.4.3 MAC/IP address resolution request/response

The definition and the format are described below.

- Used to obtain the IP address of a Home Network node that has a NMa.
- The node that wishes to resolve the NMa (i.e., that wishes to know the IP address) shall be referred to as the “requesting node” and the node that notifies the relationship between the addresses in response to the request shall be referred to as the “target node”.
- The requesting node multicasts to the Home Network subnet an IP address resolution request packet containing the NMa to be resolved. Upon receipt of the request, the target node sends an IP address resolution response packet containing the relevant addresses if TMac and THLen are exactly the same as the target node.

Table 4 below shows the format for MAC/IP address resolution request packets.

Table 4 – Format for “MAC/IP address resolution request” packets

Item	Size(octet)	Explanation
Version	1	Enter “0x01” (Version 1)
Type	1	Packet type (MAC/IP address resolution request ; enter “0x01”)
Padding	1	Padding
RMAC	1	NMa of requesting node
RIPAddr	4	IP address of requesting node
RHType	1	Hardware type of requesting node
RHLen	1	Ha length of requesting node
RHAddr	RHLen	Ha of requesting node
Padding	1	Padding
TMac	1	NMa of target node
TIPAddr	4	IP address of target node (Enter “null”)
THType	1	Hardware type of target node (Enter “null”)
THLen	1	Ha length of target node (Enter “RHLen”)
THAddr	THLen	Ha of target node (Enter “null”)