System Specifications

Communication Media

KNX IP

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Summary

This document defines specifies how the Internet Protocol (IP) shall be used as a KNX medium by KNX devices that are connected to an IP network only.

Version 01.00.01 is a KNX Approved Standard.

This document is part of the KNX Specifications v2.1.

Document updates

Version	Date	Modifications
AN117 v02	2010.02.02	Preparation of the Draft for Voting.
3/2/6 v1.0.00	2010.07.23	- Integration of resolution of comments from Final Voting. - Publication of the Approved Standard.
01.00.01	2013.10.28	Editorial updates for the publication of KNX Specifications 2.1.

References

[1] Chapter 3/1/1 "Architecture"
[2] Chapter 3/3/2 "Data Link Layer General"
[3] Chapter 3/6/3 "External Message Interface"
[4] Chapter 3/8/1 "KNXnet/IP Overview"
[5] Chapter 3/8/2 "KNXnet/IP Core"
[6] Chapter 3/8/5 "KNXnet/IP Routing"

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Contents

1 Specification of the KNX IP Communication Medium

1.1 Physical specification of the medium

As the KNX IP multicast access for message transportation at Physical Layer does not physically access the client IP medium but is transporting the KNX Telegram data as Application Layer payload for the client IP stack, no physical specification for this KNX medium type is necessary.

1.2 Mechanical requirements

The equipment used to connect to the IP network shall conform to the specific requirements for the IP medium access (e.g. 802.3 for Ethernet LANs or 802.11 for Wireless LANs etc.) and all national regulations for electric installations.

1.3 Supplemental IP protocols

The KNX IP medium requires the implementation of a minimal set of supplemental IP protocols for interworking. Required IP protocols for the KNX IP medium access are ARP, BootP/DHCP, UDP, ICMP and IGMP.

Additional IP protocols may be required for the implementation of optional, device specific KNX IP services.

1.4 Physical topology

The physical topology of the KNX IP medium depends on the installation of the underlying IP network (LAN, WLAN or WAN), which must ensure that IP multicast telegrams are transported correctly across different IP topology segments.

1.5 Topology constraints

The proposal assumes that IP defines the transmission mechanism as well as the physical specifications (e.g. Ethernet). KNXnet/IP Routing is defined as the standard protocol for communication.

KNX IP Routers assigned to the same Project-Installation-ID SHALL use the same ROUTING_MULTICAST_ADDRESS as KNXnet/IP Routers with the same Project-Installation-ID.

This adds some restrictions to where inside the topology KNX IP Subnetworks can be used and where not. If a KNX IP device is assigned to a Subnetwork, then that Subnetwork and any Subnetwork higher in the logical topology shall contain KNX IP devices only. This leads to additional rules for the logical topology (compare first three rules with [6]).

Only one KNXnet/IP Routing multicast address shall be used by KNXnet/IP Routers [1)].

KNX IP devices have to implement Core Services, Device Management and KNXnet/IP Routing (see [4] clause 3.5 KNXnet/IP device classes) except those parts that are specific to the function of a KNXnet/IP Router.

1) Flow control affects all devices and all communication between KNX IP devices.

The following four rules apply to KNX IP devices. The first three rules already apply to KNXnet/IP Routers.

Rule 1

In general a KNXnet/IP Router may be used as a Line Coupler or a Backbone Coupler. The Individual Address has the format x.y.0, with x = 1 to 15 and y = 0 to 15.

Rule 2:

If a KNXnet/IP Router is applied as a Backbone Coupler with the Individual Address x.0.0 then no other KNXnet/IP Router with the Line Coupler Individual Address x.y.0 (y = 1 to 15) shall be placed topologically „below“ this KNXnet/IP Router.

Rule 3:

If a KNXnet/IP Router is applied as a Line Coupler (e.g. with Individual Address 1.2.0) then no other KNXnet/IP Router shall be used with a superior Backbone Coupler Individual Address (e.g. 1.0.0) in this installation.

Rule 4:

If a KNX IP device is assigned to a Subnetwork as a simple device (e.g. with Individual Address 1.0.1) then that Subnetwork and any Subnetwork higher in the system structure shall contain KNX IP devices only.

2 Datagram service

2.1 Transmission method

This clause defines the transportation levels of the KNX IP communication system complying with Chapter 3/8/5 “KNXnet/IP Routing” ([6]).

IP Datagram

The KNX IP medium uses IP UDP Datagram transfer on the fixed port 3671. The multicast address may vary for separate distinct installations on the same IP infrastructure. Usually the IP multicast address used for the KNXnet/IP Routing traffic is the same as the registered “System Setup” address 224.0.23.12.

Transmission Speed

The physical transmission speed on the KNX IP medium depends on the underlying IP network. This speed may vary across different segments of the IP topology.

Usually the effective transmission speed of the IP network is a lot faster than on KNX Twisted Pair 1 or KNX Powerline Subnetworks. Therefore a limitation of the “penetration” speed (Telegrams per second) is necessary to prevent buffer overflows in Media Couplers. This is achieved by the flow control implemented with the ROUTING_BUSY Frame (see [6]).

For KNXnet/IP Routers ROUTING_BUSY shall be a means of preventing the loss of ROUTING_-INDICATION Datagrams due to an overflow of the buffer to the KNX Subnetwork.

KNX IP devices receive Datagrams via the network transceiver (“Ethernet chip”), which forwards them to the microprocessor. Depending on the hardware and software design of the interface between the network transceiver and the microprocessor the effective data transmission rate between these two parts inside a KNX IP device may be lower than the actual transmission rate on the communication network. This internal receiving transmission rate limitation may cause the loss of Datagrams between network transceiver and microprocessor.

The transmission rate of the ROUTING_INDICATION Datagrams to the network shall be limited and at the same time KNX IP devices and KNXnet/IP Routers shall receive and process incoming ROUTING_-INDICATION Datagrams at a minimum transmission rate.

Any KNX IP device or KNXnet/IP Router SHALL limit the transmission of KNX IP ROUTING_-INDICATION Datagrams to a maximum of 50 Datagrams per second within one second.

For simplicity reasons a KNX IP device MAY choose to always pause 20 ms after it transmits a ROUTING_INDICATION Datagram. A KNX IP device or KNXnet/IP Router SHALL always pause its transmission on an assigned multicast address for at least 5 ms after it transmit a ROUTING_-INDICATION Datagram.

To ensure a minimum system performance any KNX IP device or KNXnet/IP Router SHALL be capable of receiving and processing a minimum number of ROUTING_INDICATION Datagrams per second on an assigned multicast address.

Ideally, any KNX IP device or KNXnet/IP Router SHOULD be capable of receiving and processing at least 12 750 ROUTING_INDICATION Datagrams [2)] per second on an assigned multicast address. This number enables KNX IP devices or KNXnet/IP Routers to receive and process Datagrams sent by up to 255 KNX IP devices or KNXnet/IP Routers transmitting at a rate of 50 ROUTING_INDICATION Datagrams per second.

A KNXnet/IP Router or KNX IP device SHALL be able to receive and process up to the KNX Network - respectively Application Layer at least 1 000 ROUTING_INDICATION Frames per second.

2) IP Datagram length: 64 octets. Testing SHOULD be done with evenly distanced Datagrams.

2.2 Frame encapsulation

The KNX IP medium uses cEMI encoded Data Link Layer Indication (L_Data.ind) Frames for the UDP transport on the Multicast address (see above). No changes or additions to the telegram payload will be performed on KNXnet/IP Routing layer.

The KNX IP medium uses only unconfirmed services and because of the asynchronous nature of IP networks no flow control mechanisms are defined on the IP medium.

2.3 Physical Layer service definitions

Not applicable as the Internet Protocol Frame is used as transport "medium" and thus the Physical Layer is defined by whatever medium is used as LAN or WAN.

3 Power feeding service

As the KNX IP medium is only a logical Physical Layer without capabilities to provide power feeding service for KNX devices connected to the KNX IP medium, power feeding for such devices is not in the scope of this document.

4 Data Link Layer type KNX IP

4.1 Frame format

4.1.1 Frame type summary

Each Frame shall be a sequence of octets.

Three Frame formats shall be provided:

1. a variable length Frame format (ROUTING_INDICATION) (Figure 1), and
2. a buffer overflow warning indication (ROUTING_BUSY) (Figure 3)
3. a buffer overflow indication (ROUTING_LOST_MESSAGE) (Figure 4).

In the following representation of Frames, the octet situated on the left hand side shall always be transmitted firstly.

4.1.2 Variable Length Frame Format

The structure of the variable length Frame is shown in Figure 1.

```
KNXnet/IP header
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10              |   KNXNETIP_VERSION            |
|   (06h)                       |   (10h)                       |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   ROUTING_INDICATION                                          |
|   (0530h)                                                     |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10 + sizeof(cEMI Frame)                         |
|                                                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

KNXnet/IP body
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   cEMI Frame                                                  |
|   (variable length)                                           |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
```

Figure 1 - Complete Frame encapsulation (Datagram)

The encoding of the fields of the Frame shall be done as specified in the clauses below.

KNXnet/IP header

For a detailed specification of the fields in the KNXnet/IP header see [5].

KNXnet/IP body

The KNXnet/IP body of the Routing Indication Frame shall consist only of a cEMI encoded Data Link Layer Indication message.

Message Code	Additional Info Length	Additional Information	Control field 1	Control field 2	Src. High	Src. Low	Dest. High	Dest. Low	NPDU	
MC	**AddIL**	**…**	**Ctrl1**	**Ctrl2**	**SAH**	**SAL**	**DAH**	**DAL**	**L**	TPCI/APCI & data
29h	…	…	x0r0ppxx	…	…		…		…	…

Figure 2 - cEMI Data Link Layer Indication message format

The encoding of the fields of the cEMI L_Data.ind message in the context of KNXnet/IP shall be done as specified in the clauses below.

Additional Information

Medium specific “Additional Information” headers (see [3]) are allowed on the KNX IP medium if the originator of the Frame is a KNXnet/IP Router or Media Coupler connected to a KNX medium that provides this medium specific additional information.

Control Fields

See [3].

Source Address

The Source Address shall be the Individual Address of the device that requests the transmission of the Frame.

Destination Address

The Destination Address defines the device(s) that shall receive the Frame. The Destination Address can either be an Individual Address or a Group Address, depending on the Address Type flag in the Control Fields (see above).

4.1.3 Buffer Overflow Warning Indication (ROUTING_BUSY)

The buffer overflow warning indication shall consist of a fixed length data field of six octets. It shall be used to indicate that the IP receive buffer has filled up to a point where the buffered incoming messages may take at least 100 ms to be sent to the KNX Subnetwork. The structure of the buffer overflow warning indication Frame is shown in Figure 3.

```
KNXnet/IP header
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10              |   KNXNETIP_VERSION            |
|   (06h)                       |   (10h)                       |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   ROUTING_BUSY                                                |
|   (0532h)                                                     |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10 + 4                                          |
|                                                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
BusyInfo
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   Structure Length            |   DeviceState                 |
|   (1 octet)                   |   (1 octet)                   |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   ROUTING_BUSY_WAIT_TIME (in milliseconds)                    |
|   (2 octets)                                                  |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   ROUTING_BUSY_CONTROL_FIELD                                  |
|   (2 octets)                                                  |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

Figure 3 - ROUTING_BUSY Frame binary format

Details on handling of buffer overflow warnings and the Routing Busy Message Frame can be found in [6]. The encoding of the fields of the Frame shall be done as specified in the clauses below.

KNXnet/IP header

For a detailed specification of the fields in the KNXnet/IP header see [5].

KNXnet/IP body

For the encoding of the KNXnet/IP body of the Routing Lost Telegram Frame see [6].

4.1.4 Buffer Overflow Indication (ROUTING_LOST_MESSAGE)

The buffer overflow indication shall consist of a fixed length data field of four octets. It shall be used to indicate that the IP receive buffer is full and incoming new messages got lost. The structure of the buffer overflow indication Frame is shown in Figure 4.

```
KNXnet/IP header
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10              |   KNXNETIP_VERSION            |
|   (06h)                       |   (10h)                       |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   ROUTING_LOST_MESSAGE                                        |
|   (0531h)                                                     |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   HEADER_SIZE_10 + 4                                          |
|                                                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
LostMessageInfo
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   Structure Length            |   DeviceState                 |
|   (1 octet)                   |   (1 octet)                   |
+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+-7-+-6-+-5-+-4-+-3-+-2-+-1-+-0-+
|   NumberOfLostMessages                                        |
|   (2 octets)                                                  |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

Figure 4 – ROUTING_LOST_MESSAGE Frame binary format

Details on handling of buffer overflows and the Routing Lost Message Frame can be found in the [6]. The encoding of the fields of the Frame shall be done as specified in the clauses below.

KNXnet/IP header

For a detailed description of the fields in the KNXnet/IP header see [5].

KNXnet/IP body

For the encoding of the KNXnet/IP body of the Routing Lost Telegram Frame see [6].

4.2 Medium Access Control

KNX IP uses an asynchronous access to IP multicast medium. Medium access control on the IP network shall be handled by the underlying IP infrastructure.

Medium access is restricted by the ROUTING_BUSY scheme (see [6]).

Further, a KNX IP device or KNXnet/IP Router shall limit the number of KNX IP ROUTING_INDICATION Datagrams to a maximum of 50 Datagrams per second.

4.3 Data Link Layer services and protocol

4.3.1 L_Data service

See [2] for the description of the service interface. The actions performed by Data Link Layer are listed in [1].

Frames shall be transported as cEMI (Data Link Layer, L_Data.ind = cEMI message code 29h) messages.

Frame Acceptance

A Frame shall be considered valid if the number of characters received without error is consistent with the content of the "Frame length" subfield.

Any reserved fields shall have the expected value.

Any invalid Frame shall be ignored.

Frames exceeding the reception capabilities of the device shall be ignored.

Address Check

The Frame is intended for the receiving device if the Destination Address (Individual Address or Group Address according to CTRL field) is recognised.

Data Link Layer acknowledgement sending and retransmissions

The KNX IP medium does not support Data Link Layer acknowledging of Frames on the medium and hence does not define any retransmission rules on this layer.

Frame Fragmentation

Fragmentation on the physical medium is handled by the underlying IP infrastructure.

4.3.2 L_PollData service

This service is specific to KNX TP1 medium and cannot be supported on KNX IP.

NOTE 1 Periodic circular polling of devices may be achieved at application level using management supervision mechanisms (based on time slot assignment at applicative level).

4.3.3 L_Busmon service

See [2].

4.3.4 L_Service_Information service

See [2].