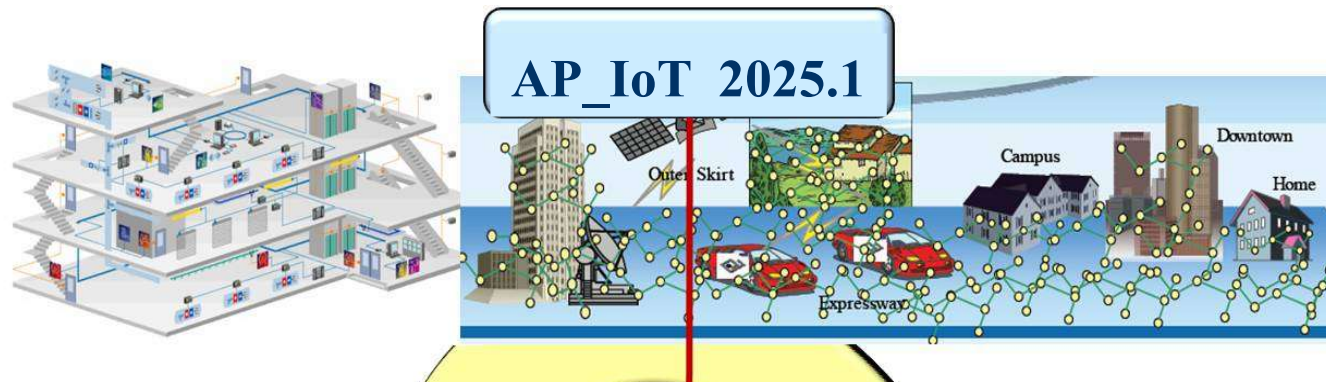


Automação Predial com IoT – Parte A - KNX

Tópicos em Engenharia 2021.1

Smart Cities, Building Automation, IoT, nZEB, ESP32,...

Adolfo Bauchspiess
Universidade de Brasília - Brazil

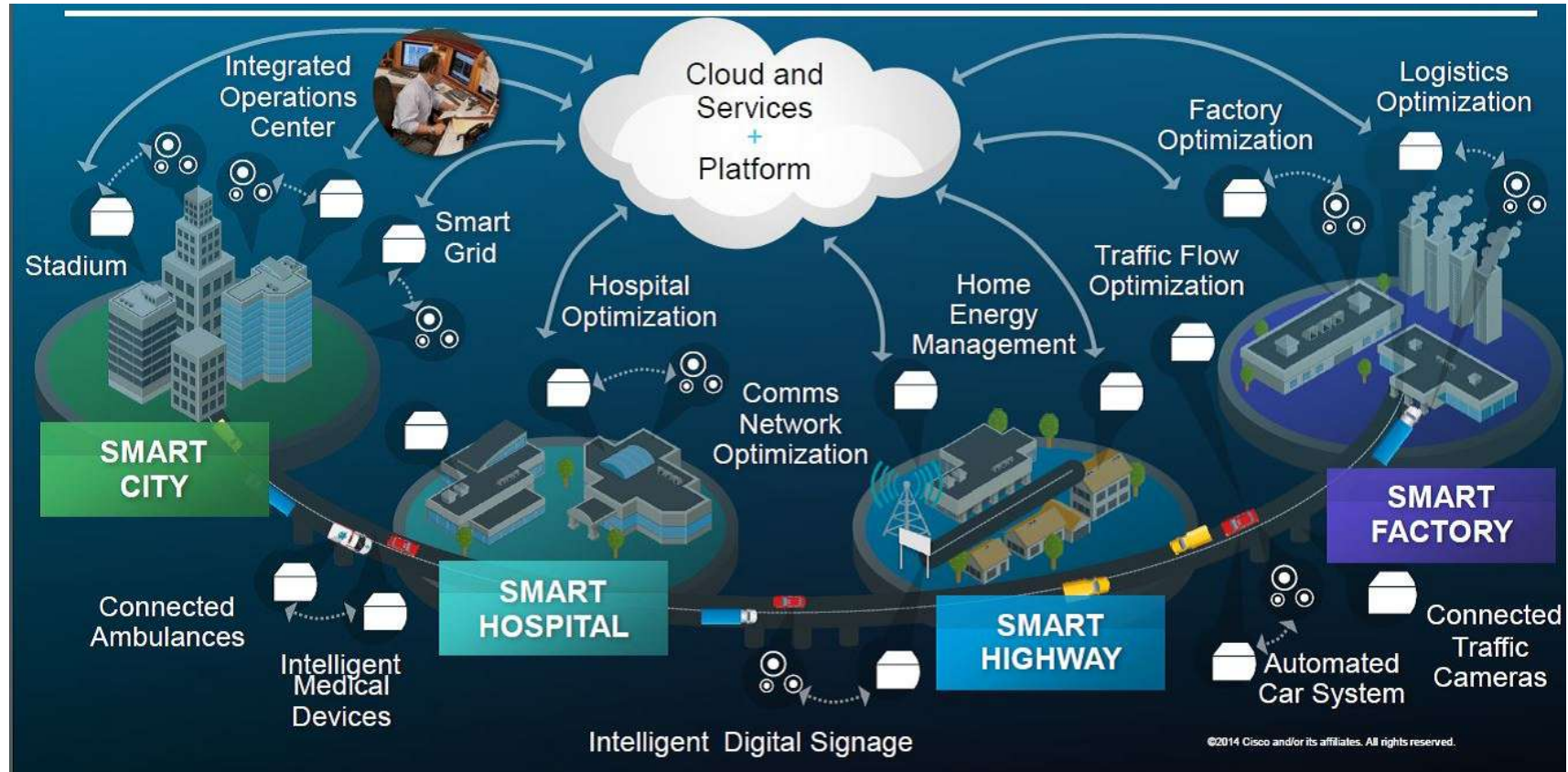


Conteúdo

- 1 – Smart Cities
- 2 – Automação Predial
- 3 – IoT
- 4 - ESP32
- 4 - Exemplos e Aplicações
- 5 - Conclusões



Part 1 -Introdução – Smart Cities



Part 1

Introdução – Smart Cities



Adolfo Bauchspiess

Short C.V.

- SENAI/1982 – *Eletricista de Dispositivos de Comandos Elétricos*
- UnB/1986 - *Eng. Elétrica*
 - Estágios: *Telebrasil (1984), Prólogo (1985), Novadata (1986)*
- *Engenheiro: Novadata Sistemas e Computadores Ltda (1986-1990)*
- UnB/1990 - *Mestre Eng. Elétrica*
- *Erlangen-Alemanha/1995 – Dr.-Ing.*
- *ENE/UnB 1995 ... - Prof. Controle & Automação*
 - *Pós-Doc (Aachen/1997, Kaiserslautern/2005-6, Santa Barbara/2014)*
 - *Projetos: FAP-DF, CNPq, CAPES, FINEP*
 - *Erasmus Mundus – Kaiserslautern*
 - *Coordenador Eng. Mecatrônica UnB 2015/17*



Alguns Journals - BuildingAutomation – IoT

- IEEE – Internet of Things Journal
 - Elsevier – Internet of Things
 - International Journal of Internet of Things and Cyber-Assurance
 - IEEE – Wireless Communications
 - IEEE – Transactions on Wireless Communications
 - Wireless Networks (SpringerNature) - Springer –
 - IGI Global – International Journal of Hyperconnectivity and the Internet of Things
 - IGI Global – Protocols and Applications for the Industrial Internet of Things
 - MDPI – Sensors — Open Access Journal
-
- Energy and Buildings - Elsevier
 - IEEE Transactions on Cybernetics
 - IEEE Transactions on Systems, Man, and Cybernetics
 - IEEE Transactions on Control of Network Systems
 - IEEE Transactions on Industrial Informatics
 - Automation in Construction - Elsevier
 - Automation in Construction – Elsevier
 - Buildings - MDPI - Open Access Journal
 - Smart Cities - MDPI - Open Access Journal
 - Sustainable Cities and Society - Journal - Elsevier

ESP32 Modules



DOIT DEVKIT V1



ESP32 DevKit



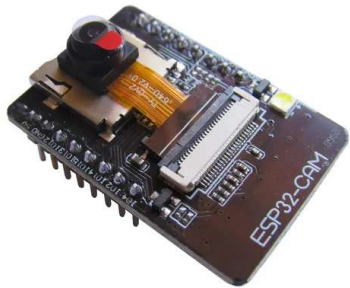
ESP-32S NodeMCU



ESP32 Thing



ESP32-CAM



WEMOS LOLIN32



"WeMos" OLED



HUZZAH32



Others

(...)

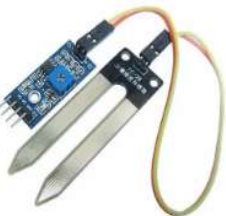
ESP32_Web_Server_with_Arduino_IDE, Rui Santos & Sara Santos

<https://makeradvisor.com/esp32-development-boards-review-comparison/>

<https://randomnerdtutorials.com/esp32-web-server-arduino-ide/>

Sensores

e.g., MercadoLivre
ardu_robotica_eireli

 R\$ 163³⁵ em 12x R\$ 15⁵² Frete grátis 15 X Módulo Detector Sensor De Som Palmas Ky-037 Arduino Pic	 R\$ 25⁸⁰ em 5x R\$ 5⁵² 2 X Módulos Sensor De Movimento Presença Hc-sr501 Pir Arduino	 R\$ 13⁸⁹ em 2x R\$ 7²⁹ Sensor MQ-3 MQ3 Arduino Raspberry	 R\$ 10⁹⁹ em 2x R\$ 5⁷⁷ Sensor Bmp180 De Pressão E Temperatura Barométrico Bmp 180	 R\$ 28⁴⁸ em 5x R\$ 6²¹ Sensor De Temperatura E Umidade Dht22
 R\$ 32⁹⁹ em 6x R\$ 5⁵⁰ sem juros Kit Leitor Temperatura Max6675 Termopar Tipo K Arduino	 R\$ 10⁹⁸ em 2x R\$ 5⁷⁸ Sensor De Umidade Solo Pi/ Arduino Pic Arm	 R\$ 2.000 em 12x R\$ 189⁹⁸ Frete grátis Sensor Indutivo De Proximidade Npn - Arduino, Pic	 R\$ 17²⁰ em 3x R\$ 6¹¹ MQ-7 Módulo Sensor De Gás Monóxido De Carbono MQ-7 Arduino	 R\$ 15⁹⁹ em 3x R\$ 5⁶⁸ Módulo Sensor De Corrente Acs712 - 5a Arduino Pic

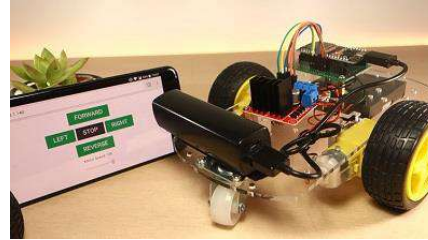
ESP32 Projects

ESP32_Web_Server_with_Arduino_IDE, Rui Santos & Sara Santos

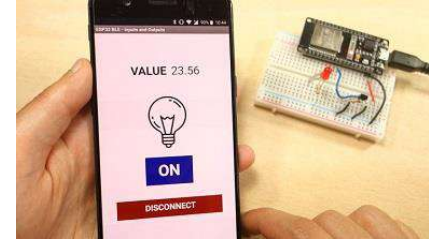
<https://randomnerdtutorials.com/esp32-web-server-arduino-ide/>



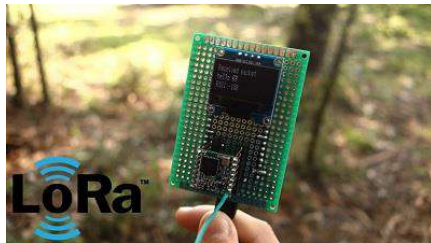
ESP32 Wi-Fi Multisensor – Temperature, Humidity, Motion, Luminosity, and Relay Control



Remote Controlled Wi-Fi Car Robot



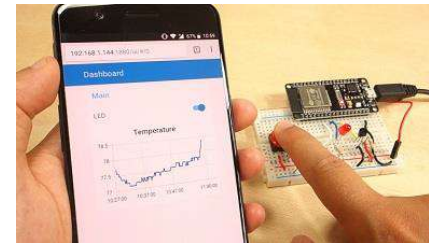
Bluetooth Low Energy (BLE) Android Application with MIT App Inventor – Control Outputs and Display Sensor Readings



LoRa Technology with the ESP32

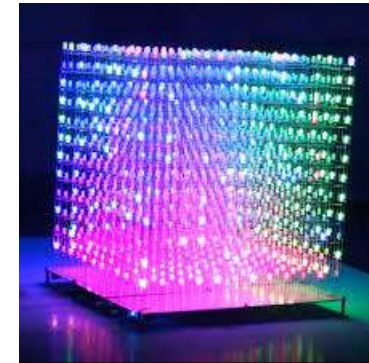
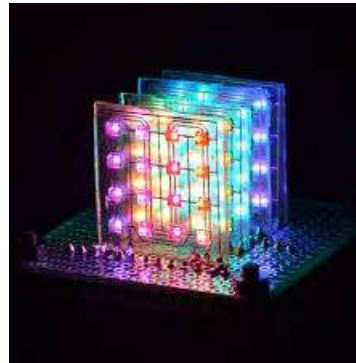
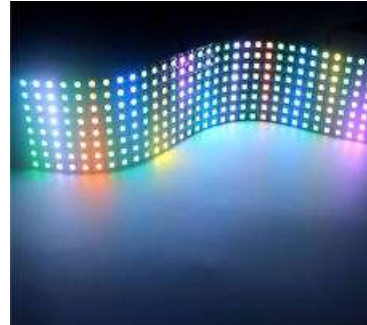
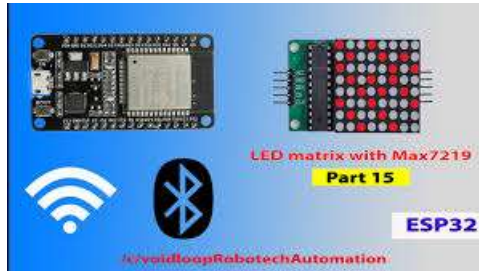


LoRa Long Range Sensor Monitoring – Reporting Sensor Readings from Outside: Soil Moisture and Temperature

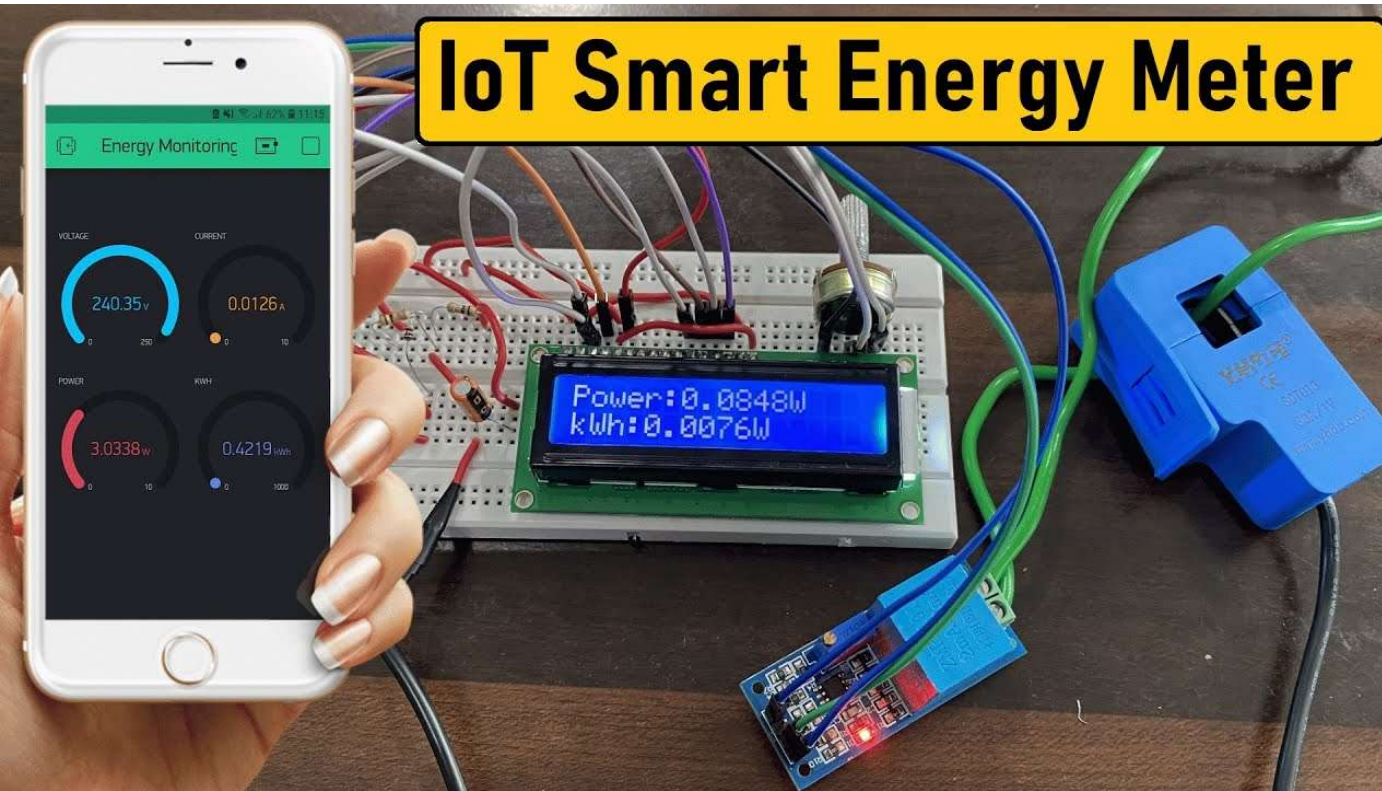


ESP32 with MQTT

ESP32 Projects – Led Matrix

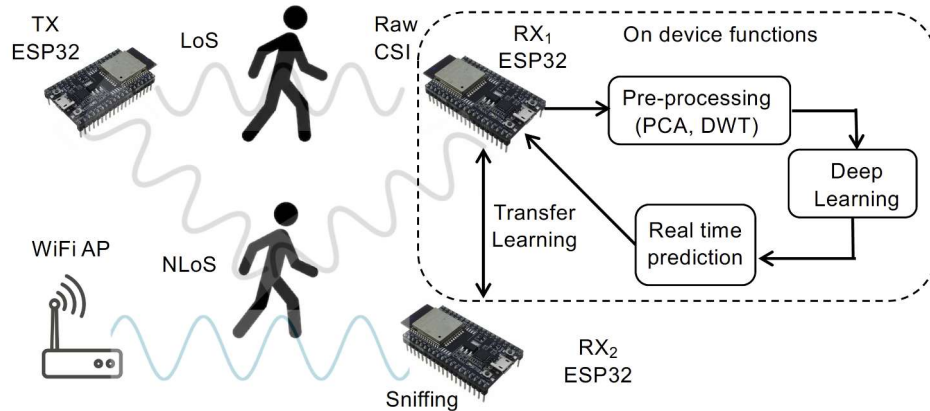


ESP32 Projects – Energy Meter



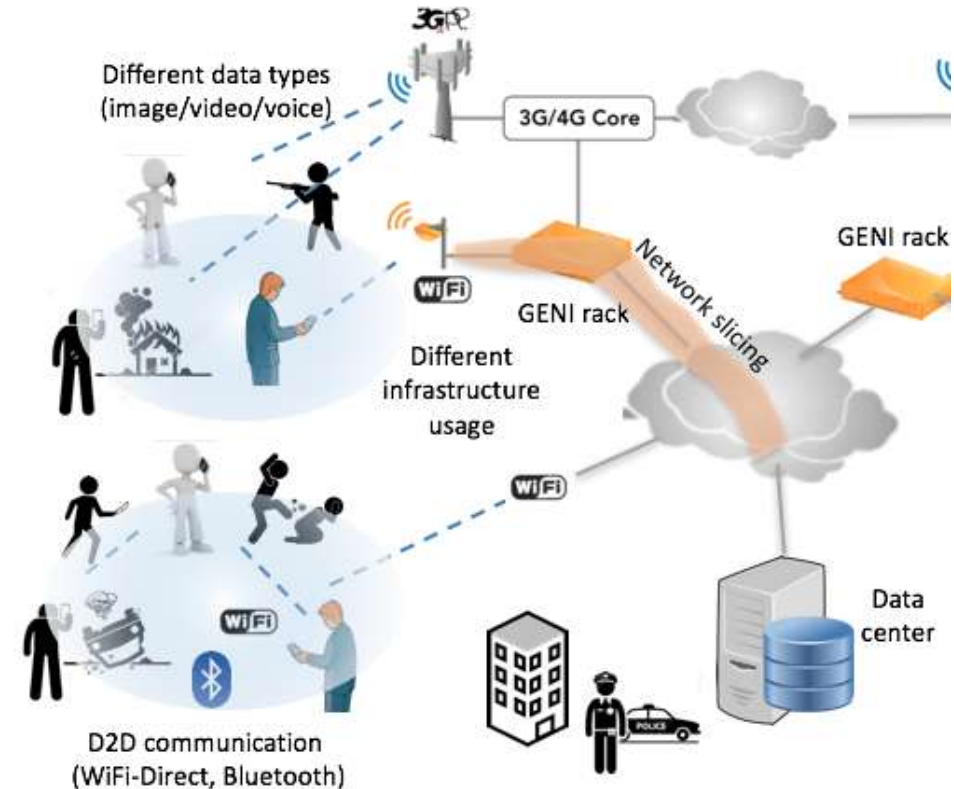
ESP32 Projects –

<http://www.people.vcu.edu/~ebulut/research.html>

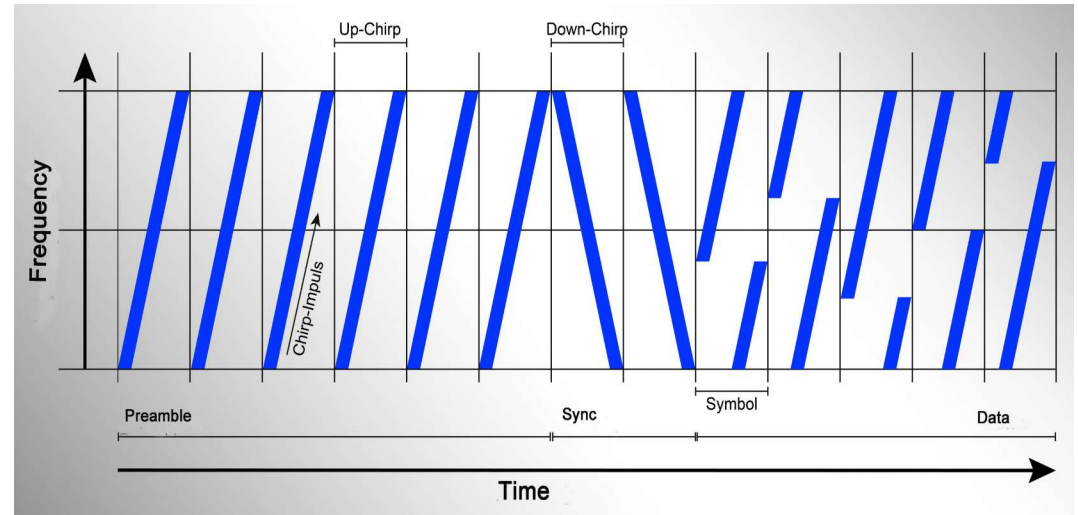
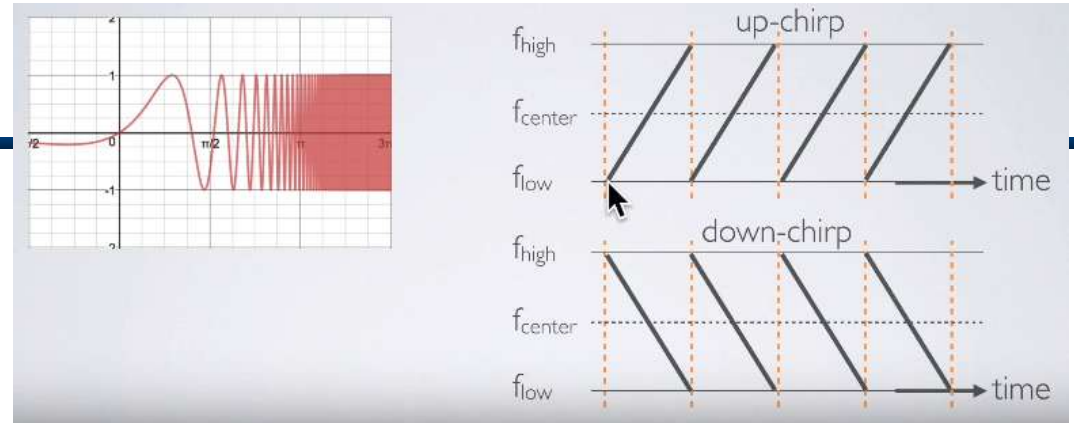
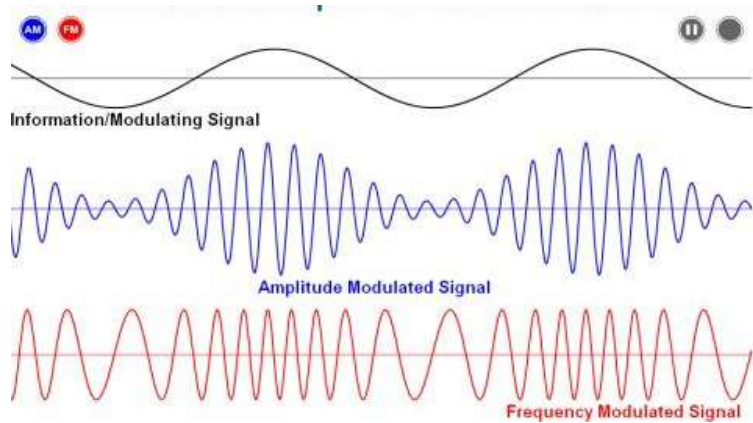


Device-Free WiFi Sensing based Occupancy Detection in Buildings

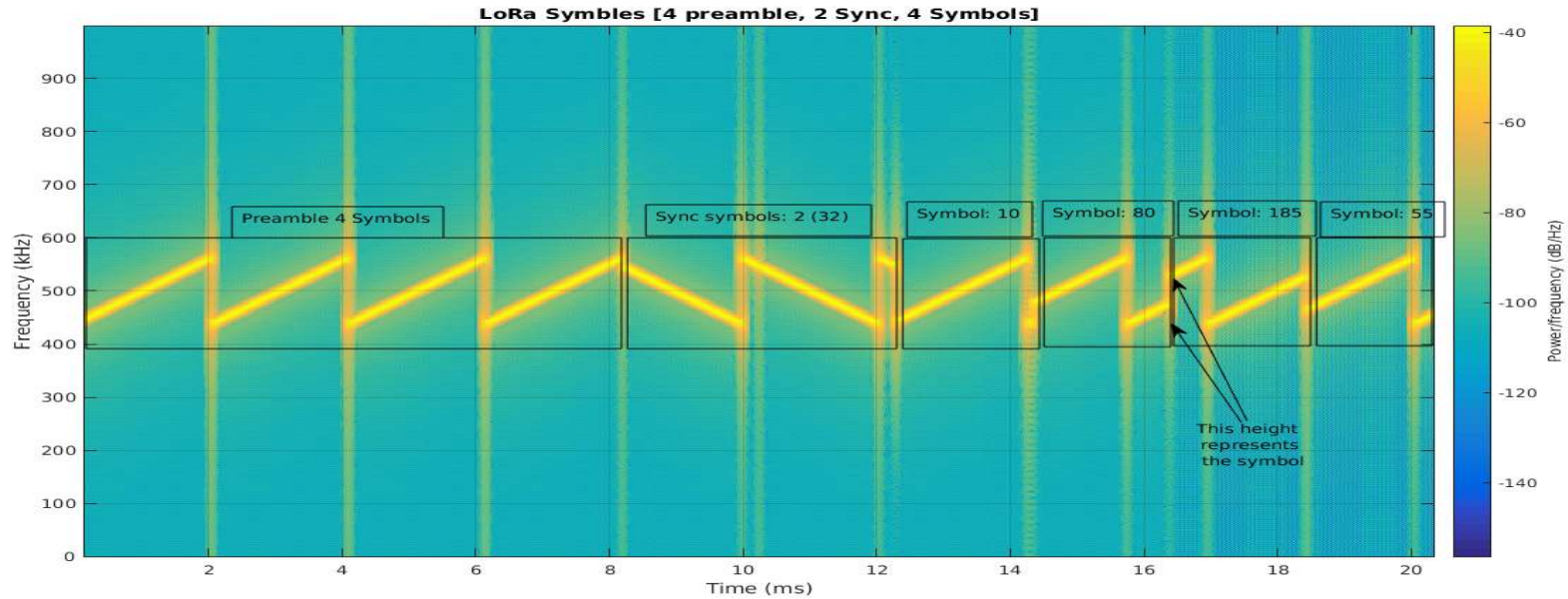
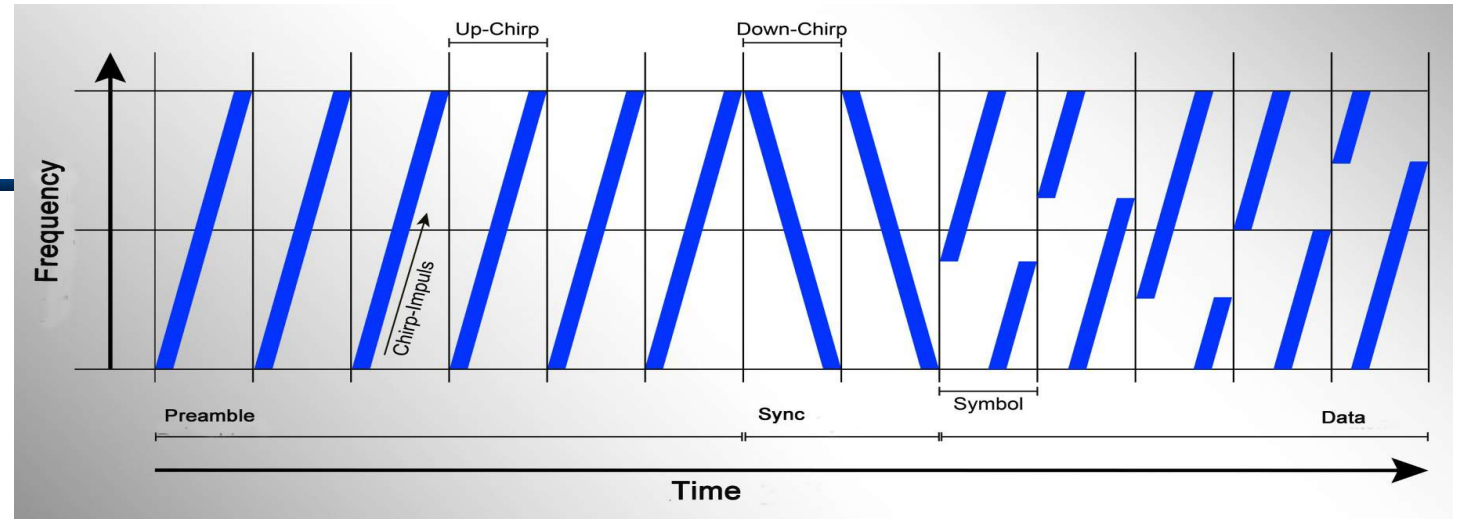
Rapid and Resilient Critical Data Sourcing for Public Safety and Emergency Response

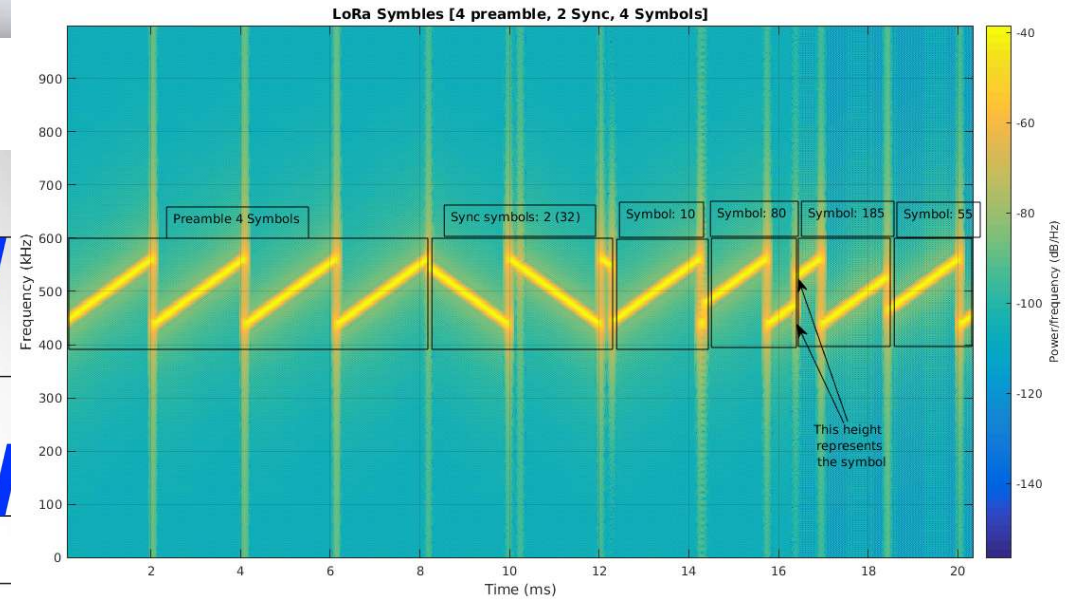
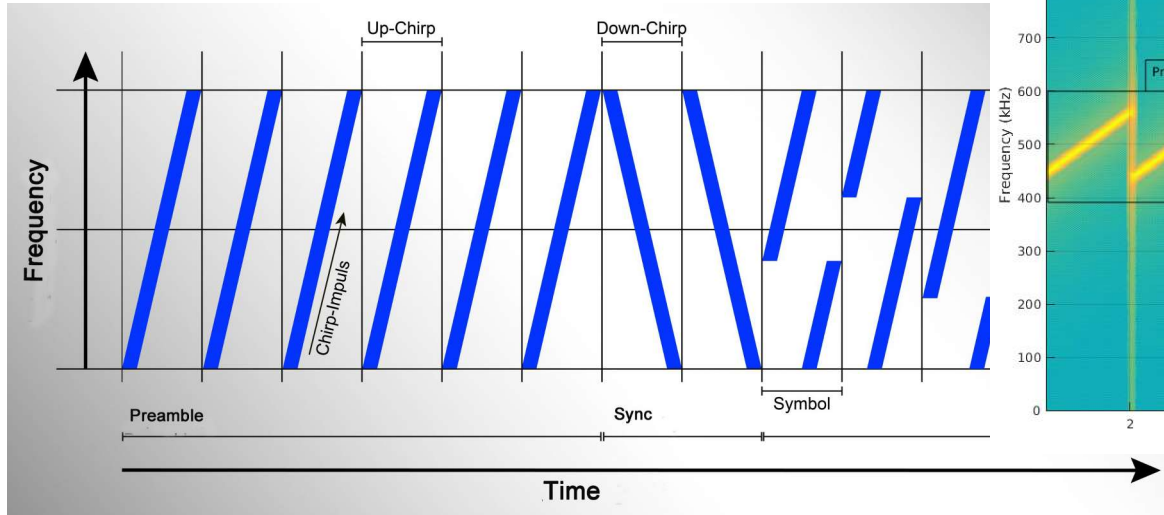
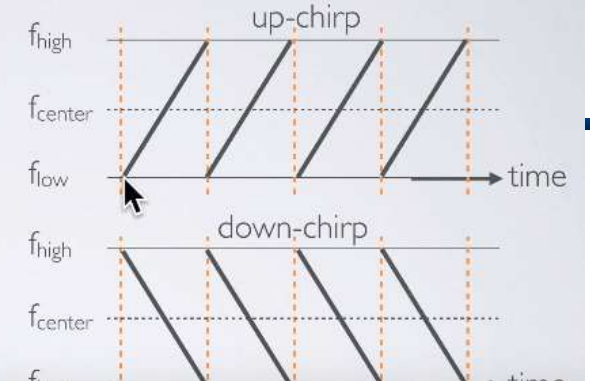
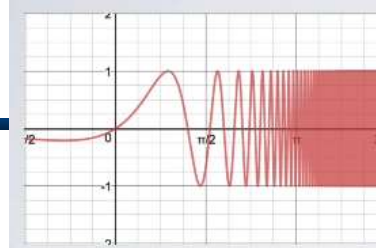
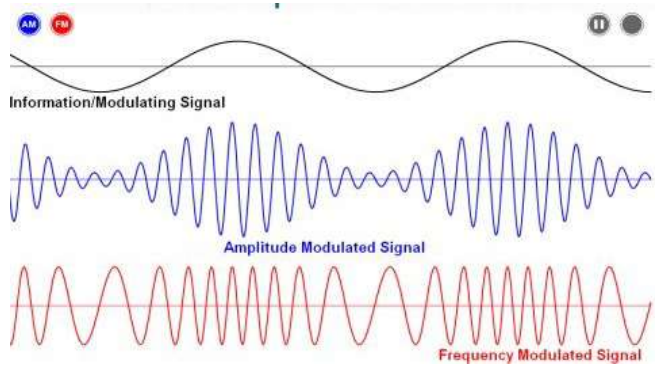


LoRa



LoRa

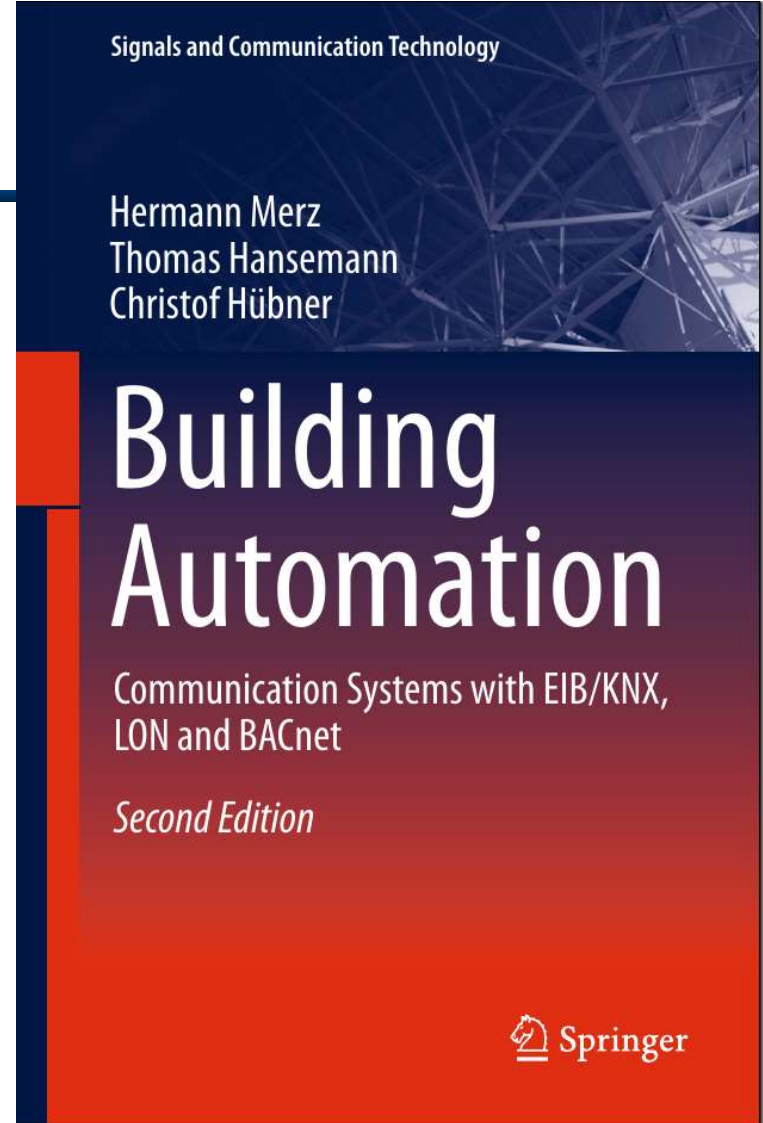




Livro Texto 1a) (Merz, 2018)

As figuras utilizadas nos próximos slides
forma extraídas da Referência:

Merz, Hansemann, Hübner
Building Automation, 2009 (2018 - 2nd ed)
Springer



(Merz,2009)

Commercial Buildings Automation

Integração de Sistemas

- Medir
- Processar
- Atuar



Fig. 1.1 A ventilation system in a commercial building [ABB]

(Merz,2009) Direct Digital Controller

Processos Simples – Localizados
- Controle Digital Direto

DDC vs PLC

O termo DDC é mais utilizado em automação predial para um “pequeno CLP”.

DDC pode ser implementado em um CLP, um computador ou de forma distribuída.

DCS Distributed Control System
e.g. Airbus A380.



Fig. 1.2 A direct digital controller (DDC) [TAC02]

(Merz,2009) Systems in Building Automation

Building control components, such as four-gang blind actuators are usually mounted in a control cabinet or next to the device to be controlled (for example, a blind).
Building control systems do not require central DDCs.

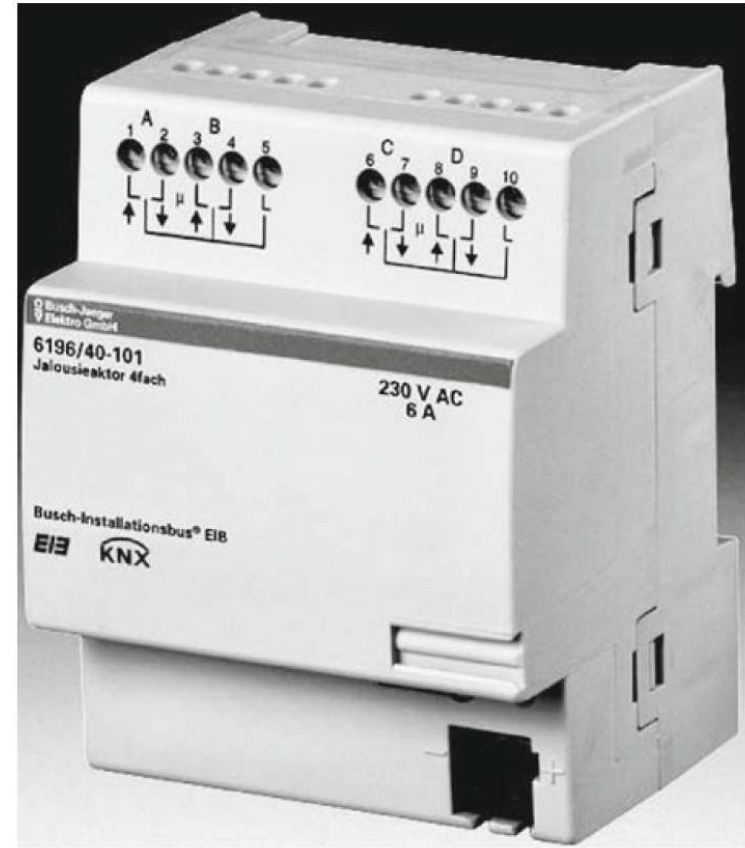


Fig. 1.3 A 4-gang blind actuator for mounting in a control cabinet [Busch-Jaeger Electro]

(Merz,2009)

Systems in Building Automation

- Systems can be connected via DDCs and building control components.

(heating, ventilation, air-conditioning, lighting and shade control systems).
- Systems can also be connected via special DDCs that perform only input and output functions.

(sanitation and power supply systems, own in-built automation mechanisms).
- If a system needs to transfer a large amount of information or has its own computer, then it can be directly connected to the building automation control computer.

(Data is then transferred via a bus system or network as opposed to over individual wires. This is common in subordinate video or superordinate accounting systems).

Table 1.1 Systems in building automation

System	Usually integrated into building automation	Increasingly integrated into building automation	Systems that are controlled by DDCs or other building automation components
Heating	×		×
Cooling	×		×
Ventilation	×		×
Power supply	×		
Lighting control	×		×
Blinds	×		×
Sanitation	×		
Central fire alarm	×		
Burglar alarm		×	
Access control		×	
Video surveillance (CCTV)		×	
Network engineering		×	
Multimedia		×	
Elevators		×	
Telephones		×	
Maintenance management		×	
Payroll/accounting		×	
Facility management		×	

(Merz,2009) Systems in Building Automation

Building control represents a small subsection of building automation

Involves the localized automation of components in an individual room – known as single room control or room automation.

Table 1.2 Systems in building control

System	Room automation possible with building control components
Heating, cooling, and ventilation	×
Lighting control	×
Shade/blinds	×

(Merz,2009) Systems in Building Automation

In building automation, **information technology is used to link all the systems** enabling them to be **centrally monitored by a control computer at the management level**.

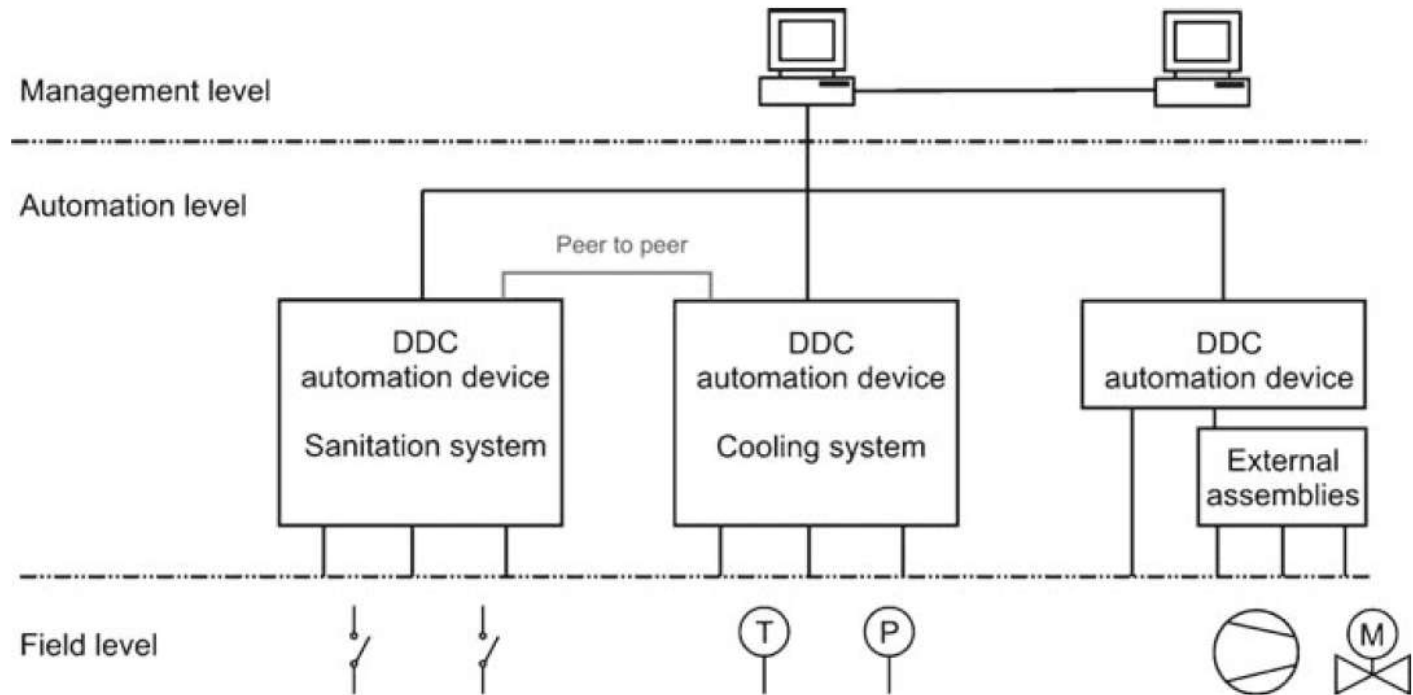


Fig. 1.4 The IT network of systems in building automation

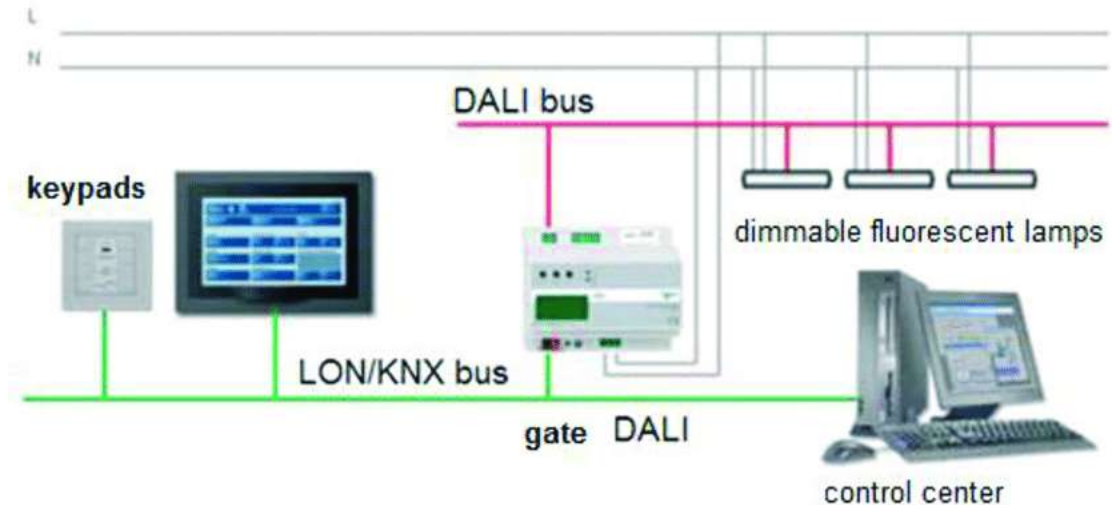
(Merz,2009) Systems in Building Control

An **intelligent processor-controlled push button** directly connected to the bus is used to **send the signal to turn on a light**.

Another component is then used as an intelligent processor-controlled switch actuator to execute the command. This actuator is either mounted directly next to the light or in a control cabinet.



Fig. 1.5 A building control switch actuator [ELKA]



Systems

A **presence sensor** near the door, can ensure that as the last person leaves the room, the **lights** are automatically switched off and the **radiator** is turned down or off. The automated functions are processed by the **building control components** and not by a central DDC.

Figure 1.6 gives you an idea of the building control systems found in a room.

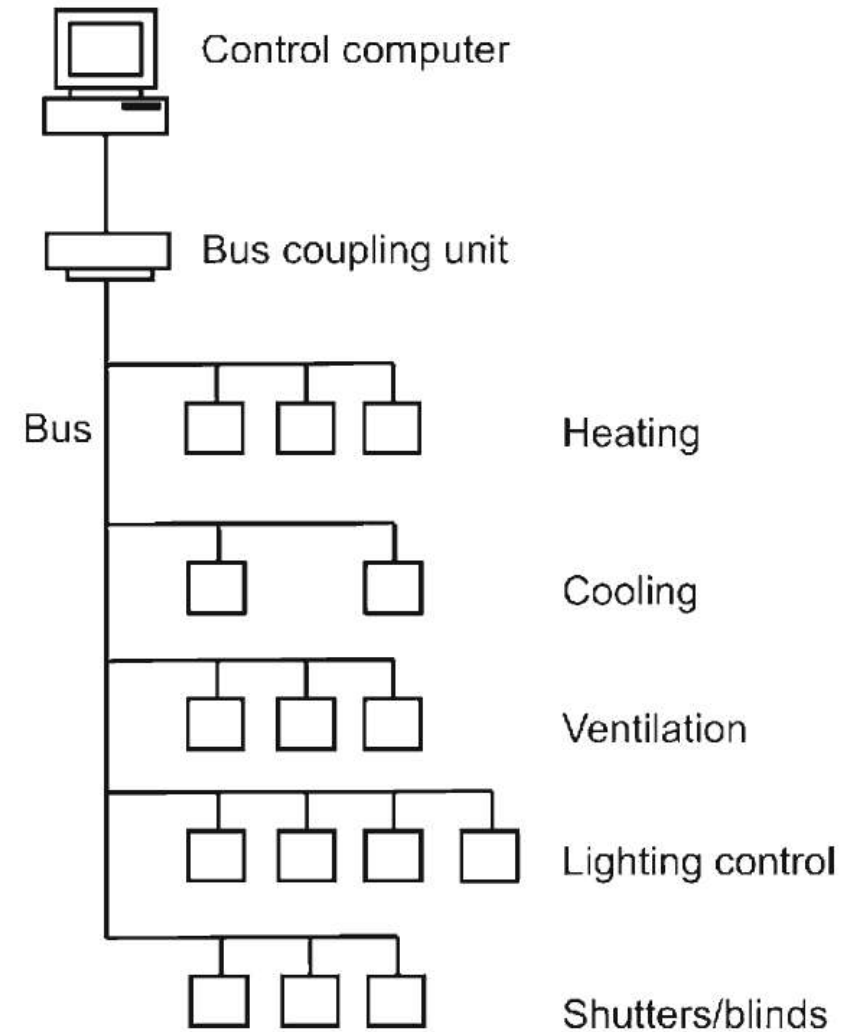
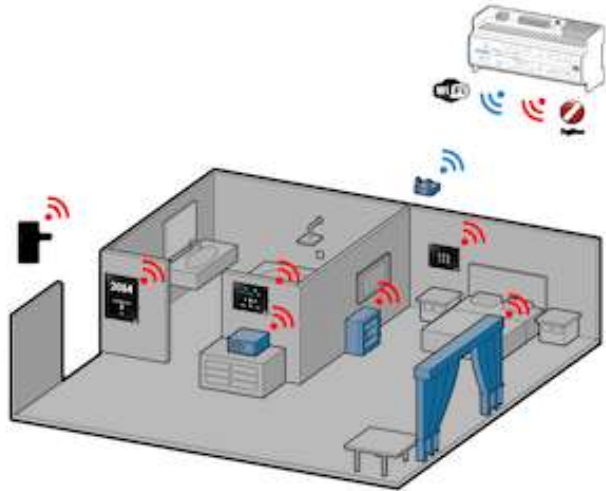


Fig. 1.6 Building control systems in a room

(Merz,2009)

Structure of Building Automation and Control Networks

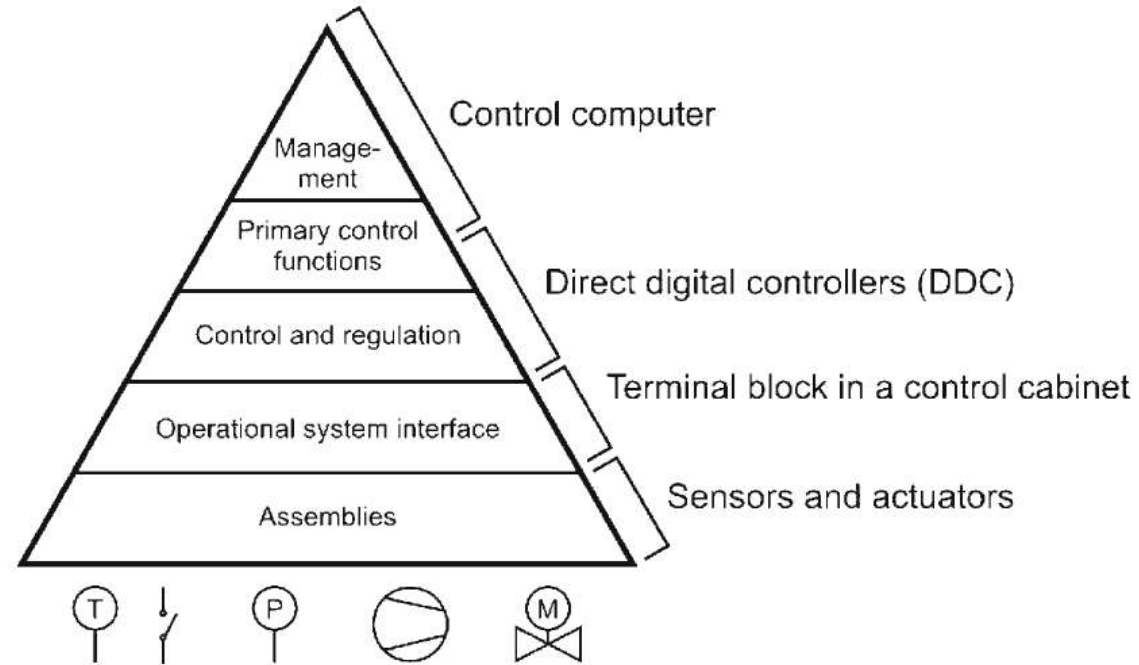


Fig. 1.7 The hierarchical structure in building automation

Sensors and Actuators

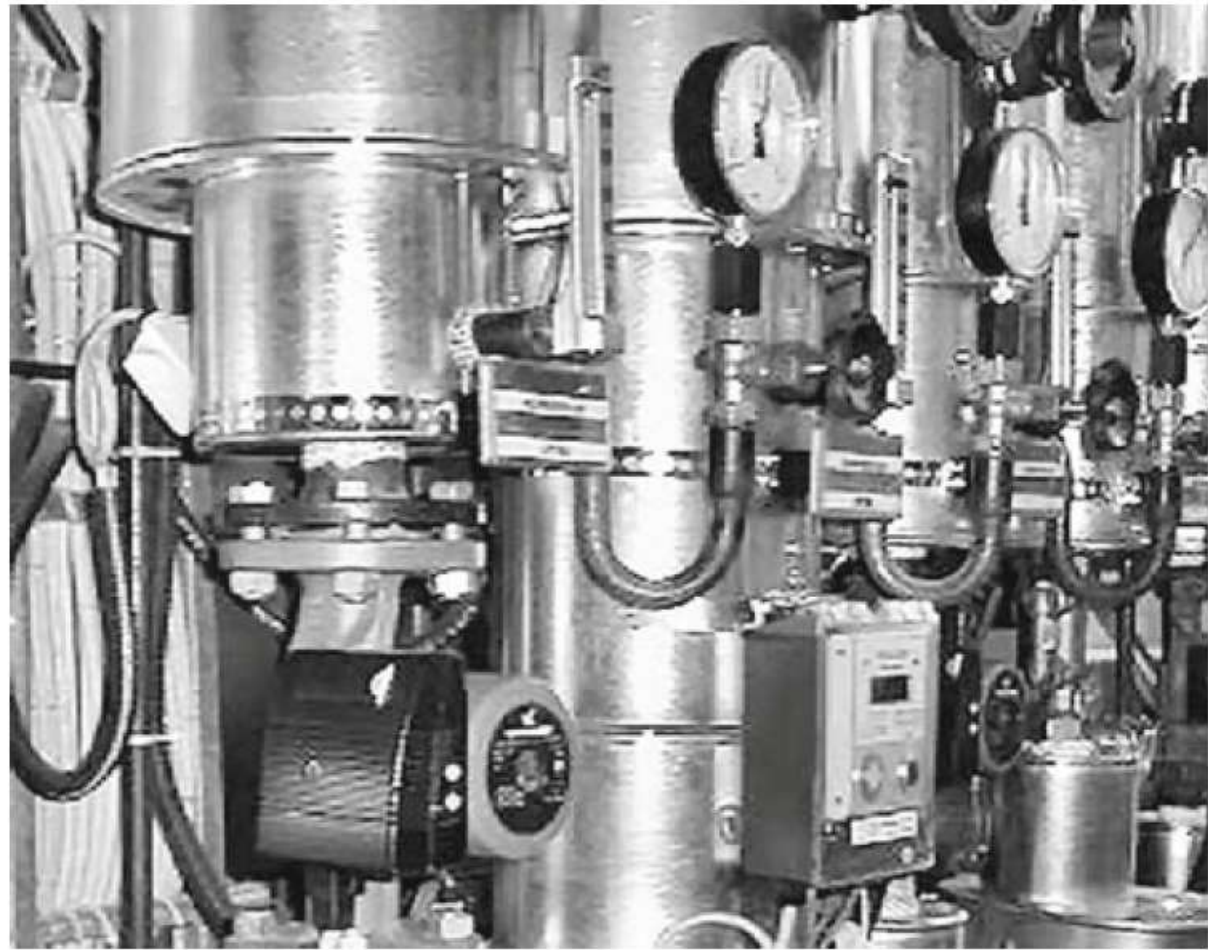


Fig. 1.8 Sensors and actuators in a ventilation system [ABB]

(Merz,2009)

Terminal Block, DDCs and a Control Cabinet

Wires (**usually twisted pair**) connect the sensors and actuators to the DDCs that control and regulate the system(s).

One of the wire pairs is used to transmit status messages and the other is used for transmitting sensor signals. The DDCs are mounted in a control cabinet (see Fig. 1.9), which is positioned next to the operational system interface.

The close proximity of the control cabinet to the operational system interface **reduces the amount of cabling** required

- Sinais Digitais (?):
- Par trançado/ (blindado)
 - Transm. diferencial
 - 24 V
 - 220 V
 - Laço de corrente 4-20 mA
 - **Wireless**



Fig. 1.9 The terminal block and DDCs mounted in a control cabinet [ABB]

SCADA

Supervisory Control and Data Acquisition

If all the systems are in close proximity to each other and the building operator does not have to make constant adjustments, then specially optimized DDC can be used to implement high-level control functions.

Alternatively, these **high-level control functions can be managed by a control computer** (see Fig. 1.10).

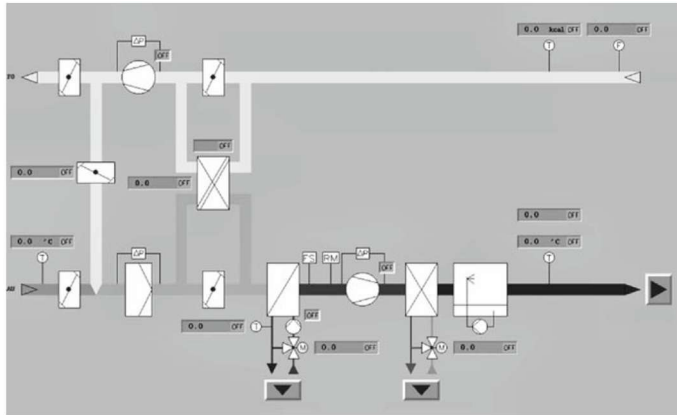
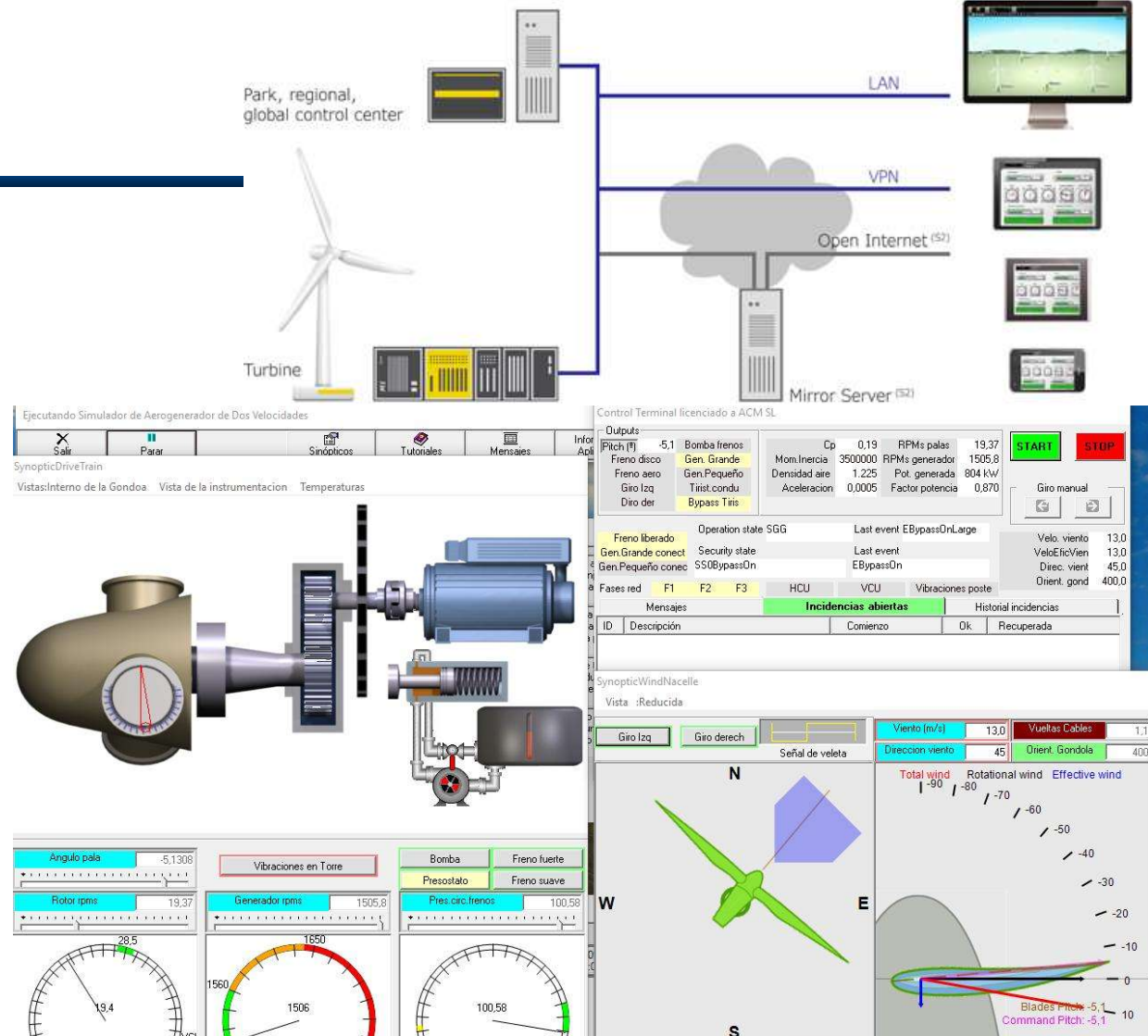


Fig. 1.10 A ventilation system displayed on a control computer



The Hierarchical Structure in Building Control

By housing the **sensor together with an in-built processor and a bus connector**,

You can combine different levels into one (see Fig. 1.11).

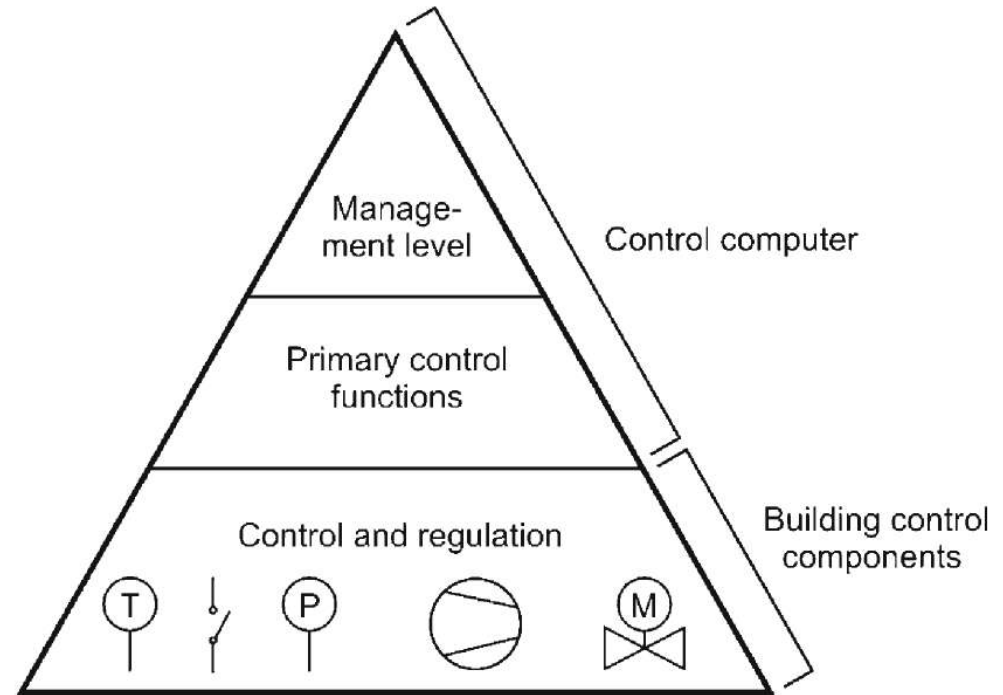


Fig. 1.11 The special hierarchical structure found in building control systems

Automação Predial – Merz – Cap. 1

Fig. 1.12 A building control temperature sensor with a setpoint adjuster and control program (a Busch-triton® 5-gang switch sensor with thermostat) [Busch-Jaeger Elektro]



Demand-Driven Setpoint Adjustment

A common example is the weather-controlled *regulation of a heating system's flow temperature* (see Fig. 1.13) that **uses the outside temperature to adjust the heating controller's setpoint value.**

When the outside temperature is low, the heating system's flow temperature is increased; and when the outside temperature is moderate, the flow temperature is reduced to the lowest possible value.

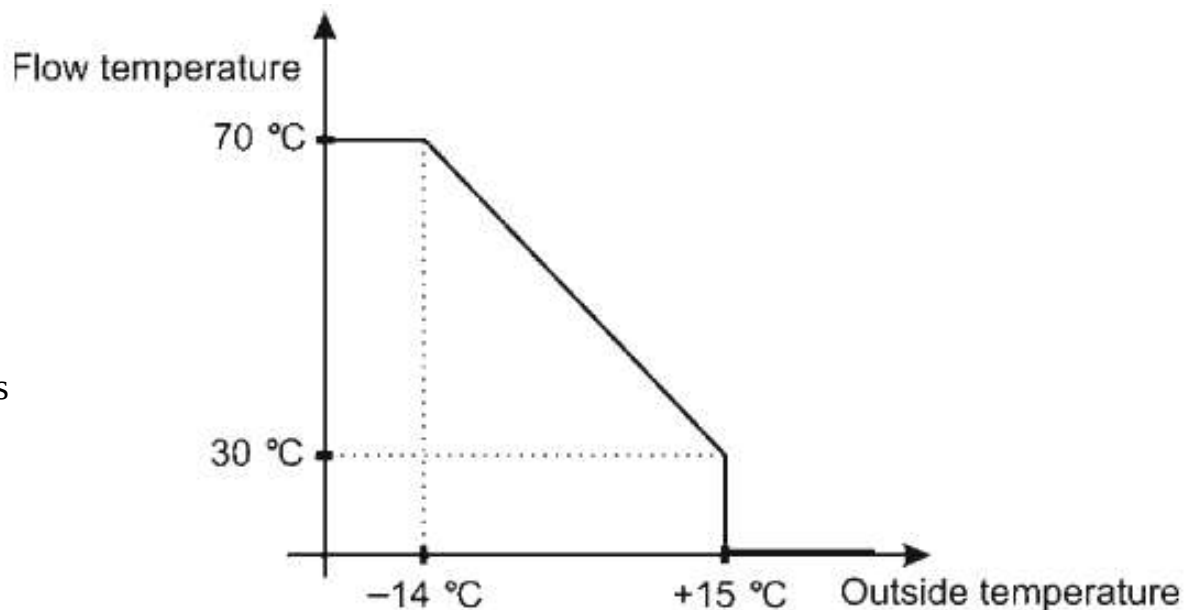


Fig. 1.13 Demand-driven setpoint adjustment

Optimum Start/Stop

Scheduled start/stop programs are programmed to switch the system(s) on and off at specific times.

The optimum start/stop program, on the other hand, is self-regulating and uses the outside and inside temperatures and the thermal characteristics of the building to calculate the optimum times to start and stop a system.

In other words, the latest time a system can be switched on in the morning, and the earliest time it can be switched off in the evening.

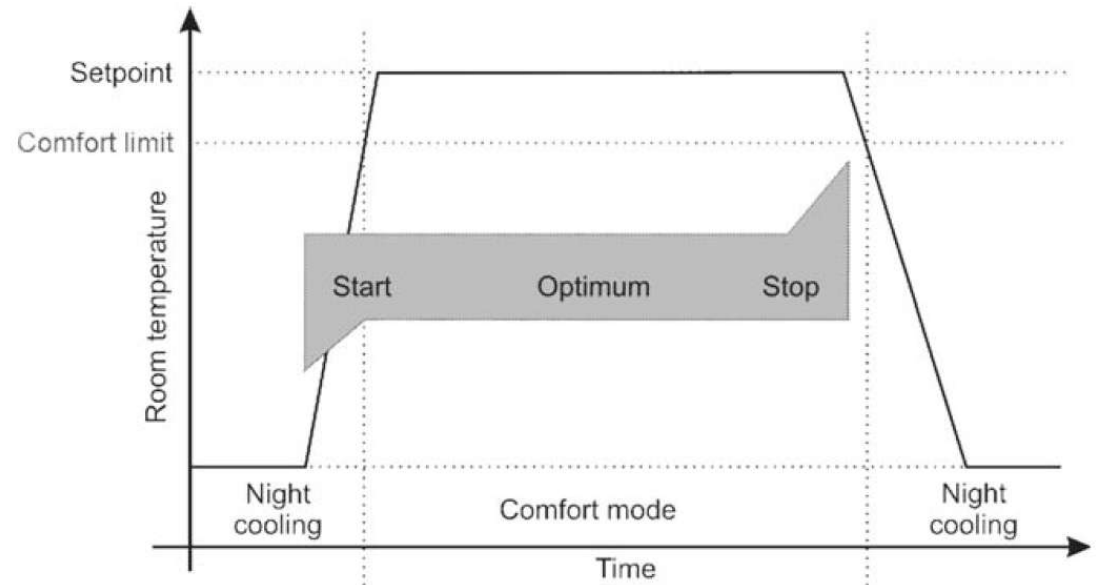


Fig. 1.14 Optimum start/stop

“Demanda Contratada”

- Another way of saving energy is regularly shut down some of the large loads.

e.g., Demenada Contratada com a CEB!

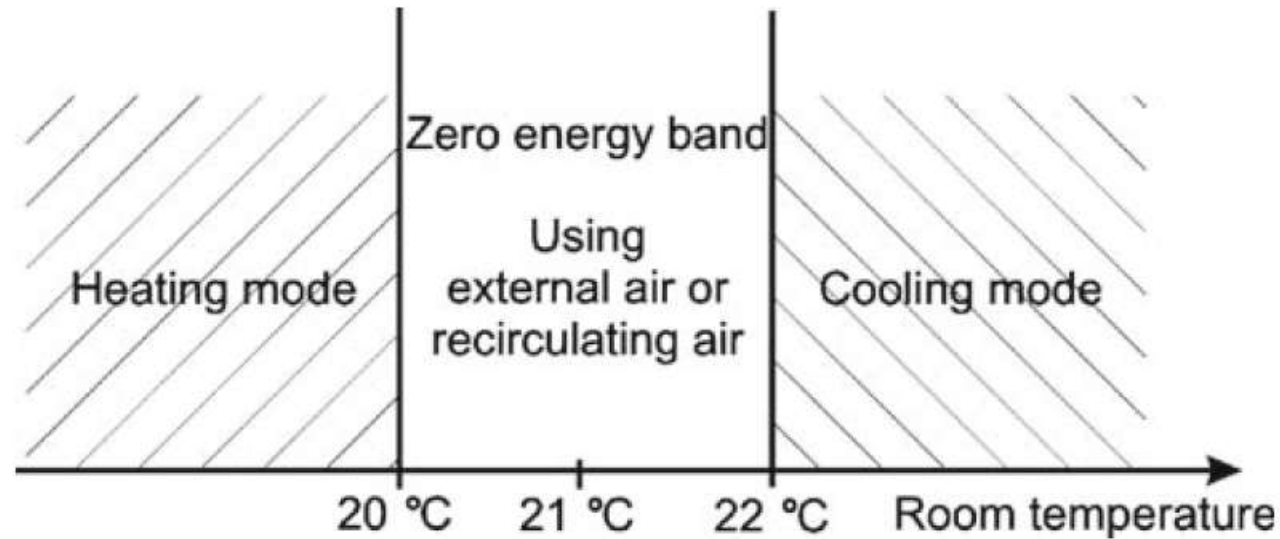


Fig. 1.15 Zero-energy band control

Duty Cycling

- Duty cycling is hard to control, but works well in oversized installations.

e.g., Controle PWM de AVAC L/D, ciclo 10 min

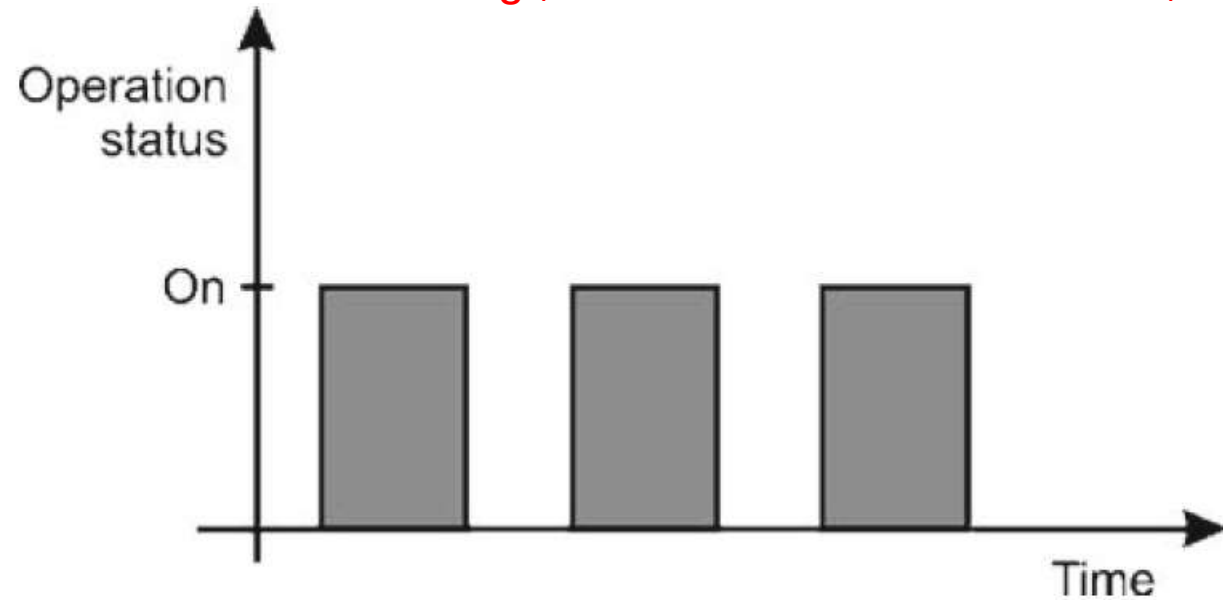


Fig. 1.16 Duty cycling

Energy Management (para demanda contratada)

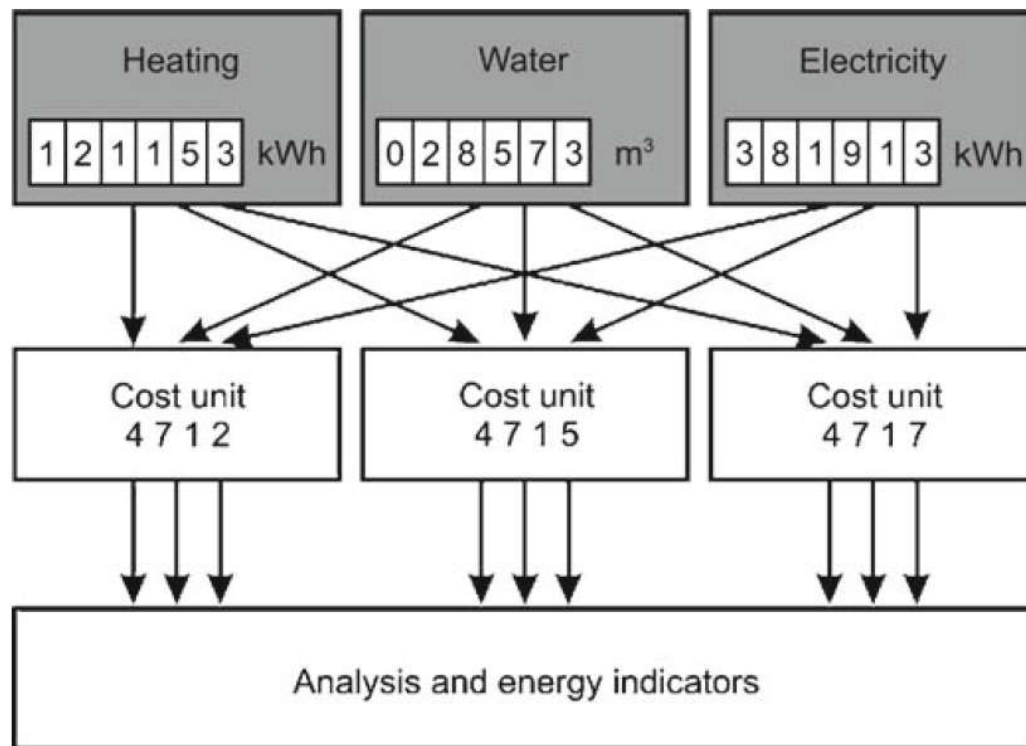


Fig. 1.17 Energy control (energy management function)

Limiting Peak Demand

Demanda contratada - Tarifação diferenciada

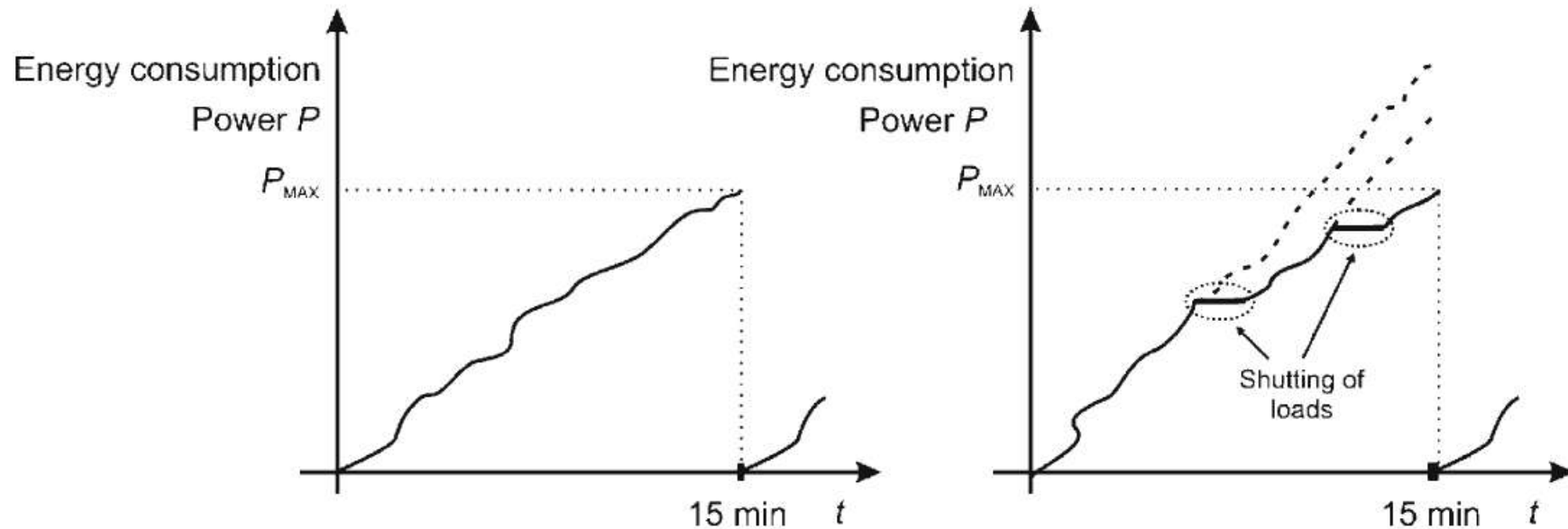


Fig. 1.18 Limiting peak load (energy management function)

Automação Predial – Merz – Cap. 1

Hierarchical structure of building automation

bus systems are used for different functions.

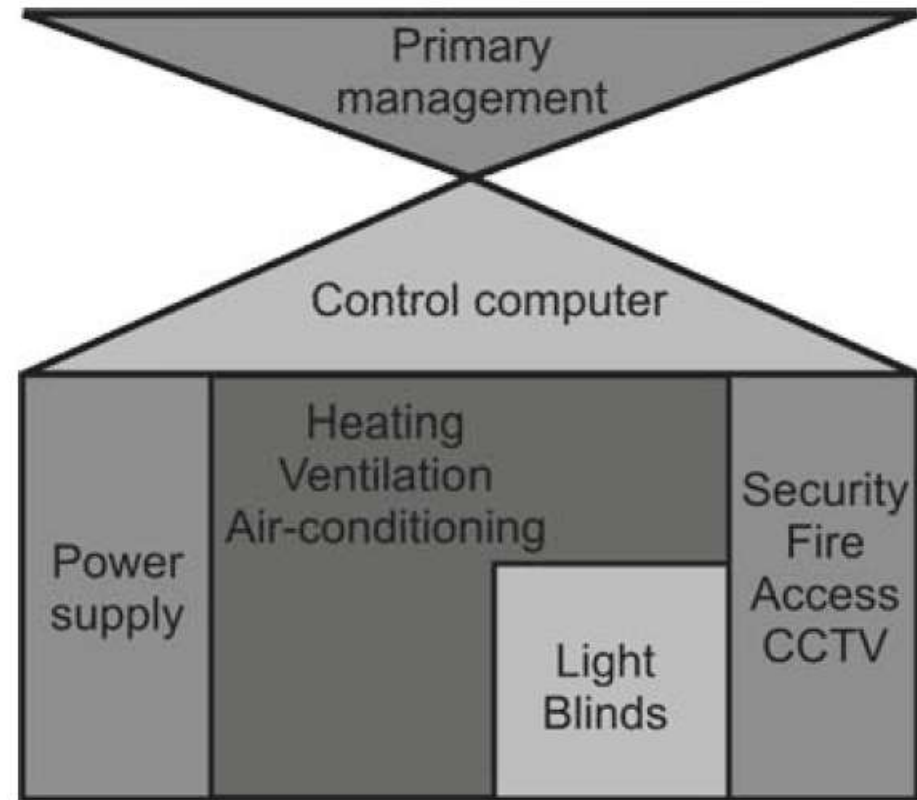


Fig. 1.19 Areas of use of bus systems and networks in a building

Automação Predial – Merz – Cap. 1

KNX was not developed for controlling operational systems and, as a result, cannot be used for transmitting many analog signals. Nevertheless, it has still been very successful in Europe because it is easy to install and maintain.

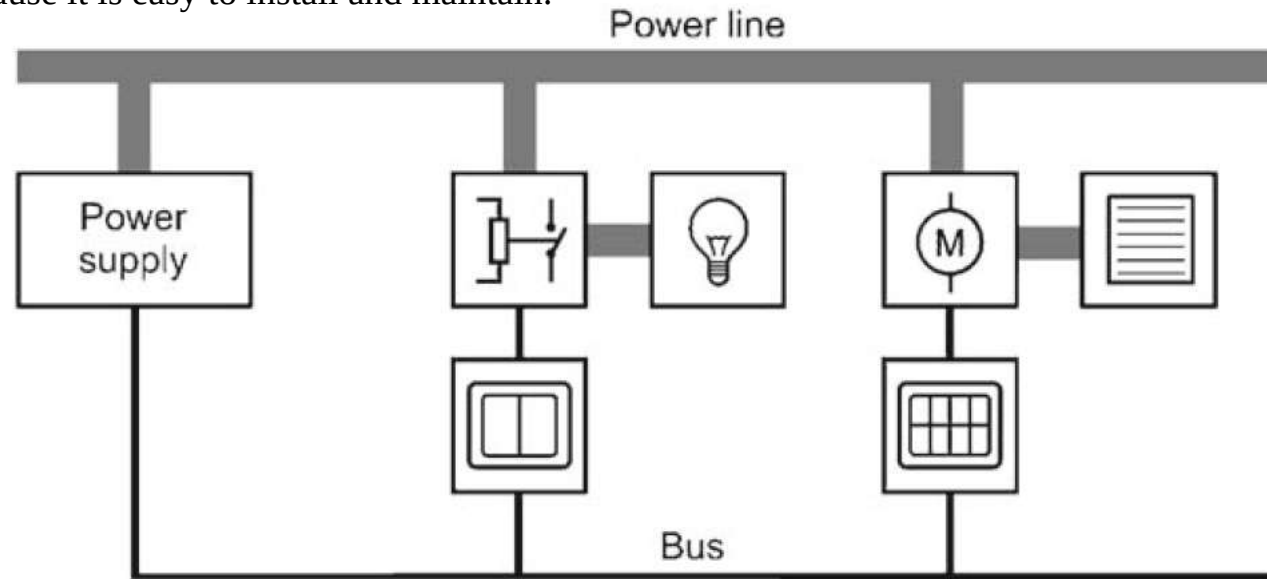


Fig. 1.20 KNX used for lighting control

and Air-Conditioning Systems

To control operational systems, a variety of measured values, setpoints, and other parameters need to be processed. The software applications place higher demands on the processor and the software engineer. The LonWorks technology (LON) was developed to meet these demands.

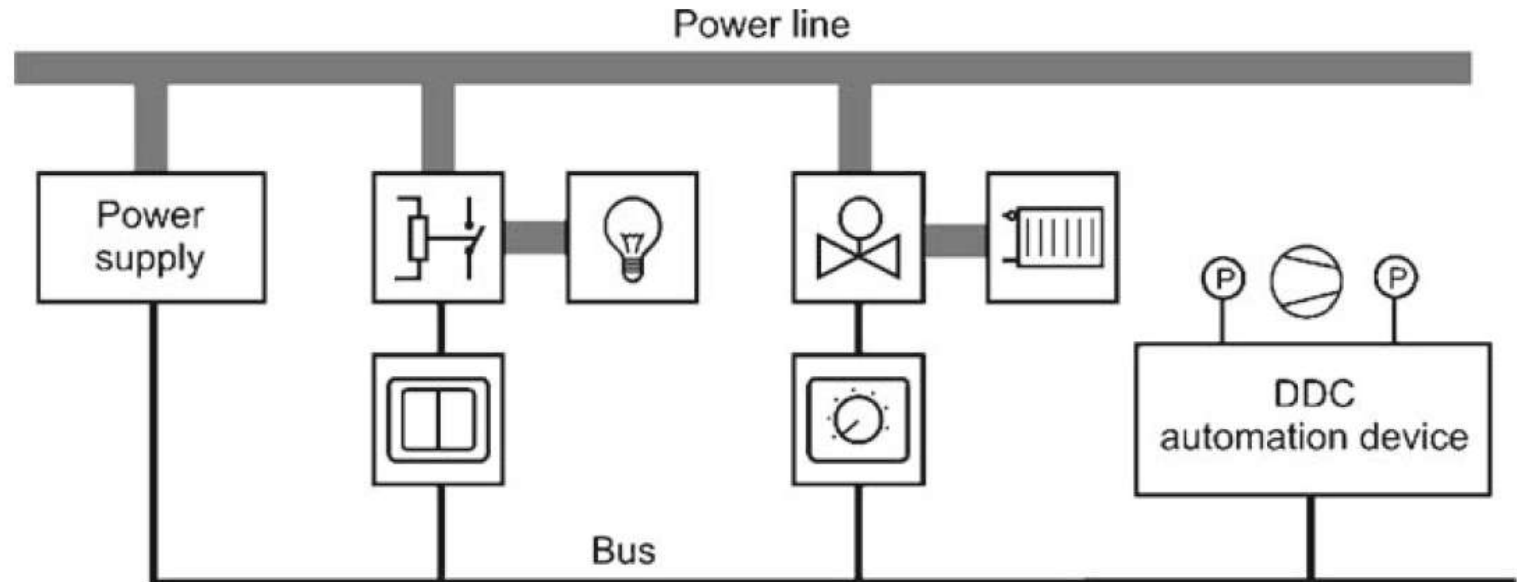


Fig. 1.21 System structure of LONWORKS

Automação Predial – Merz – Cap. 1

Extensive building automation systems in hospitals, universities or administration buildings, often have several operating stations. Extend the building to control computer (Fig. 1.22), ISO BACnet.

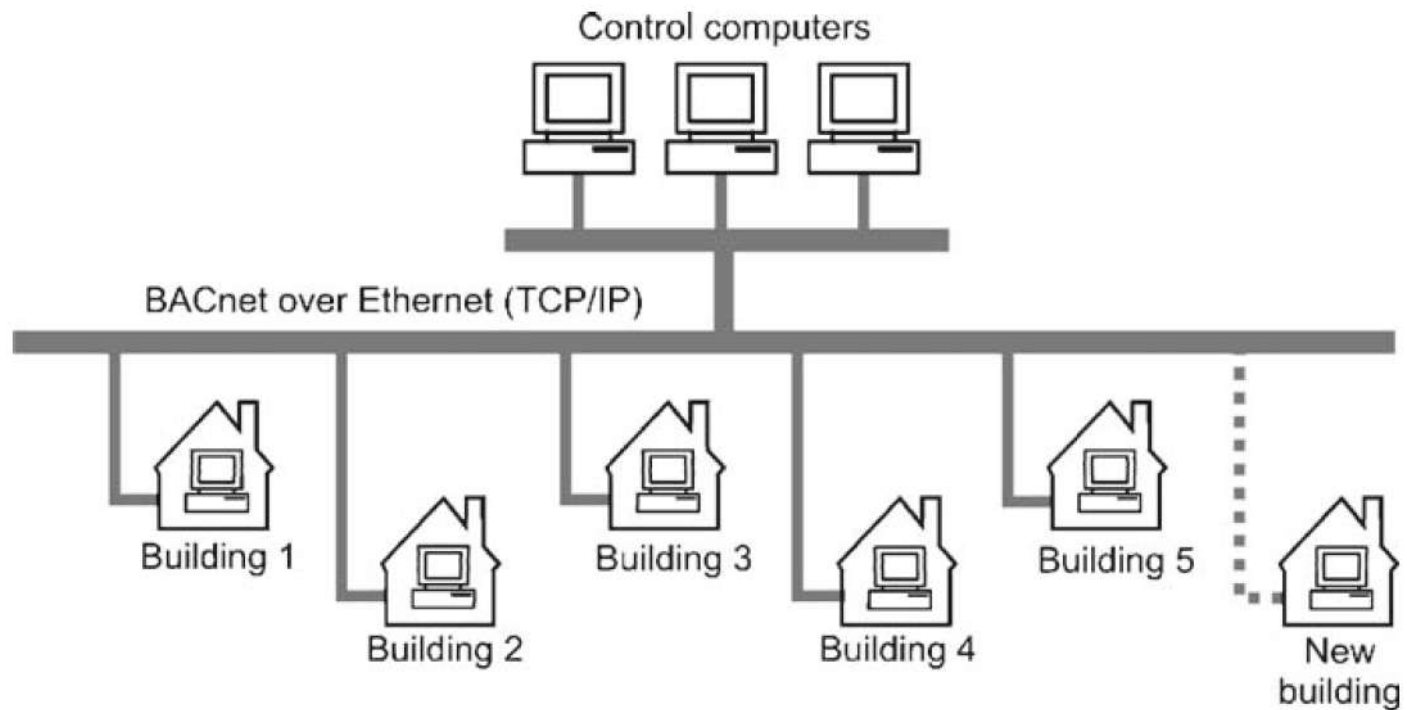


Fig. 1.22 Data exchange between remote buildings

Current Standards

Many proprietary bus systems and networks on the market, but only a few. Figure 1.23 shows the standards in 2015.

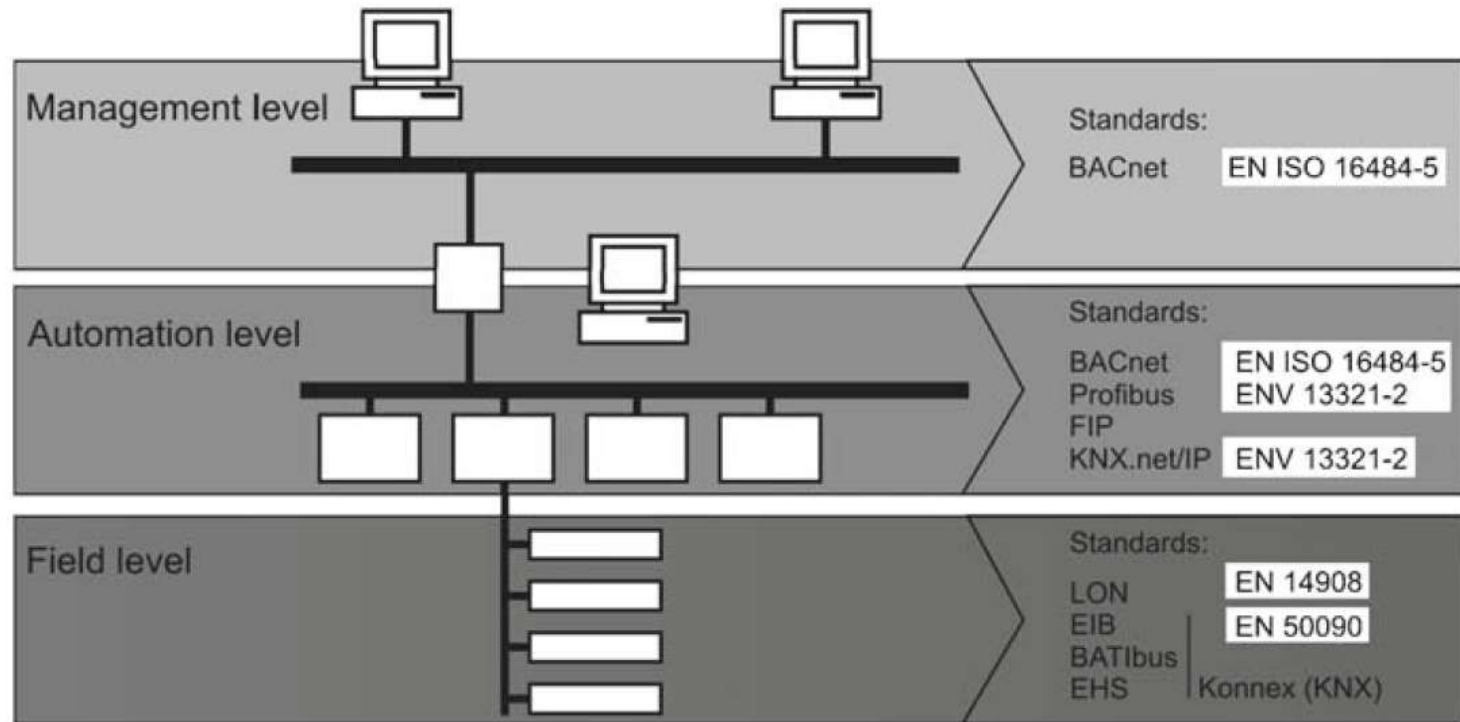
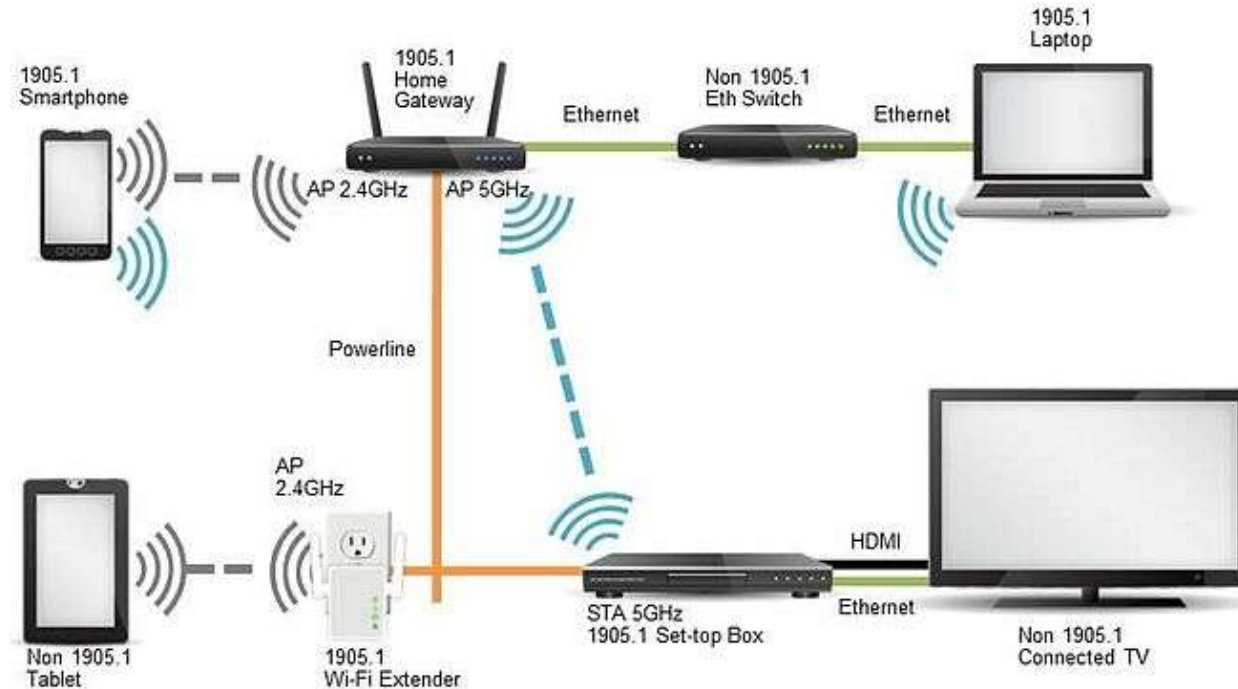


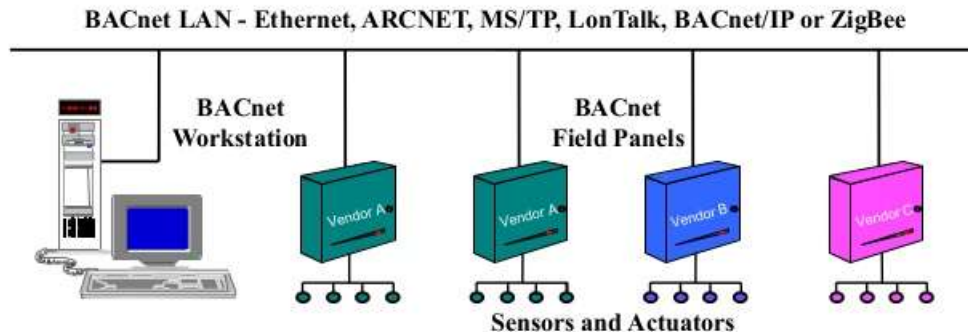
Fig. 1.23 Standardized bus systems and networks in building automation

Current Standards – IEEE 1905

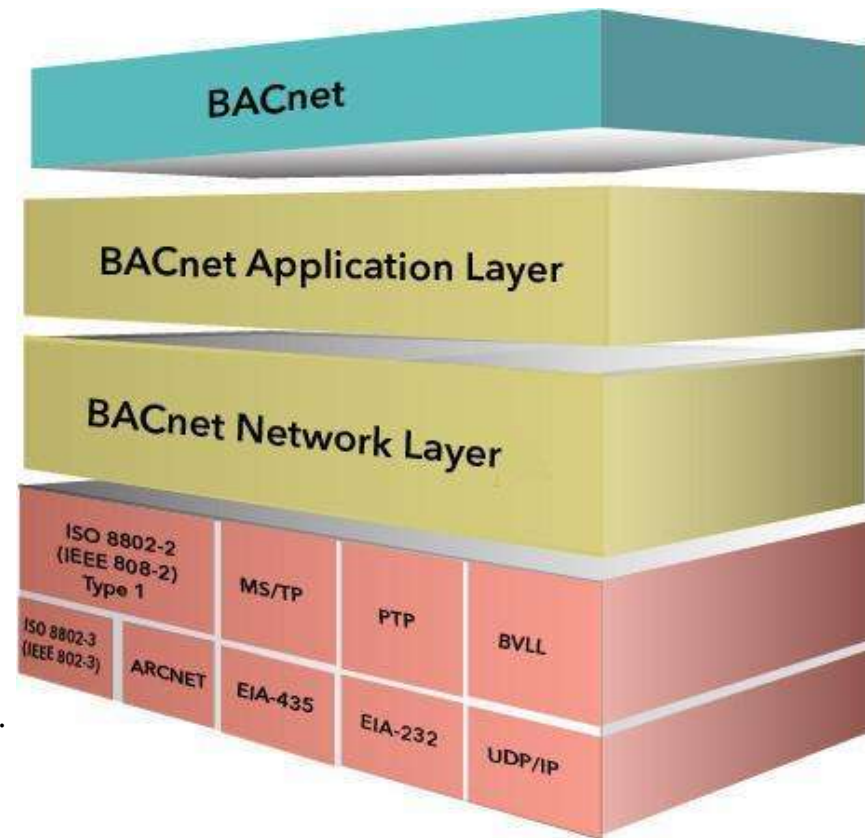
The IEEE 1905.1 Standard Working Group is sponsored by the IEEE **Power-Line Communication Standards Committee (PLCSC)**. [4] nVoy [1] officially certifies products as 1905.1-compliant and is intended to become the dominant brand name and identity for all 1905.1 devices.



"Native" BACnet

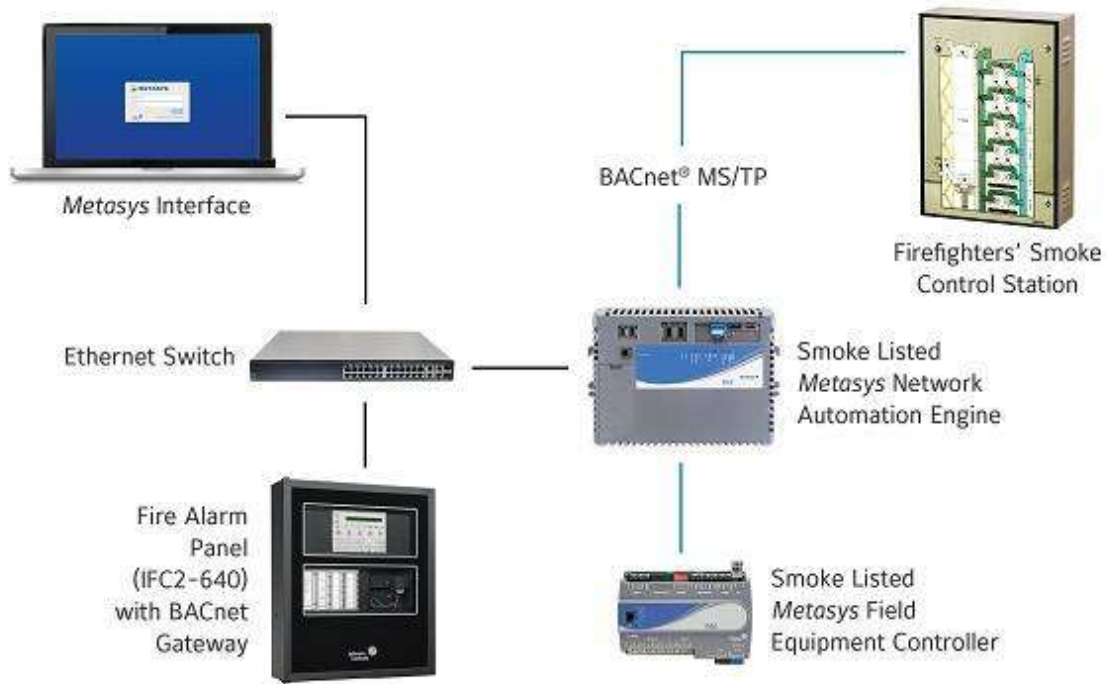


Native BACnet devices provide BACnet communications directly, device to device



BACnet - A Data Communication Protocol for Building Automation and Control Networks.

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), BACnet is an **American** national standard, a **European** standard, a national standard in more than 30 countries, and an **ISO** global standard.



(Merz,2009)

2 The Basics of Industrial Communication Technology

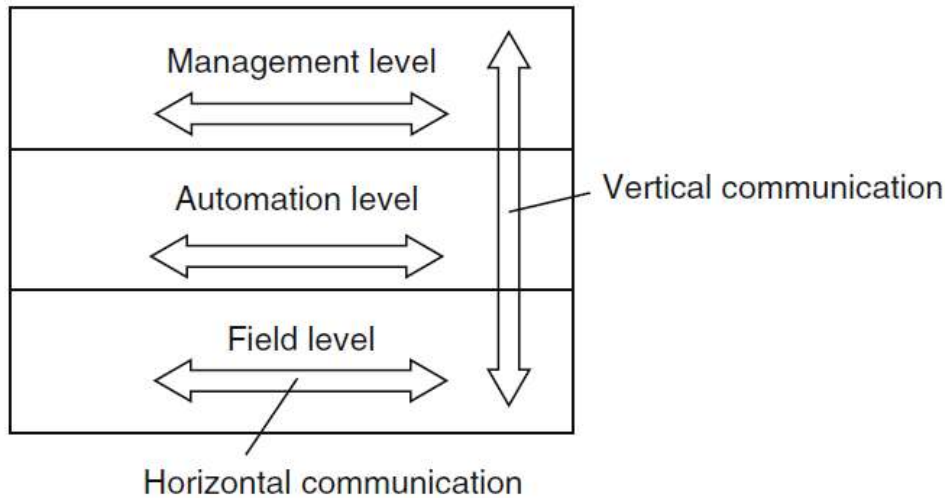


Fig. 2.1 Horizontal and vertical communication in the three-tier building automation model

Field Bus Communication

Table 2.1 Examples of field buses and the fields they are used in

Field buses	Field of use
Controller area network (CAN)	Automobile engineering
Local interconnect network (LIN)	
Process field bus (Profibus)	Process and factory automation
Interbus	
Konnex (KNX)	Building automation
Local operating network (LON)	
Local control network (LCN)	
Serial real time communication system (SERCOS) interface	Drive engineering

(Merz,2009)

2.2 Digital Data Transfer: Important Terms and Definitions

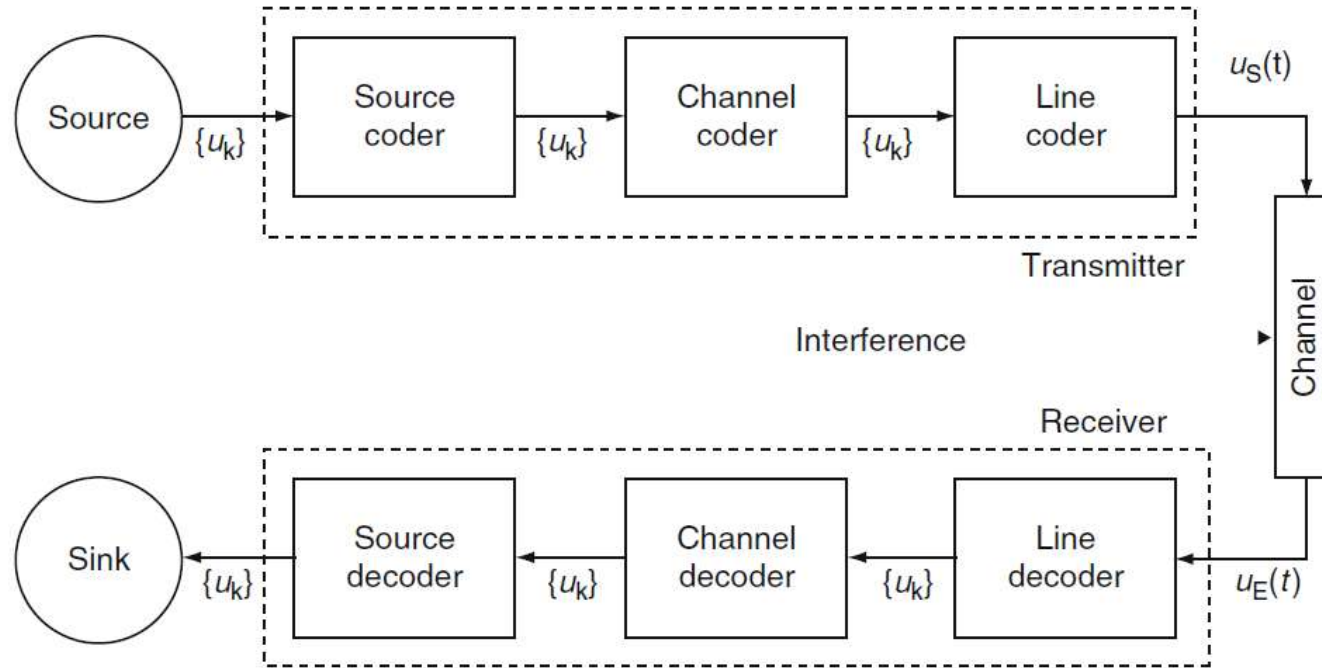


Fig. 2.2 The basic structure of a digital data transmission system

(Merz,2009)

2.2 Digital Data Transfer:

Important Terms and Definitions

Table 2.5 The transmitter and receiver components and their respective tasks

Components	Function
Source coder	Removes redundant source data bits
Source decoder	Adds redundant source data bits
Channel coder	Adds error-correction bits with additional redundant bits
Channel decoder	Removes the error-correction bits
Line coder	Converts the bit sequence into a physical signal
Line decoder	Converts the physical signal into a bit sequence

RL: 0,0,0,0,1,1 = 4x0 2x1

Running Length source coding

(A)	(C)	(B)	(D)
0.5	0.25	0.125	0.125
0	1	1	1
	0	1	1
		0	1

+Cryptography

Original

B C A D A

1011 1100 1010 1101 1010 (octetos)

Ex. Shannon-Fano source coding

Shannon-Fano

110 10 0 111 0

(Merz,2009)

2.2 Parity Check

Parity Check

Paridade par: 0100 0011 **1**

Paridade impar: 0100 0011 **0**

Block Parity Check

10101110 / 01011101 / 11000000 0 01101000 / 01011011 /

45 bits are sent instead of 32 bits.

$$(4+1) \times (8 \text{ bits} + 1)$$

Table 2.6 Example of block parity

1	0	1	0	1	1	1	0	→	1
0	1	0	1	1	1	0	1	→	1
1	1	0	0	0	0	0	0	→	0
0	1	1	0	1	0	0	0	→	1
↓	↓	↓	↓	↓	↓	↓	↓		
0	1	0	1	1	0	1	1	→	1

Check
character

(Merz,2009) 2.2 Cyclic Redundancy Check

CRC-16 polynomial: 1 1000 0000 0000 0111 $x^{16} + x^{15} + x^2 + x^1 + x^0 = x^{16} + x^{15} + x^2 + x + 1$.

The rules of Modulo 2 arithmetic apply when subtracting during polynomial division:

$$1-0=1, 1-1=0, 0-1=1 \quad \boxed{0-0=0}$$

Ex: 11 0101 1011

CRC polynomial: k=4, 1 0 0 1 1

Remainders are not carried (see Table 2.7)

Divide the data bit sequence (including the 0-bits) by the check polynomial.

$$\begin{array}{r} 11010110110000 : 10011 = 1100001010 \\ - 10011 \\ \hline 10011 \\ - 10011 \\ \hline 10110 \\ - 10011 \\ \hline 10100 \\ - 10011 \\ \hline 1110 \text{ Remainder} \end{array}$$

Transmit:

11 0101 1011 **1110**

Receive:

11 0101 1011 1110 /₂ 10011
= **1110**

The resultant check-bit sequence is: 1110.

(Merz,2009) 2.2 Line (canal) Coding/Decoding

NRZ

Non-Return-to-Zero

KNX

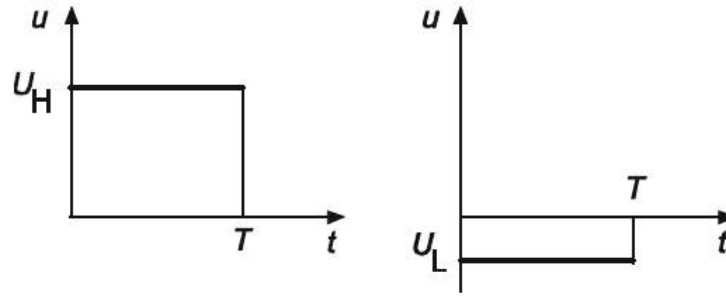


Fig. 2.3 NRZ code signal elements

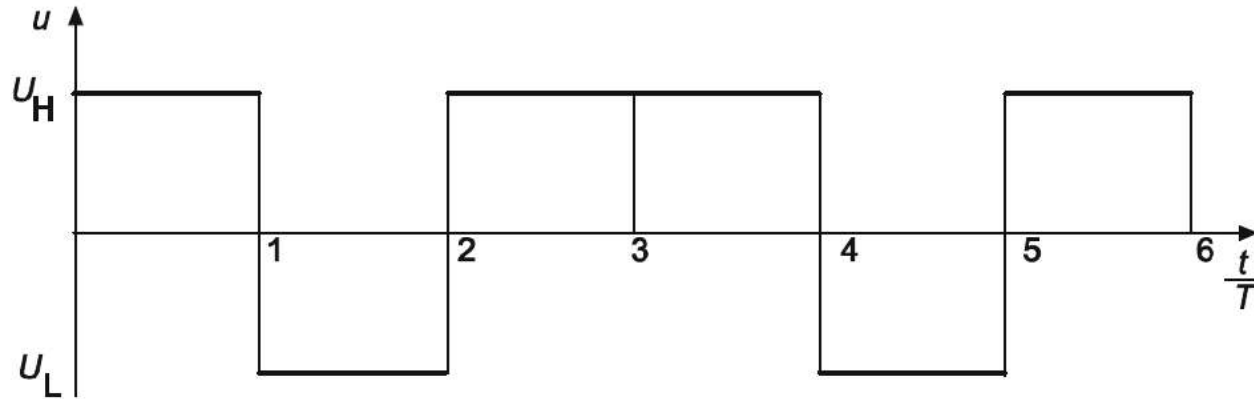


Fig. 2.4 An NRZ coded RS-232 voltage signal

010010

(Merz,2009) 2.2 Line (canal) Coding/Decoding

No clock transmitted

The clock sync
is extracted from
the signal transitions

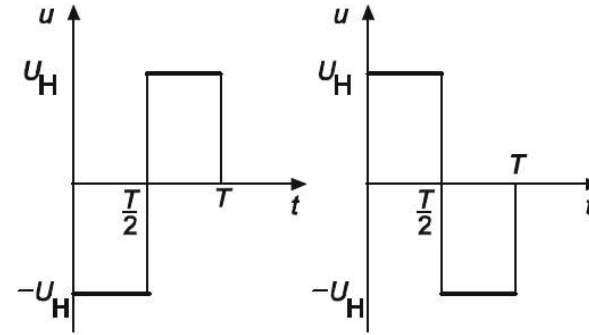


Fig. 2.5 Signal elements in the Manchester code

Many 0's or 1's ?!

→ errors!!

Manchester coding!

Ethernet LANs

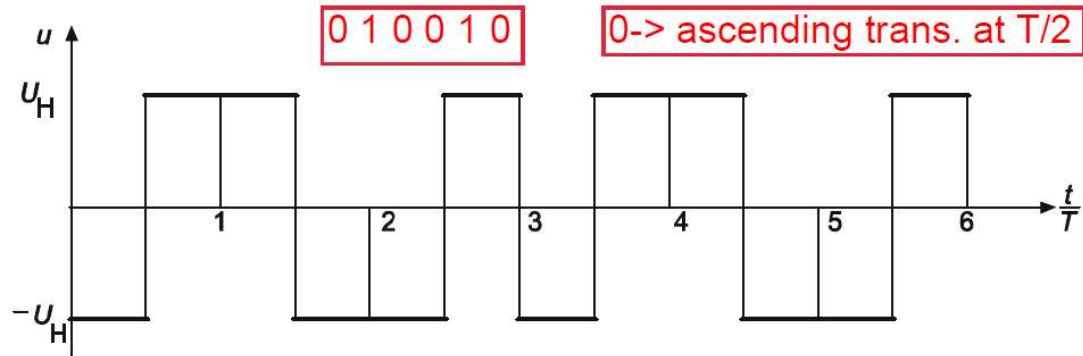


Fig. 2.6 Example of the Manchester code (Biphase-L)

(Merz,2009) 2.2 Line (canal) Coding/Decoding

No clock transmitted

The clock sync
is extracted from
the signal transitions

Many 0's or 1's ?!
→ errors!!

Manchester
Differential
Coding!

LON

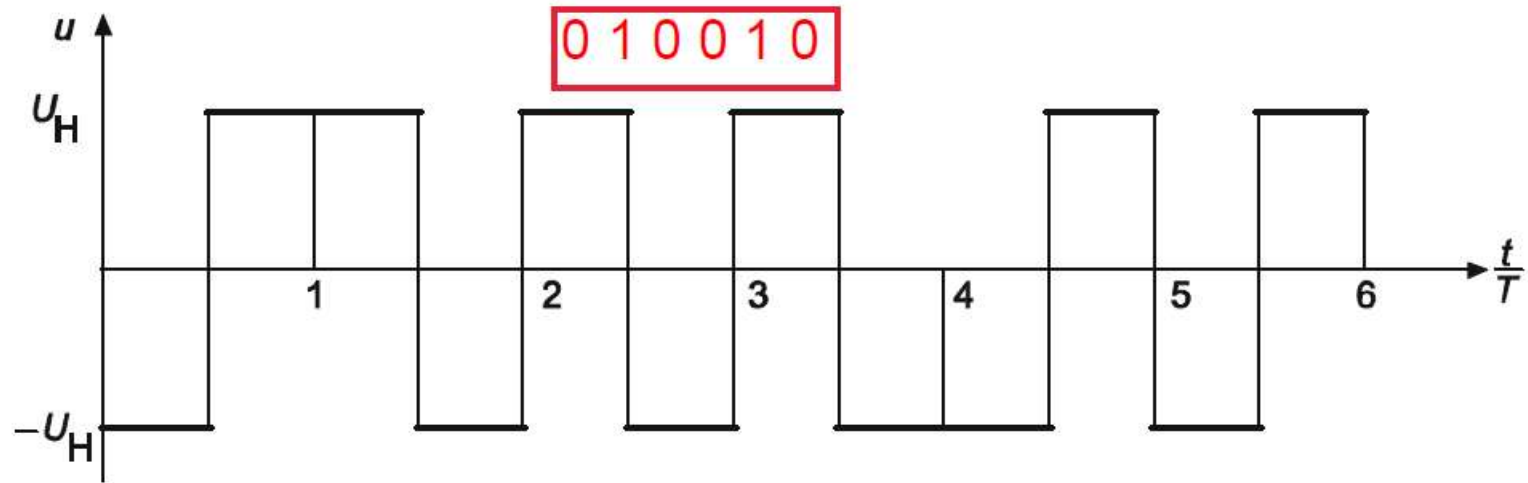


Fig. 2.8 An example of Differential Manchester coding

(Merz,2009) 2.2.4 ISO/OSI Reference Model

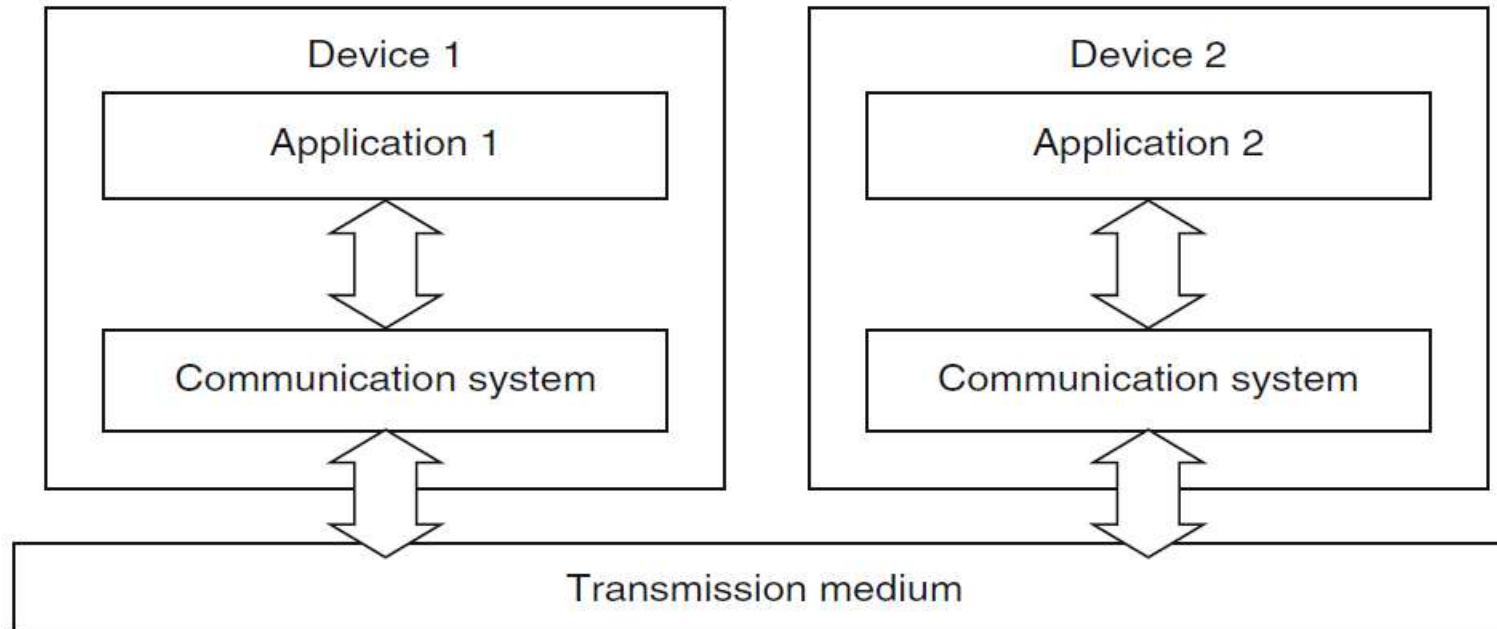


Fig. 2.10 Applications and communication systems from two communication devices

(Merz,2009) 2.2.4 ISO/OSI Reference Model

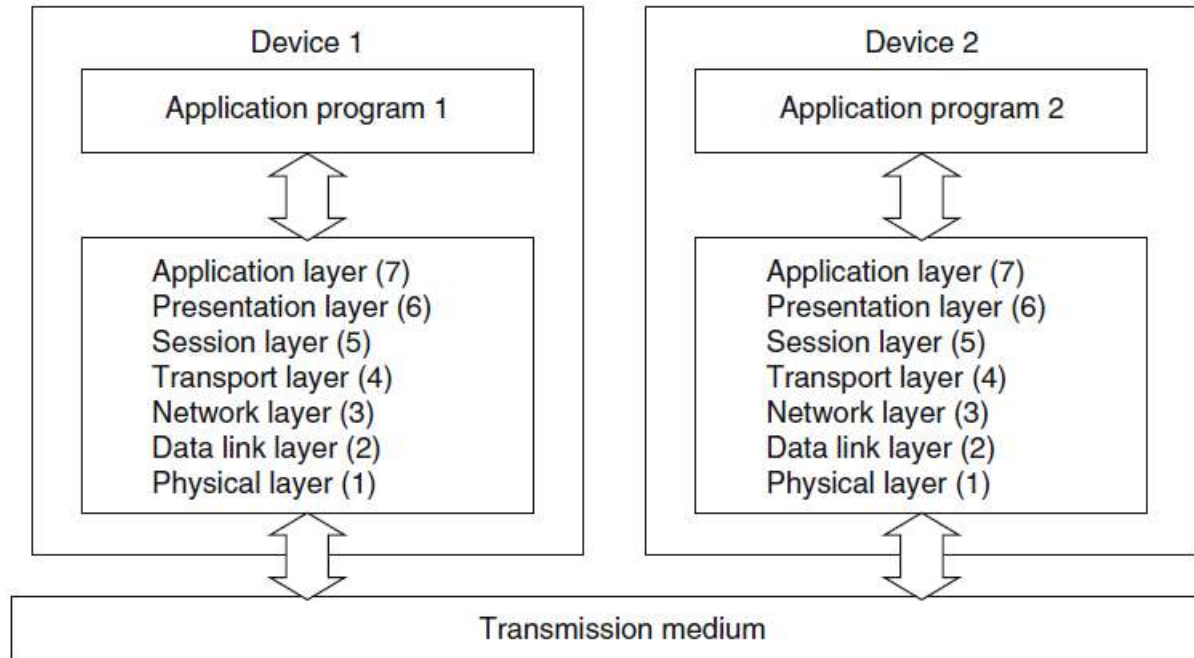


Fig. 2.11 The seven OSI layers

(Merz,2009) 2.2.4 Network Topology

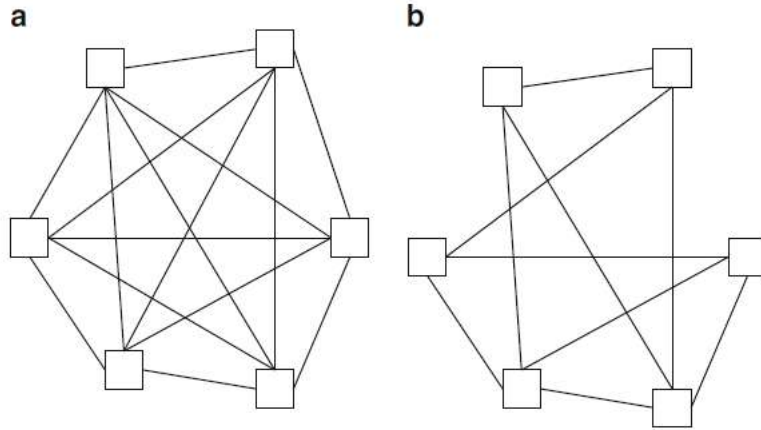


Fig. 2.12 A full (a) and partial (b) mesh topology

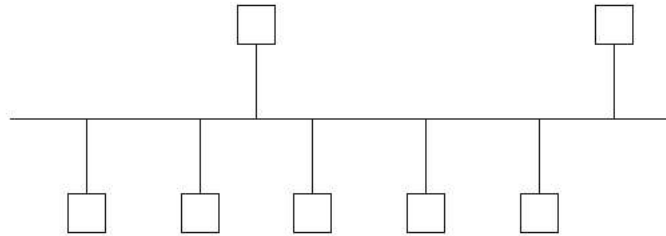


Fig. 2.13 Bus topology

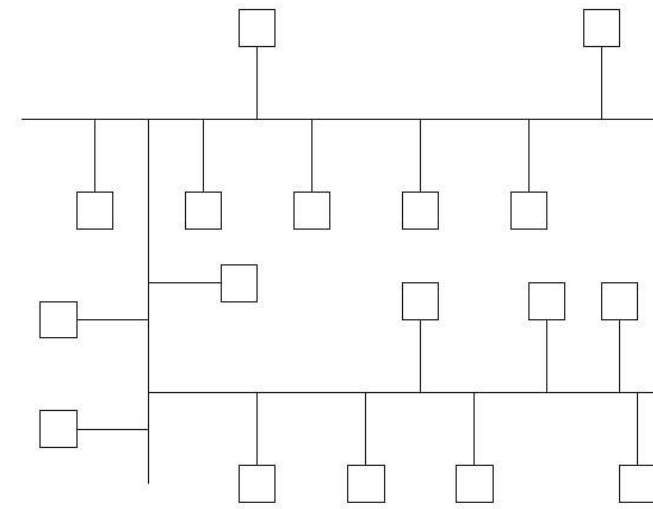


Fig. 2.14 Tree topology

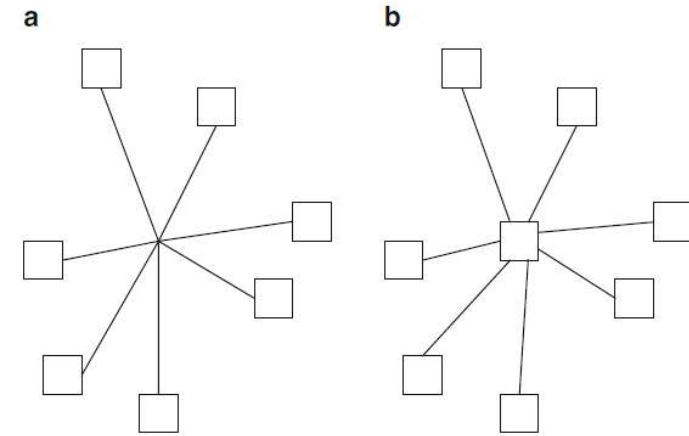


Fig. 2.15 Star topology (a) without a central station and (b) with a central station

(Merz,2018)

3



Konnex Association



EIBA, BatiBUS and EHSA joined to form the Konnex Association

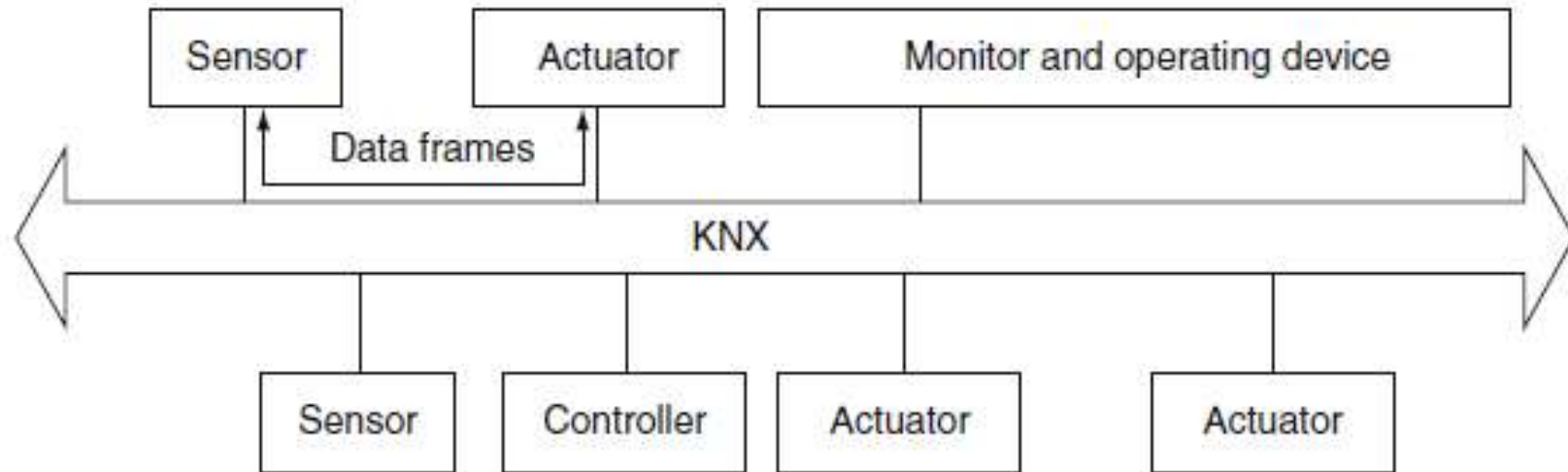


Fig. 3.1 Building control devices connected over Konnex

(Merz,2018)

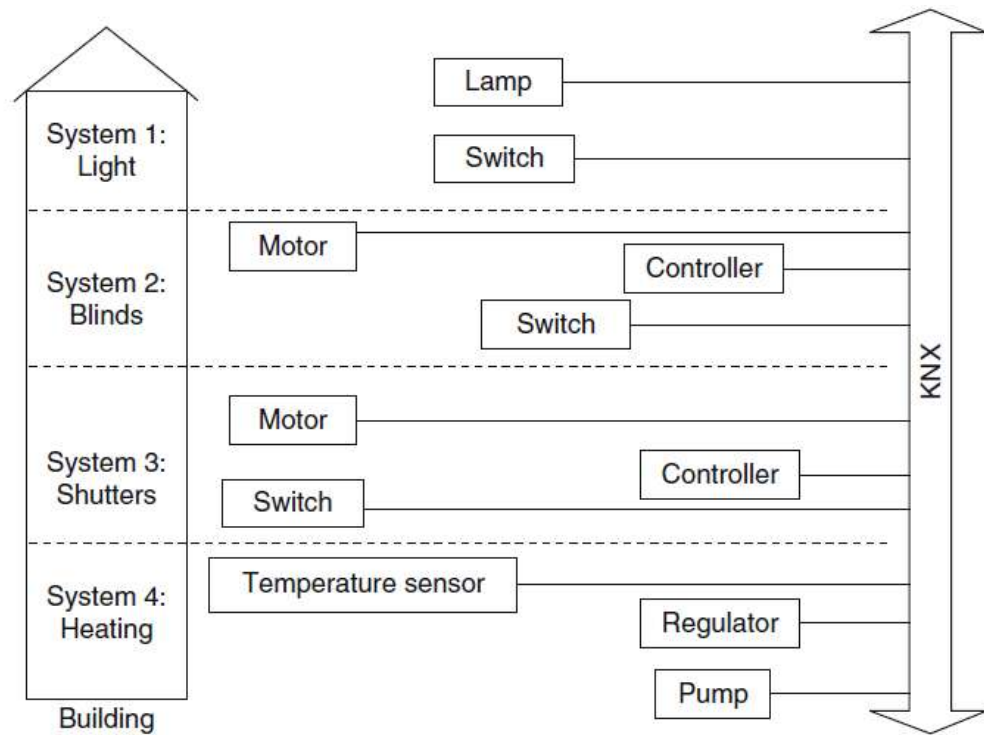
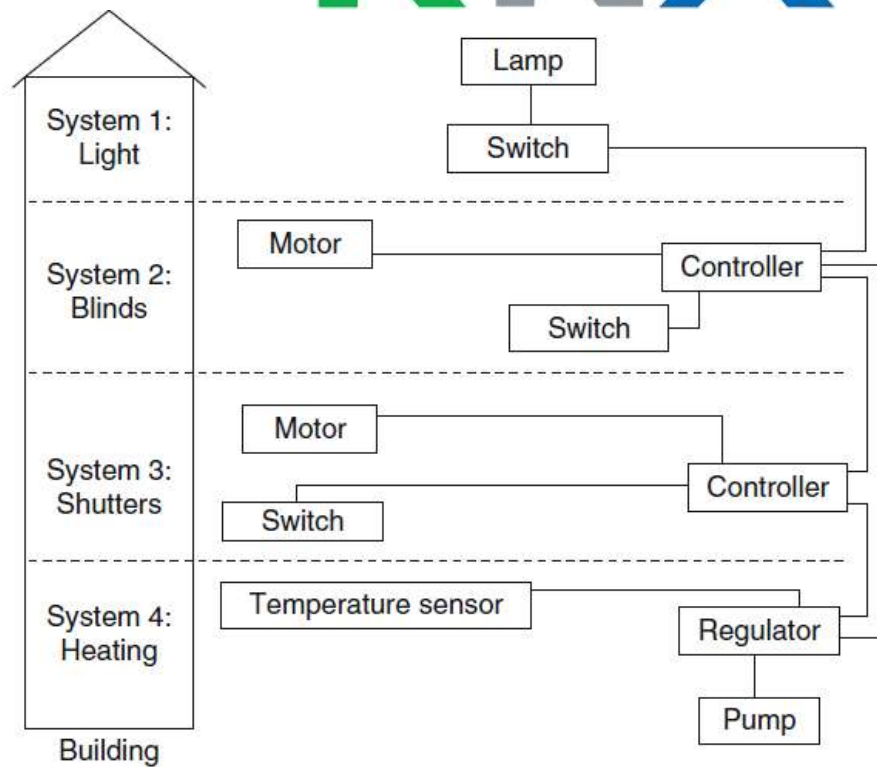


Fig. 3.2 Conventional building technology – separate systems, high cabling costs

Fig. 3.3 Building control with KNX – integrated systems, lower cabling costs

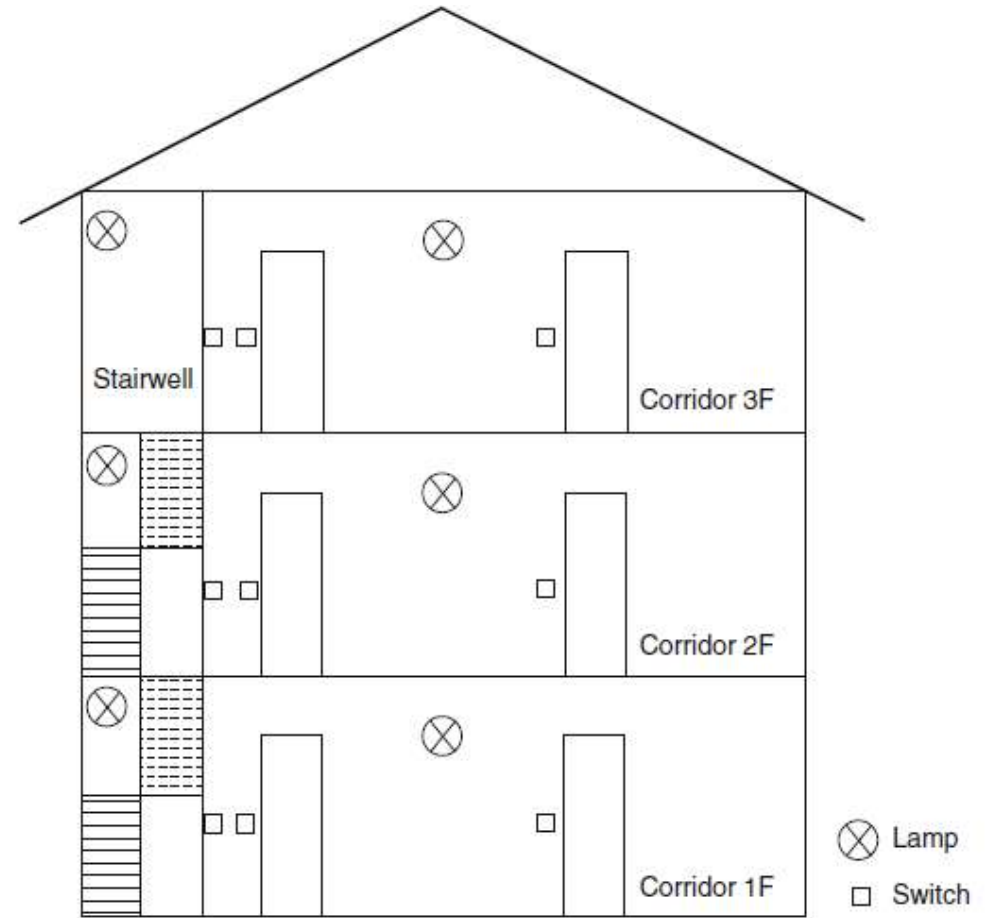


Fig. 3.3 An apartment building with stairwell and corridor lighting

(Merz,2018) **3.2**

Conventional Installation

Fig. 3.4 Unipolar and bipolar on/off switches

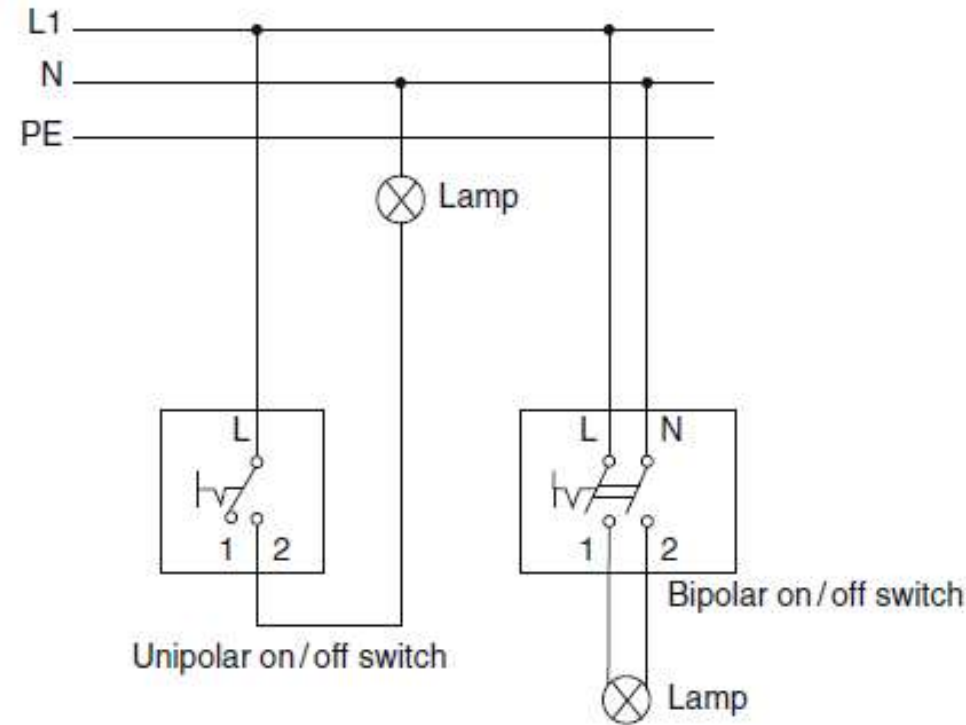


Table 3.1 On/off switch functions as shown in Fig. 3.7

	On/off switch	Lamp
Switch setting	Left (1)	Off
	Right (2)	On

(Merz,2018) **3.2**

Changeover

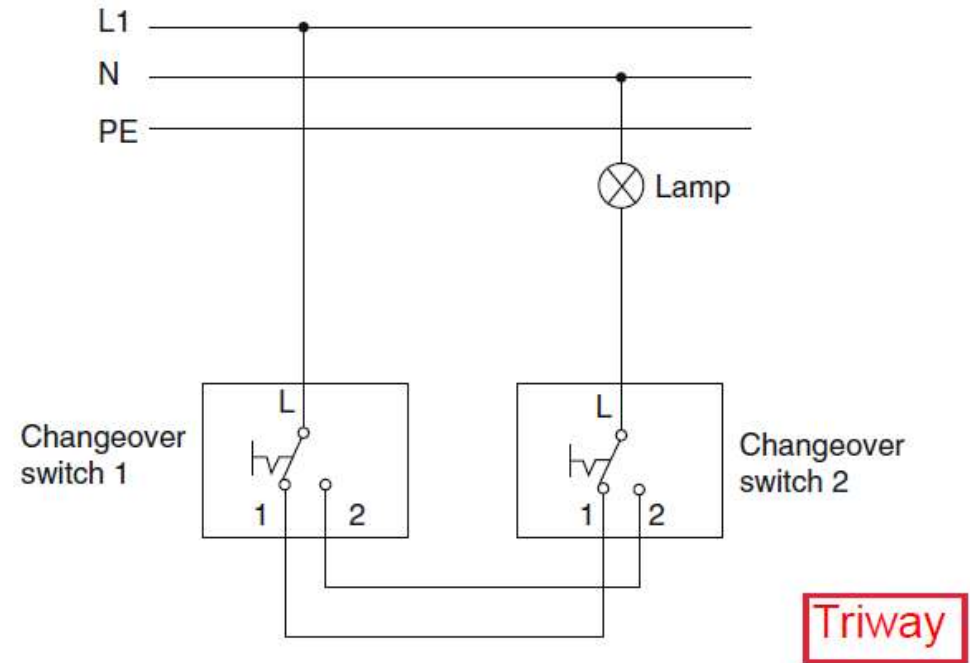


Fig. 3.8 A changeover switching circuit

Table 3.2 Changeover switching circuit functions, as shown in Fig. 3.8

	Changeover switch 1	Changeover switch 2	Lamp
Switch setting	left (1)	left (1)	On
	left (1)	right (2)	Off
	right (2)	right (2)	On
	right (2)	left (1)	Off

(Merz,2018) **3.2**

Crossover

Table 3.3 Crossover switching circuit functions, as shown in Fig. 3.9

	Changeover switch 1	Crossover switch	Changeover switch 2	Lamp
Switch setting	left (1)	left	left (1)	on
	right (2)	left	left (1)	off
	left (1)	right	left (1)	off
	left (1)	left	right (2)	off
	right (2)	right	left (1)	on
	right (2)	left	right (2)	on
	left (1)	right	right (2)	on
	right (2)	right	right (2)	off

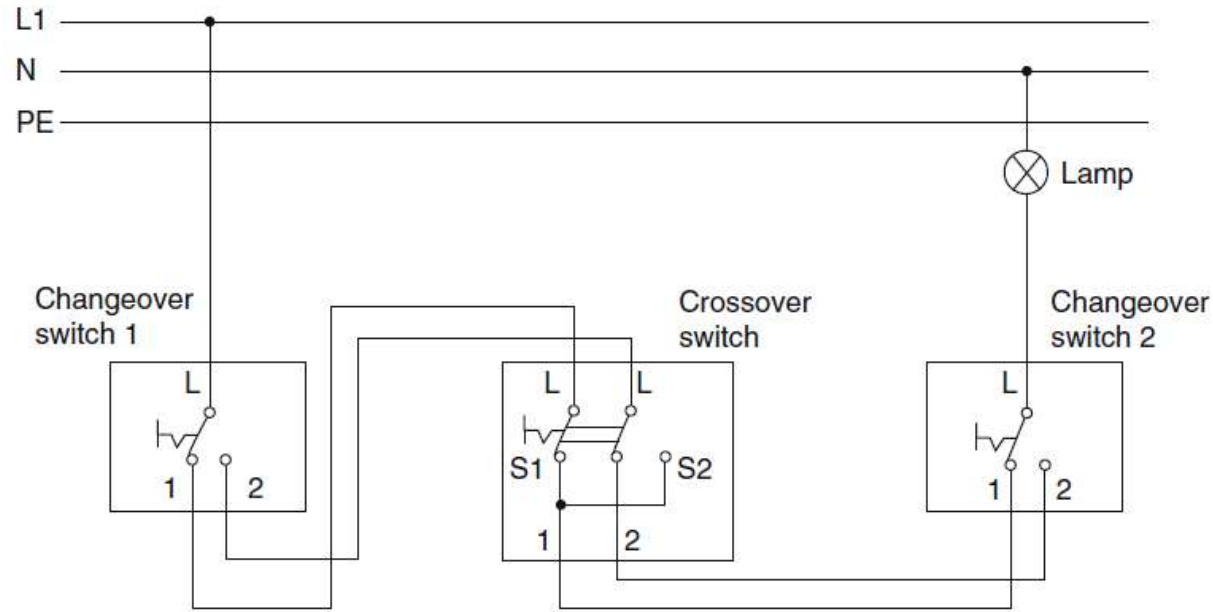
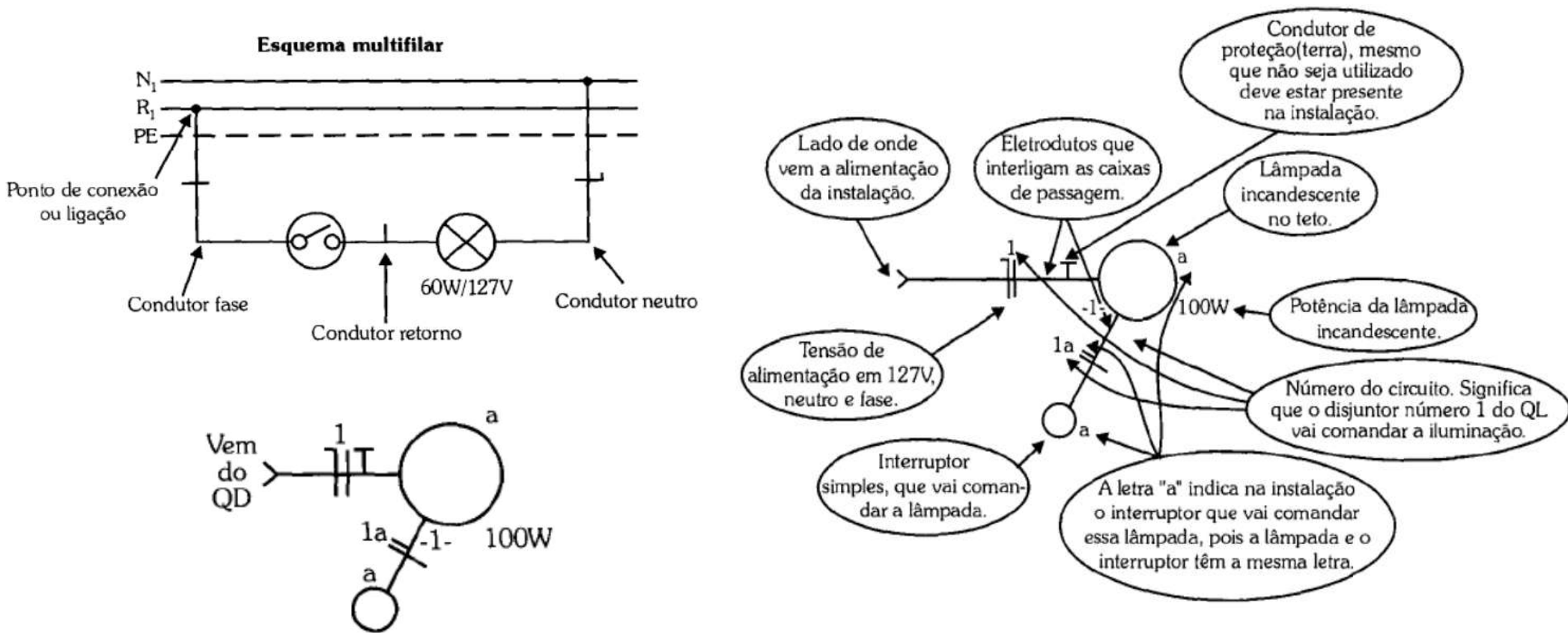


Fig. 3.9 A crossover switching circuit

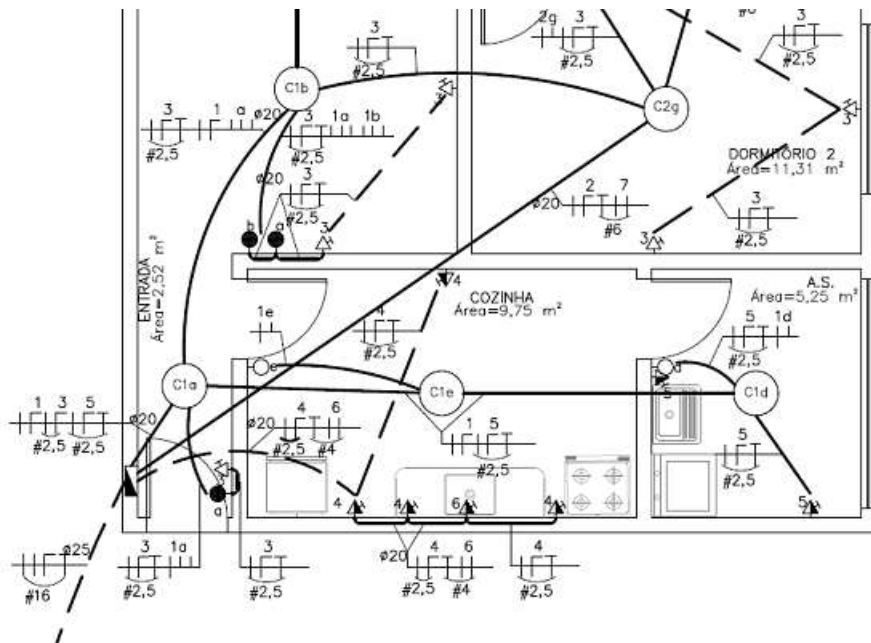
Fourway

3.2 Diagrama Unifilar



http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

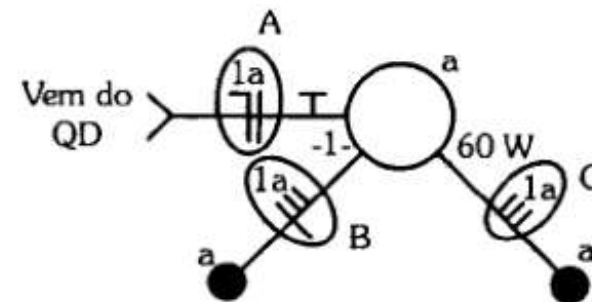
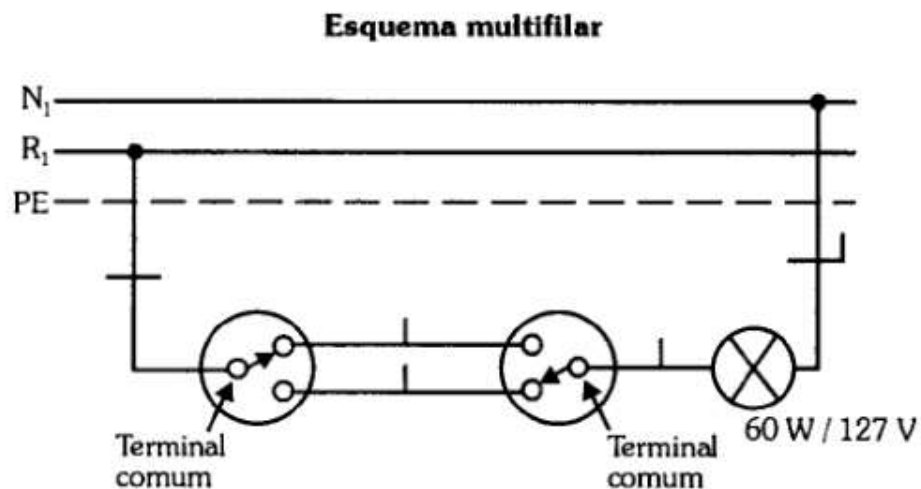
3.2 Simbologia Elétrica ABNT 5410



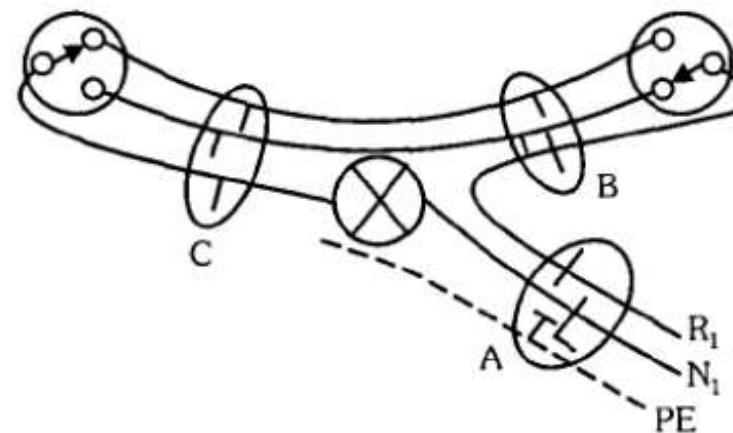
DESIGNAÇÃO	USUAL	ABNT
Ponto de luz incandescente	no teto	no teto
	na parede	na parede
	não embutido	não embutido
Ponto de luz fluorescente	embutido	embutido
Circuito que sobe		
Circuito que desce		
Circuito que passa		
Tomada de luz na parede	Baixa	Baixa
	Meo alta	Meo alta
	Alta	Alta
Tomada de luz	no piso	no piso
	no teto	no teto
Tomada de força	na parede	na parede
	no piso	no piso
	no teto	no teto
Interruptor de 1 seção	S1	S1
Interruptor de 2 seções	S2	S2
Interruptor de 3 seções	S3	S3
Interruptor paralelo ou "Three-way"	S3w	S3w
Interruptor intermediário ou "Four-way"	S4w	S4w
Botão de campainha		
Cigarra		
Campainha		
Saída para telefone	externo	externo
	interno	interno
Motor		

DESIGNAÇÃO	USUAL	ABNT
Tomada para rádio e TV		
Caixa de passagem		
Quadro parcial de luz ou força		
Quadro geral de luz ou força não embutido		
Quadro geral de luz ou força embutido		
Caixa de telefone		
Eletroduto no teto ou na parede		
Eletroduto no piso		
Tubulação para telefone externo		
Tubulação para telefone interno		
Condutores de fase, neutro, retorno e terra em eletroduto		
Botão de minuteria		
Minuteria		
Ligação a terra		
Fusível		
Disjuntor a seco		
Chave com fusíveis para alta tensão		
Chave com fusíveis para baixa tensão		
Disjuntor a óleo		
Chave blindada		
Transformador de corrente		
Transformador		
Relógio elétrico no teto		
Relógio elétrico na parede		

3.2 Triway



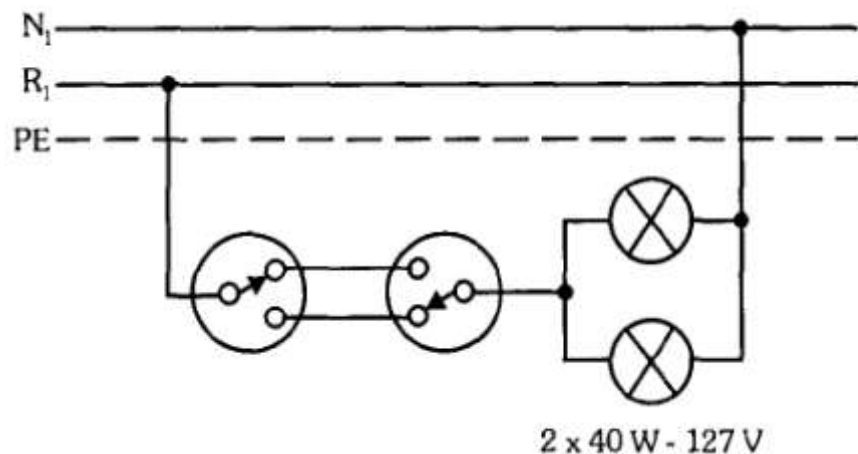
De forma prática temos:



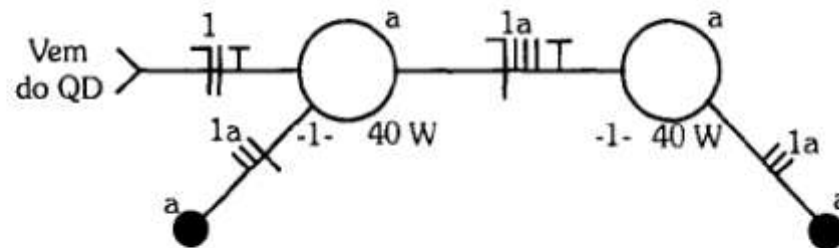
http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

3.2 Triway

Esquema multifilar

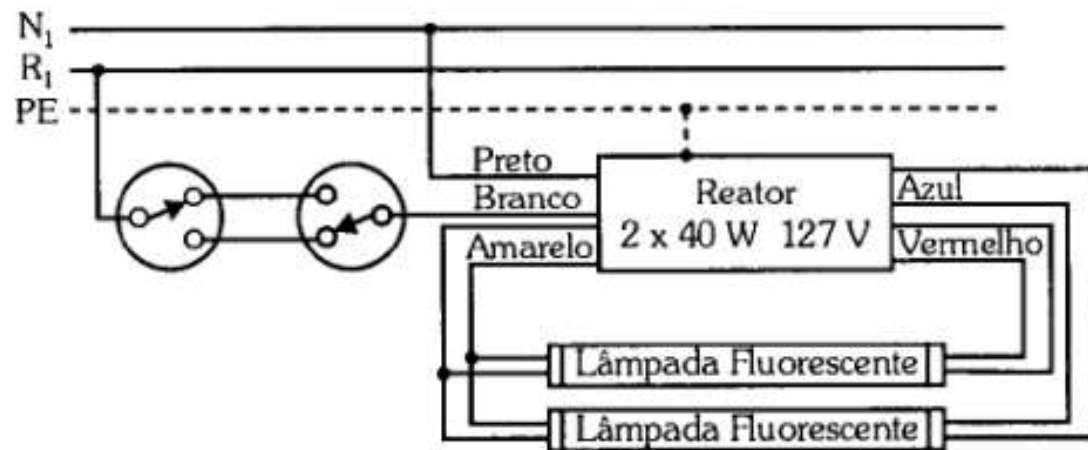


Esquema unifilar

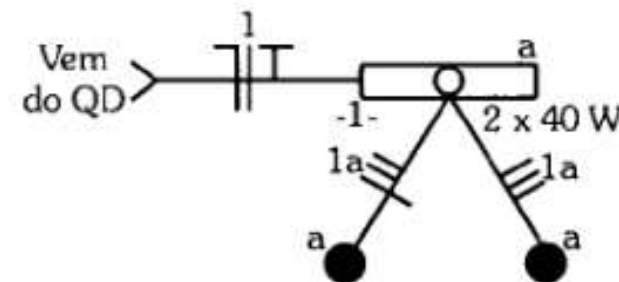


3.2 Triway

Esquema multifilar



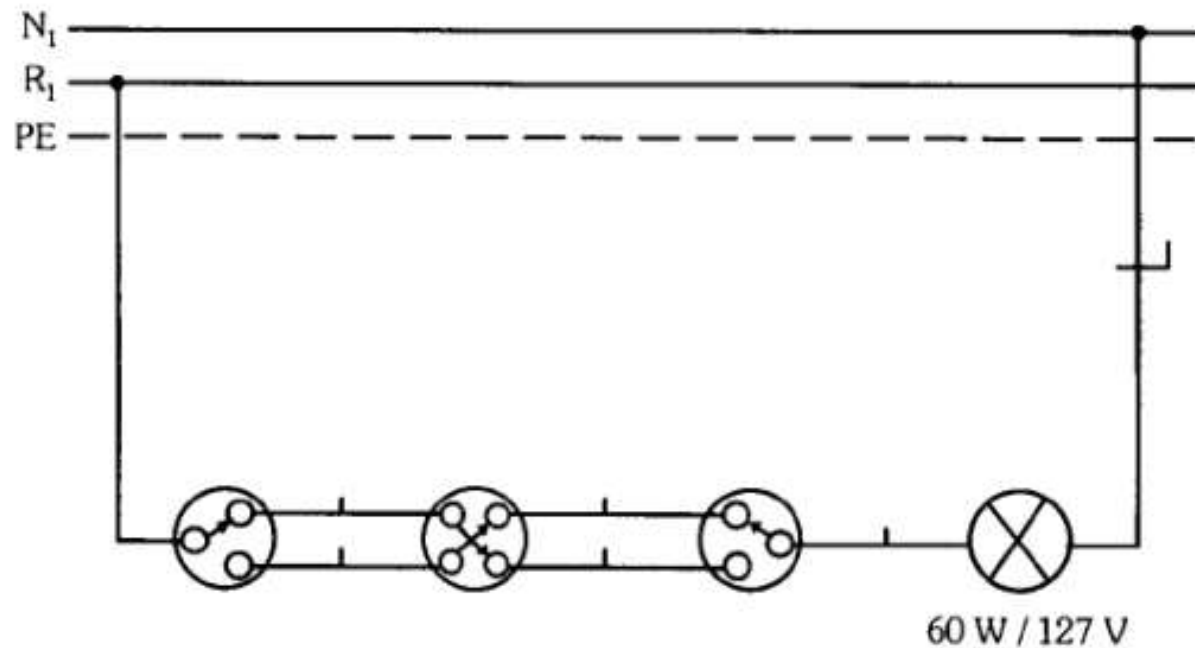
Esquema unifilar



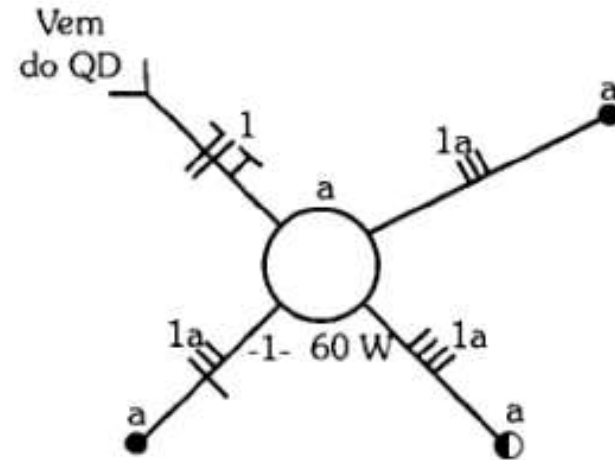
http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

3.2 Fourway

Esquema multifilar



Esquema unifilar



http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

(Merz,2018)

3.3 KNX Overview

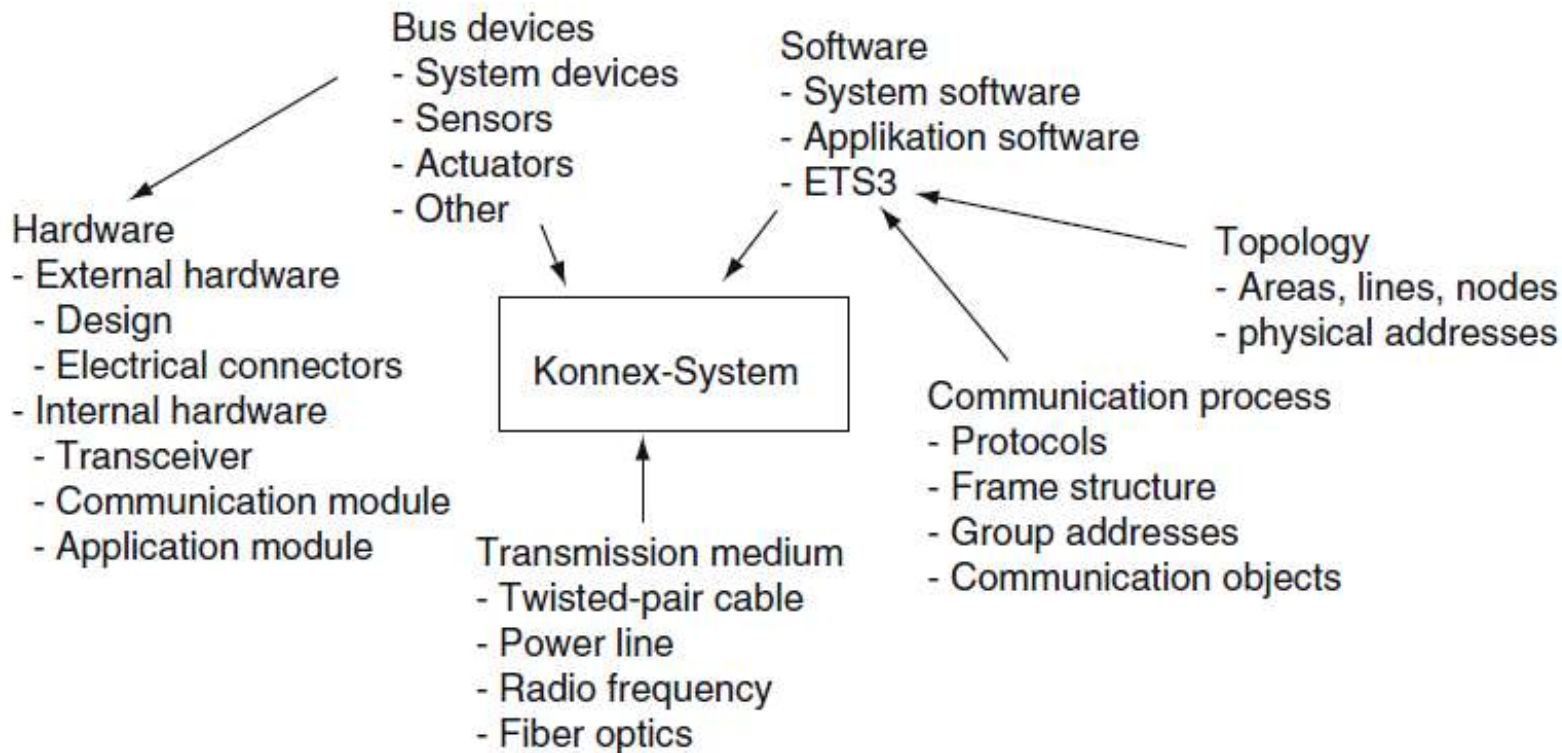


Fig. 3.11 Overview of KNX

(Merz,2018) 3.4 KNX Devices

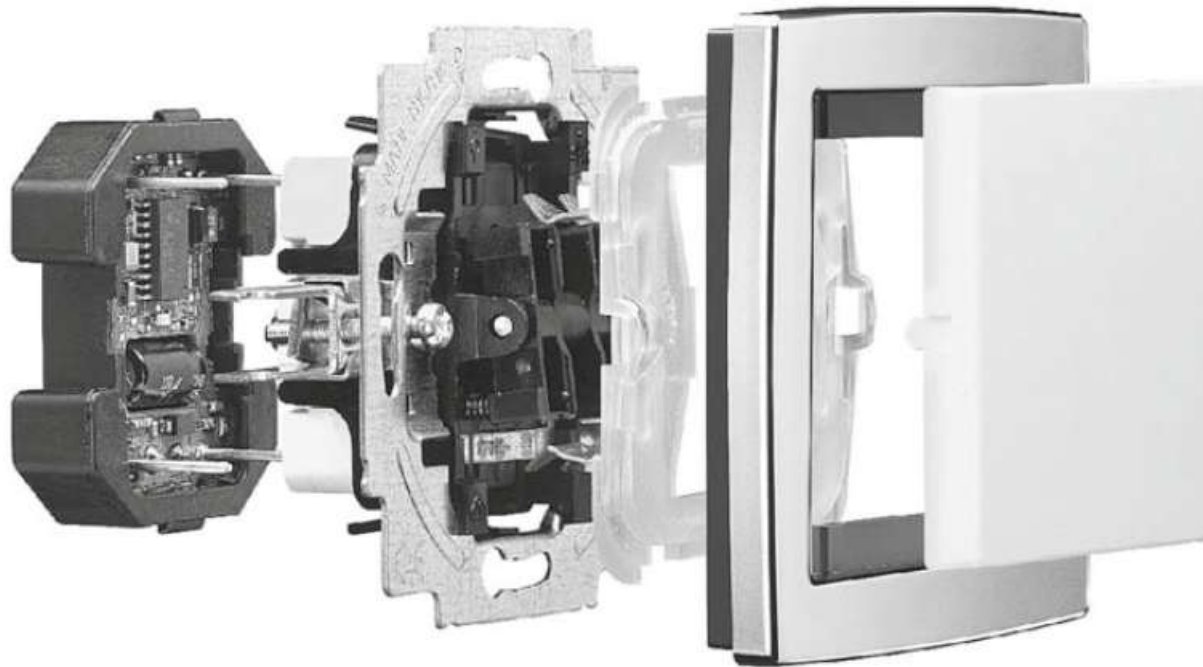


Fig. 3.12 A modular KNX.PL device [Busch-Jaeger Elektro]

(Merz,2018) 3.4 KNX Devices



Fig. 3.13 A power supply unit 640 mA (RM) with an integrated choke and two 30 V DC outputs [ABB06])

(Merz,2018) 3.4 KNX Devices



Fig. 3.14 A six-gang switch actuator (RM) [ABB06]

(Merz,2018) 3.4 KNX Devices



Fig. 3.15 A bus coupler (BC) and four-gang switch sensor [ABB06]

(Merz,2018) 3.4 KNX Devices

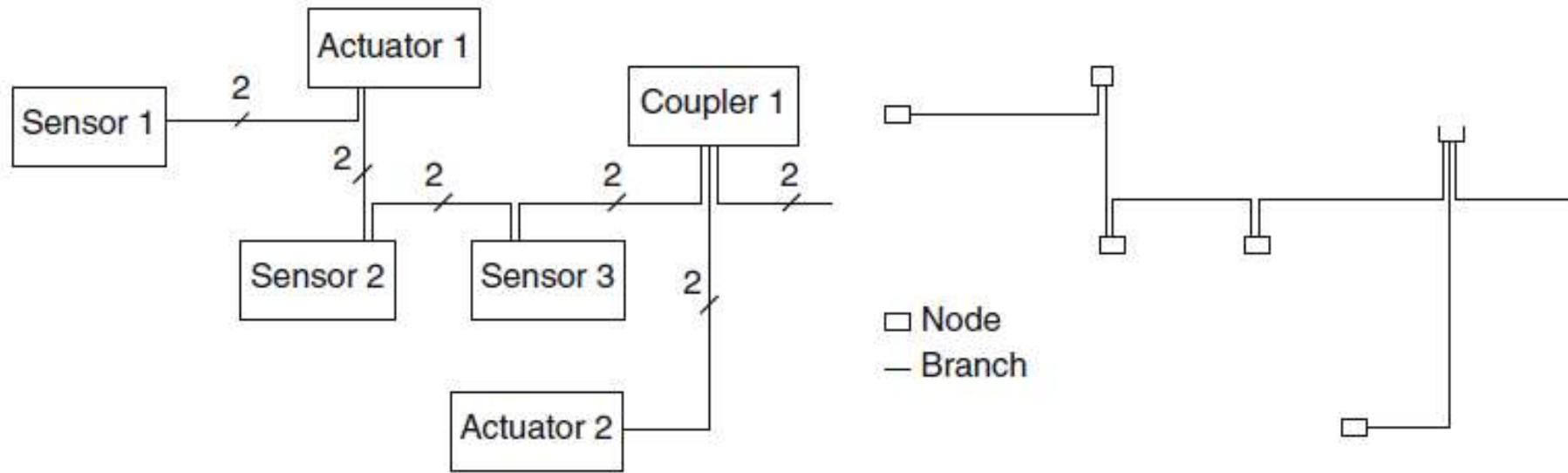


Fig. 3.16 Example of topology. A KNX system (left) and its network (right)

(Merz,2018)

3.5 KNX Topology

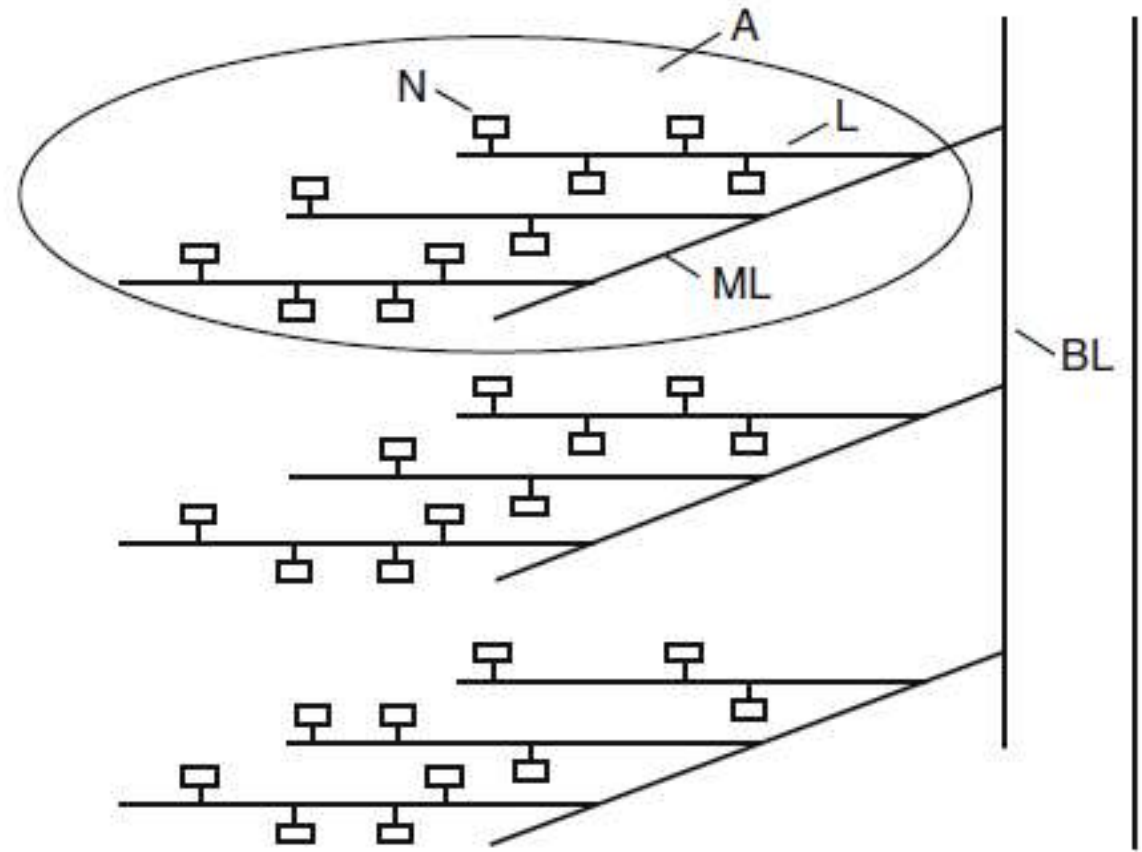


Fig. 3.17 KNX tree topology

Nodes, Lines and Areas

(Merz,2018) 3.5 KNX



Fig. 3.18 Coupler [ABB06]

(Merz,2018) 3.5 KNX

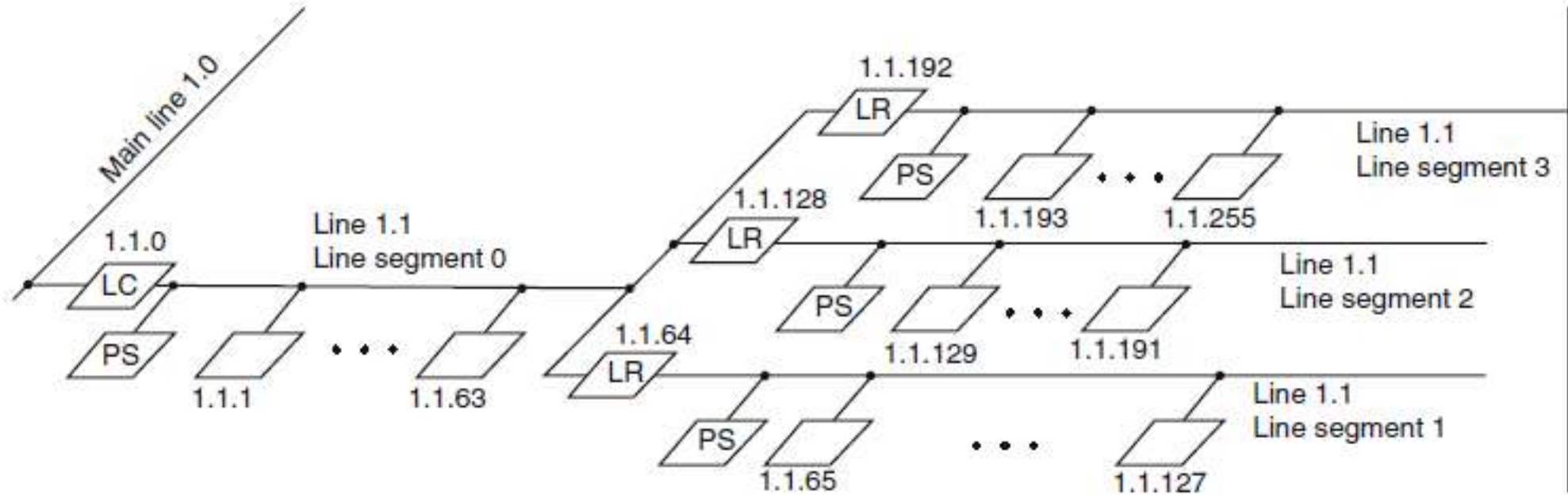


Fig. 3.19 A line with three line repeaters and four segments

(Merz,2018) **3.5**

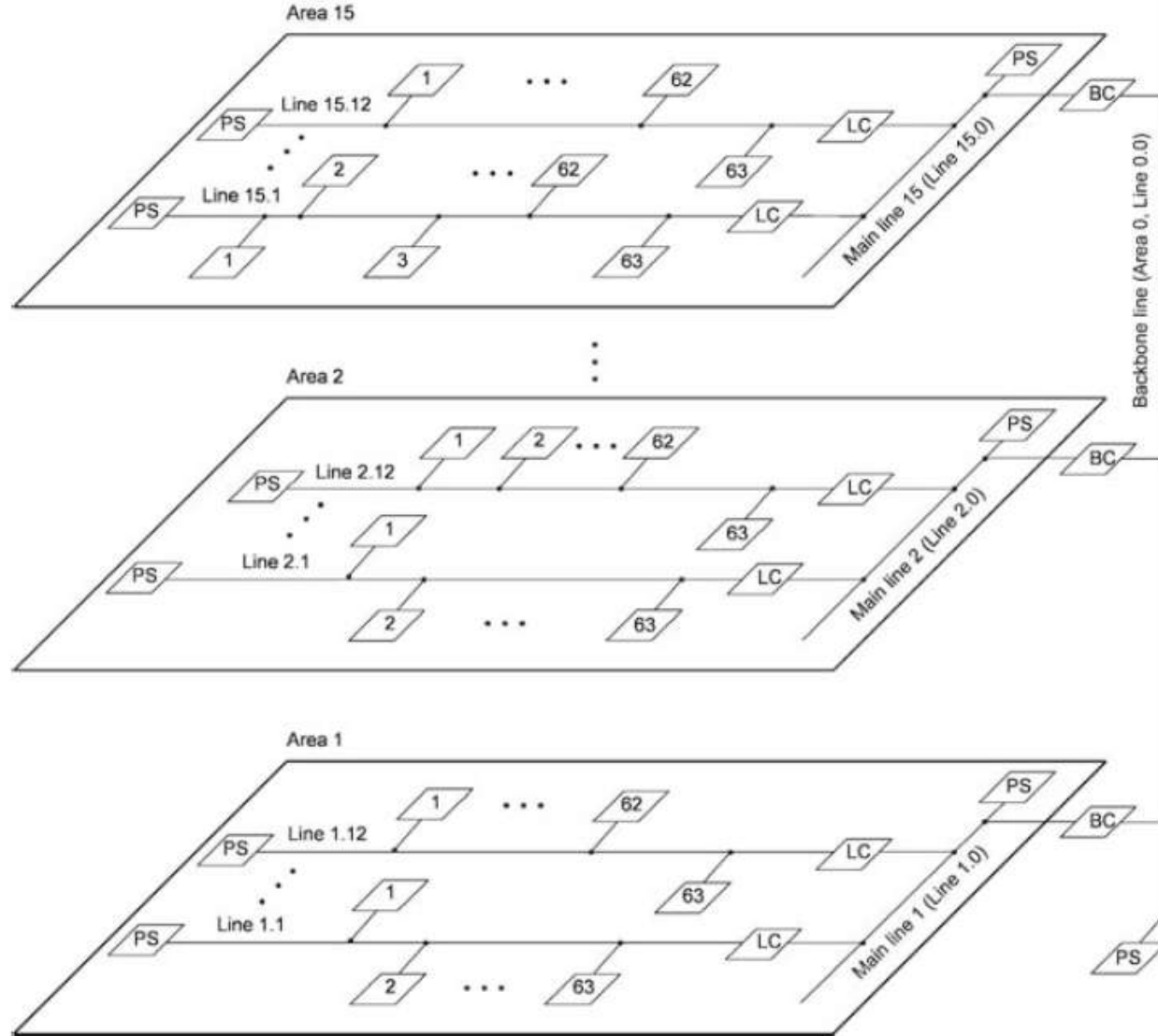


Fig. 3.20 Topology of an KNX system with 11,535 devices

3.4 Transmission Media

Most common media: Twisted pair (\$)

YCYM 2×2×0.8

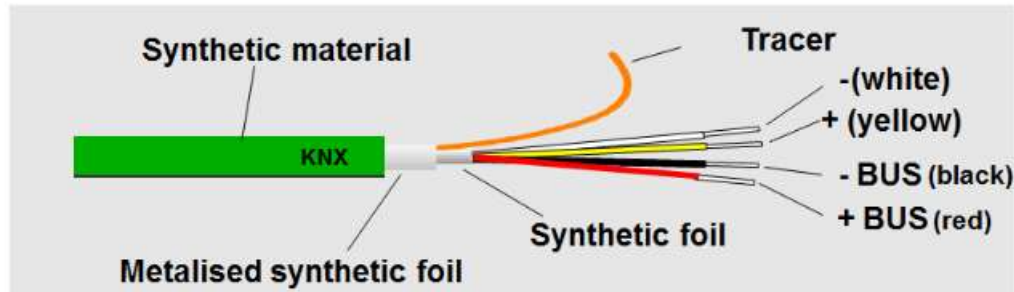
Fixed installation:
dry, humid and wet rooms; wall-mounted, flush-mounted, in conduits; outdoor (if protected against direct sun radiation);

Test voltage: 4 kV according to EN 50090

J-Y (St) Y 2×2×0.8 VDE 0815

Fixed installation:
dry and humid industrial sites: wall-mounted, flush-mounted and in conduits
Outdoor: flush-mounted and conduits

Test voltage: 2,5 kV according to EN 50090



- Twisted pair (KNX.TP)
- Power line (KNX.PL)
- Radio frequency (KNX.RF)
- Ethernet (KNXnet/IP)
- Infrared (KNX.IR)
- Optical fiber interface, (KNX LL/S 1.1)

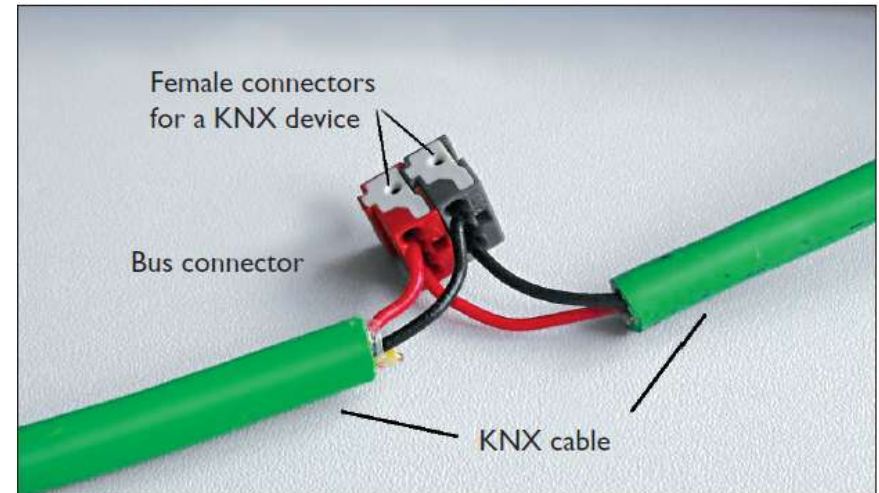
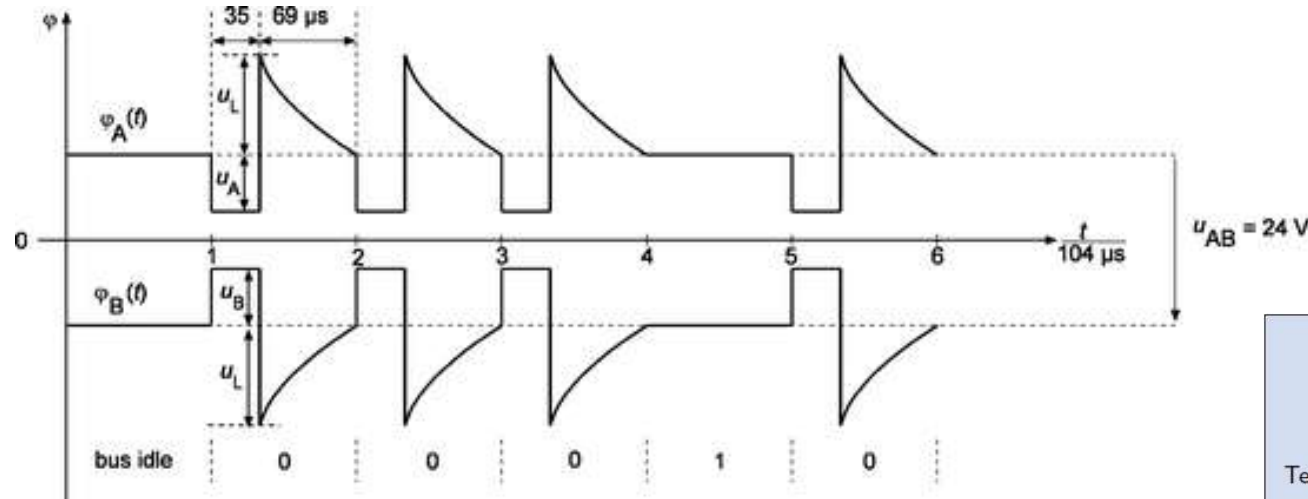


Figure 8. Bus terminal with incoming and outgoing bus cable

3.4 KNX.TP – Signal Coding



Choke (Inductor):

Separates

- DC (devices power supply)
- Signal, KNX telegram

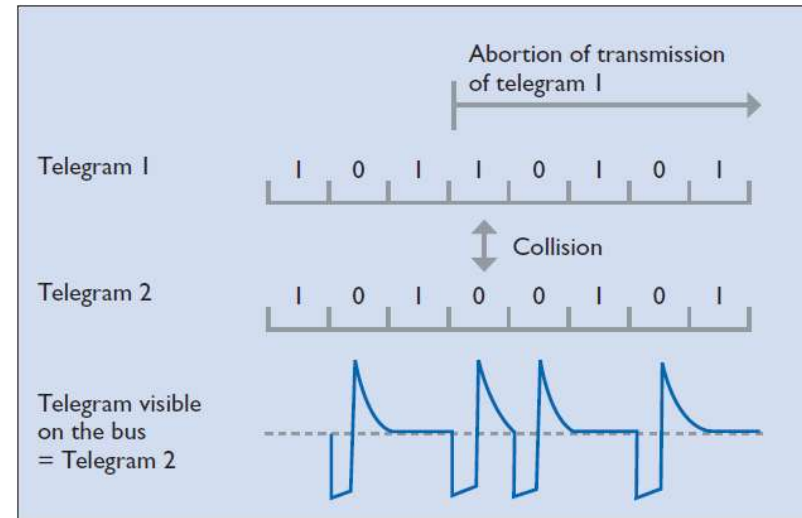


Figure 9. Collision avoidance in KNX TP

CSMA/CA

3.4 KNX.TP – Signal Specification

In case of a zero-bit, the transceiver of the transmitter actively lowers the voltage level during the time period of 35 μs . For the falling edge and the constant level starting at point t_A , the following applies:

$$(u_{\text{ref}} - 10.5 \text{ V}) \leq u_a \leq (u_{\text{ref}} - 0.7 \text{ V})$$

For the constant level and the rising edge until point t_B , the following applies:

$$(u_{\text{ref}} - 10.5 \text{ V}) \leq u_a \leq (u_{\text{ref}} - 0.5 \text{ V})$$

After that, there is an equalizing pulse releasing the energy mainly stored in the inductor and the following applies:

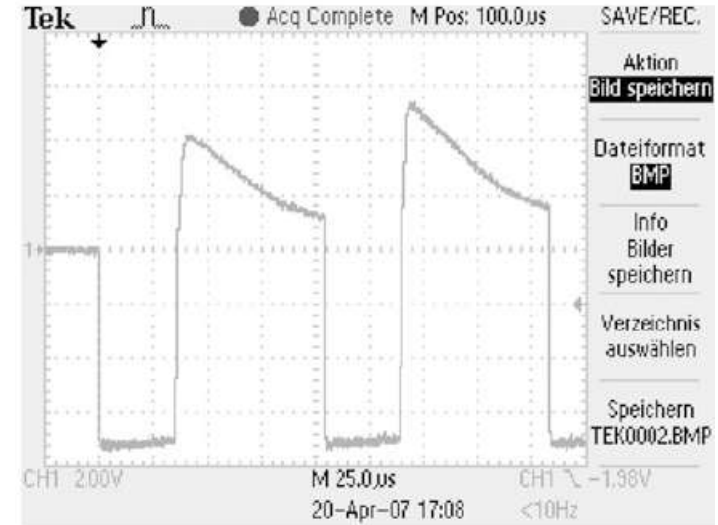
$$u_{\text{ref}} \leq u_e \leq (u_{\text{ref}} + 13 \text{ V})$$

At the end of a bit period of 104 μs , the following has to apply to the zero-bit signal element:

$$(u_{\text{ref}} - 0.35 \text{ V}) \leq u_{AB} \leq (u_{\text{ref}} - 1.8 \text{ V})$$

If a zero-bit is sent prior to a one-bit, a linear voltage drop can occur at the one-bit signal element during the bit period T_{bit} . In order to safely identify the one-bit, the following conditions have to be met:

- The voltage u_{AB} can not fall with a rate higher than 400 mV/ms
- At the end of the bit period the following has to apply: $(u_{\text{ref}} - 2 \text{ V}) \leq u_{AB} \leq (u_{\text{ref}} + 0.3 \text{ V})$



Bitrate:

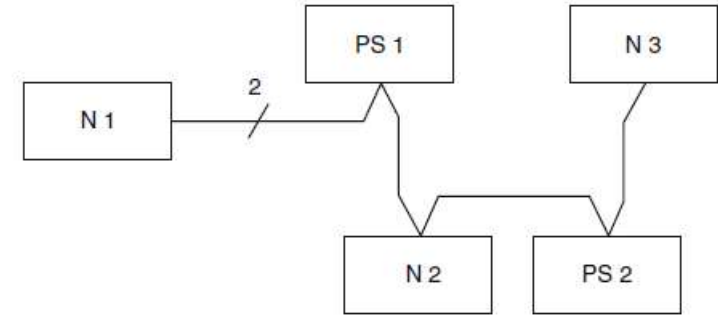
$$T_{\text{bit}} = 104 \text{ } \mu\text{s}$$

$$R_{\text{bit}} = 1/T_{\text{bit}} \sim 9615 \text{ bit/s} \sim 9.6 \text{ kbit/s}$$

3.6.5 Installation Guidelines

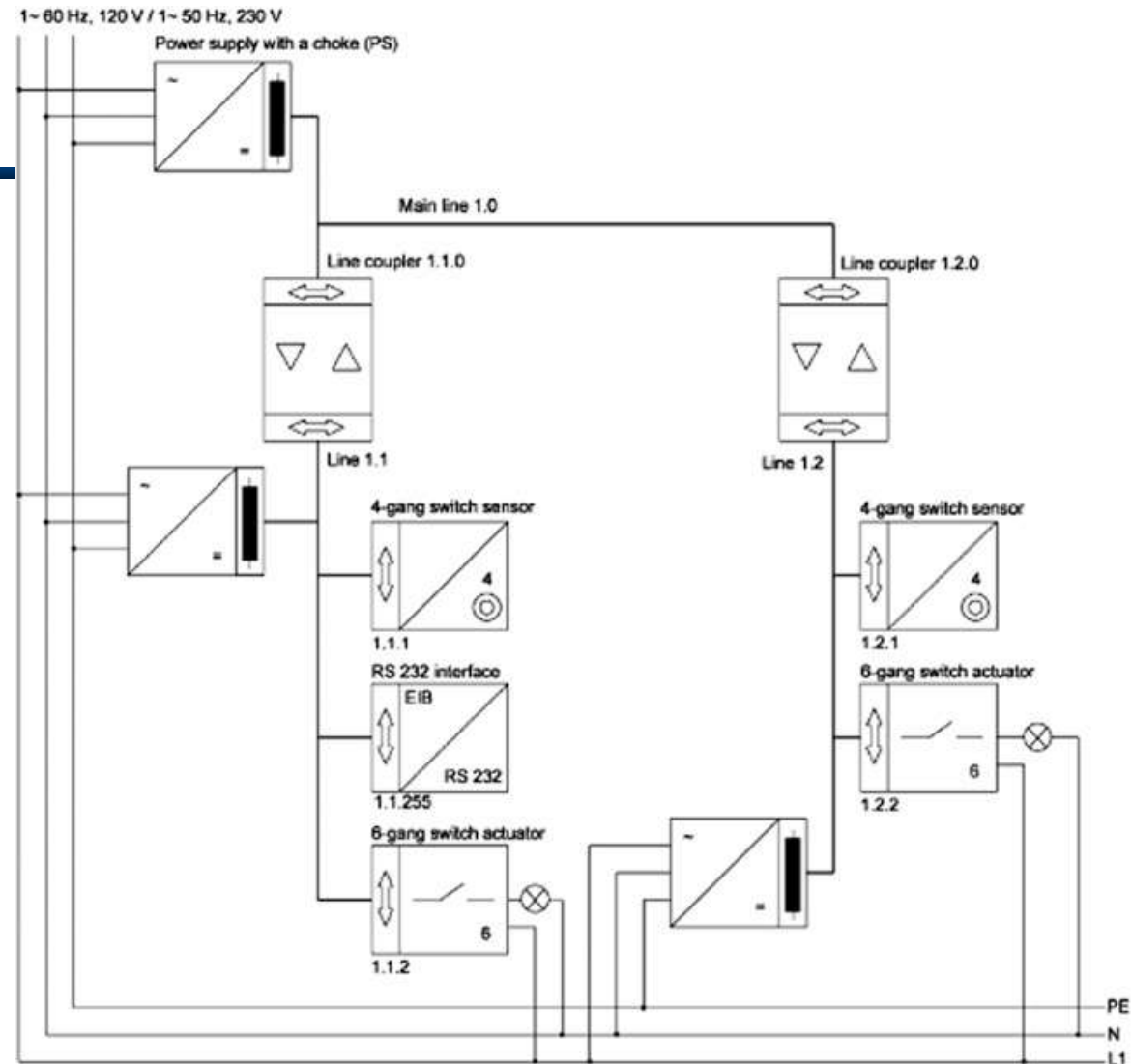
The following rules apply to a line or a line segment:

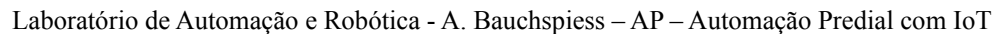
- A line must be no more than 1000 m long.
- The length of cable between the two bus devices that are the furthest (e.g., N1 and N3 in Fig. 3.21) must be no more than 700 m.
- The length of cable between a power supply unit and a device (e.g., between PS1 and N1 or between PS2 and N3 in Fig. 3.21) must be no more than 350 m.
- Any two power supplies on one segment must be at least 200 m apart. More than two power supplies can not be used.



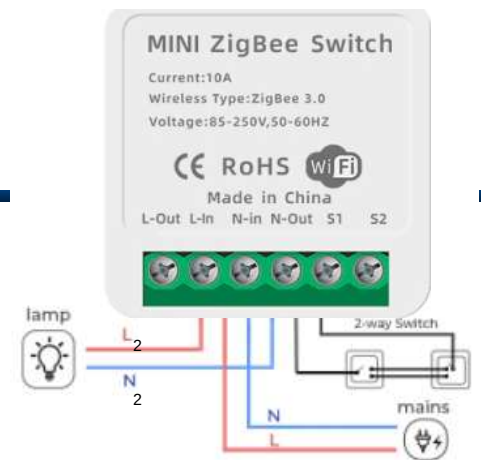
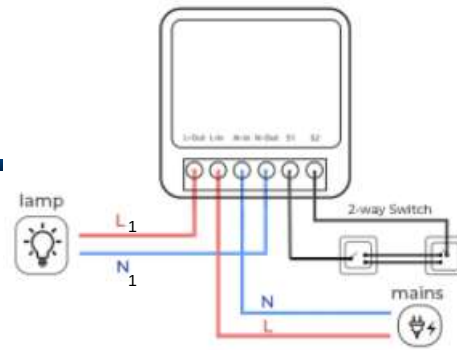
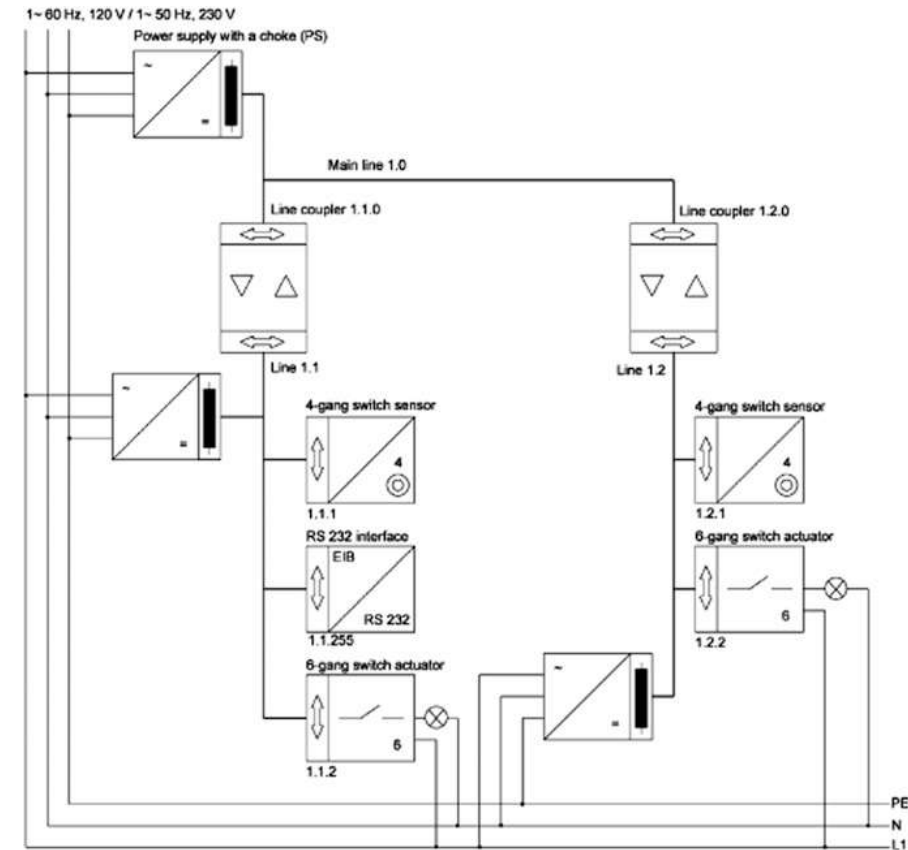
3.6.6 Standard Device Symbols

Merz 2018
Fig. 3.22
Small KNX system
with one area and two
lines





Trad. x KNX x ZigBee



ZigBee
GateWay

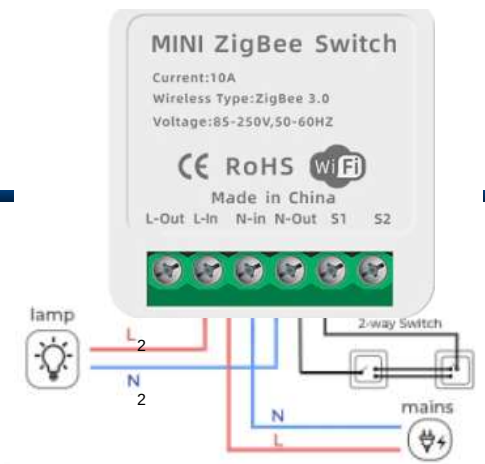
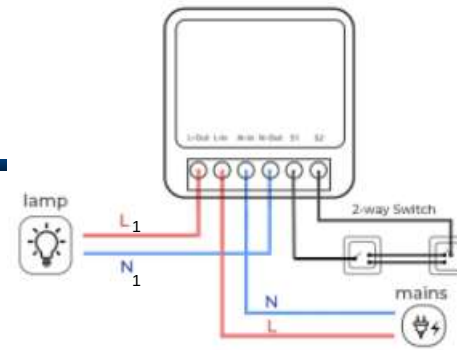
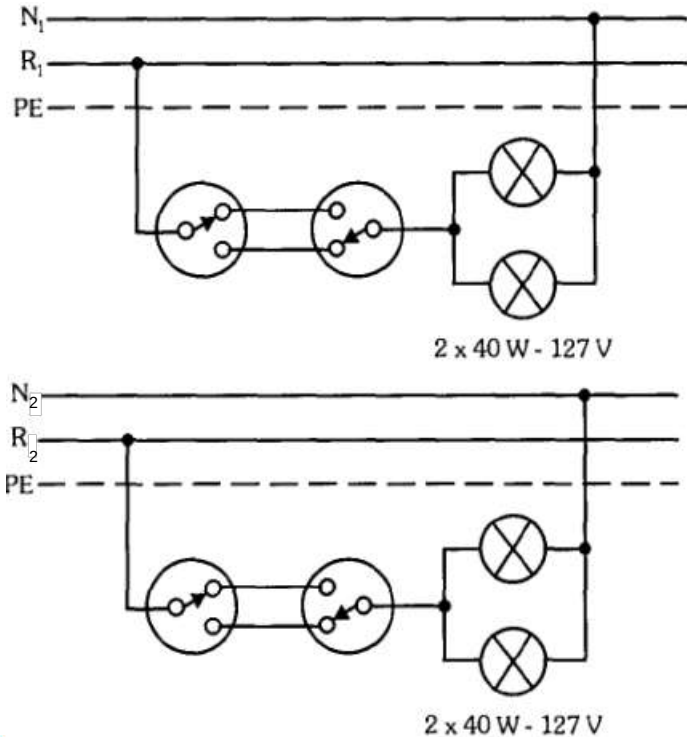
Access Point
Wi-Fi



Other ZigBee Devices



Trad. x KNX x ZigBee



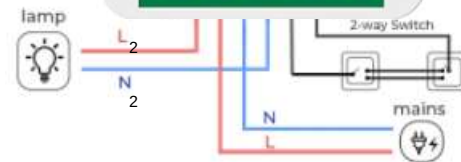
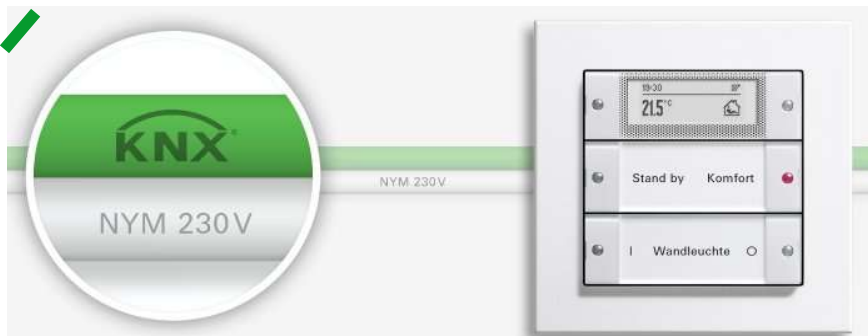
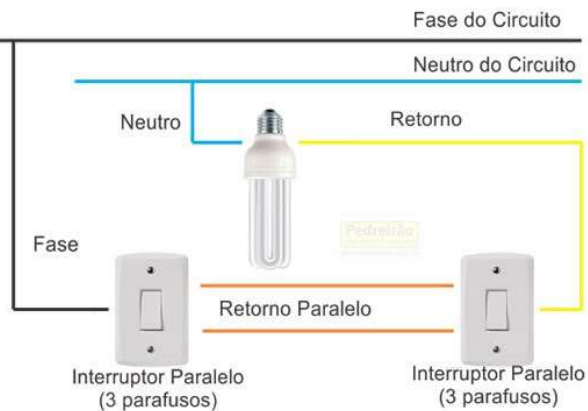
Trad.

x

KNX

x

ZigBee



3.7 Addressing Nodes (Devices)

Physical Address: Area.Line.Node (A.L.N.)

- $2^4 = 16$ areas
- $2^4 = 16$ lines
- $2^8 = 256$ nodes per line

Table 3.4 Source address in a data frame

High byte								Low byte							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
A3	A2	A1	A0	L3	L2	L1	L0	N7	N6	N5	N4	N3	N2	N1	N0
Area				Line				Node (per line)							

Physical Addresses for Couplers and Line Repeaters

- A.L.0 for **line couplers** (e.g. 1.1.0, 1.2.0, ..., 1.12.0, 2.1.0, 2.2.0, ..., 15.12.0)
- A.0.0 for **backbone couplers** (e.g. 1.0.0, 2.0.0, ..., 15.0.0)

Line repeaters must be assigned a node number that is greater than zero, for example, 1.1.64.

3.7 Addressing Nodes (Devices)

Physical Addresses of Devices connected to a main line:

PS -> a maximum of 63 sensors/actuators can be connected to the main line.

Examples of addresses:

- 1.0.1–1.0.63
- 2.0.100–2.0.162.

Examples of physical Addresses:

- The address 1.2.2 refers to the second node on the second line in the first area.
- 1.12.0 is a line coupler that connects the 12th line in the 1st area to the 1st area's main line. The main line is referred to as the superordinate line and the line is referred to as the subordinate line.
- 2.0.0 represents a backbone coupler that connects the second area's main line to the backbone line. The backbone line is the superordinate line and the main line is the subordinate line.

3.7.2 Group Addresses (Logical Adr.)

Two-level addressing: **Table 3.5** Two-level addressing

High byte								Low byte							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	M3	M2	M1	M0	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1	S0
Main group					Subgroup										

- $2^4 = 16$ main groups (numbers 0-15)
- $2^{11} = 2048$ subgroups (numbers 0-2047)

Two-level addr.: Main group/subgroup to identify a certain group, assigne names.

Examples for group addresses:

- 0/1 lightning central on/off
- 1/1 lightning living room on/off
- 1/2 lightning office on/off
- 2/1 blinds down/up.

3.7.2 Group Addresses (Logical Adr.)

Three-level addressing: **Table 3.6** Three-level addressing

High byte								Low byte							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	M3	M2	M1	M0	G2	G1	G0	S7	S6	S5	S4	S3	S2	S1	S0
Main group					Middle group			Subgroup							

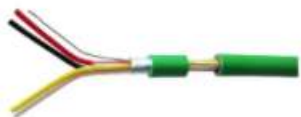
- $2^4 = 16$ main groups (numbers 0–15)
- $2^3 = 8$ middle groups (numbers 0–7)
- $2^8 = 256$ subgroups (numbers 0–255)

Three-level addr.: Main group/middle group/subgroup to identify a certain group, assigne names.

Examples for group addresses:

- 1/1/1 lightning living room ceiling on/off
- 1/1/2 lightning living room standing lamp on/off
- 1/2/1 lightning office ceiling on/off
- 1/2/2 lightning office desk on/off.

Projeto KNX – “Mercado Livre”



Cabo Automação Padrão Knx
2x2x0,8 Rolo 100 Metros Discabos

R\$ 935⁴⁴

em 12x R\$ 88⁸⁶

Frete grátis



Central De Controle Schneider
Mtn6214-4146 Knx Push Button

R\$ 1.500

em 12x R\$ 125 sem juros

Frete grátis



Intesisbox Modbus Tcp
Ibox-knx-mbtcp-100-9-...

R\$ 280

em 12x R\$ 23³³ sem juros

Frete grátis



Interface Usb Eib/knx Tapko Uim-knx
42 Dinrail

R\$ 749⁹⁹

em 12x R\$ 62⁵⁰ sem juros

Frete grátis



Fonte De Energia Com Função Bus
Elsner Knx Ps640+

R\$ 1.700

em 12x R\$ 141⁶⁷ sem juros

Frete grátis



Gateway Knx/dali Hager
Mod:tya670d

R\$ 1.045

em 12x R\$ 87¹² sem juros

Frete grátis



Sensor Para Automação Residencial
Theben Knx Luna 131 S

R\$ 1.200

em 12x R\$ 100 sem juros

Frete grátis

Projeto KNX – “Mercado Livre”



Fonte De Energia Com Função Bus
Elsner Knx Ps640+



R\$ 1.700

em 12x R\$ 141⁶⁷ sem juros

Frete grátis



Projeto KNX – “Mercado Livre”



Modulo Sbus Relé Knx 8ch 16a High Power Switch Actuator

R\$ 1.340

em 12x R\$ 111⁶⁷ sem juros

Frete grátis



Modulo Sbus Relé Knx 4ch 16a High Power Switch Actuator

R\$ 950

em 12x R\$ 79¹⁷ sem juros

Frete grátis

Projeto KNX – “Mercado Livre”



Sensor Para Automação Residencial
Theben Knx Luna 131 S

R\$ 1.200

em 12x R\$ 100 sem juros

Frete grátis

Projeto KNX – “Mercado Livre”



Gateway Knx/dali Hager
Mod:tya670d

R\$ 1.045

em 12x R\$ 87¹² sem juros

Frete grátis



Projeto KNX – “Mercado Livre”



Central De Controle Schneider
Mtn6214-4146 Knx Push Button

R\$ 1.500

em 12x R\$ 125 sem juros

Frete grátis



KNX Modulation

Webinar ABB, Jul 2020

- [KNX Radio Frequency \(KNX RF\).pdf](#),

- [Youtube](#), 3 Ago 2020

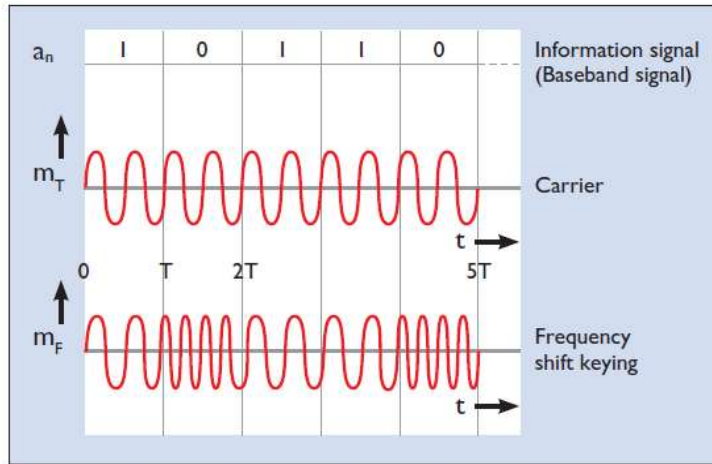


Figure 12. Frequency modulation and signal in KNX RF

*868.3 MHz FSK, modulated by ± 48 kHz to ± 80 kHz (1 and 0)

*ISM - Industrial Scientific and Medical frequencies

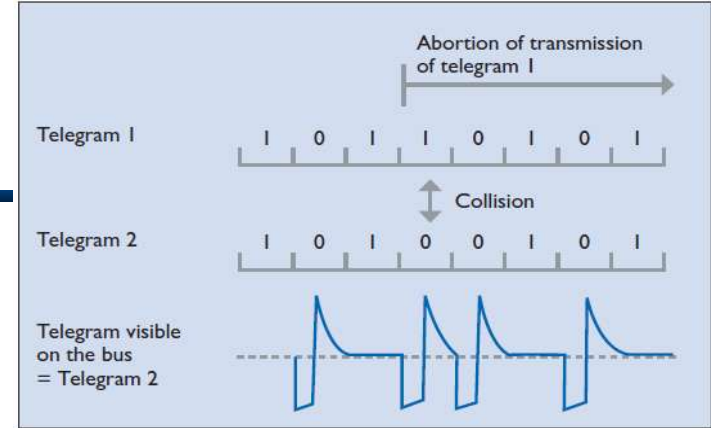


Figure 9. Collision avoidance in KNX TP

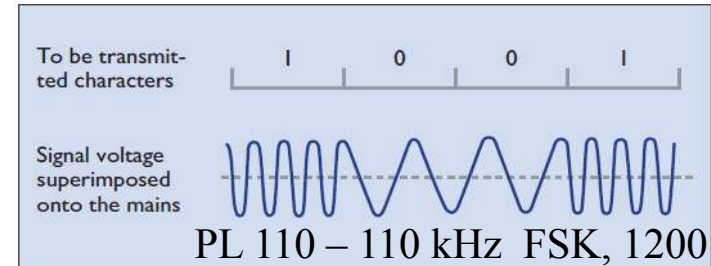


Figure 10. Signal structure in KNX PL

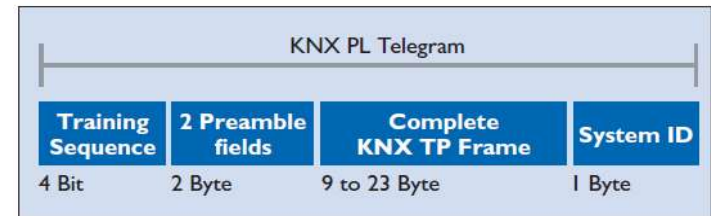


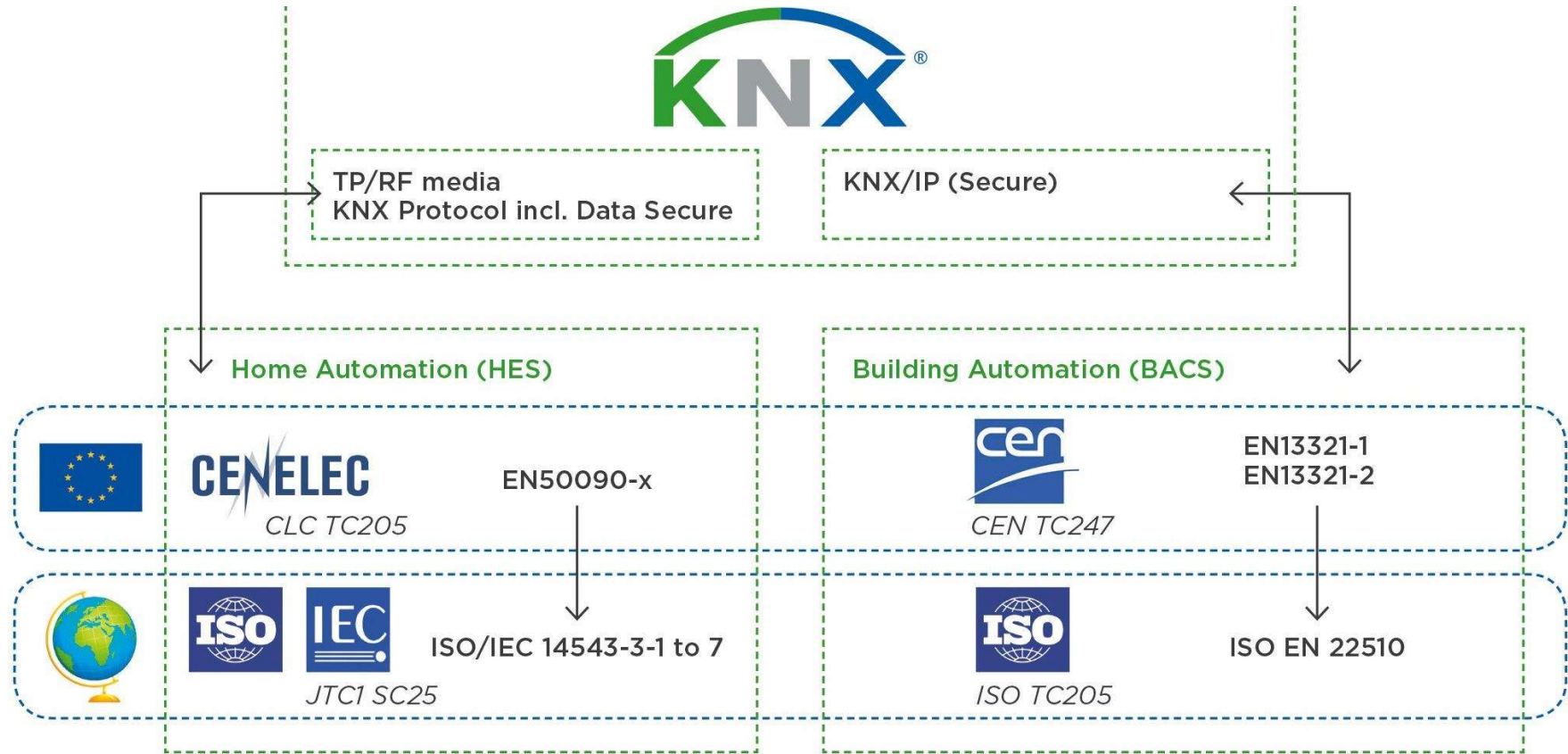
Figure 11. Telegram structure in KNX PL

Technologies



<https://www.led-professional.com/resources-1/articles/lighting-building-automation-technologies-by-leviton-manufacturing>

03.03.2020 KNX IP Secure becomes new ISO Standard



BIG DATA FOR SMART BUILDINGS

Emerging Solutions



DASHBOARDS & DATA VISUALISATION



FAULT MONITORING & DETECTION



PREDICTIVE ANALYTICS



BUILDING OPTIMIZATION

The IoT by 2020



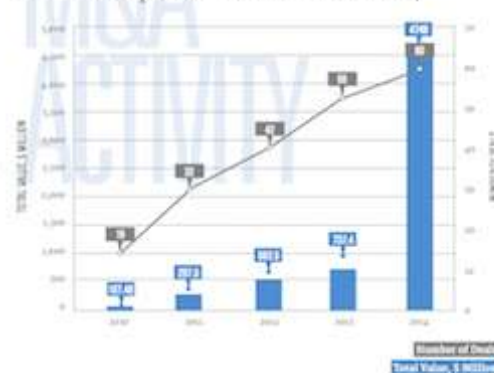
Big Data Analytics



- Energy Efficiency
- Operational Efficiency
- Tenant Satisfaction
- \$75BN market by 2020



BIOT and Building related Big Data Deals Completed from 2010 to 2014



Mobile access to big data



Top Big Data Challenges



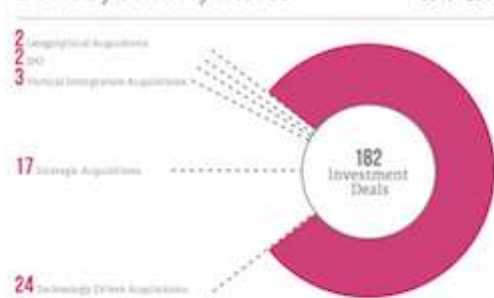
The Protocol Soup

LEGACY BUILDING PROTOCOLS	BACnet / LonWorks / ModBus / KNX / DALI / C-Bus
COMMUNICATIONS PROTOCOLS	6LoWPan / Wifi / Zigbee / Bluetooth / ZWave / RFID / Wired
IOT MESSAGING PROTOCOLS	MQTT / CoAP / DDS / AMQP / XMPP
ALLIANCES & CONSORTIA	AllSeen / Open Interconnect Consortium / Industrial Internet Consortium / Wi-Sun Alliance / Thread Group

Exploding Data Volumes



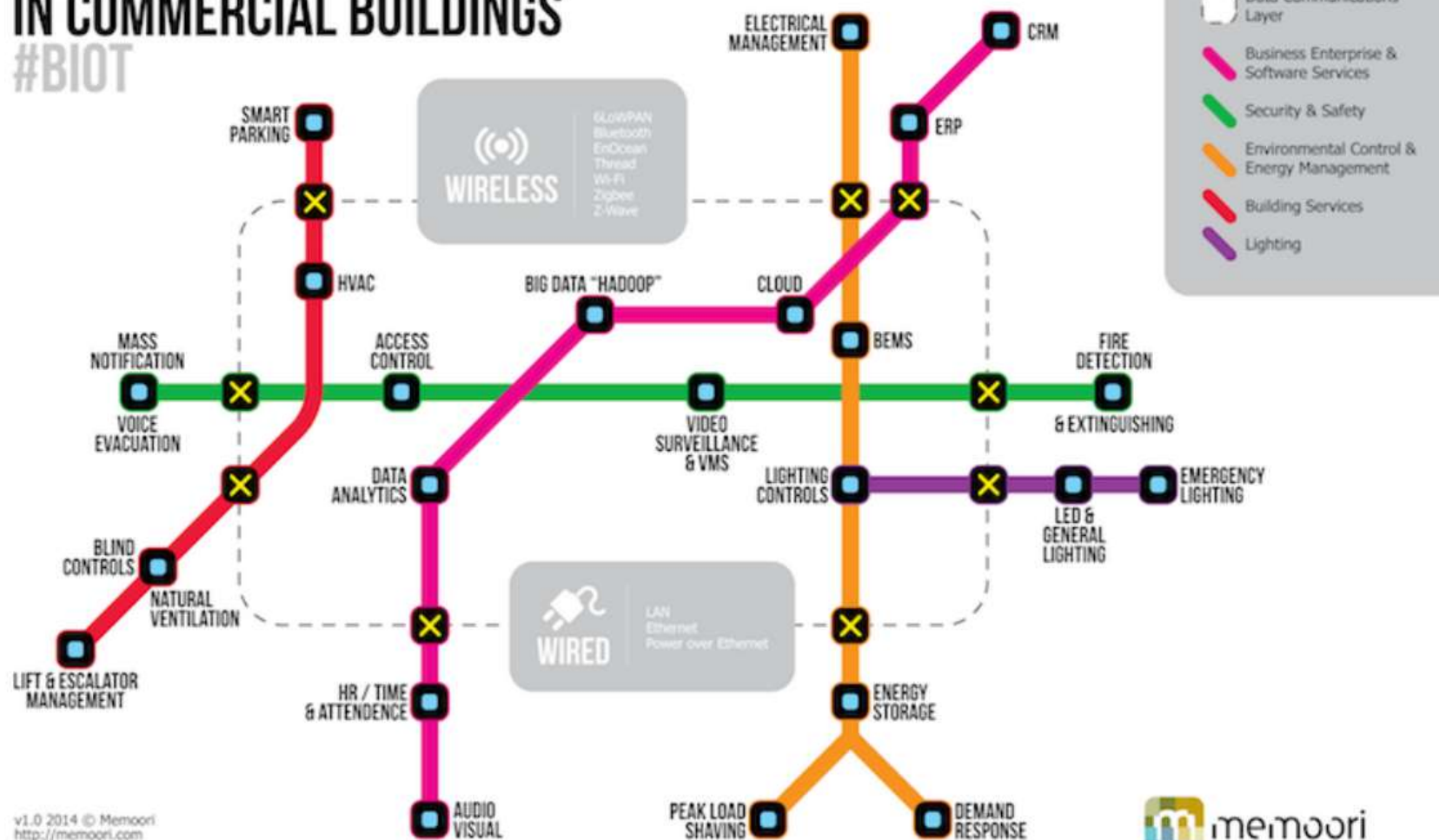
Deals by Primary Driver



BIOT – Building Internet of Things

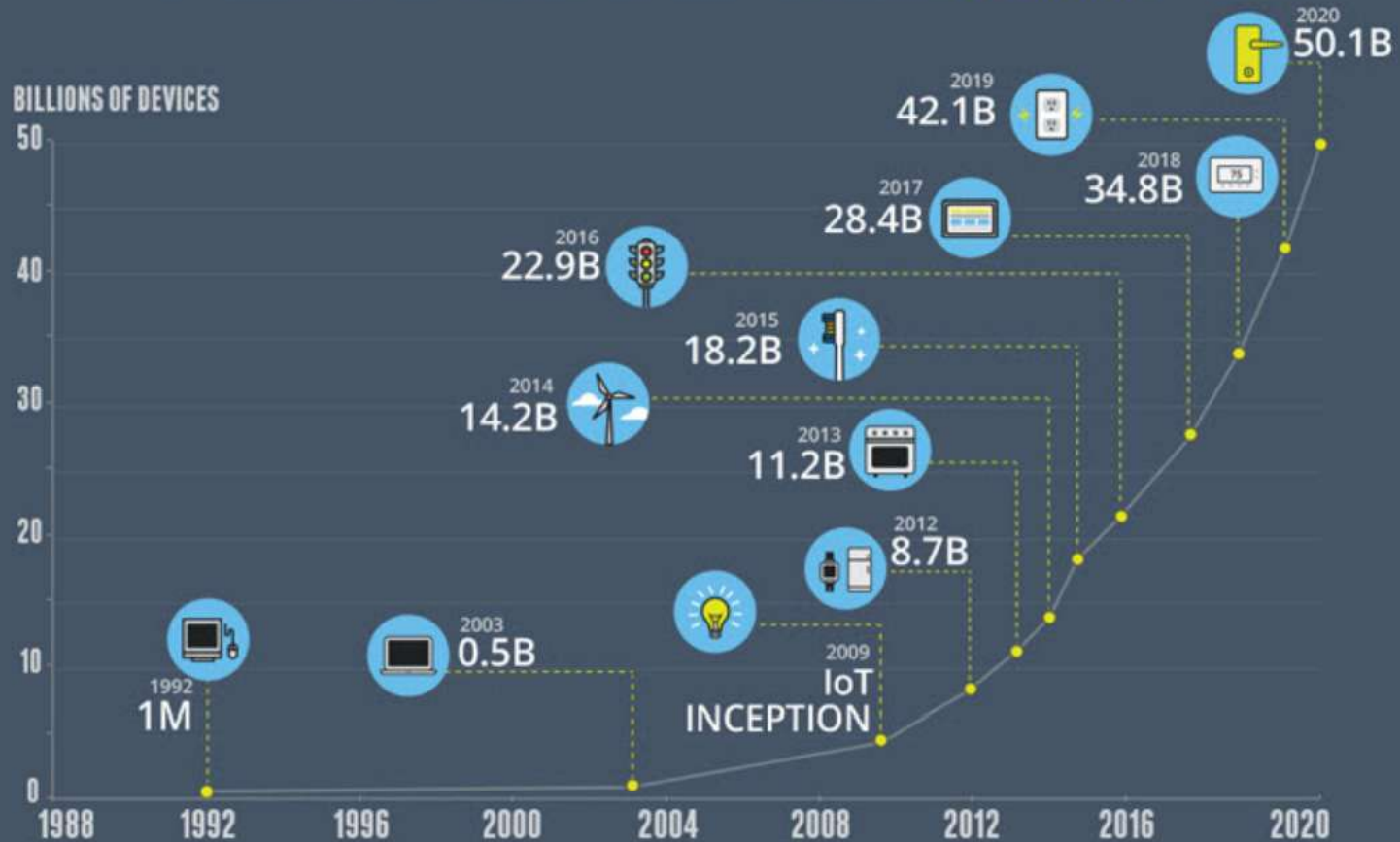
THE INTERNET OF THINGS IN COMMERCIAL BUILDINGS

#BIOT

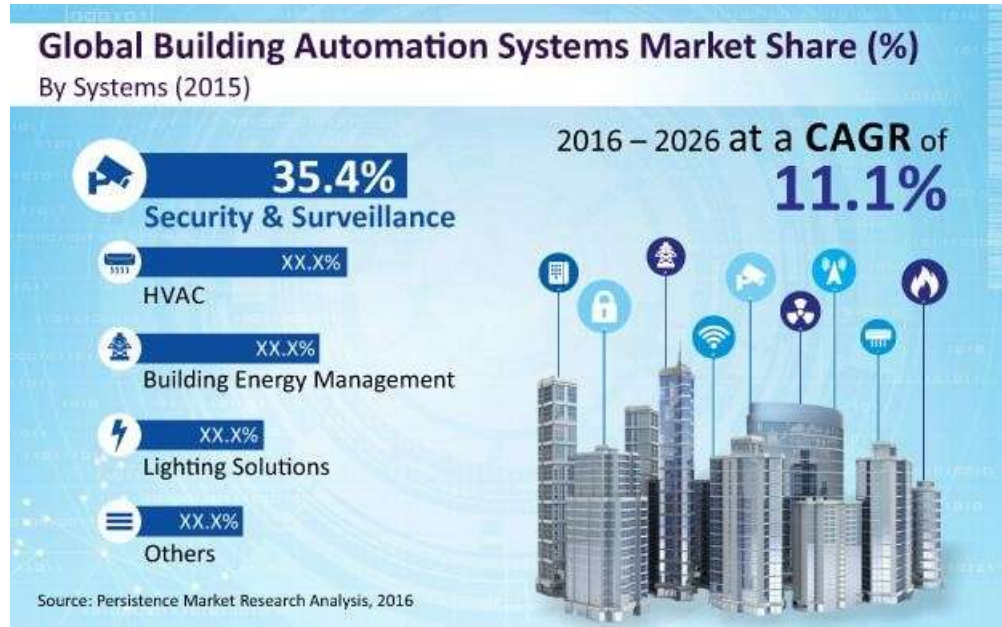


GROWTH IN THE INTERNET OF THINGS

THE NUMBER OF CONNECTED DEVICES WILL EXCEED **50 BILLION** BY 2020

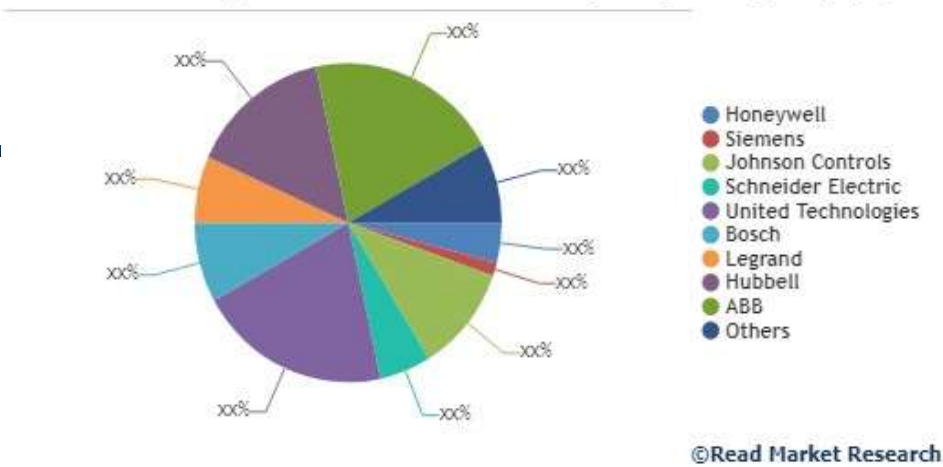


Credit: Enterprise Irregulars

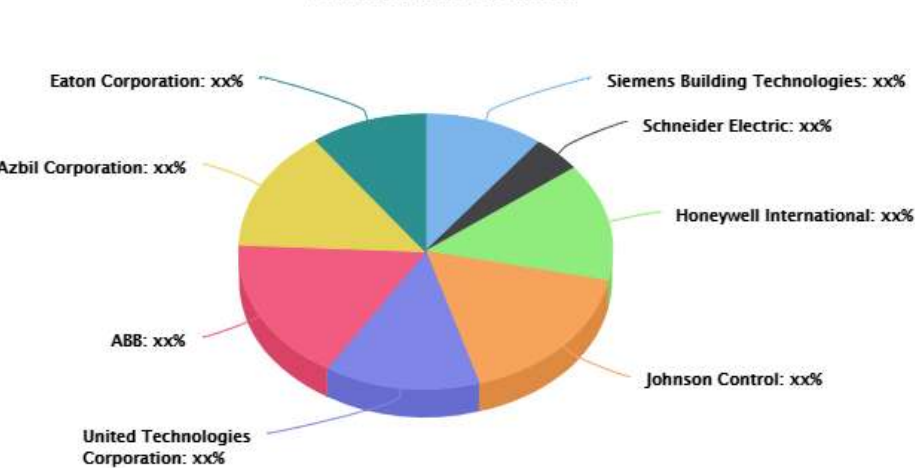


CAGR refere-se à taxa de crescimento anual composta

Global Building Automation Market Share by Companies (2020) (%)



Global Smart Building Automation Technologies Market Share (%) By Players
www.amplemarketreports.com





01 As the DRAM industry officially enters the EUV era, NAND Flash stacking technology advances past 150L



02 Mobile network operators will step up their 5G base station build-out while Japan/Korea look ahead to 6G



03 Internet of Things evolves into Intelligence of Things as AI-enabled devices move closer to autonomy



04 Integration between AR glasses and smartphones will kick-start a wave of cross-device applications



05 A crucial part of autonomous driving, driver monitoring systems will skyrocket in popularity



06 Foldable displays will see adoption in more devices as a means of upping screen real estate



07 Mini LED and QD-OLED will become viable alternatives to white OLED



08 Advanced packaging will go full steam ahead in HPC and AI, undeterred by COVID-19



09 Chipmakers will pursue shares in the AIoT market through an accelerated expansionary strategy



10 Active matrix Micro LED TVs will make their highly anticipated debut in the consumer electronics market

TRENDFORCE

2021

Top 10 Technology Trends

AIoT: Artificial Intelligence of Things



So where is AIoT heading next?
We can see these trends all around us.

The 4 Major AIoT Segments



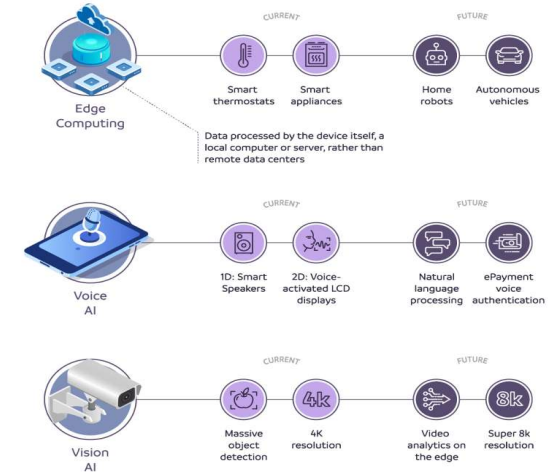
While AIoT technology is still in its infancy, these segments represent a direct impact in our daily lives.

While AIoT technology is still in its infancy, these segments represent a direct impact in our daily lives.

Future AIoT Technologies

AIoT innovation **shows no signs of slowing down.**

AIoT will test how much data our devices can process, future advancements will push the boundaries of processing and learning.



AIoT promises to radically transform how we interact with our homes, offices, and cities every day.

Presented by



Facebook: /visualcapitalist, Twitter: @visualcap, LinkedIn: visualcapitalist

KNX Telegram

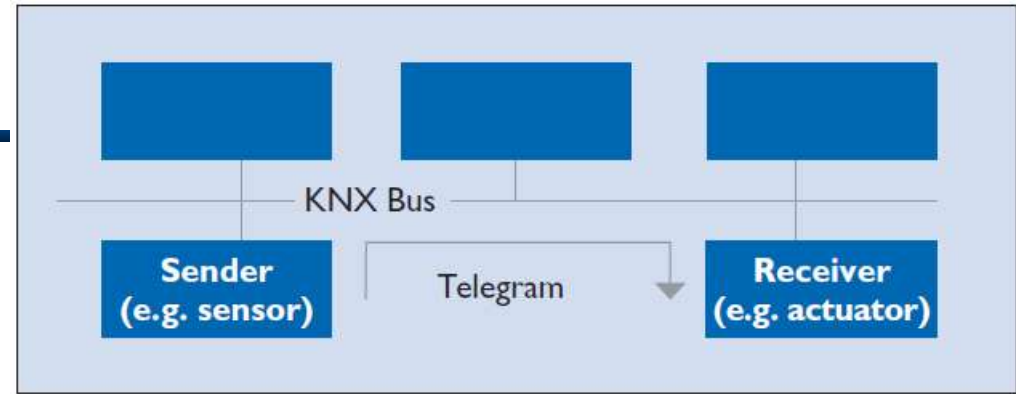


Figure 4. Sensor/actuator principle

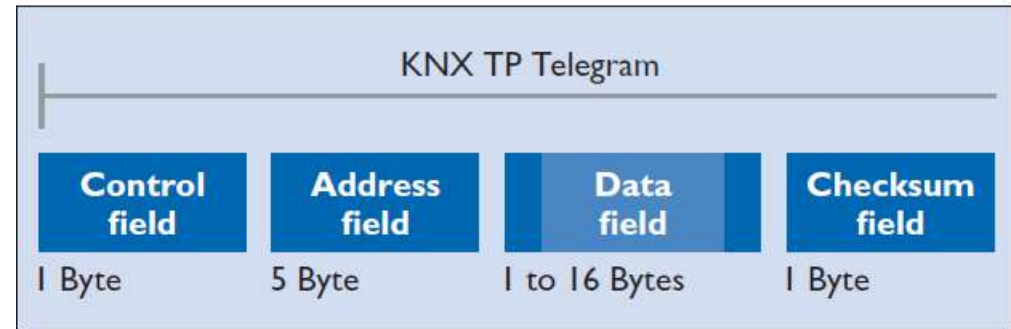


Figure 7. Telegram structure in KNX TP

KNX Telegram

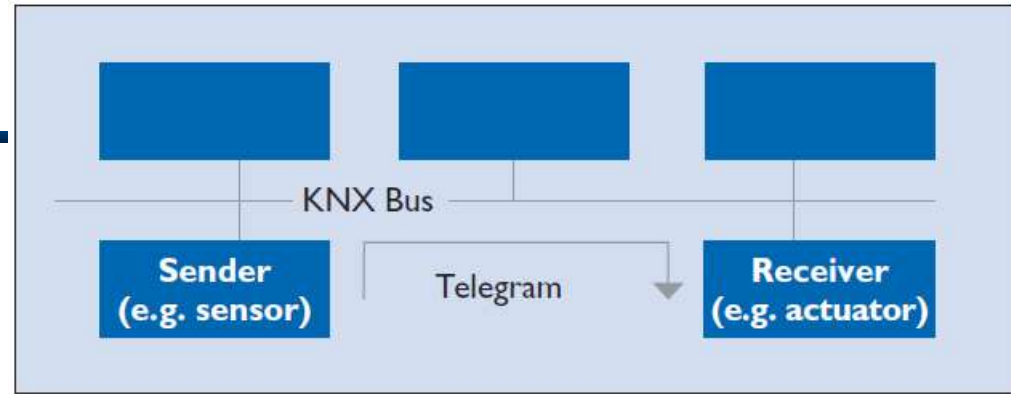


Figure 4. Sensor/actuator principle

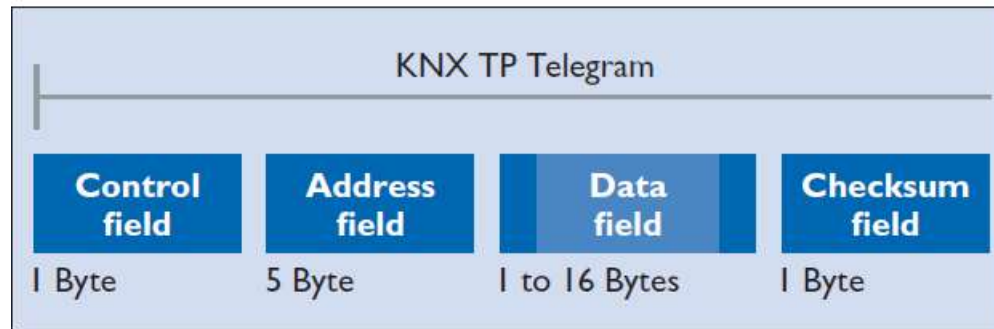


Figure 7. Telegram structure in KNX TP

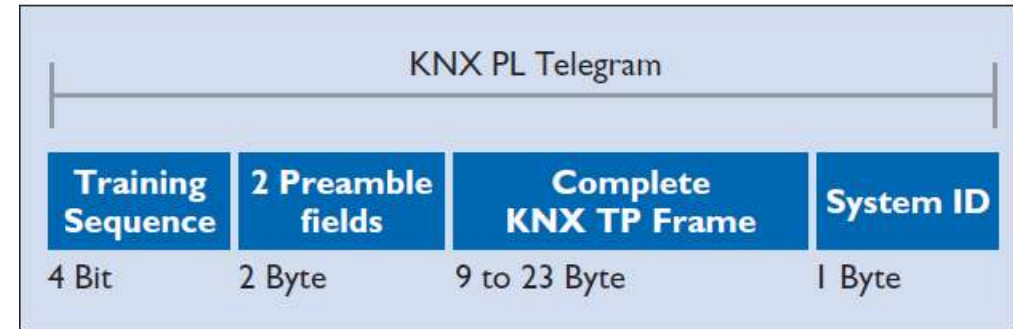


Figure 11. Telegram structure in KNX PL

KNX Telegram

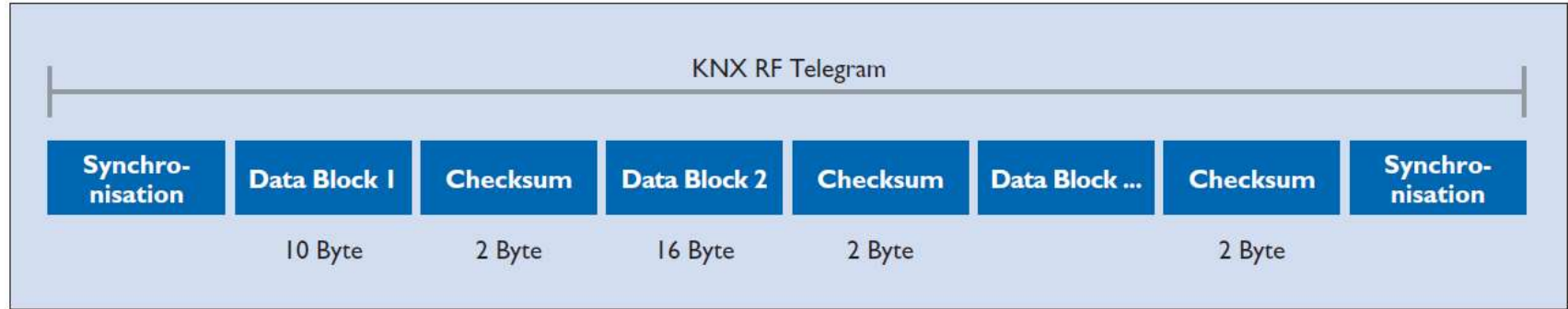


Figure 13. Telegram structure in KNX RF

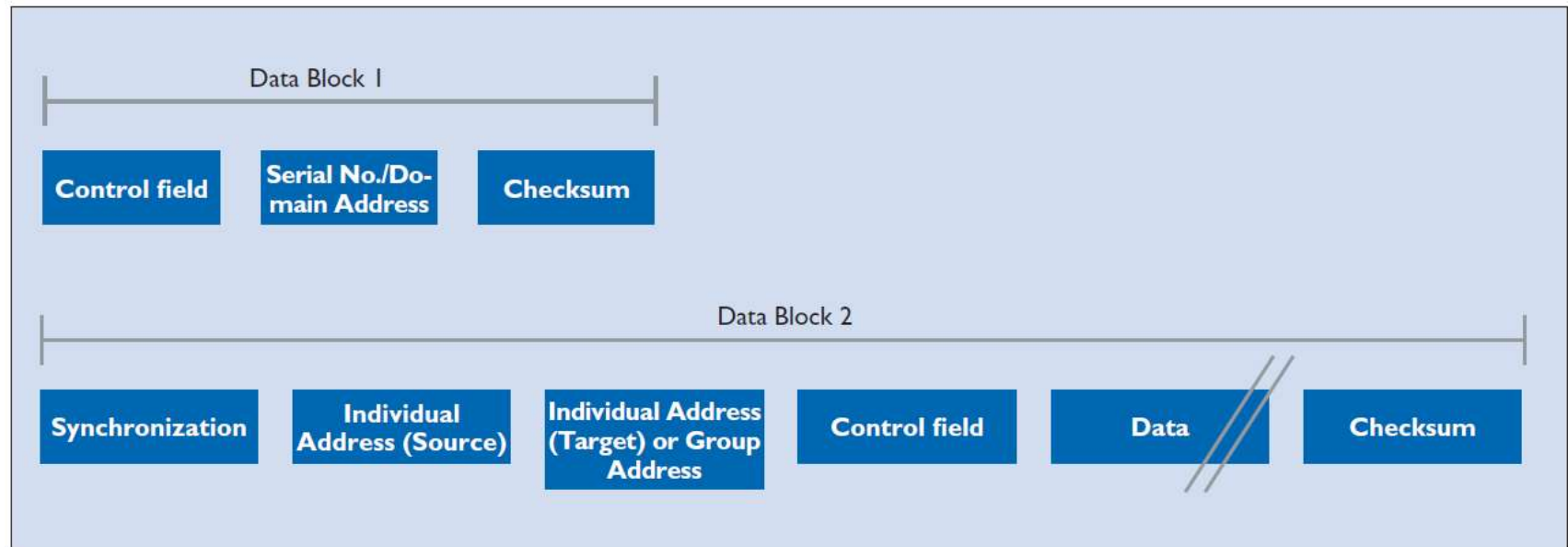


Figure 14. Data blocks in a KNX RF telegram

KNX Telegram

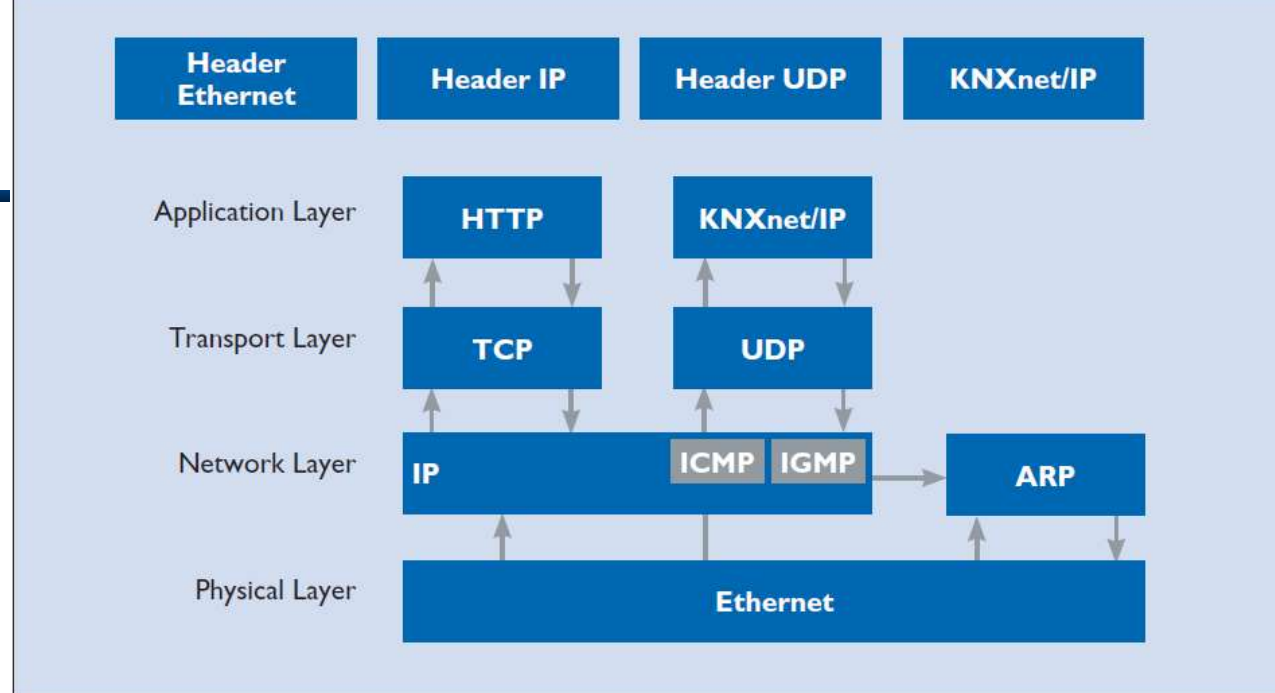


Figure 15. KNXnet/IP in the OSI reference model

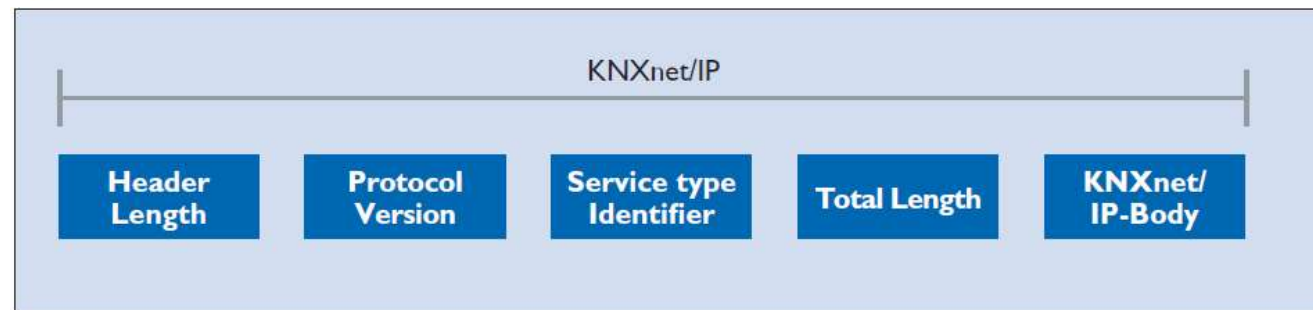


Figure 16. KNXnet/IP telegram

KNX Topology

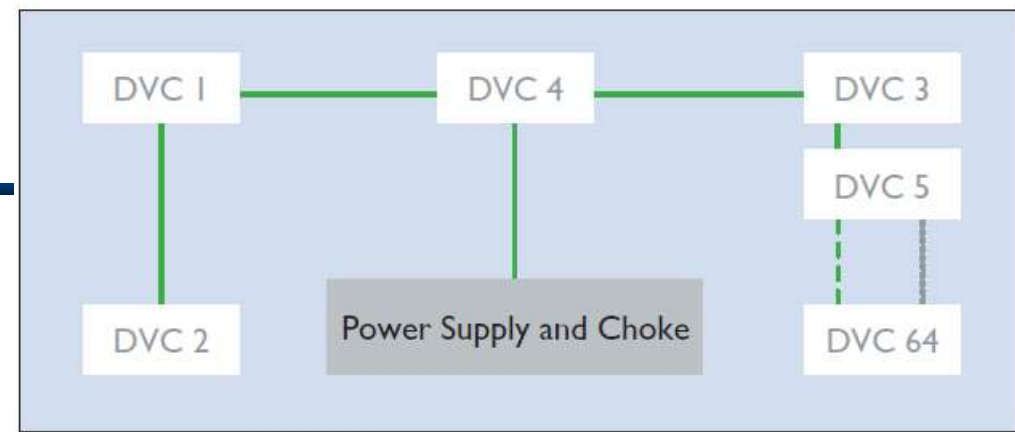


Figure 19. KNX TP line

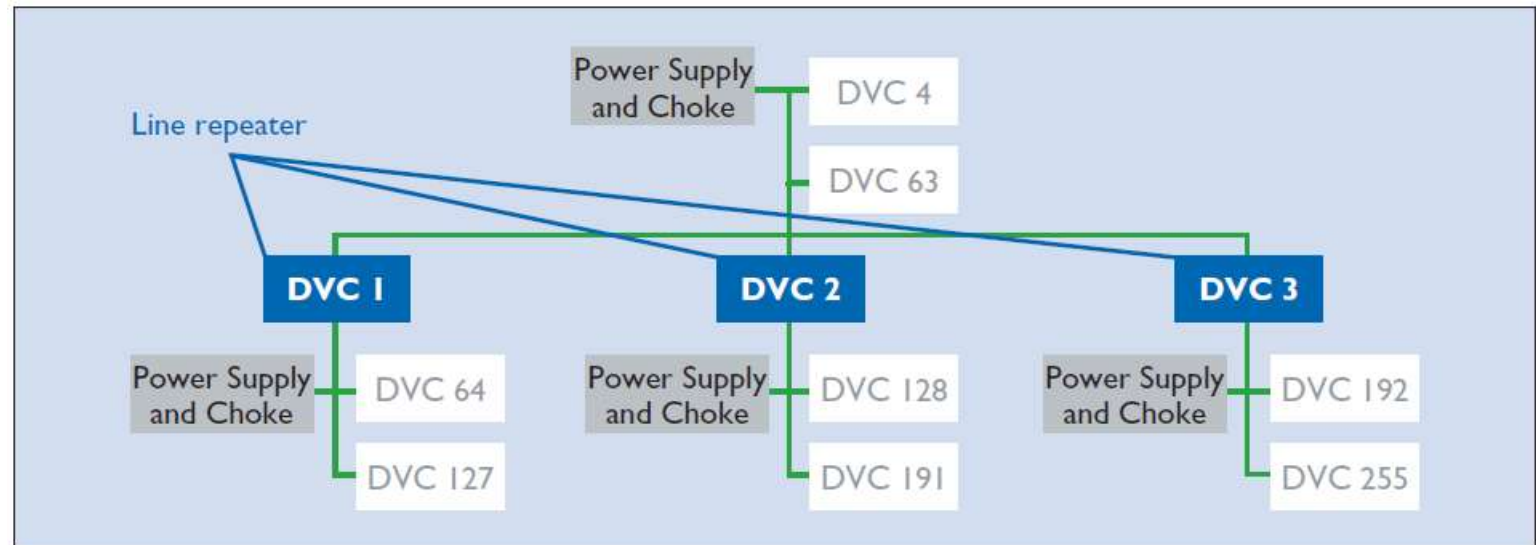


Figure 20. Maximum length of a line in KNX TP

KNX Topology

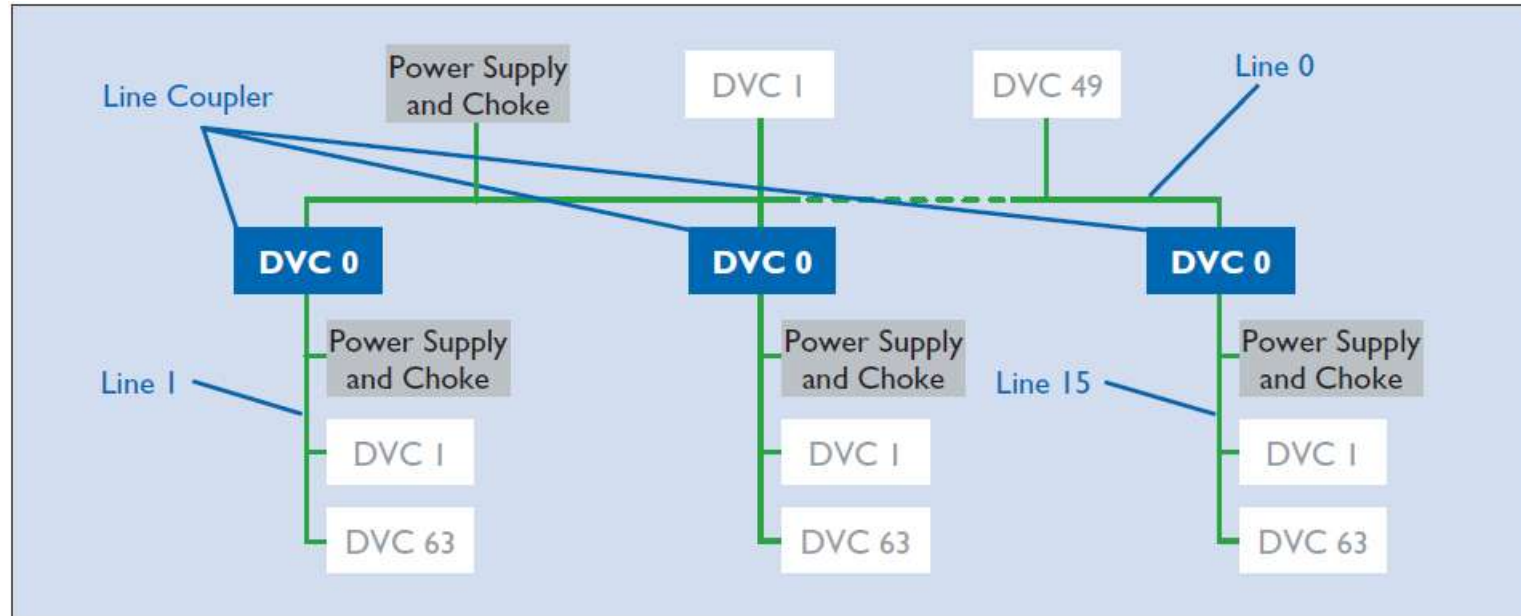


Figure 21. An “area” in KNX TP: up to 15 lines can be coupled via a main line.

KNX Topology

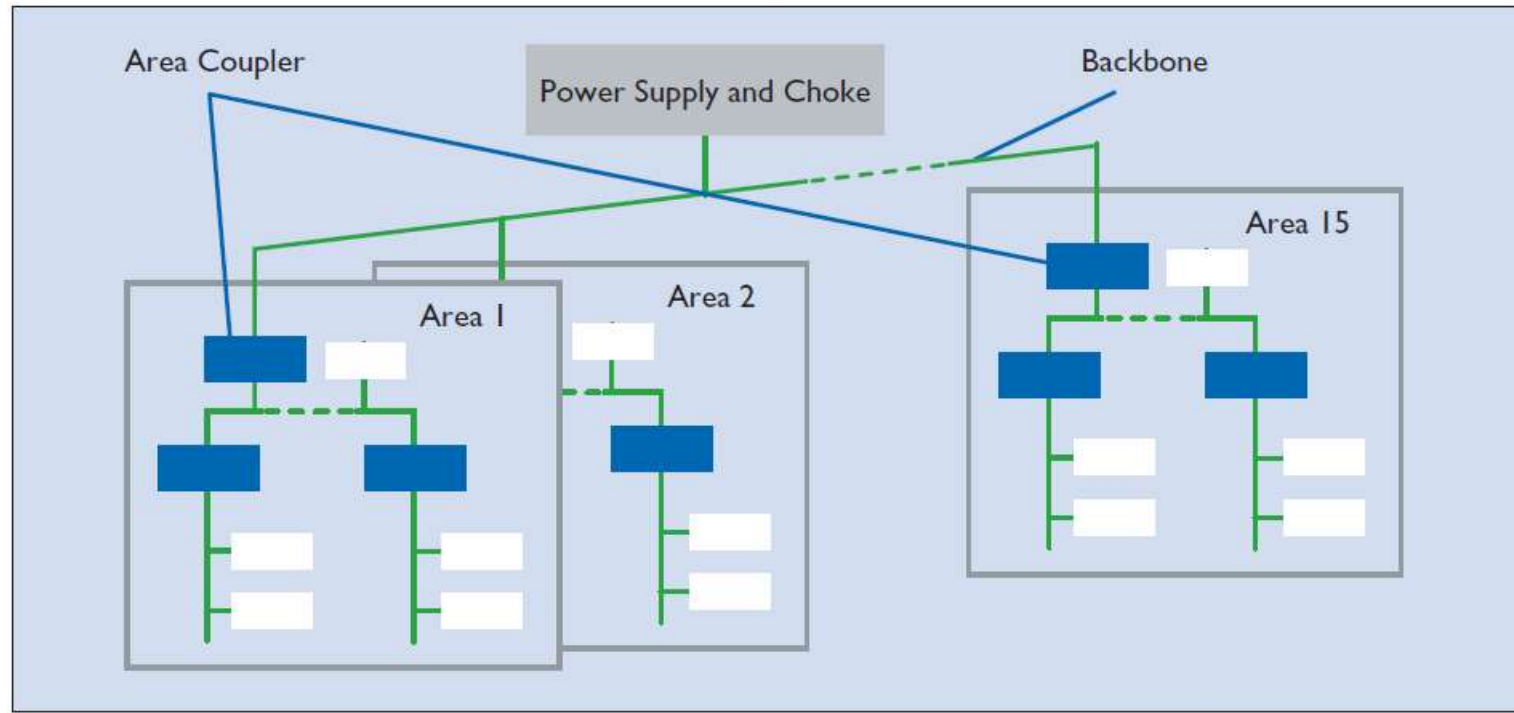


Figure 22. Up to 15 areas can be coupled via area couplers in KNX TP.

ETS – Engineering Tool Software

ETS™ - Merz3.10

ETS Edit Workplace Commissioning Diagnostics Apps Window

Close Project Undo Redo Reports Workplace Catalogs Diagnostics

Buildings

Add Devices Delete Download Info Reset Unload Print

Buildings

Dynamic Folders

Merz3.10

Cellar

Cellar Room

Floor

Living Room

Address	Room	Description	Application Program	Adr	Prg	Par	Grp	Cfg	Manufacturer	Order Num	Product
1.1.2	Cellar Room		Power Supply, Diagnosis, 640mA/1.1a	-	-	-	-	-	ABB	2CDG 110...	SV/S30.640.5.1 Power Supply,Diag
1.1.3	Cellar Room		Push-button coupler 4gang/1	-	-	-	-	-	ABB	6108/07-A...	Push-button coupler 4gang 6108/
1.1.4	Cellar Room		Switch 4f 6A/3.2b	-	-	-	-	-	ABB	2CDG 110...	SA/S4.6.1.1 Switch Actuator,4-fold,

Devices Parameter Functions

Add Group Addresses Delete Download Info Reset Unload Print

Group Addresses

Dynamic Folders

0 Central functions

0/1 New group address

1 Floor 1

2 Cellar

Address	Name	Description	Centra	Pass T	Data Type	Length	No. of	Last Value
0/1	New group address		No	No			0	

Group Addresses

Import... Export... Download

ABB Output Binary output, 4-fold

switch

Manufacturers

ABB

Albrecht Jung

APRICUM

ARBONIA

Arco-eds

Se	Manufacturer	Name	Order	Mediu	Application	Version
	ABB	SA/S4.6.1.1	2CDG...	TP	Switch 4f 6A/3.2b	3.2
	ABB	SW/S2.5 2f-...	GH Q...	TP	Switch Value Priority Cyclic/1	0.0
	ABB	FW/S4.5 4f-A...	GH Q...	TP	Switch Value Cyclic/1	0.0
	ABB	FW/S4.5 4f-A...	GH Q...	TP	Switch Value Cyclic/2	0.0
	ABB	FW/S4.5 4f-A...	GH Q...	TP	Switch Value Priority Cyclic/2	0.0
	ABB	SW/S4.5 4f-A...	GH Q...	TP	Switch Value Cyclic/1	0.0

Items: 1 in Building Parts Cellar Room Add

<no interface selected> 1.1 New line ABB SA/S4.6.1.1 Switch Actuator,4-fold,6A,MDRC Last used workspace

Properties

Catalog Application

SA/S4.6.1.1 Switch Actuator,4-fold,6A,MDRC
ABB/Output/Binary output, 4-fold

Order Number 2CDG 110 152 R0011

DIN rail mounting 72 mm (4M)

Bus current 12 mA

Switch 4f 6A/3.2b



Uses potential free contacts to switch 4 independent electrical loads via the ABB i-bus®. The 6A-AC3 device is especially suited to switch resistive, inductive or capacitive loads.

Technical Documentation
SAS_x611_TD_EN_V3-1_2CDC505050D0205...

Find and Replace

Workspaces

Todo Items

Pending Operations

Undo History

3.8 Communication Objects – C.Obj.

A Communication object is a **memory area** that is used for data exchange with other applications or devices by the application software of a KNX device in combination with the Communication software.

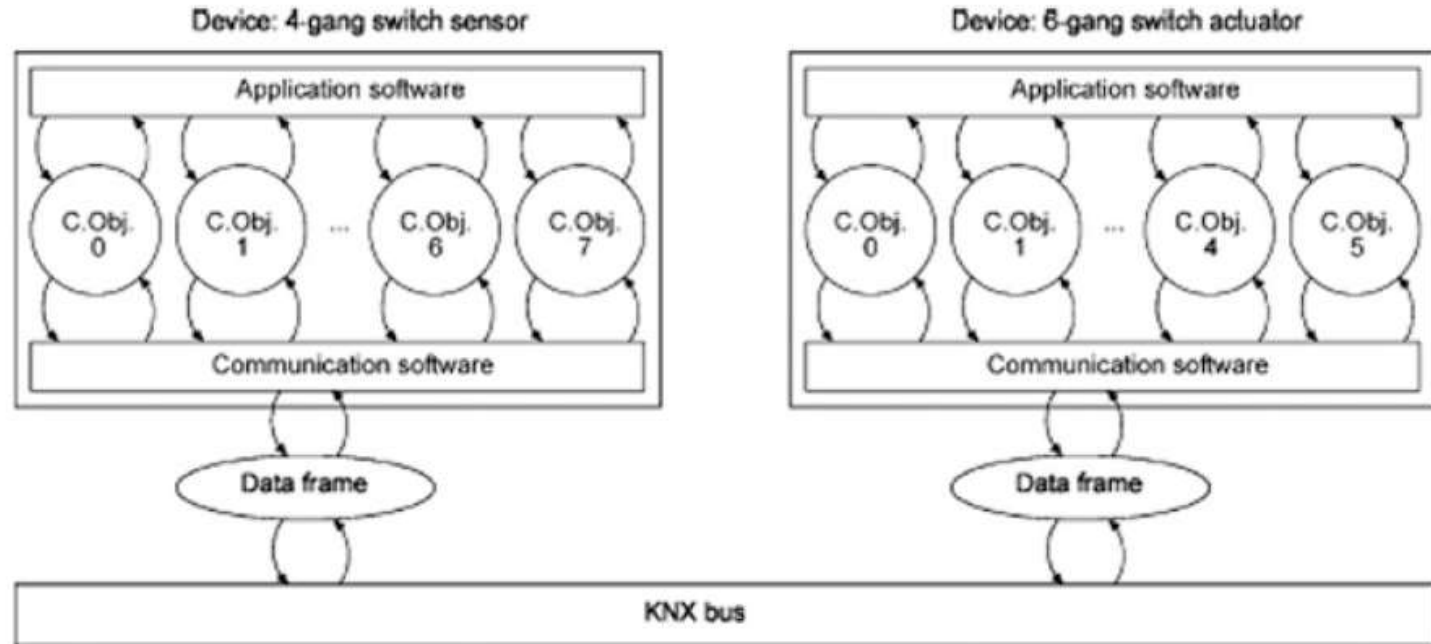


Fig. 3.23 Communication Object of a four-gang Switch Sensor and a six-gang Switch Actuator

3.8 Communication Objects – C.Obj.

Structure:

- a bit field (length 1 bit, 4 bit, 8 bit etc.)
- a variable (integer, float)
- a time or date
- a text (e.g. 14 ASCII letters).

Attributes:

- number
- name
- function
- group address
- length (1 bit, 4 bit, 1 B etc.)
- flags: communication (C), read (R), write (W), transmit (T), update (U), read on initialization (I), Table 3.7.

Access Methods:

Services for reading and writing.

A commonly used service in the application layer is e.g. **A_GroupValue_Write**, which is used to write the object value.

3.8

C.Obj. flags

Table 3.7 Flags

Flag	Flag set	Flag not set
C (Communication)	C.Obj. is connected to the bus	Acknowledgement of frames but C.Obj. is not changed
R (Read)	Value of C.Obj. can be read by bus	Value of C.Obj. can not be read by bus
W (Write)	Value of C.Obj. can be changed by bus	Value of C.Obj. can not be changed by bus
T (Transmit)	If the objects value changes (for a sensor), the new value is transmitted by bus	Object value is transmitted by bus only during read commands
U (Update)	Objects value is updated by a value answer frame on the bus (service A_Value_Response). Value answer frame is a reaction to a value reading frame (service A_Value_Read) sent by e.g. a visualization	Objects value is not updated
I (Read on initialization)	C.Obj. reads the object's value from the bus during initialization (only some devices)	C.Obj. does not read the objects value during initialization

3.8 C.Obj. Flags in Sensors

Table 3.8 The communication objects for the *Switch Dim LED* function in a four-gang switch sensor

No.	Type (bit)	Object name	Function
0	1	Left push button—short	Telegr.switch
1	1	Mid left push button—short	Telegr.switch
2	1	Mid right push button—short	Telegr.switch
3	1	Right push button—short	Telegr.switch
4	4	Left push button—long	Telegr. relative dimming
5	4	Mid left push button—long	Telegr. relative dimming
6	4	Mid right push button—long	Telegr. relative dimming
7	4	Right push button—long	Telegr. relative dimming

- Pressing and releasing the push buttons upper contact (the corresponding C-Obj. then contains a “1”) sends a switch ON data frame. Pressing and releasing the push button’s lower contact (the corresponding C.Obj. is assigned a “0”) sends a switch OFF data frame.
- Pressing and holding down a push button’s upper contact sends a brighter-dimming data frame. Pressing and holding the lower contact sends a darker-dimming data frame. As soon as the push button is released, a *stop dimming* data frame is sent.

3.8 C.Obj. Flags in Actuators

Table 3.9 The communication objects for the *Switch Default Staircase function/3* in a six-gang switch actuator

No.	Type (bit)	Object name	Function
0	1	Output A	Switch
1	1	Output B	Switch
2	1	Output C	Switch
3	1	Output D	Switch
4	1	Output E	Switch
5	1	Output F	Switch

- If the *Switch function* parameter has been set to *normally opened contact*, then the actuator switches the relay on when it receives a data frame with the value “1” (the corresponding C.Obj. then contains a “1”) and switches it off when it receives a data frame with the value “0” (the corresponding C.Obj. then contains a “0.”
- If the *Switch function* parameter has been set to *normally closed contact*, then the actuator switches the relay on when it receives a data frame with the value “0” and off when it receives a one with the value “1.”

3.8 Assigning C.Obj. To Group Addresses

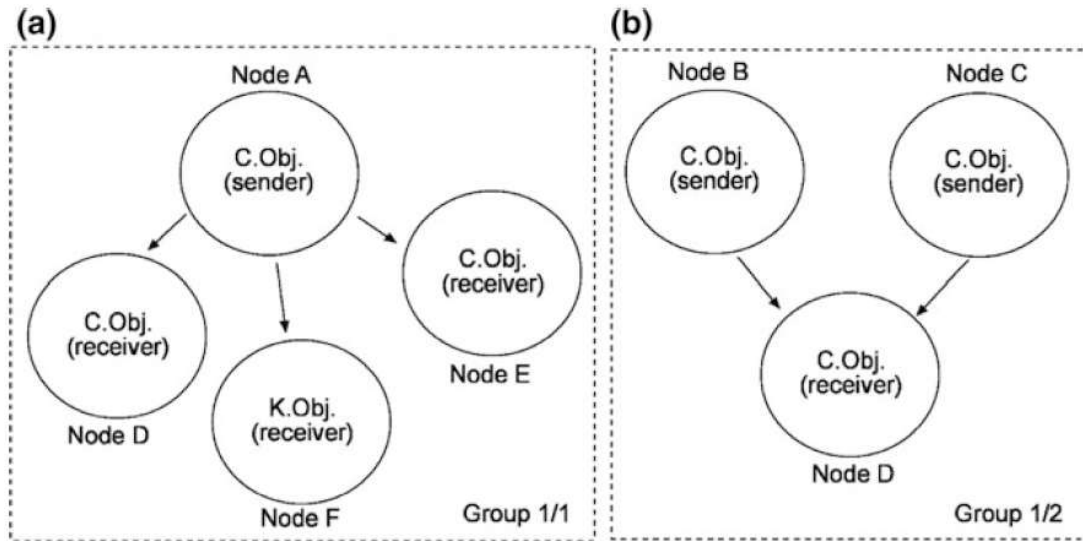


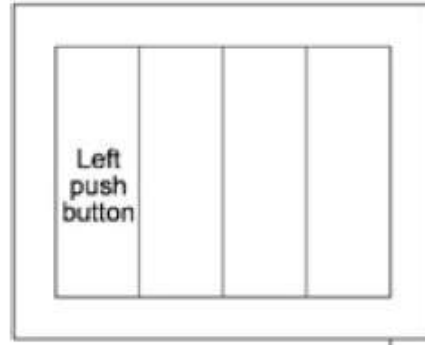
Fig. 3.24 Groups with sender and receiver communication objects

- At least one sensor and at least one actuator have to exchange data.
- A transmitting C.Obj. can only be assigned to one group address.
- A receiving C.Obj. can be assigned to multiple group addresses.

Both the transmitting and the receiving applications use a number of C.Obj. that have to share one group address. This is equivalent to a connection of the devices.

3.8 Example

4-gang switch sensor
Physical address: 1.1.1
Application: Switch Dim LED



1~ 60 Hz, 120 V / 1~ 50 Hz, 230 V

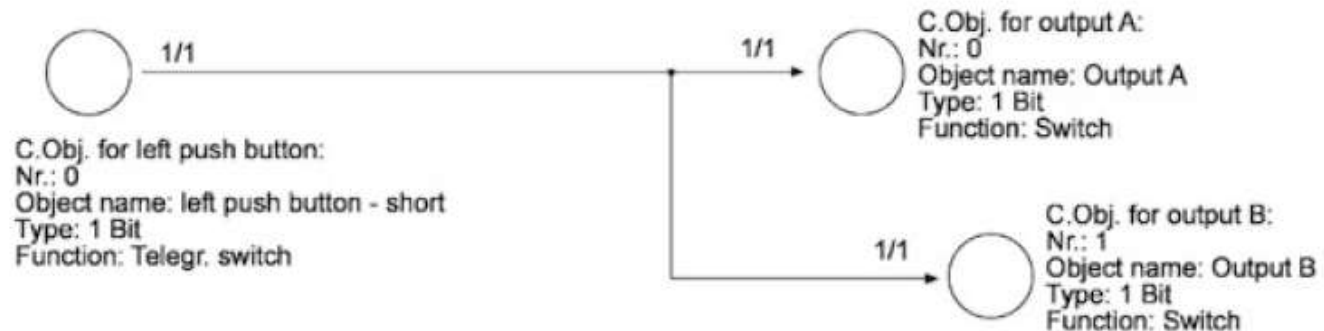
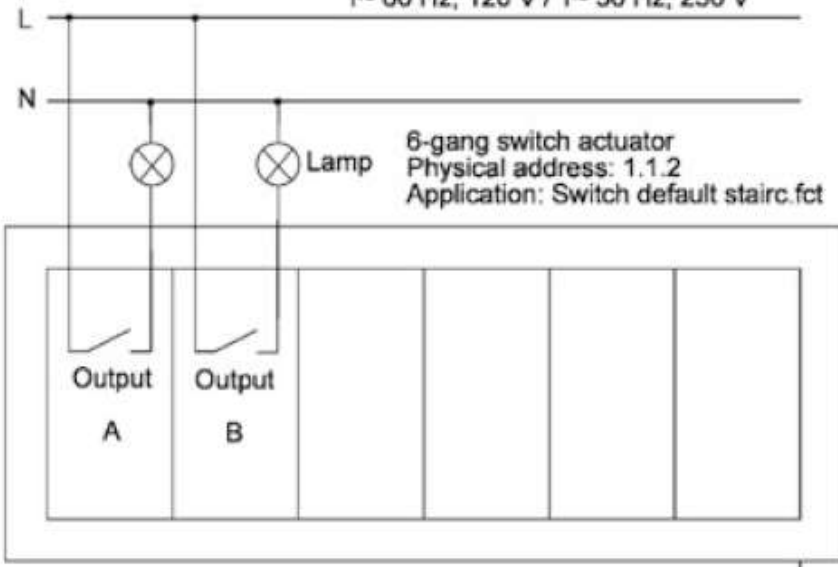
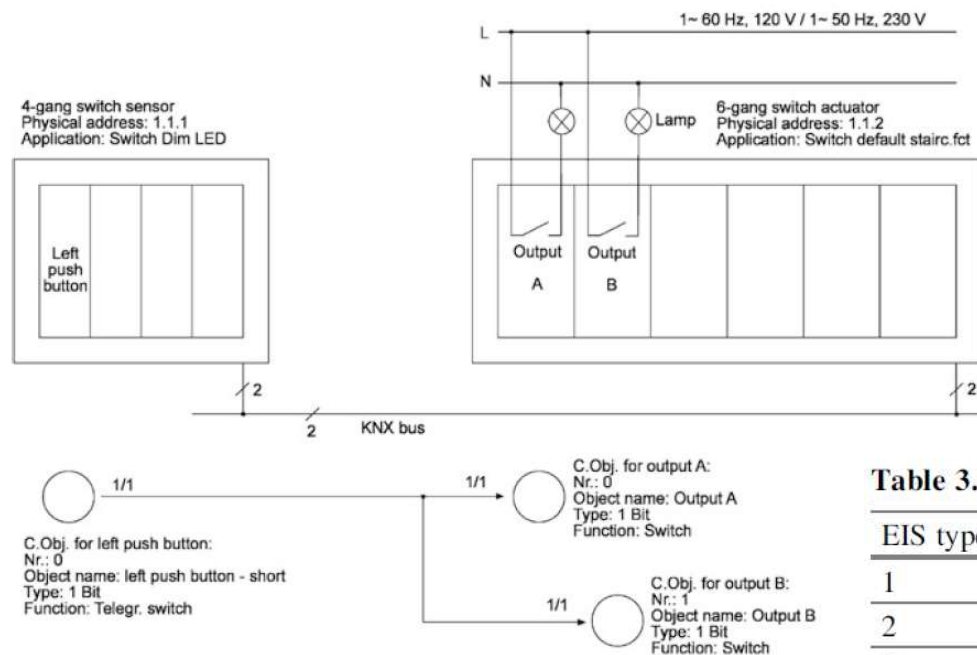


Fig. 3.26 Assigning communication objects to a group address

3.9 EIS – EIB Internetworking Standard



- Reading a C.Obj.: A_GroupValue_Read (A_ stands for application layer) and
- Writing a C.Obj.: A_GroupValue_Write

Table 3.10 EIS types (examples)

EIS type	Function	Length of C.Obj.	Length of user data
1	Switching	1 bit	2 byte
2	Dimming	4 bits	2 bytes
3	Time (d, h, min, s)	3 bytes	5 bytes
4	Date (day, month, year)	3 bytes	5 bytes
5	Float	2 bytes	4 bytes
15	String	14 bytes	16 bytes

Fig. 3.26 Assigning communication objects to a group address

3.9 EIS – Switching Command

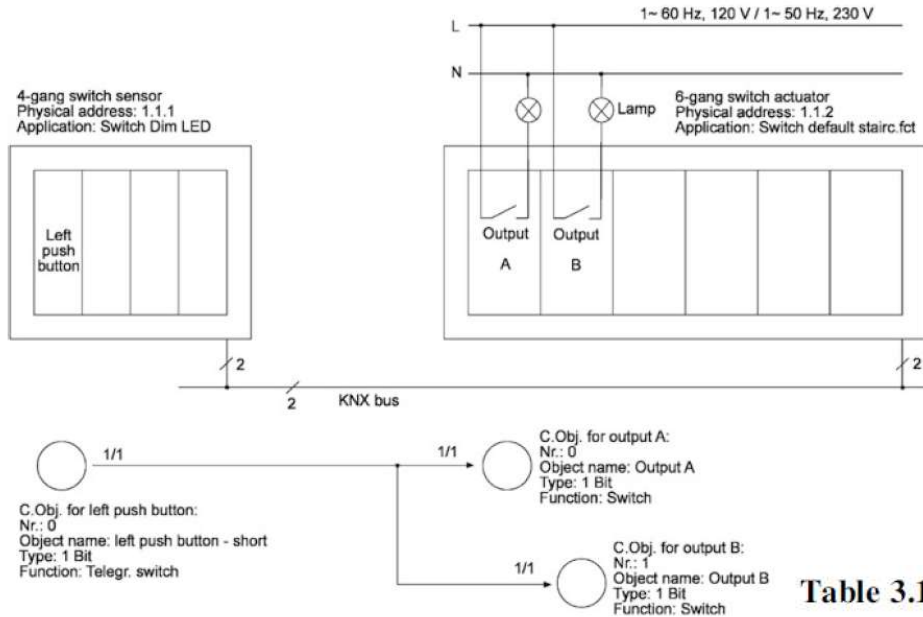


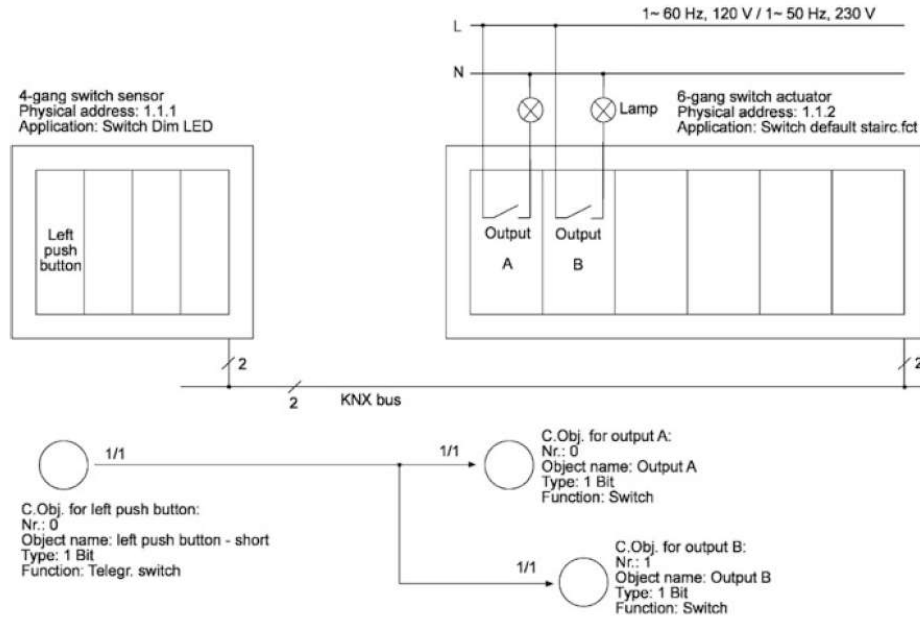
Fig. 3.26 Assigning communication objects to a group address

- Bits B9, B8, B7 and B6 contain 0010 corresponding to the service
A_GroupValue_Write—writing in a C.Obj.
- Bit D0 = B0 in Byte 7 is used for the actual switching information. Value 1 means switching on and value 0 means switching off
- Every other bit is transmitted as a zero bit and not further processed.

Table 3.11 The first two user data bytes for a switching command

Byte 6								Byte 7								Command
MSB							LSB	MSB							LSB	
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0	
						B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	Switch on
0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	Switch off

3.9 EIS – Dimming Command



- Bits B9, B8, B7 and B6 contain 0010 corresponding to the service A_GroupValue_Write—writing in a C.Obj.
- The actual dimming function requires 4 bits in byte 7 (D3 = B3, D2 = B2, D1 = B1 and D0 = B0)
 - Bit D3 contains the dimming information. A one bit means increase brightness and a zero bit means decrease brightness
 - Bits D2, D1 and D0 contain 011 corresponding to “dimming level 4”, this means “to the next dimming level (0, 25, 50, 75, 100%) depending on the current level
- Every other bit is transmitted as a zero bit and not further processed.

Fig. 3.26 Assigning communication objects to a group address

Table 3.12 The first two user data bytes for a switching command

Byte 6								Byte 7								Command
MSB							LSB	MSB							LSB	
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0	
						B9	B8	B7	B6	B5	B4	B3	B2	B1	B0	
0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	Dimming

3.10 The Communication Process

A data frame is sent in response to an individual action such as pressing the upper-left rocker switch on a four-gang switch sensor (there are also KNX devices that send data frames periodically). The bus device then sends a data frame that has a specific group address.

All devices (receivers) that belong to this group simultaneously confirm that they have received the data frame by returning an acknowledgment frame. This acknowledgment frame is also called a summation frame, because it comprises the confirmation frames from all the receivers. If the sender transmits a frame to a device located on another line, the coupler confirms receipt of the frame.

3.8 CSMA/CA

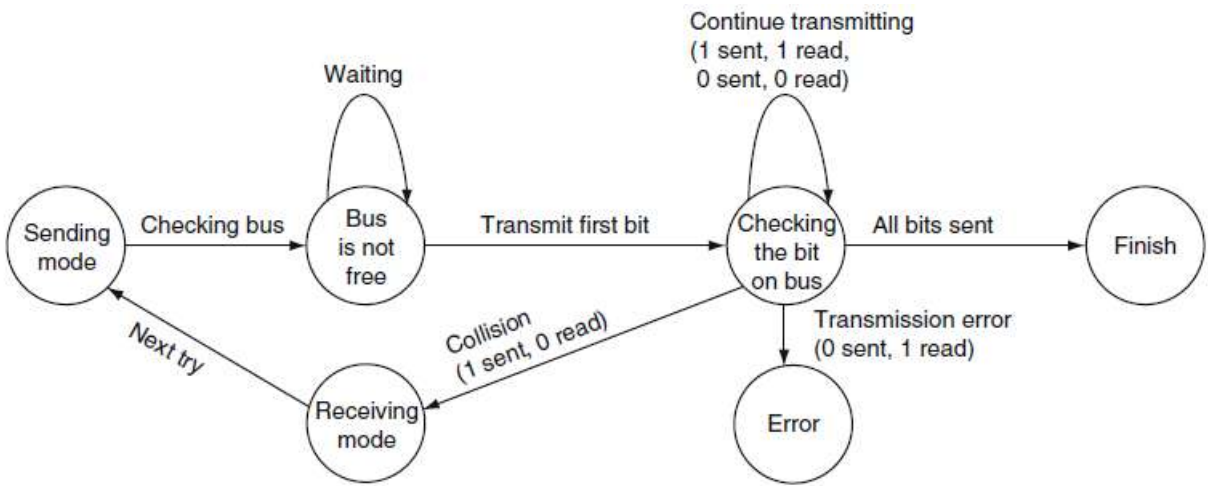


Fig. 3.28 Status diagram for the CSMA/CA protocol

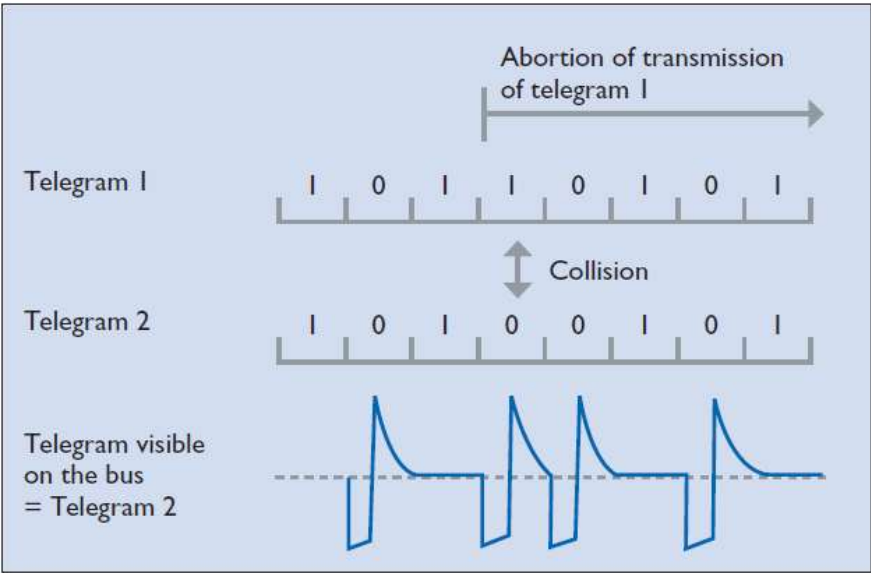
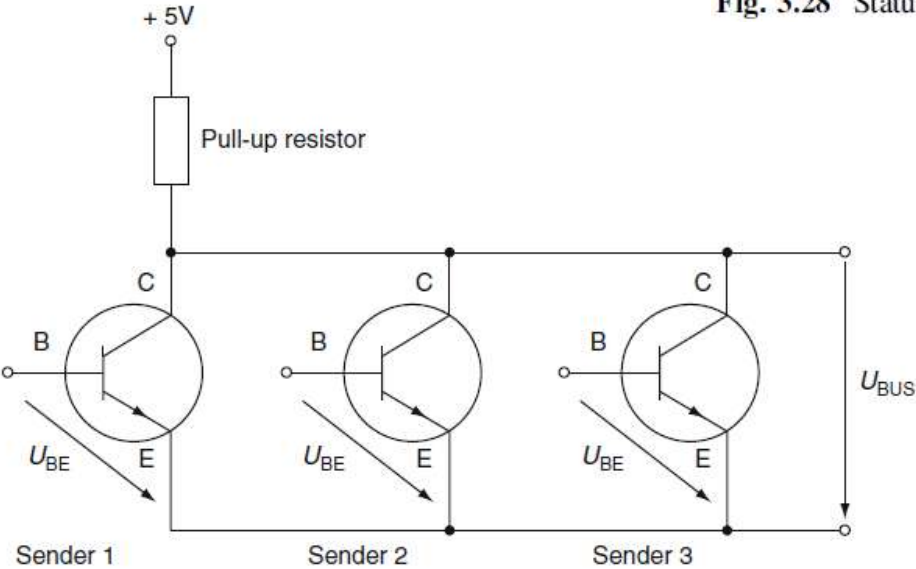


Figure 9. Collision avoidance in KNX TP

Fig. 3.27 Wired-AND switching: dominant and recessive bits

Simulador KNX-Virtual: help.knx.org/kv

KNX Virtual

Get Started

User Guide

Help

Examples

How-to

Release notes

Examples

- › Base view
- › Switching++ view
- › Dimming++ view
- › Blinds++ view
- › HVAC view (room1)
- › Room21-24 view

ETSS™ - KV2.3 - hvac

ETS Edit Workplace Commissioning Diagnostics Apps Window

Close Project Undo Redo Reports Workplace Catalogs Diagnostics

Buildings

+ Add Buildings | X Delete Download | Info Reset Unload Print Search

Buildings	Address	Room	Description	Application Program	Adr	Prg	Par	Grp	Cfg	Manufacturer	Order Num	Product
Dynamic Folders	1.1.1			KliX	✓	✓	✓	✓	✓	KNX Association	D4-v23	KliX (D4)
Initial devices	1.1.2			Setpoint Manager	✓	✓	✓	✓	✓	KNX Association	D15-v23	Setpoint Manager (D15)
Modified devices	1.1.3			Binary Input Control	✓	✓	✓	✓	✓	KNX Association	D11-v23	Binary Input Module (D11)
Not assigned to a room	1.1.4			Movement/Presence	✓	✓	✓	✓	✓	KNX Association	D10-v23	Movement/Presence Detector (D10)
	1.1.5			Heat Controller	✓	✓	✓	✓	✓	KNX Association	D16-v23	Heat Controller (D16)
Trades	1.1.6			Weather Module Control	✓	✓	✓	✓	✓	KNX Association	D12-v23	Weather Module (D12)
	1.1.7			Heat Exchanger	✓	✓	✓	✓	✓	KNX Association	D17-v23	Heat Exchanger (D17)
	1.1.8			Valve Control	✓	✓	✓	✓	✓	KNX Association	D6-v23	Valve Actuator (D6)

Devices Parameter

New Connection (1) (0.0.0.0:3671)



KV

KNX Basics (switching) – Programming KNX devices

The screenshot shows the ETS (Energy Management System) software interface for programming KNX devices. The main window displays the 'Group Objects' table, which lists the objects created in the project. The table has columns for 'Number', 'Name', 'Object Function', 'Description', and 'Group Address'.

Number	Name	Object Function	Description	Group Address
1.1.1.000				
1.1.1.001	CH-1 - Switching - On/Off	CH-1 - Switching - On/Off	E1	5/0/1
1.1.1.002	CH-1 - Switching - Feedback	CH-1 - Switching - Feedback	E1 - Status On/Off	5/0/2
1.1.1.003	CH-2 - Switching - On/Off	CH-2 - Switching - On/Off		
1.1.1.004	CH-3 - Switching - On/Off	CH-3 - Switching - On/Off		
1.1.1.005	CH-4 - Switching - On/Off	CH-4 - Switching - On/Off		
1.1.1.006	CH-5 - Switching - On/Off	CH-5 - Switching - On/Off		
1.1.1.007	CH-6 - Switching - On/Off	CH-6 - Switching - On/Off		
1.1.1.008	CH-7 - Switching - On/Off	CH-7 - Switching - On/Off		
1.1.1.009	CH-8 - Switching - On/Off	CH-8 - Switching - On/Off		
1.1.2.000	1.1.2 Switching Actuator			
1.1.2.001	CH-1: On/Off	CH-1: On/Off	E1	5/0/1
1.1.2.002	CH-1: Info On/Off	CH-1: Info On/Off	E1 - Status On/Off	5/0/2
1.1.2.003	CH-2: On/Off	CH-2: On/Off		
1.1.2.004	CH-3: On/Off	CH-3: On/Off		
1.1.2.005	CH-4: On/Off	CH-4: On/Off		
1.1.2.006	CH-5: On/Off	CH-5: On/Off		

The 'Diagnostics' window is also visible, showing the 'Group Monitor' tab. It displays the 'Group Address' (5/0/1), 'Data point type' (1001 switch), and 'Last received value' (Value: ON). The 'Info' section shows the recording status and the current project name: 'Current project: KNX Basics (Switching) with KNX Virtual'.

The screenshot shows the 'KNX Virtual' interface, which is a graphical representation of the KNX system. It features three main sections: 'Push Buttons', 'Lamps', and 'Blinds'. Each section contains a grid of controls for the respective devices.

- Push Buttons:** A 6x2 grid of buttons. The first column contains buttons labeled '0' and the second column contains buttons labeled '1'. The buttons are arranged in a grid that corresponds to the objects in the ETS project.
- Lamps:** A section labeled 'Dimmable Lamps' containing five black rectangular buttons labeled 'ch1', 'ch2', 'ch3', 'ch4', and 'ch5'. The first button 'ch1' is highlighted with a red border.
- Blinds:** A section labeled 'Blinds' containing five black rectangular buttons labeled 'ch1', 'ch2', 'ch3', 'ch4', and 'ch5'.

The interface is designed to be intuitive, allowing users to interact with the KNX system through a simple graphical user interface.



KNX IoT

Unleashing a wealth of available KNX data!

KNXperience

Joost Demarest – KNX, Brussels, 28.02.20

The KNX IoT 3rd Party Interface: unleashing a wealth of KNX data(for general KNX community)

<https://www.youtube.com/watch?v=XE7VZnhTy9U>, dec 18th, 2020

Why KNX IoT and what added value does it bring to the installer?

- *active in the residential sector*
- *Active in the commercial sector*
- *As a system integrator*

How did and do we connect to KNX installations today?

How will KNX IoT allow to connect to KNX installations?

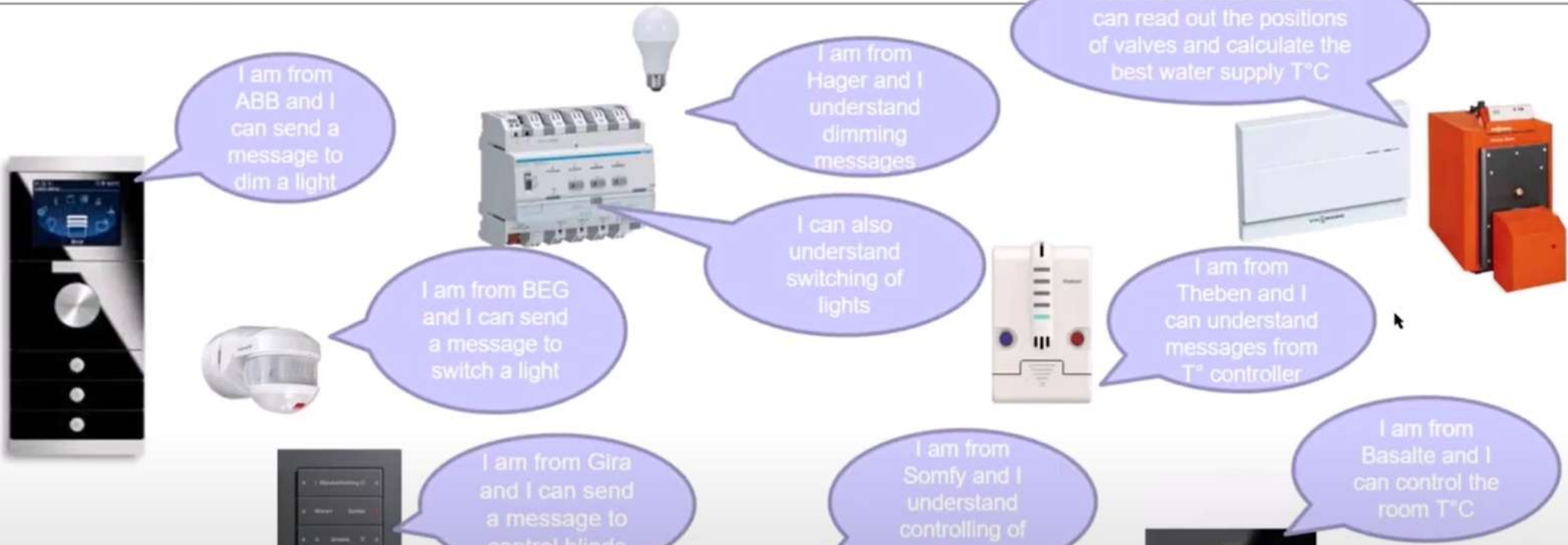
How will the installer see this in ETS?

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

KNX : everything perfectly understands each other



KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

ETS – the unique application and vendor independent tool



- Documents in a standardized way all links between the different functions of the different devices
- The integrator/installer
 - Documents which devices are located where
 - gives all links a name and a number – all these links combine functions that serve a specific purpose

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

We are sitting on a pile of standardized data – unique in building automation

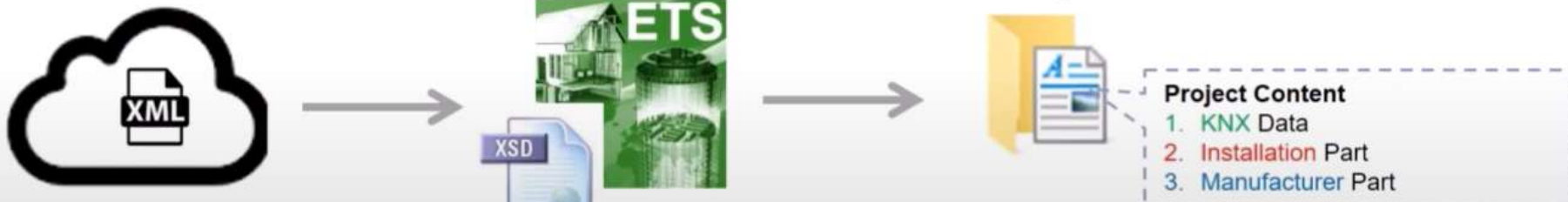
ETS Data Model is (currently) based on (XML) XSD scheme.

- XSD is part of every MT5 installation (covers **installation/** **manufacturer/** **KNX** data)
- **Installation** data created by ETS user → topology/ building structure/ GAs ...,
- **Manufacturer** data created by KNX manufacturer → MT applications (*.knxprod)
- **KNX** “Master Data”, are online available and part of every ETS/MT project/ ETS installation



KNX / Manufacturer Data

ETS Project

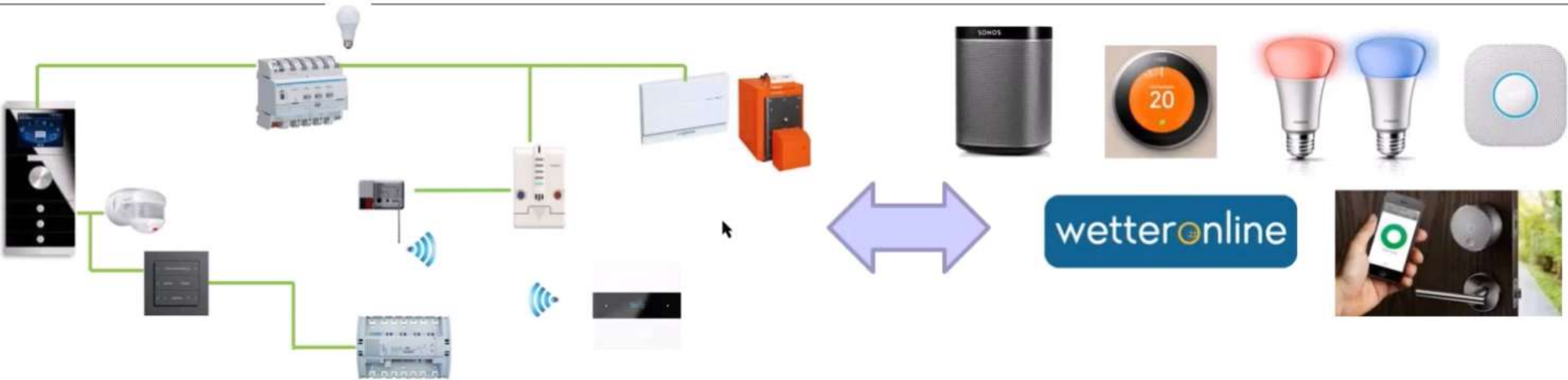


KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

I am an installer active in the residential sector



My customer buys smart consumer electronics – My customer wants to connect to external services: I need to convince him that:

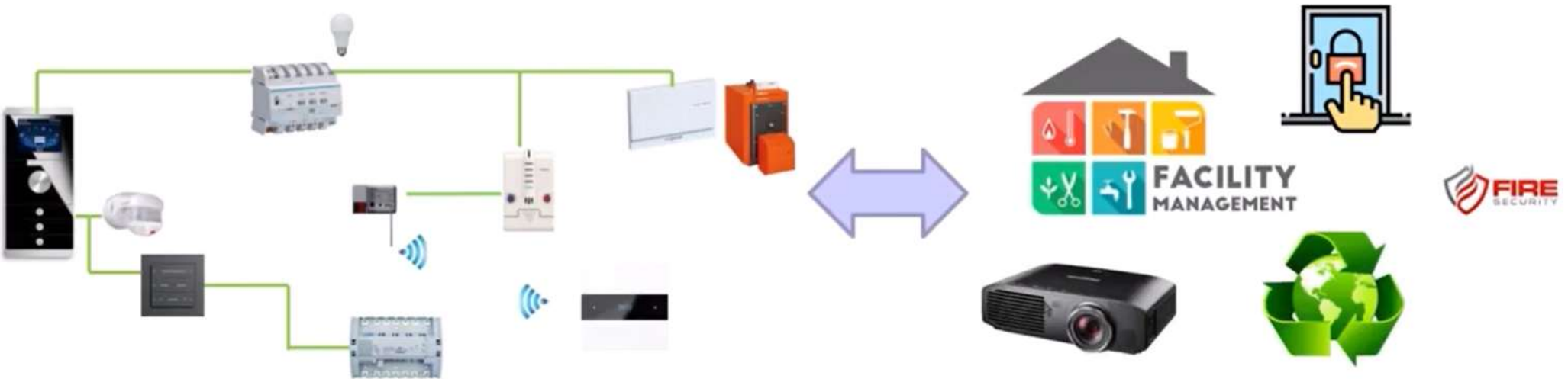
- KNX is not a closed system and integration is easily possible
- His investment in KNX pays off and is future proof (will be able to integrate future solutions as well)

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

I am an installer active in the commercial sector or I am a system integrator



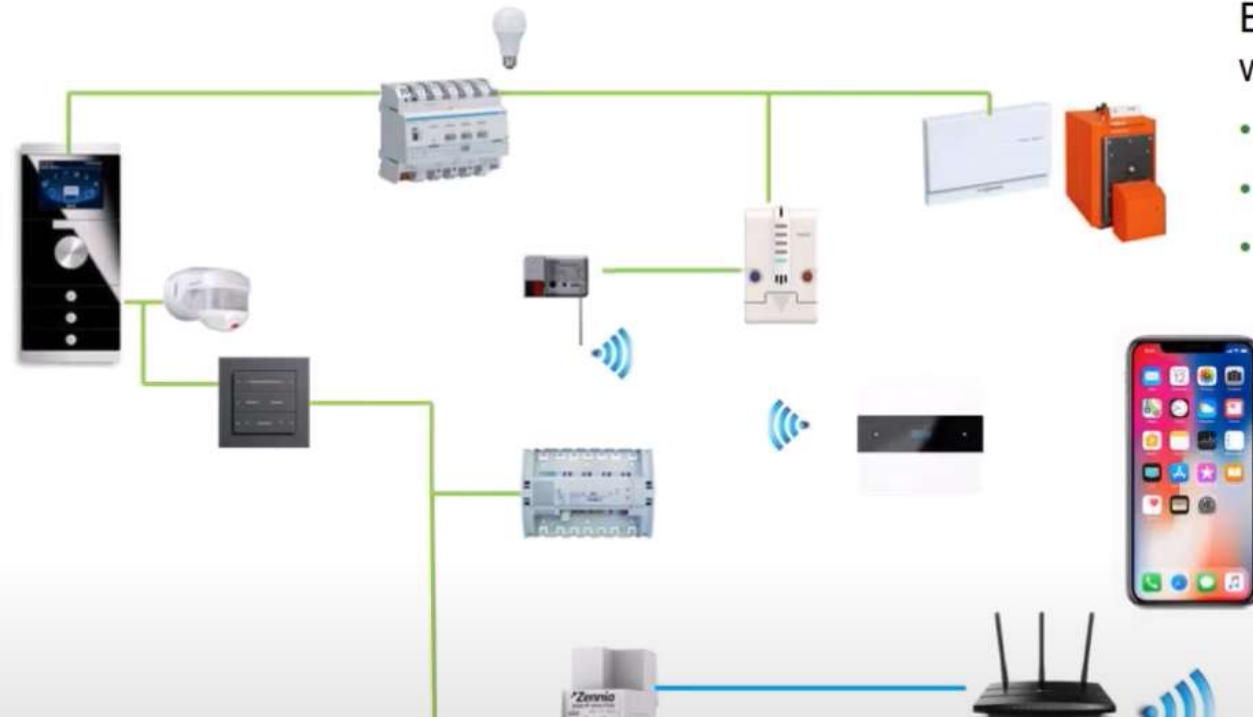
My customer would like to integrate with other systems that are not directly KNX compatible:

- Same arguments as before
- I would like to make sure that the customer only has access to data that he should be entitled to, not the entire

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

How did we access this data in the past (and we still do)?



E.g. PC with Visualization connected to PC with

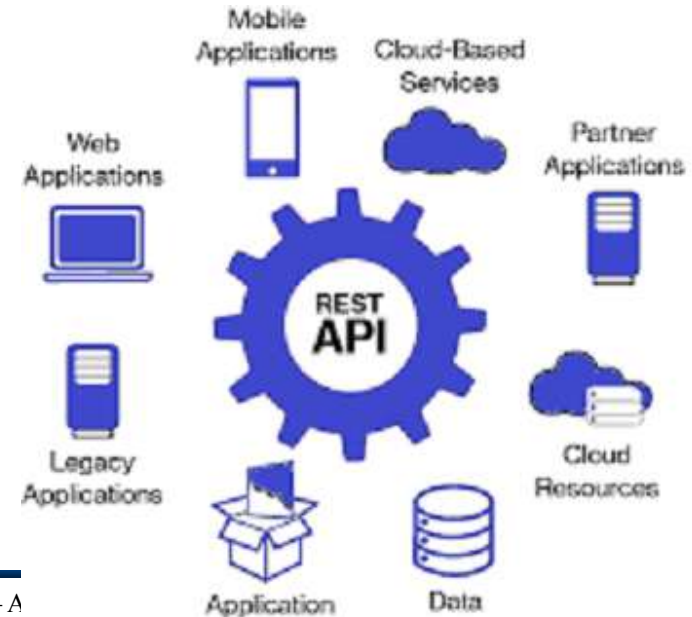
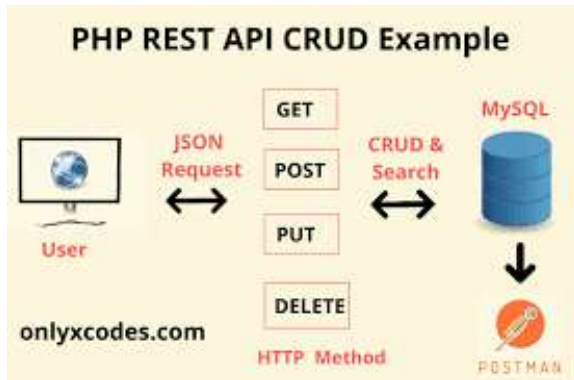
- RS232
- USB
- KNXnet/IP Interface
 - **However** data always offered “KNX style” – if you want to understand our messages “Read the specs” and convert them to your messages
 - Every information entered into ETS needs to be re-entered in “thing” wanting to access the data (or has to make proprietary use of the exported ETS project data)
 - Access to the data not secured, neither locally nor remote [until KNX IP Secure]
 - All these interfaces offer full access – no possibly to limit access to certain data

REST - CRUD

{ REST }

Representational State Transfer

software architectural **style** which uses a subset of HTTP.
It is commonly used to create **interactive applications** that use Web services.

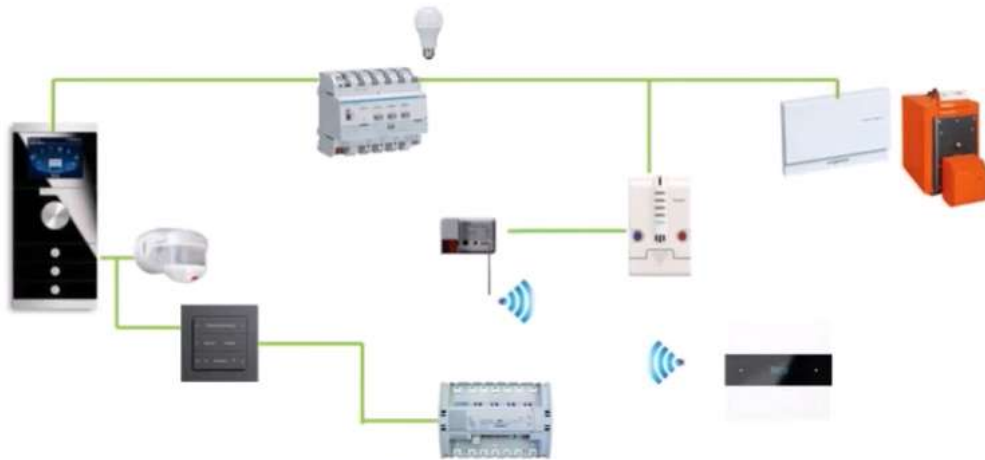


KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

Fulfilling the new requirements – how?



Project information as XML information is not suitable

- Changes too often
 - Because of new system features in ETS (e.g. KNX S-mode multi)
 - non-KNX “things” making use of the data need to adapt too frequently to changing format

KNX IoT solution

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

How will you as installer provide all the data for the KNX IoT API ??

In case of a new project

The screenshot shows the ETS5 KNX Semantic Project interface. The left sidebar displays a tree view of the project structure, including 'Buildings', 'Dynamic Folders', 'My Castle', 'Auxiliary Building', 'Main Building', 'First Floor', 'Ground Floor', '#0 Main Corridor', '#1 Office', and '#2 Bed Room'. The main area shows a table of objects with columns: Address, Name, Description, Data Type, Length, Central, Pass Thru, No. of, and Last Value. The table lists objects 160 through 164, including 'Switching (set)', 'Switching (status)', 'Dimming (control)', 'Dimming Value (current value)', and 'Dimming Value (set)'. Annotations with callout boxes identify specific elements: 'Function' points to the 'Name' column, 'Function Point (Group Address)' points to the 'Address' column, and 'Channel' points to the 'Data Type' column.

Address	Name	Description	Data Type	Length	Central	Pass Thru	No. of	Last Value
160	Switching (set)	Role: SwitchOnOff	switch	1 bit	No	No	2	
161	Switching (status)	Role: InfoOnOff	switch	1 bit	No	No	2	
162	Dimming (control)	Role: DimmingControl	dimming control	4 bit	No	No	2	
163	Dimming Value (current value)	Role: InfoDimmingValue	percentage (0.100%)	1 byte	No	No	2	
164	Dimming Value (set)	Role: DimmingValue	percentage (0.100%)	1 byte	No	No	2	

By entering the building view elements as before

By making use of the Functions that are already defined in ETS and will be extended

- *ETS will in the background add semantic information to group objects, channels, function points*
- *When making the export to the KNX IoT Interface, this will contain all semantical data to be exposed on the API and will create the IoT endpoints that can be addressed by a third party*

In future versions of product data, this

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

How will you as installer provide all the data for the KNX IoT API ??

In case of an existing project

ETS3™ - KNX Semantic Project - w/o manuals/ extra texts

Buildings

Address	Name	Description	Data Type	Length	Central	Pass Thru	No. of	Last Value
160	Switching (set)	Role: SwitchOnOff	switch	1 bit	No	No	2	
161	Switching (status)	Role: InfoOnOff	switch	1 bit	No	No	2	
162	Dimming (control)	Role: DimmingControl	dimming control	4 bit	No	No	2	
163	Dimming Value (current value)	Role: InfoDimmingValue	percentage (0..100%)	1 byte	No	No	2	
164	Dimming Value (set)	Role: DimmingValue	percentage (0..100%)	1 byte	No	No	2	

Callouts:

- Function: Points to the 'Name' column (e.g., Switching, Dimming).
- Function Point (Group Address): Points to the 'Address' column (e.g., 160, 161, 162, 163, 164).
- Channel: Points to the 'Description' column (e.g., Role: SwitchOnOff, Role: InfoOnOff, Role: DimmingControl, Role: InfoDimmingValue, Role: DimmingValue).

Existing project possibly have not used standard ETS functions

Manufacturers will be offered the possibility to extend their current product data with missing semantical information – can be separate from the current product data

- *ETS can then fetch this additional semantical data for the used projects in the KNX online catalogue*

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

Summary of KNX IoT Benefits



- *KNX continues to provide a solid data foundation for any type of integration, be it consumer electronics, non-KNX based solutions or third party services*
- *Third Party Adapters to KNX can focus on one single interface instead of multiple proprietary interfaces*
- *KNX is a future-proof investment for any type of customer*
- *The KNX installer can focus on what he does best: making superb KNX installations*
- *KNX Installer can hand-over project and not run into warranty problems*
- *KNX Installer does not need to provide uncontrolled and unsecured [if not using KNX Secure] access to data in a KNX installation*
- *When properly documenting a KNX installation in ETS, KNX IoT interfacing does not cause additional efforts for the KNX installer*