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Open data communication in building automation, controls and building management — Home and building electronic systems — KNXnet/IP communication

Réseau ouvert de communication de données pour l'automatisation, la régulation et la gestion technique du bâtiment — Systèmes électroniques pour les foyers domestiques et les bâtiments — Communication KNX/IP

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 247, *Building Automation, Controls and Building Management*, in collaboration with ISO Technical Committee TC 205, *Building environment design*, in accordance with the agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 16484 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

This document is intended for the design of new buildings and the retrofit of existing buildings in terms of acceptable indoor environment, practical energy conservation and efficiency.

KNXnet/IP is a protocol designed to transport KNX home and building electronic system (HBES) control frames over an IP network. It is used as an infrastructure backbone for connecting KNX sub-networks, as a communication medium for KNX-IP devices and to provide IP based services for clients (e.g. connecting a tool software to a KNX installation). The main advantages of using IP for these purposes are that IP network infrastructure is inexpensive, available almost everywhere and that the distance of two communication parties on an IP network is virtually unlimited.

Widespread deployment of data networks using the Internet protocol (IP) presents an opportunity to expand building control communication beyond the local KNX control bus, providing:

- remote configuration;
- remote operation (including control and annunciation);
- fast interface from LAN to KNX and vice versa;
- WAN connection between KNX systems (where an installed KNX system is at least one line);
- an interface to super ordinate building management and energy management systems.

A KNXnet/IP system contains at least these elements:

- one EIB line with up to 64 (255) EIB devices; or
  one KNX segment (KNX-TP1, KNX-RF, KNX-PL110);
- a KNX-to-IP network connection device (called KNXnet/IP server); and typically
- additional software for remote functions residing on e.g. a workstation (may be data base application, BACnet Building Management System, browser, etc.).

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KNXnet/IP differentiates between unicast and multicast services. KNXnet/IP unicast services are used to connect a single client to a single KNXnet/IP server (e.g. KNXnet/IP Tunnelling). KNXnet/IP multicast services are mainly used to connect different KNX sub-networks using IP communication on the KNX backbone. The KNXnet/IP routing services are defined for this purpose. KNXnet/IP multicast services build on top of IP multicast.

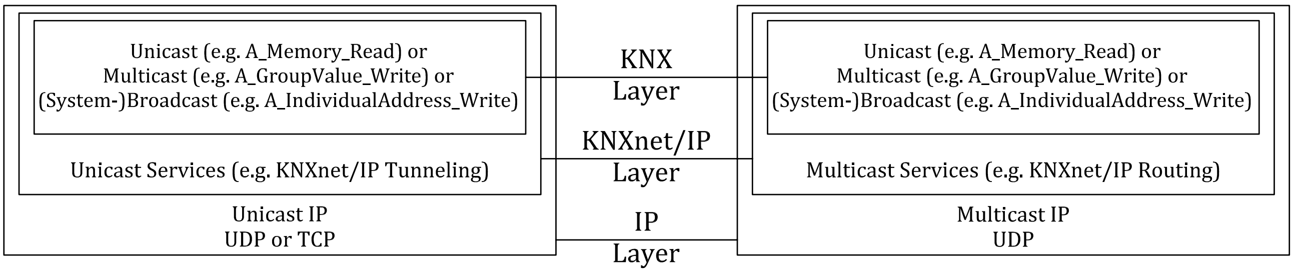
Unicast (e.g. A_Memory_Read) or
Multicast (e.g. A_GroupValue_Write) or
(System-)Broadcast (e.g. A_IndividualAddress_Write)
Unicast Services (e.g. KNXnet/IP Tunneling)
Unicast IP
UDP or TCP
KNX
Layer
KNXnet/IP
Layer
IP
Layer
Unicast (e.g. A_Memory_Read) or
Multicast (e.g. A_GroupValue_Write) or
(System-)Broadcast (e.g. A_IndividualAddress_Write)
Multicast Services (e.g. KNXnet/IP Routing)
Multicast IP
UDP

Figure 1 — Unicast and multicast in the sense of KNX, KNXnet/IP and IP

Figure 1 shows a typical scenario where a KNXnet/IP client (e.g. running ETS) accesses multiple KNX installed systems or KNX subnetworks via an IP network. The KNXnet/IP client may access one or more KNXnet/IP servers at a time. For subnetwork, routing server-to-server communication is possible.

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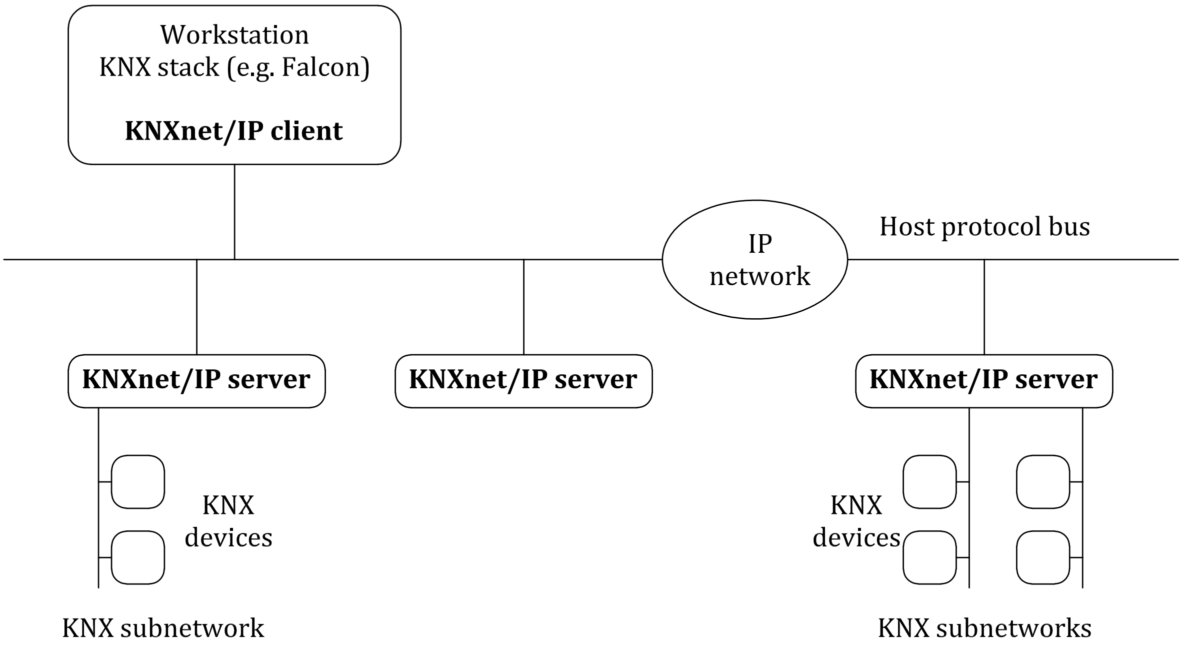

Figure 2 — Device types and configuration examples

Figure 2 shows device types and configuration examples. This document defines the integration of KNX protocol implementations within the Internet protocol (IP) named KNXnet/IP. It defines a standard protocol, which is implemented within KNX devices, Engineering Tool Software (ETS) and other implementations to support KNX data exchange over IP networks. In fact, KNXnet/IP provides a general framework, which accommodates several specialised “Service Protocols” in a modular and extendible fashion.

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Open data communication in building automation, controls and building management — Home and building electronic systems — KNXnet/IP communication

1 Scope

This document defines the integration of KNX protocol implementations on top of Internet protocol (IP) networks, called KNXnet/IP. It describes a standard protocol for KNX devices connected to an IP network, called KNXnet/IP devices. The IP network acts as a fast (compared to KNX twisted pair transmission speed) backbone in KNX installations.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at https://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

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3.1
backbone key
key used for encryption and message authentication of secure KNXnet/IP multicast communication in a KNXnet/IP routing multicast group, configured by ETS and a shared secret between all members of the secure KNXnet/IP routing multicast group

3.2
cipher
generic term that denotes the encrypted data

Note 1 to entry: Cipher is the opposite of *plain* (3.22).

3.3
common external message interface
generic structure for medium independent *KNX* (3.14) messages

Note 1 to entry: cEMI (common EMI) frames are used to encapsulate KNX messages within Internet protocol (IP) packets.

3.4
communication channel
logical connection between a *KNXnet/IP client* (3.16) and a *KNXnet/IP server* (3.20) or, in case of routing, between two or more KNXnet/IP servers

Note 1 to entry: A communication channel consists of one or more connections on the definition of the host protocol used for KNXnet/IP.

3.5
dynamic host configuration protocol
communication protocol for automatic assignment of IP address settings

3.6
domain name system
assigns Internet names to IP addresses

3.7
engineering tool software
software used to configure *KNX* (3.14) devices

3.8
european installation bus
predecessor protocol to KNX

Note 1 to entry: Standard for building controls (EN 50090).

3.9
host protocol address information
structure holding the IP host protocol address information used to address a KNXnet/IP endpoint on another *KNXnet/IP device* (3.17)

3.10
individual address
unique *KNX* (3.14) address of a KNX device in a KNX system

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3.11
IP channel
logical connection between two IP host/port endpoints

Note 1 to entry: IP channels are either a guaranteed, reliable TCP (transmission control protocol) or an unreliable point-to-point or multicast (in case of routing) UDP (user datagram protocol) connection.

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3.12
Internet control message protocol
extension to the Internet protocol (IP) for error, control, and informational messages

Note 1 to entry: ICMP is defined by RFC[1] 92 and supports packet containing error, control, and informational messages. The PING command, for example, uses ICMP to test an Internet connection.

3.13
Internet group management protocol
extension to the Internet protocol (IP) for management of IP multicasting in the Internet

Note 1 to entry: IGMP is defined in RFC 1112 as the standard for IP multicasting in the Internet. It is used to establish host memberships in particular multicast groups on a single network. By using Host Membership Reports, the mechanisms of the protocol allow a host to inform its local router that it wants to receive messages addressed to a specific multicast group. All hosts conforming to level 2 of the IP multicasting specification require IGMP.

3.14
KNX
standard for building controls

Note 1 to entry: See EN 50090, ISO/IEC 14543-3-1 to ISO/IEC 14543-3-7.

[1] Request for Comment: Internet standards defined by the Internet Engineering Task Force (IETF) are firstly published as RFCs.

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3.15
KNX node
device implementing a *KNX* (3.14) protocol stack and fulfilling the requirements according to the KNX standard

3.16
KNXnet/IP client
application using the KNXnet/IP client protocol to get access to a *KNX* (3.14) subnetwork over an IP network channel

3.17
KNXnet/IP device
implementation of KNXnet/IP services on a *KNX node* (3.15) (*KNXnet/IP server* (3.20)) or any other hardware (*KNXnet/IP client* (3.16))

3.18
KNX/IP domain
all *KNXnet/IP devices* (3.17) in the same network with the same multicast address and the same backbone encryption (either no encryption or encryption with the same key)

3.19
KNXnet/IP router
special type of *KNXnet/IP device* (3.17) that routes *KNX* (3.14) protocol packets between KNX subnetworks

3.20
KNXnet/IP server
KNX (3.14) device with physical access to a KNX network implementing the KNXnet/IP server protocol to communicate with *KNXnet/IP clients* (3.16) or other KNXnet/IP servers (in case of routing) on an IP network channel

Note 1 to entry: A KNXnet/IP server is by design always also a *KNX node* (3.15).

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3.21
KNXnet/IP tunnelling
services for point-to-point exchange of *KNX* (3.14) telegrams over an IP network between a *KNXnet/IP device* (3.17) acting as a server and a *KNXnet/IP client* (3.16)

3.22
plain
generic term that denotes unencrypted data, of which the content depends on the service and the user and not of confidentiality and authentication

Note 1 to entry: Plain is the opposite of *cipher* (3.2).

3.23
secure session
authenticated, authorized and encrypted *communication channel* (3.4) between one *KNXnet/IP client* (3.16) and one *KNXnet/IP server* (3.20) for unicast communication

3.24
session key
key used for encryption and message authentication in a *secure session* (3.23) between two KNXnet/IP communication parties, created using ECDH in the secure session setup procedure (providing perfect forward secrecy) and only valid for this individual session

3.25
subnet
portion of a network that shares a common address component known as the "subnet address"

Note 1 to entry: Different network protocols specify the subnet address in different ways.

3.26
time to live
maximum number of IP routers a multicast UDP/IP datagram may be routed through

Note 1 to entry: Each IP router the datagram passes decrements the TTL by one; the local host adapter also does this. When the TTL has reached zero, the router discards the datagram. When sending a datagram from the local host adapter, a TTL of zero means that the datagram never leaves the host. A TTL of one means that the datagram never leaves the local network (it is not routed).

3.27
transmission control protocol over Internet protocol
connection-oriented communication over the Internet

3.28
user datagram protocol over Internet protocol
connection-less communication over the Internet

4 Abbreviated terms

Abbreviated term	Description
AddIL	Length of additional information
AES	Advanced Encryption Standard
Cn	Conditions are specified under note “n”
CBC	Cipher Block Chaining
CCM	Counter with CBC-MAC
cEMI	Common External Message Interface
CTR	Counter Mode (of Operation)
DDoS	Distributed Denial of Service
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
DoS	Denial of Service
ECDH	Elliptic Curve Diffie–Hellman
EIB	European Installation Bus
ETS	Engineering Tool Software
FDSK	Factory Default Setup Key
HPAI	Host Protocol Address Information
IA	Individual Address
ICMP	Internet Control Message Protocol
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IV	Initialisation Vector
M	Mandatory
MAC	Message Authentication Code
MC	Message Code
MiM	Man-in-the-Middle
n/a	Not applicable
O	Optional
PBKDF2	Password-Based Key Derivation Function 2
R	Required
SHA	Secure Hash Algorithm

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Abbreviated term	Description
TCP/IP	Transmission Control Protocol over Internet Protocol
TTL	Time To Live
X	Not allowed
UDP/IP	User Datagram Protocol over Internet Protocol

5 Requirements

5.1 Overview

5.1.1 KNXnet/IP document parts

5.1.1.1 General

This document defines the integration of KNX protocol implementations within the Internet protocol (IP) named KNXnet/IP.

This document defines a standard protocol, which is implemented within KNX devices, Engineering Tool Software and other implementations to support KNX data exchange over IP networks. In fact, KNXnet/IP provides a general framework, which accommodates several specialised “Service Protocols” in a modular and extendible fashion.

The KNXnet/IP specification consists of the following parts:

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- Overview;
- Core specification;
- Device management;
- Tunnelling;
- Routing;
- Remote diagnosis and configuration;
- Secured communication.

KNXnet/IP supports different software implementations on top of the protocol. More specifically, these software implementations can be Building Management, Facility Management, Energy Management, or simply Data Base and SCADA (Supervision, Control and Data Acquisition) packages.

Most of these packages need be configured for the specific user application. In order to simplify this process and cut costs for engineering, KNXnet/IP provides simple engineering interfaces, namely a description “language” for the underlying KNX system. This may be done offline, for example generated as an ETS export file, or online by a mechanism that self-describes the underlying KNX system (reading data from the system itself).

KNXnet/IP supports:

- on-the-fly change-over between operational modes (configuration, operation);
- event driven mechanisms;
- connections with a delay time greater than $t_{\text{KNX\_transfer\_timeout}}$ (e.g. network connection via satellite).

5.1.1.2 Overview

"Overview" is this clause.

5.1.1.3 Core specification

“Core specification” defines a standard protocol, which is implemented within KNXnet/IP devices and the Engineering Tool Software (ETS) to support KNX data exchange over IP networks.

This specific implementation of the protocol over the Internet protocol (IP) is called KNXnet/IP.

This specification addresses:

- definition of data packets sent over the IP host protocol network for KNXnet/IP communication;
- discovery and self-description of KNXnet/IP servers;
- configuration and establishment of a communication channel between a KNXnet/IP client and a KNXnet/IP server.

5.1.1.4 Device management

“Device management” defines services for remote configuration and remote management of KNXnet/IP servers.

5.1.1.5 Tunnelling

“Tunnelling” defines services for point-to-point exchange of KNX telegrams over an IP network between a KNXnet/IP device acting as a server and a KNXnet/IP client. This point-to-point exchange may be established by a super ordinate system for building automation or management functions or by an Engineering Tool Software. It supports all ETS functions for download, test, and analysis of KNX devices on KNX networks connected via KNXnet/IP servers. This includes changes of single KNX device object properties.

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Tunnelling assumes that a data transmission round-trip between ETS or a KNXnet/IP tunnelling client and KNXnet/IP servers takes less than $t_{\text{KNX-transfer\_timeouts}}$.

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5.1.1.6 Routing

“Routing” defines services, which route KNX telegrams between KNXnet/IP servers through the IP network.

5.1.1.7 Remote diagnosis and configuration

“Remote diagnosis and configuration” defines services for a point-to-point exchange of KNX telegrams over an IP network between KNXnet/IP routers and/or KNX/IP devices. The services provide means for diagnosing communication settings and for changing these remotely.

5.1.1.8 Secured communication

“Secured communication” defines services for a secured point-to-point exchange of KNX telegrams over an IP network between a KNXnet/IP client and a KNX/IP server. The services provide means for establishing secured communication sessions by authorized KNXnet/IP clients.

5.1.1.9 List of codes

Annex A gives a complete listing of all codes used by KNXnet/IP, to which KNXnet/IP implementations shall conform, depending on the parts of this document supported.

5.1.1.10 Binary examples

Annex B gives binary examples of KNXnet/IP frames.