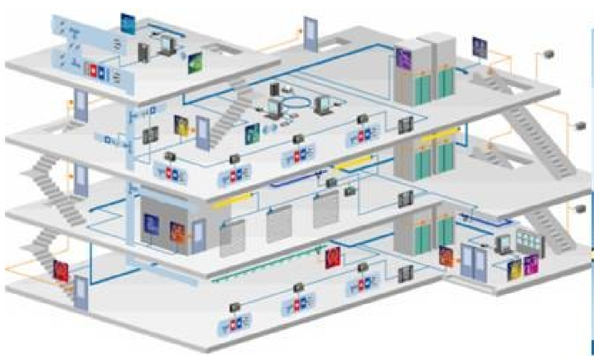
AP – Automação Predial com IoT

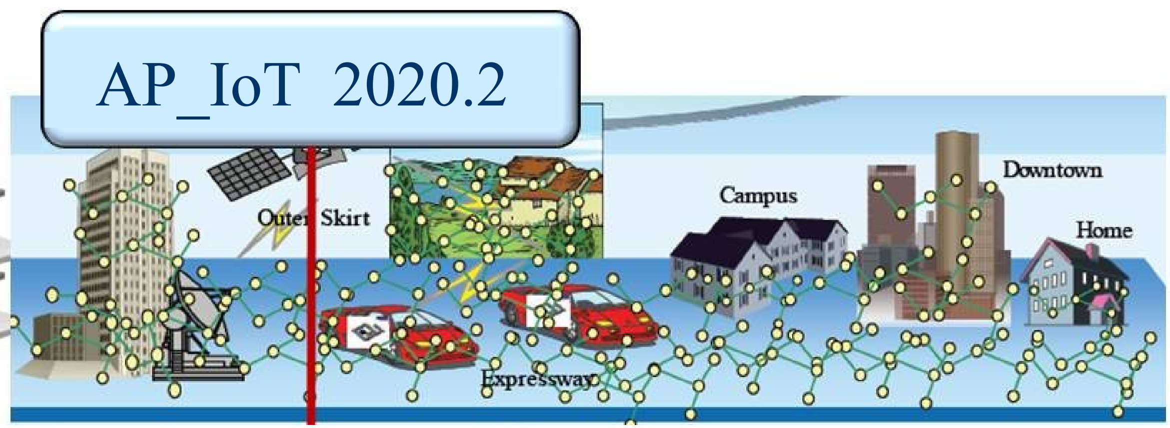
Tópicos em Engenharia 2020.2

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

Adolfo Bauchspiess

Universidade de Brasília - Brazil





Conteúdo

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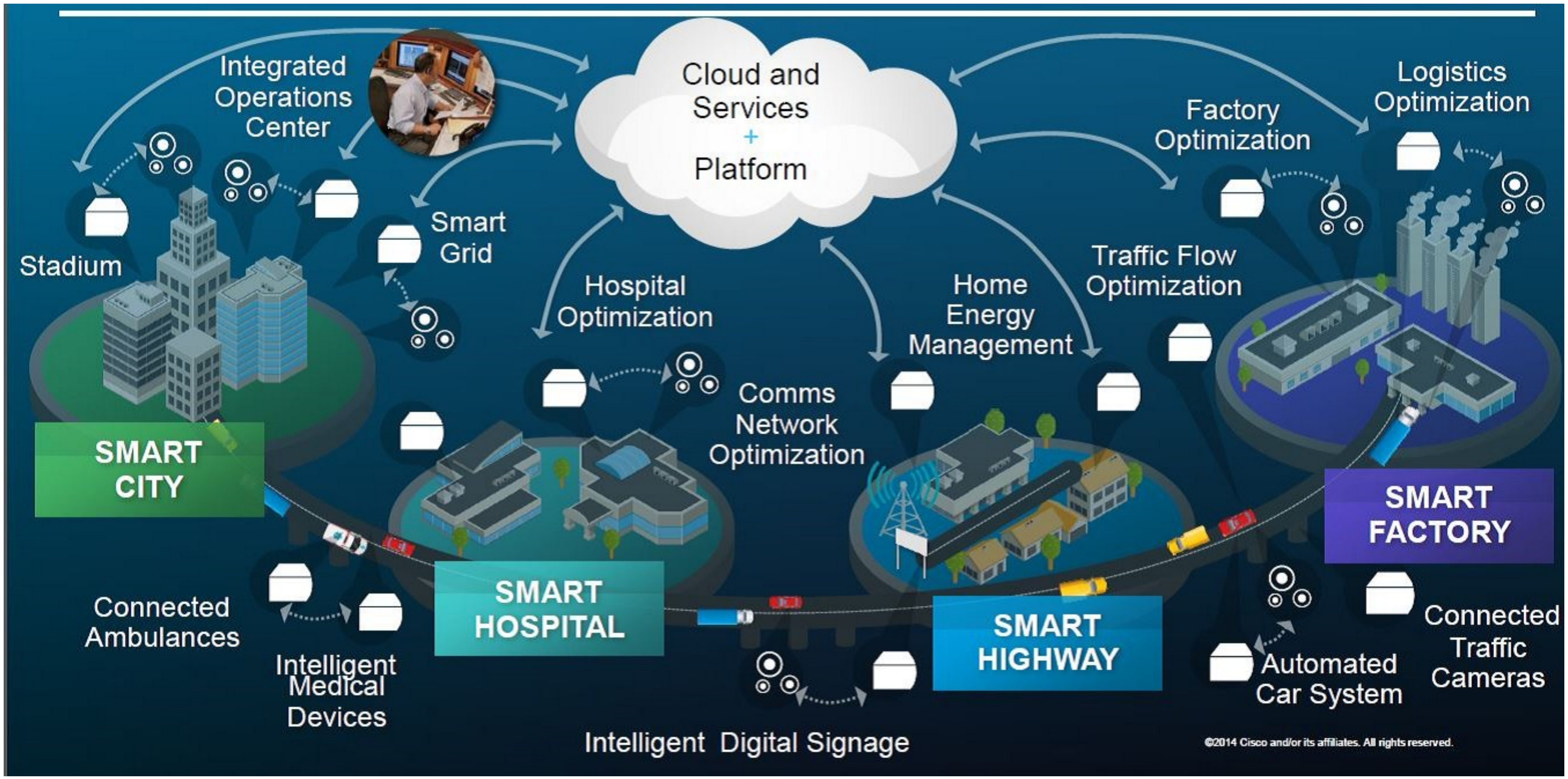
4 - Examplos e Aplicações
5 - Conclusões

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: Telebrasília (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

WEMOS LOLIN32

“WeMos” OLED

HUZZAH32

Others

(...)

ESP32 Development Boards Review and Comparison

May 18, 2020 By Sara Santos

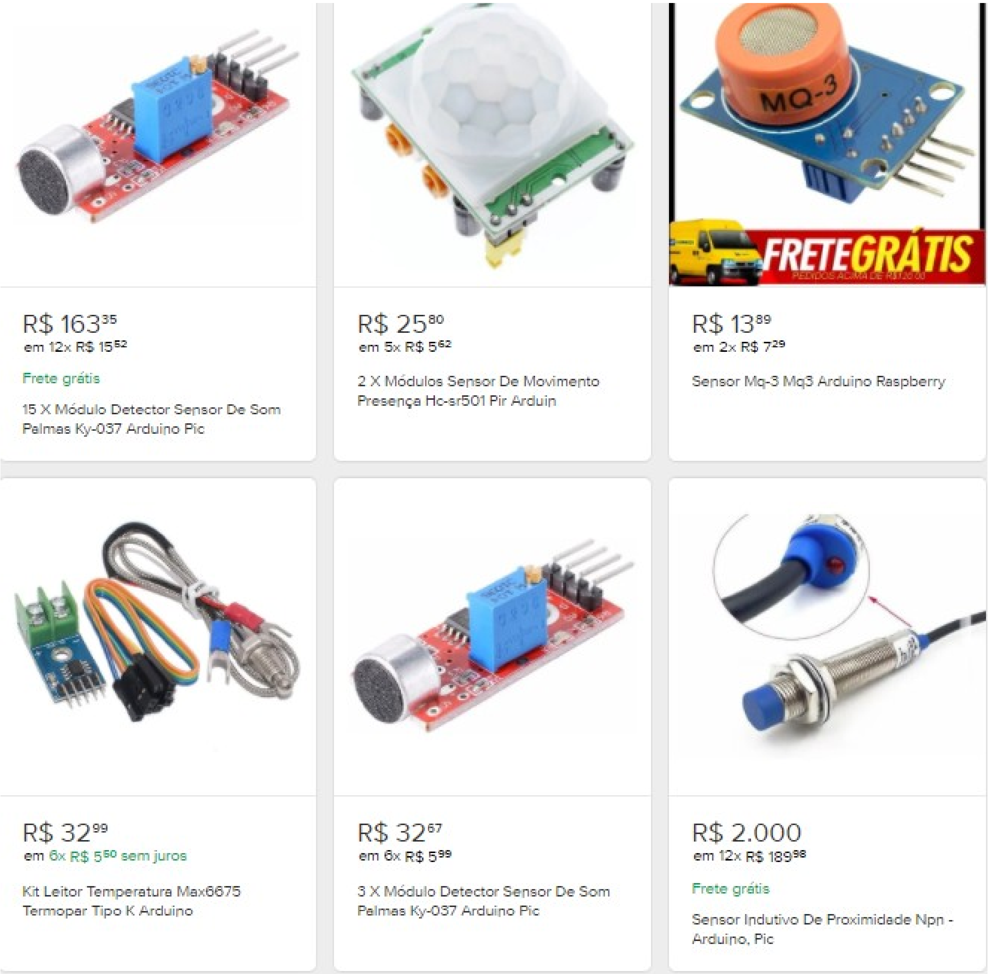
https://makeradvisor.com/esp32-development-boards-review-comparison/

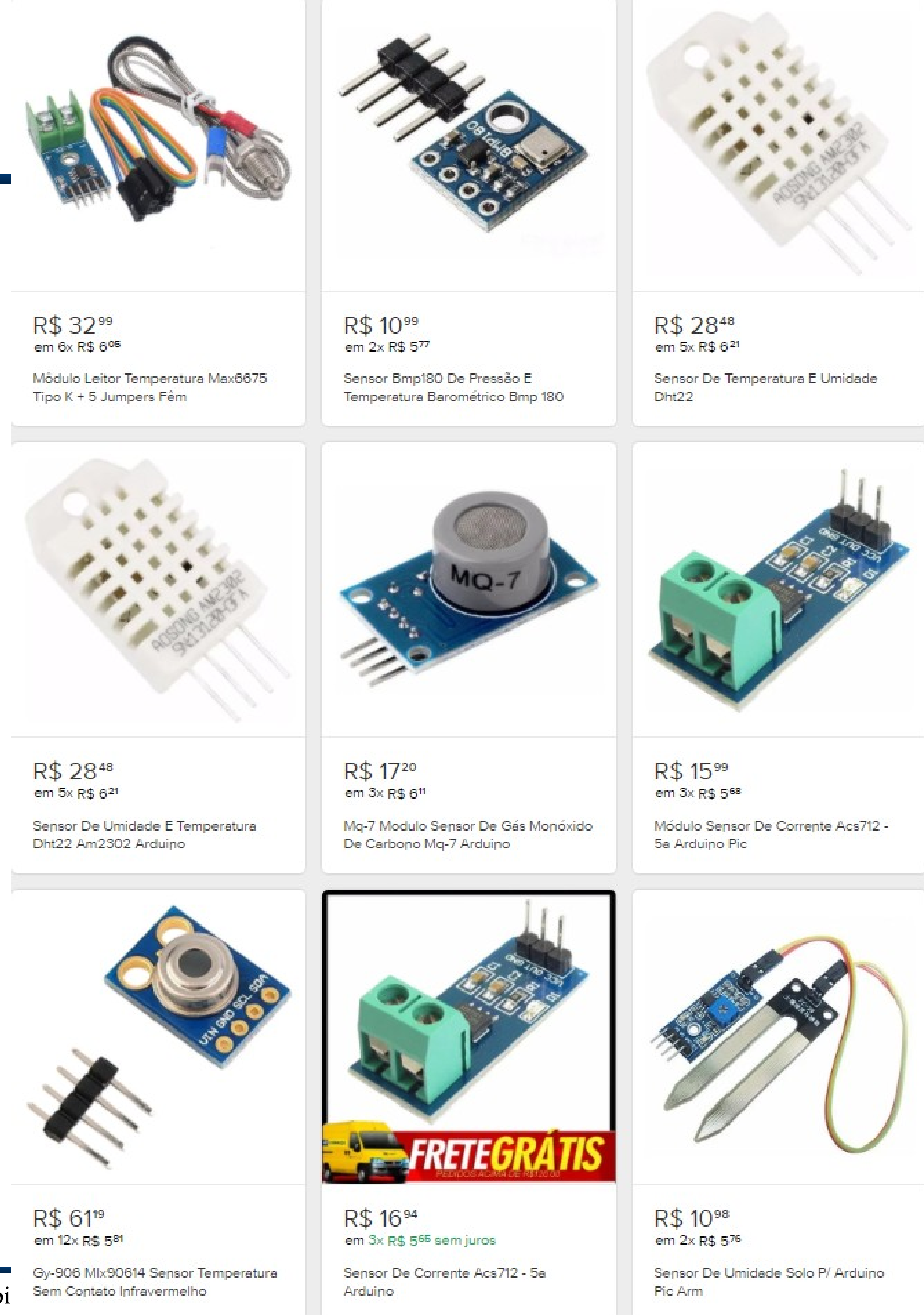
ESP32_Web_Server_with_Arduino_IDE, Rui Santos & Sara Santos

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

Sensores

e.g., Mercadolivre
ardu_robótica_eireli

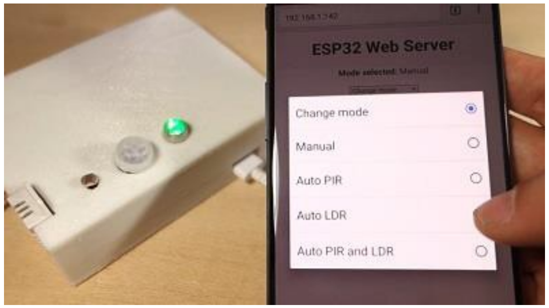




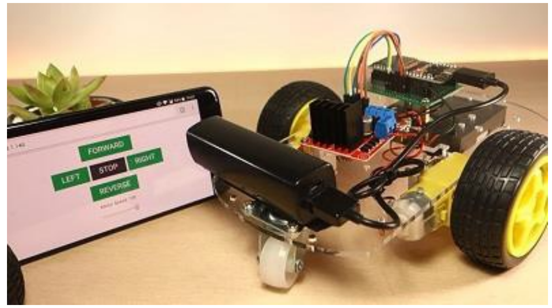
ESP32 Projects

ESP32_Web_Server_with_Arduino_IDE,
Rui Santos & Sara Santos

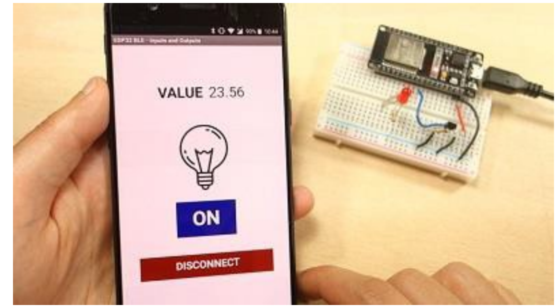
https://randomnerdtutorials.com/esp32-web-server-arduino-ide/



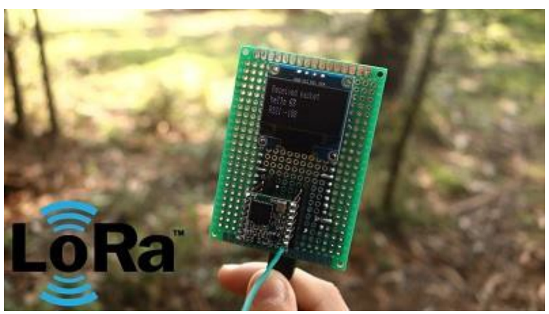
ESP32 Wi-Fi Multisensor – Temperature, Humidity,
Motion, Luminosity, and Relay Control



Remote Controlled Wi-Fi Car Robot

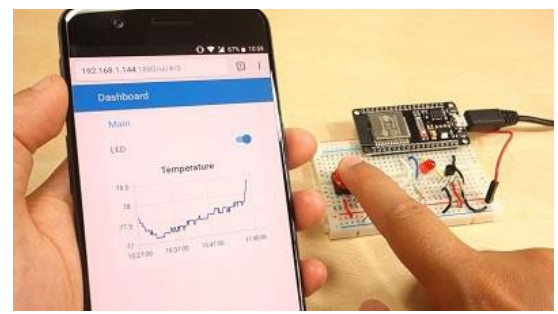


Bluetooth Low Energy (BLE) Android Application with MIT App Inventor – Control Outputs and Display Sensor Readings



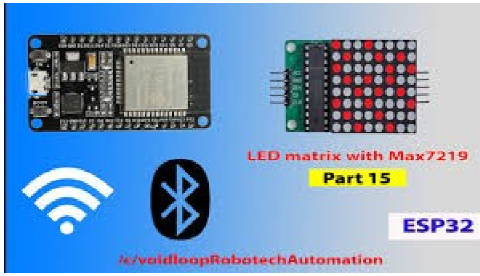
LoRa Technology with the ESP32

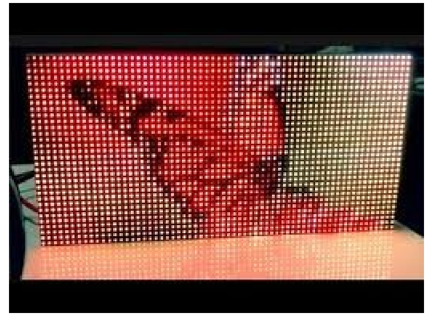
LoRa Long Range Sensor Monitoring – Reporting Sensor Readings from Outside: Soil Moisture and Temperature

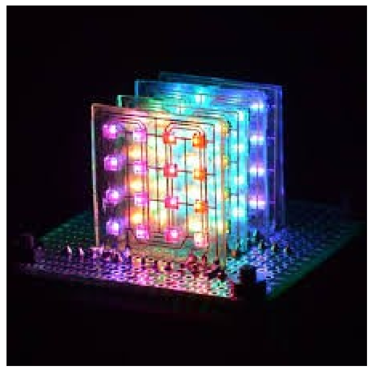


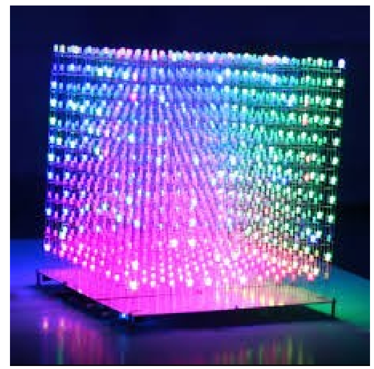
ESP32 with MQTT

ESP32 Projects – Led Matrix

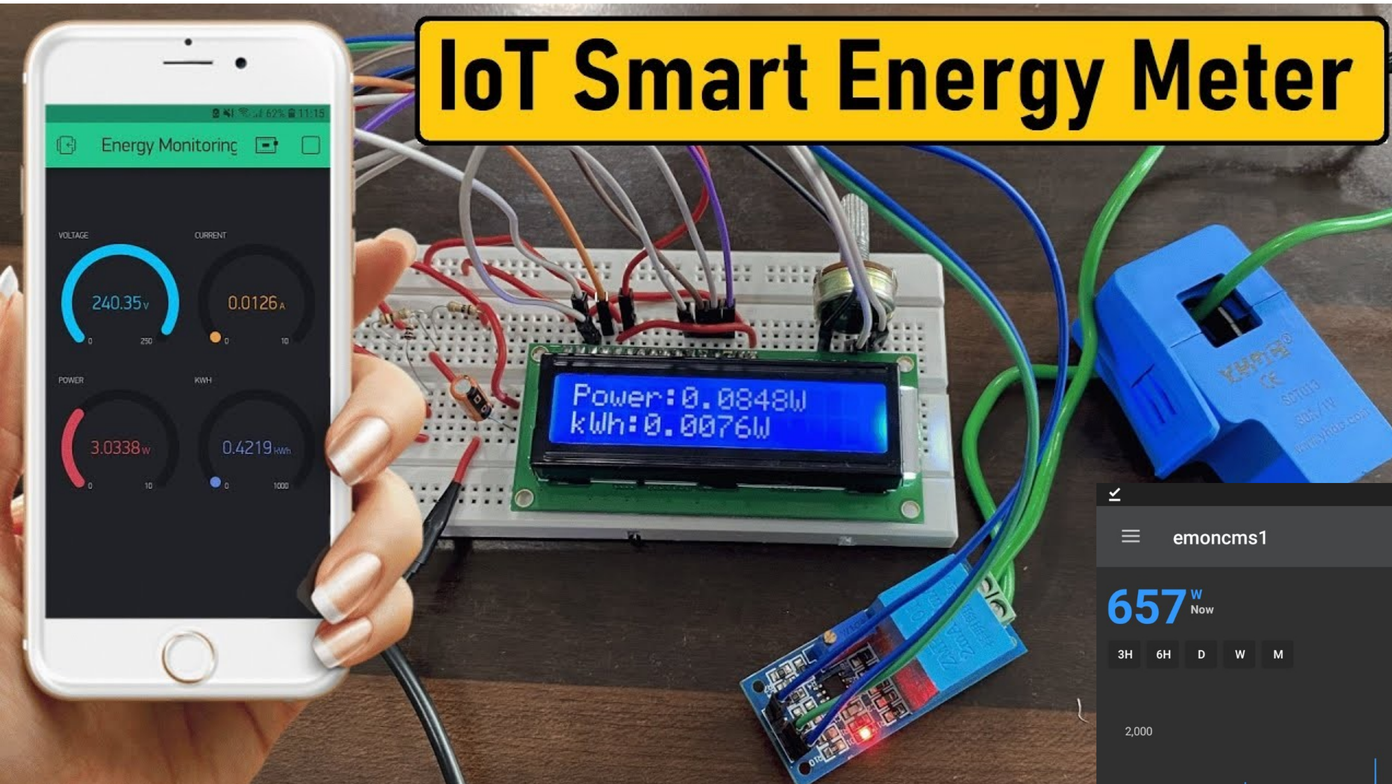


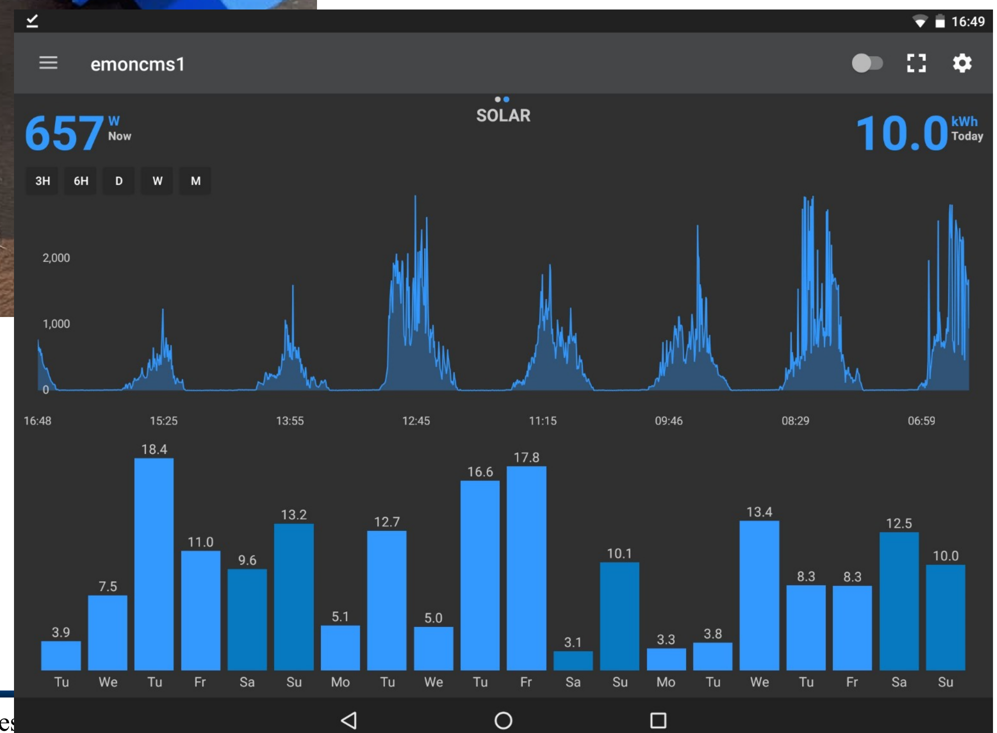






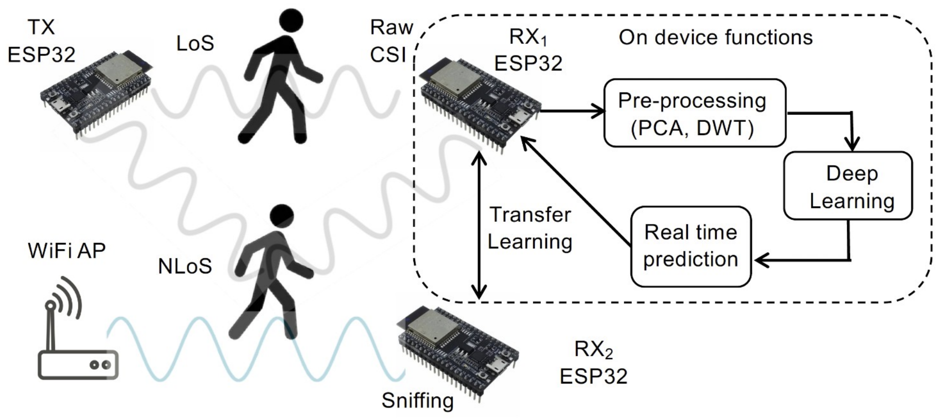
ESP32 Projects – Energy Meter



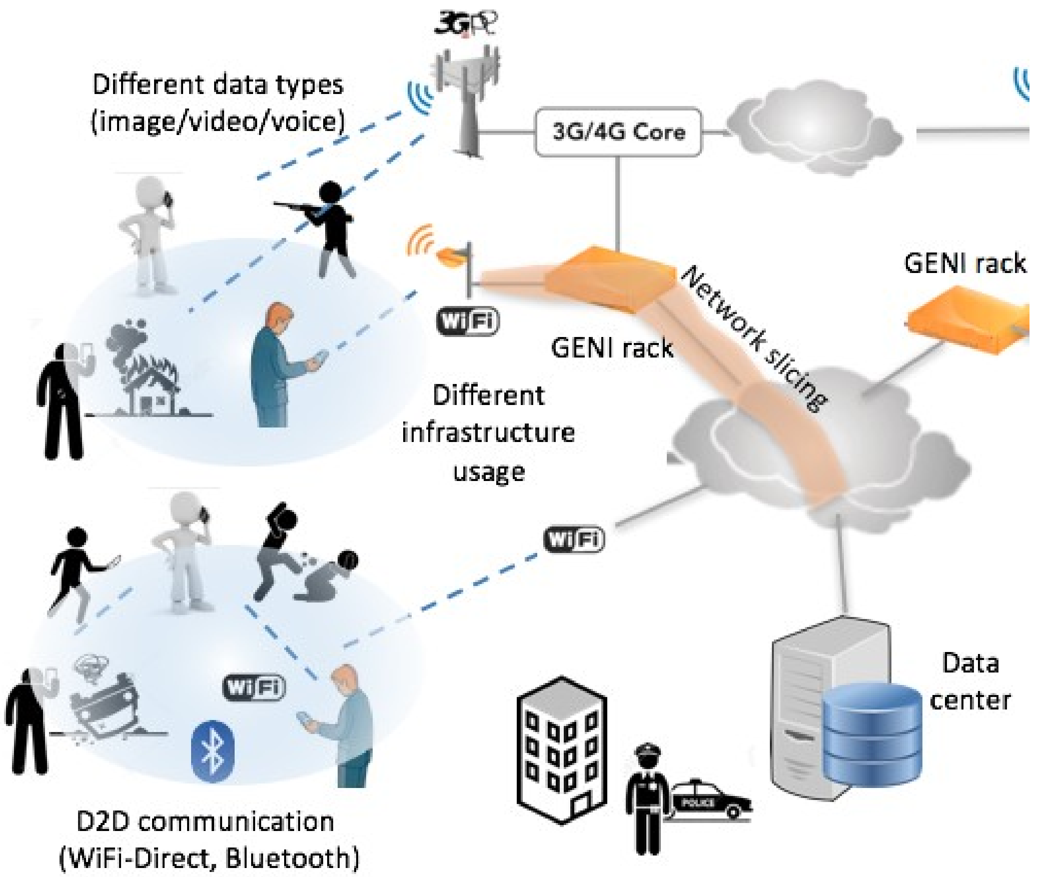


ESP32 Projects – http://www.people.vcu.edu/~ebulut/research.html

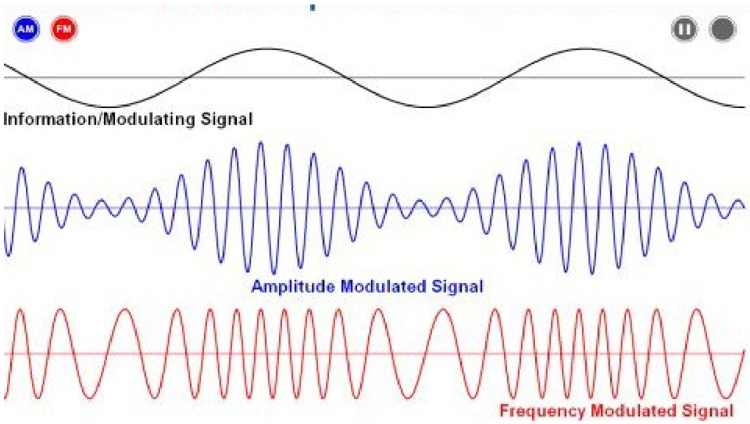
Rapid and Resilient Critical Data Sourcing for Public Safety and Emergency Response



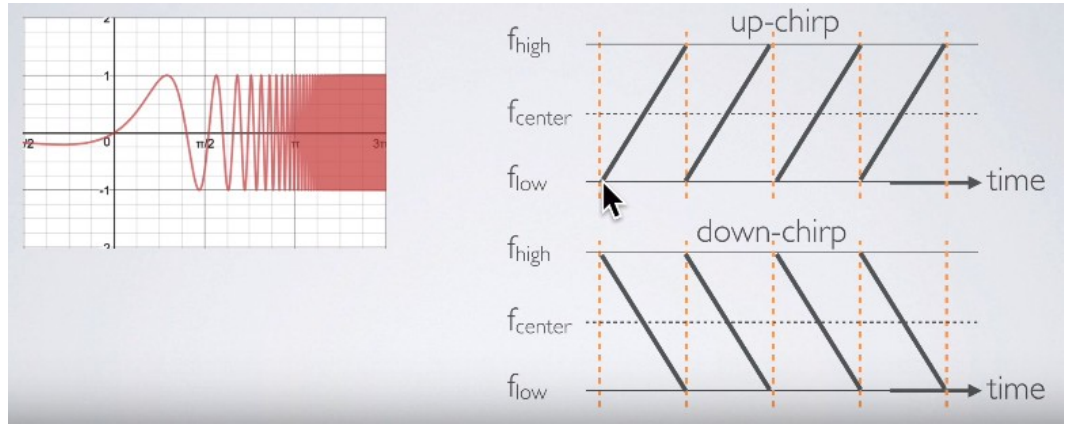
Device-Free WiFi Sensing based Occupancy Detection in Buildings



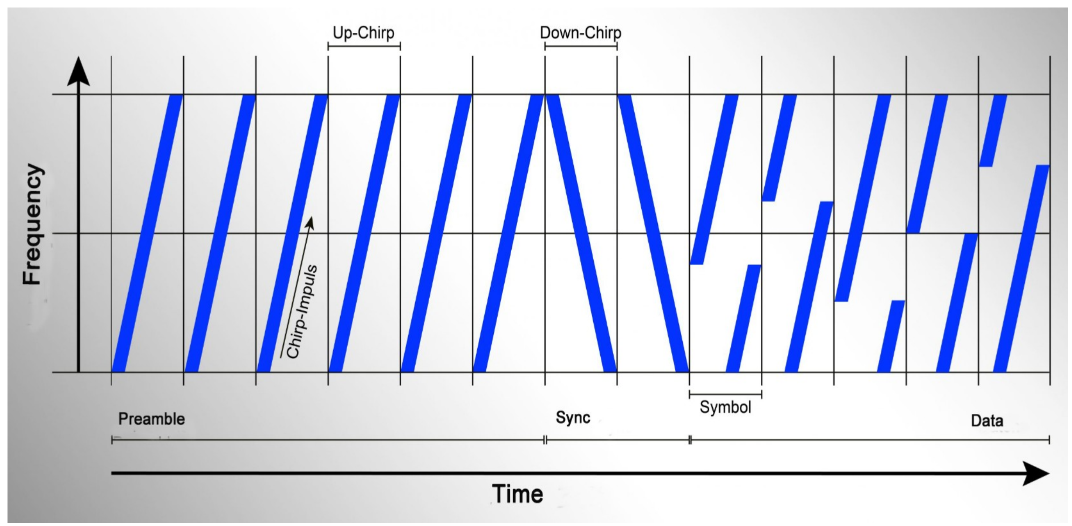
LoRa



AM
FM
Information/Modulating Signal
Amplitude Modulated Signal
Frequency Modulated Signal

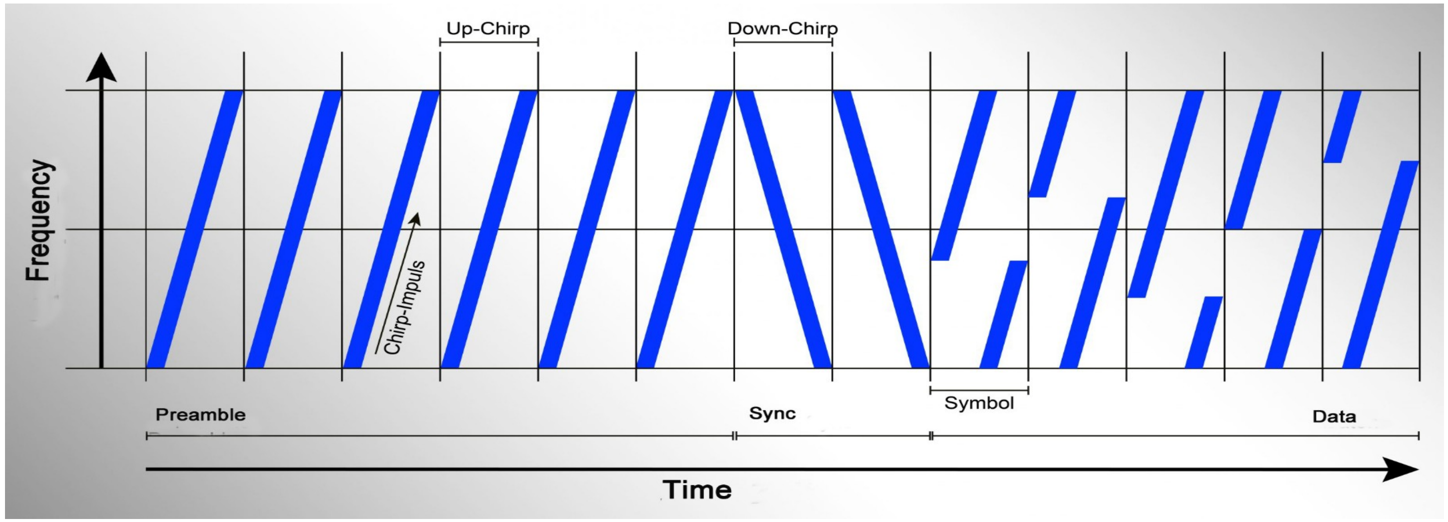


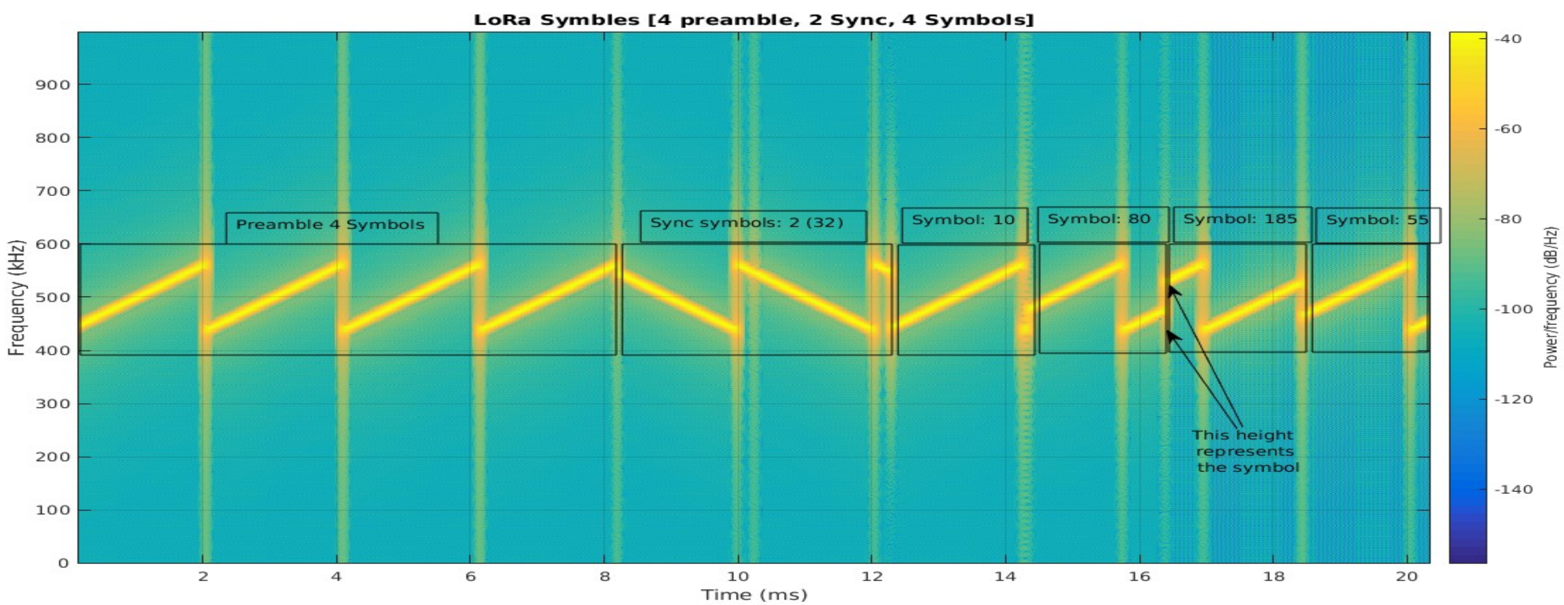
up-chirp
f_{high}
f_{center}
f_{low}
time
down-chirp
f_{high}
f_{center}
f_{low}
time



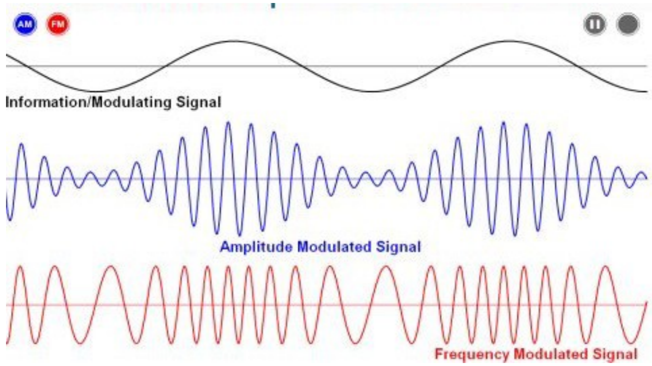
Up-Chirp
Down-Chirp
Frequency
Chirp-Impuls
Symbol
Preamble
Sync
Data
Time

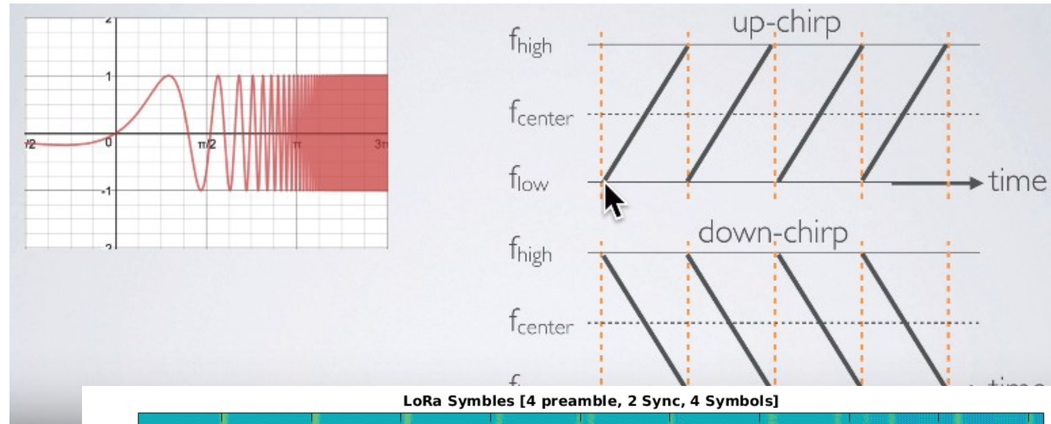
LoRa

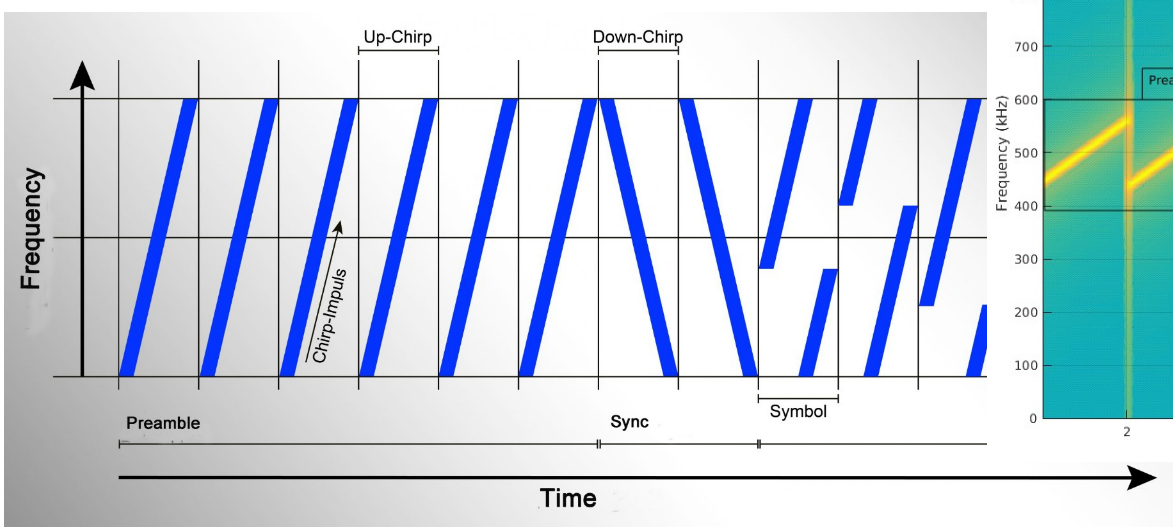

Up-Chirp
Down-Chirp
Frequency
Chirp-Impuls
Symbol
Preamble
Sync
Data
Time

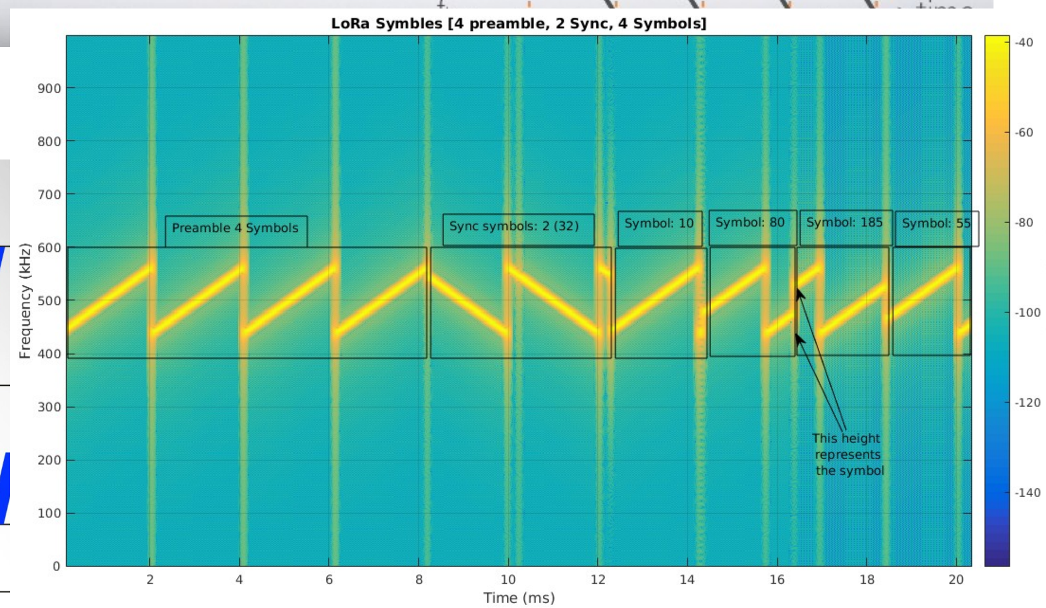

LoRa Symbles [4 preamble, 2 Sync, 4 Symbols]
Preamble 4 Symbols
Sync symbols: 2 (32)
Symbol: 10
Symbol: 80
Symbol: 185
Symbol: 55
This height
represents
the symbol
Frequency (kHz)
Time (ms)
Power/frequency (dB/Hz)

LoRa


AM
FM
Information/Modulating Signal
Amplitude Modulated Signal
Frequency Modulated Signal


up-chirp
fhigh
fcenter
flow
time
down-chirp
fhigh
fcenter


Up-Chirp
Down-Chirp
Frequency
Chirp-Impuls
Symbol
Preamble
Sync
Time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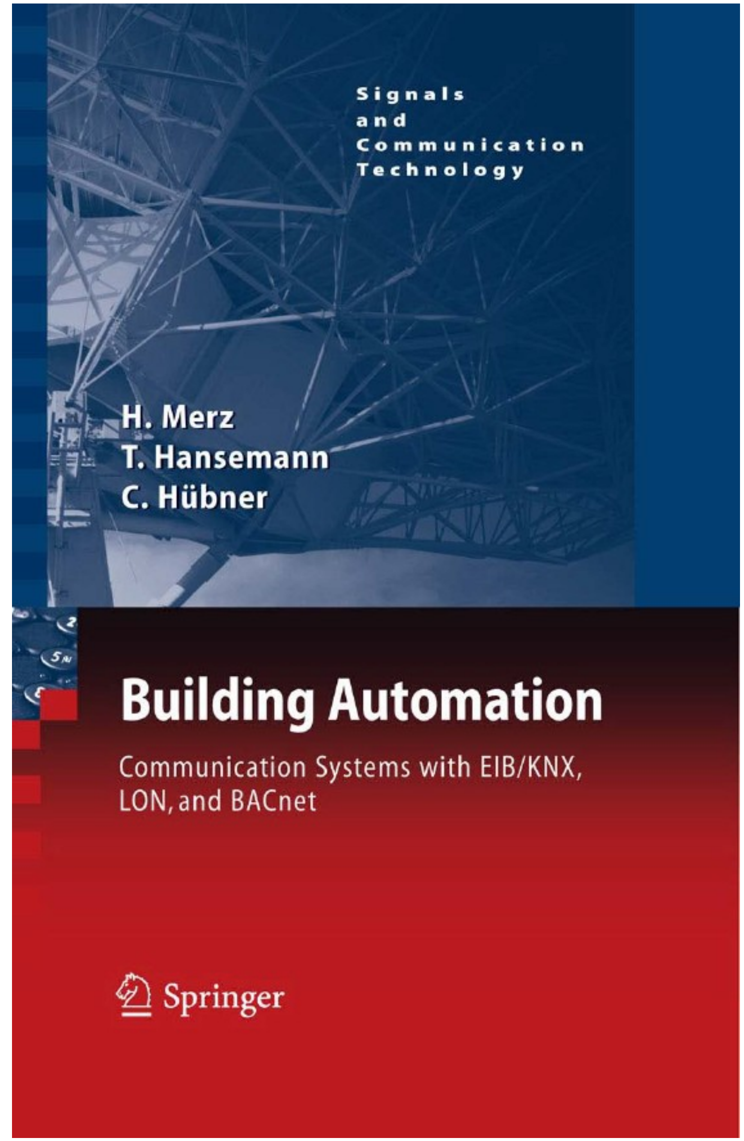
Livro Texto 1a) (Merz,2009)



As figuras utilizads nos próximos slides forma extraídas da Referência:

Merz, Hansemann, Hübner
Building Automation, 2009
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 Distribuited 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.**

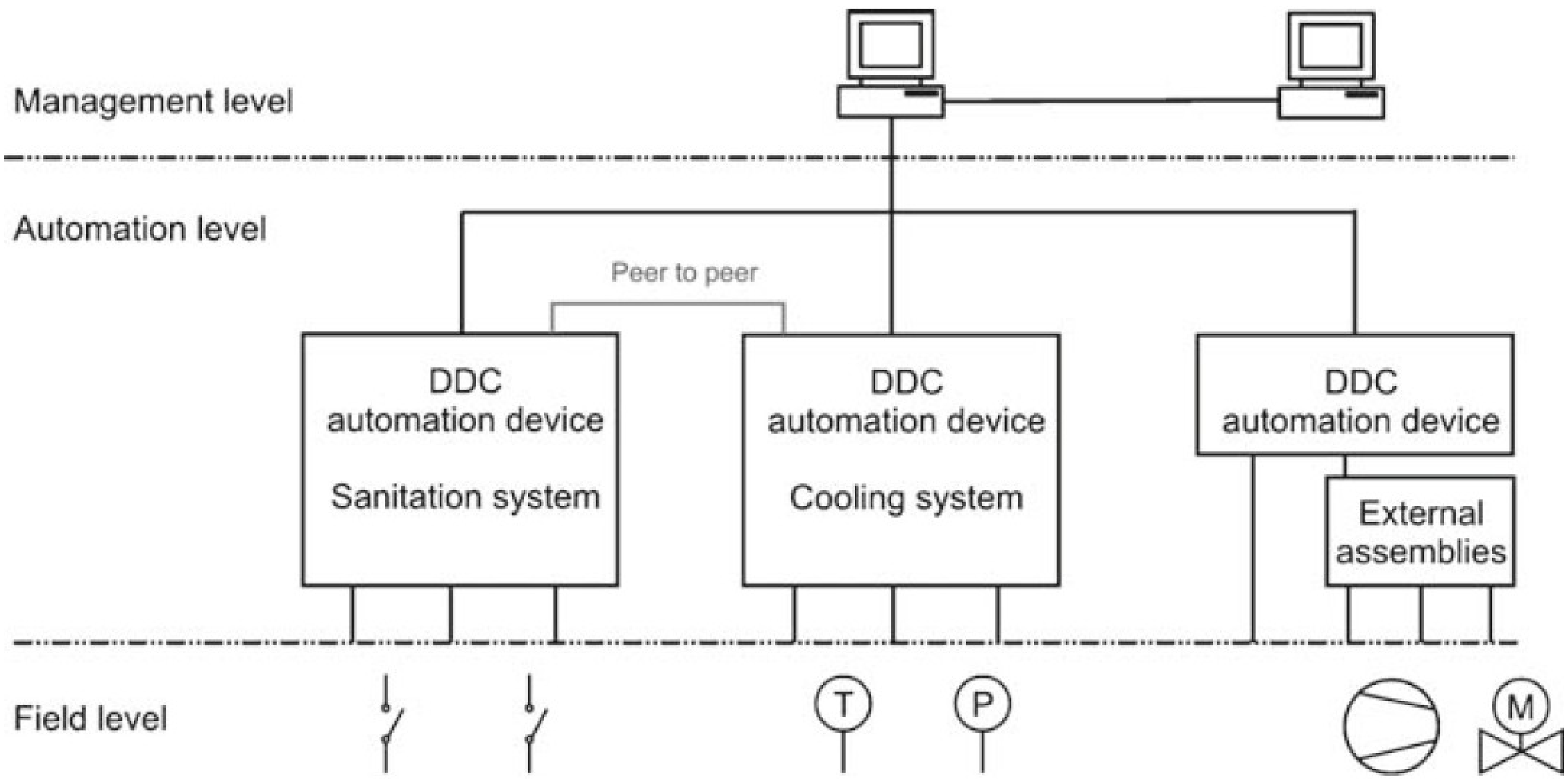
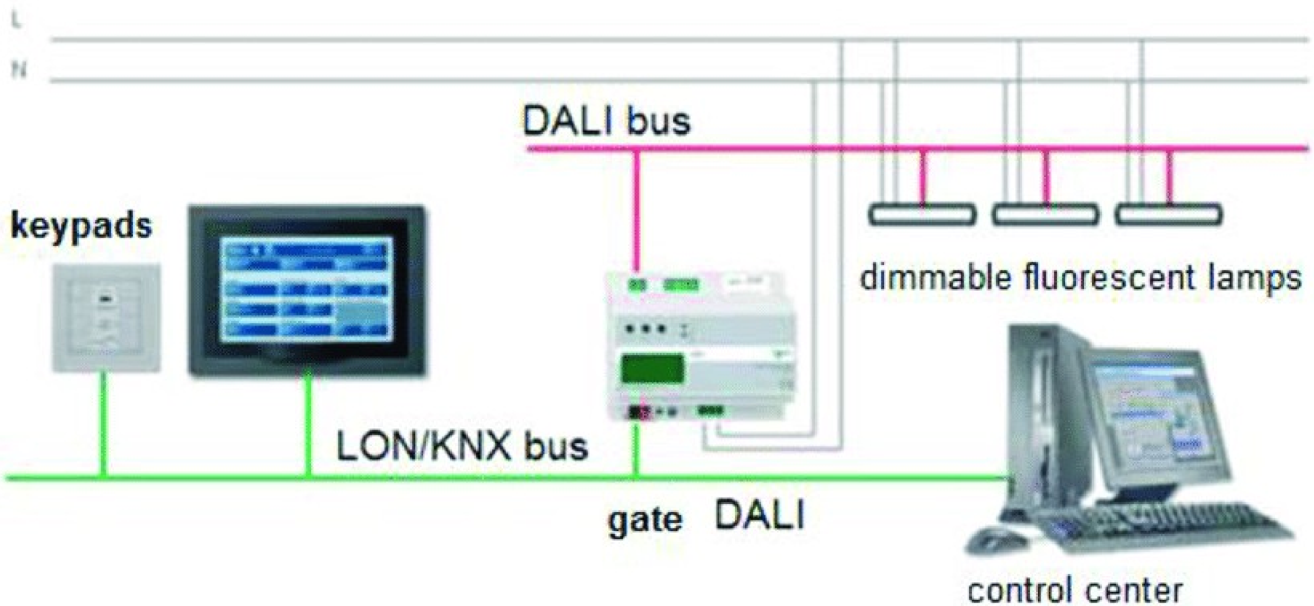


Fig. 1.4 The IT network of systems in building automation

(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.

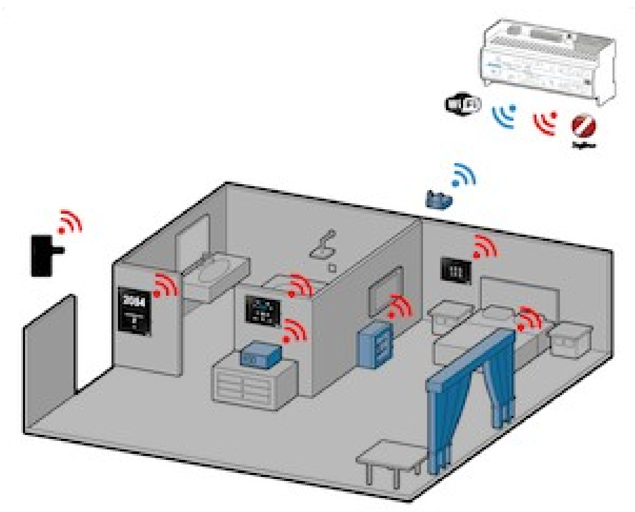
Fig. 1.5 A building control switch actuator [ELKA]



(Merz,2009) Systems in Building Control

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.



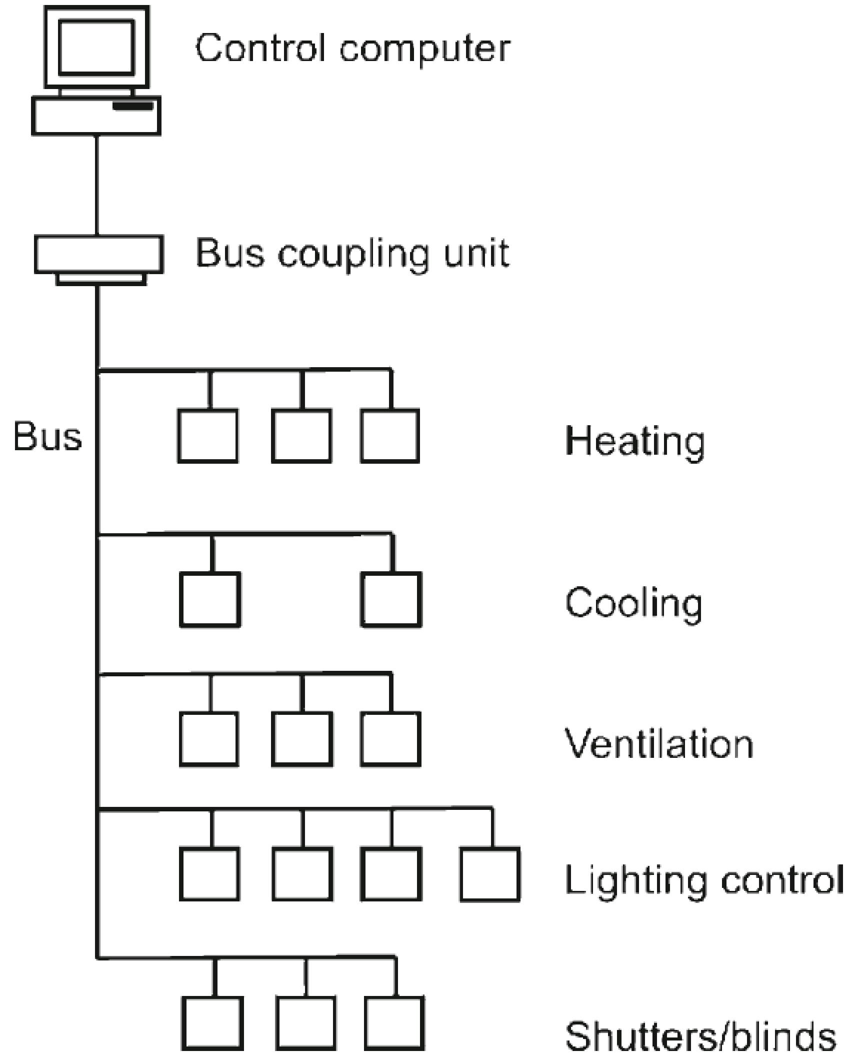


Fig. 1.6 Building control systems in a room

(Merz,2009) # Structure of Building Automation and Control Networks

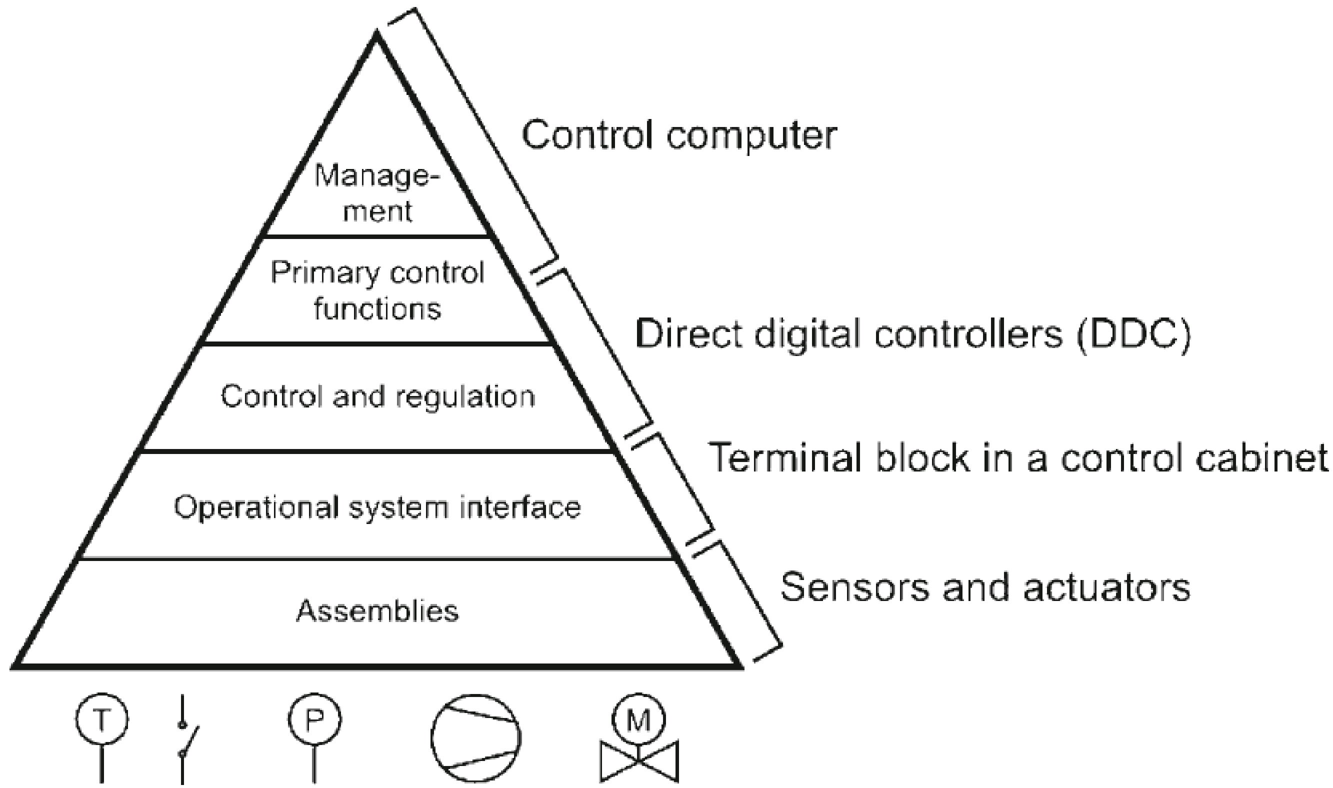


Fig. 1.7 The hierarchical structure in building automation

(Merz,2009) Sensors and Actuators

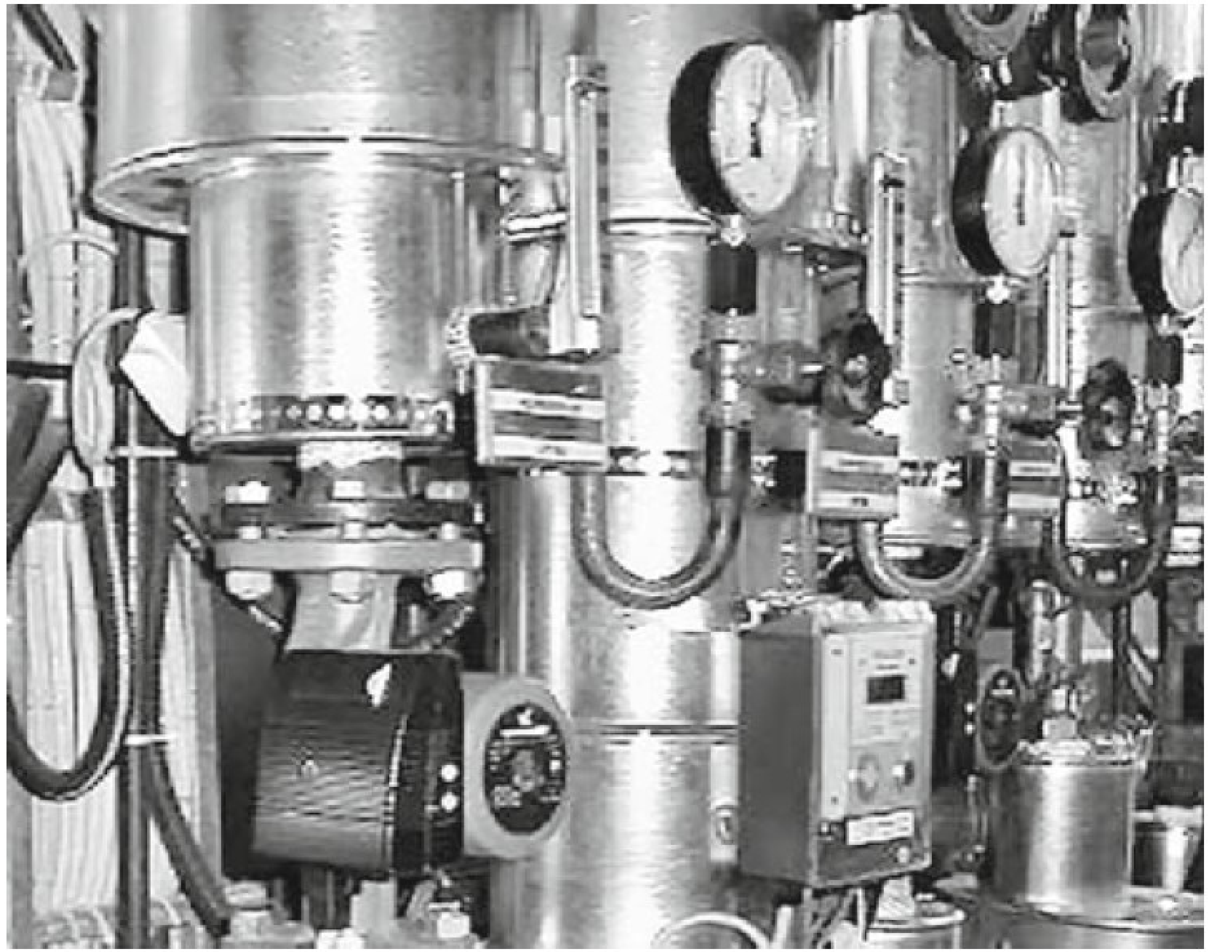


Fig. 1.8 Sensors and actuators in a ventilation system [ABB]

(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).

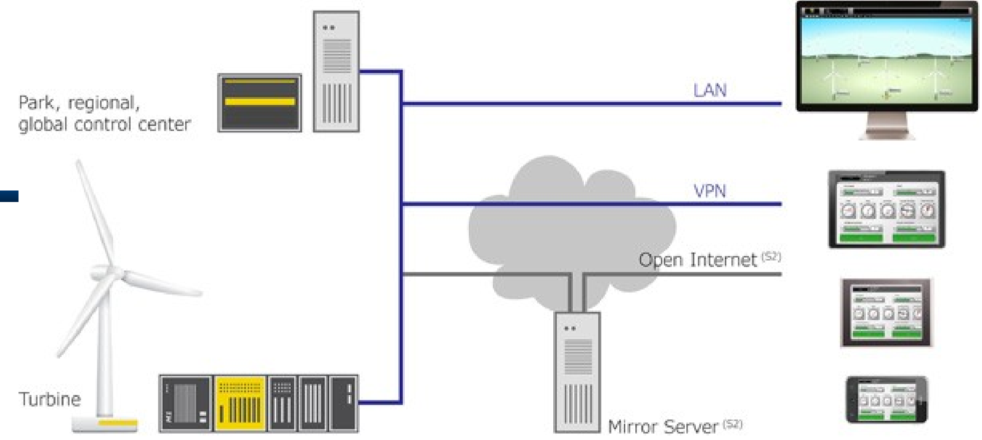
One of the wire pairs is used to transmit status messages and the other is used for transmitting sensor signals. The DDCs are mounted in a control cabinet (see Fig. 1.9), which is positioned next to the operational system interface.

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

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

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

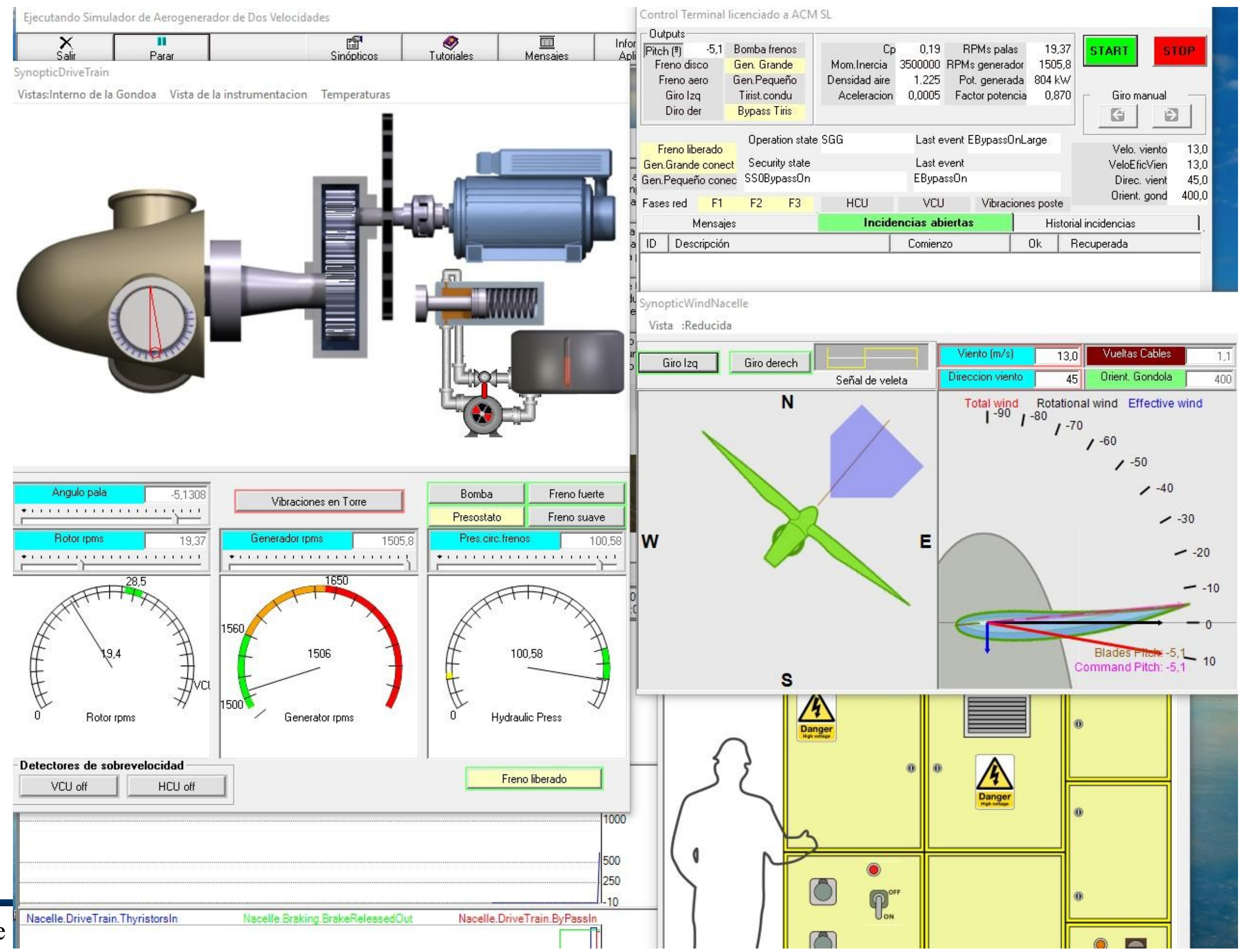
SCADA



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).



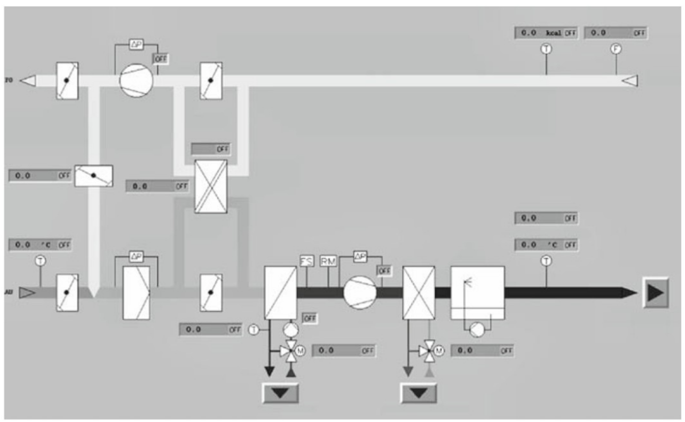


Fig. 1.10 A ventilation system displayed on a control computer

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 **)** .

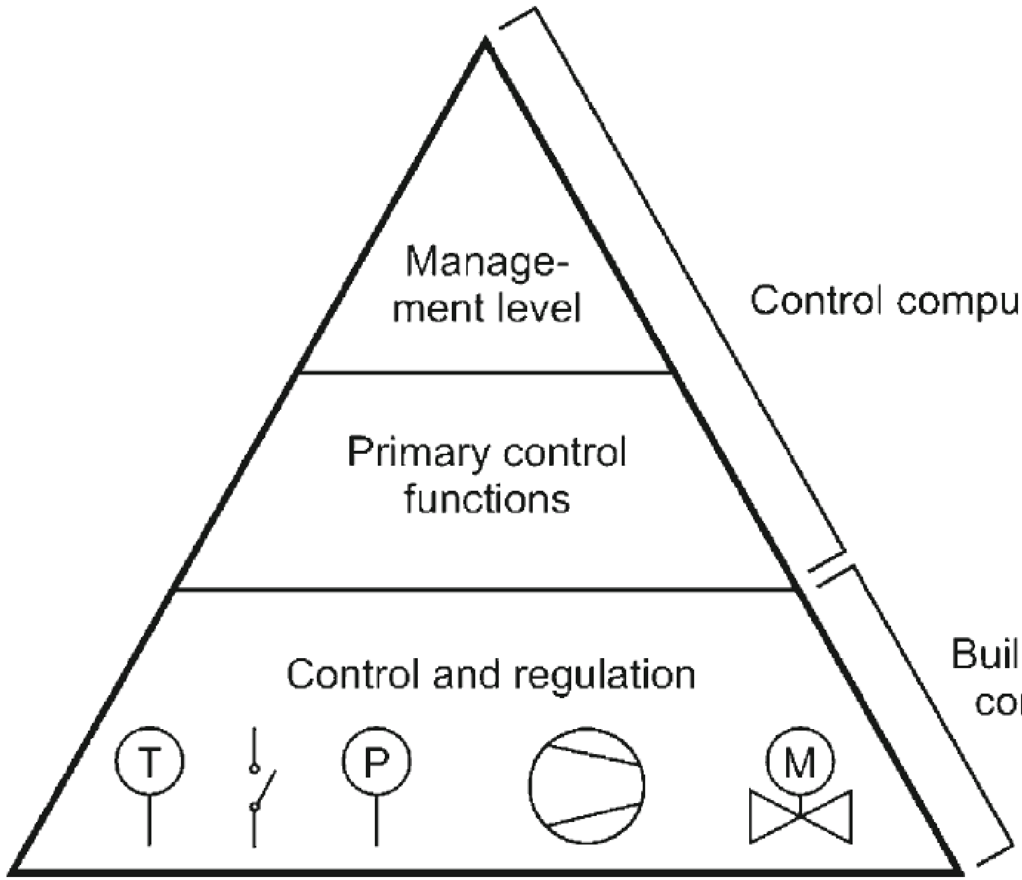


Fig. 1.11 The special hierarchical structure found in building control systems

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.

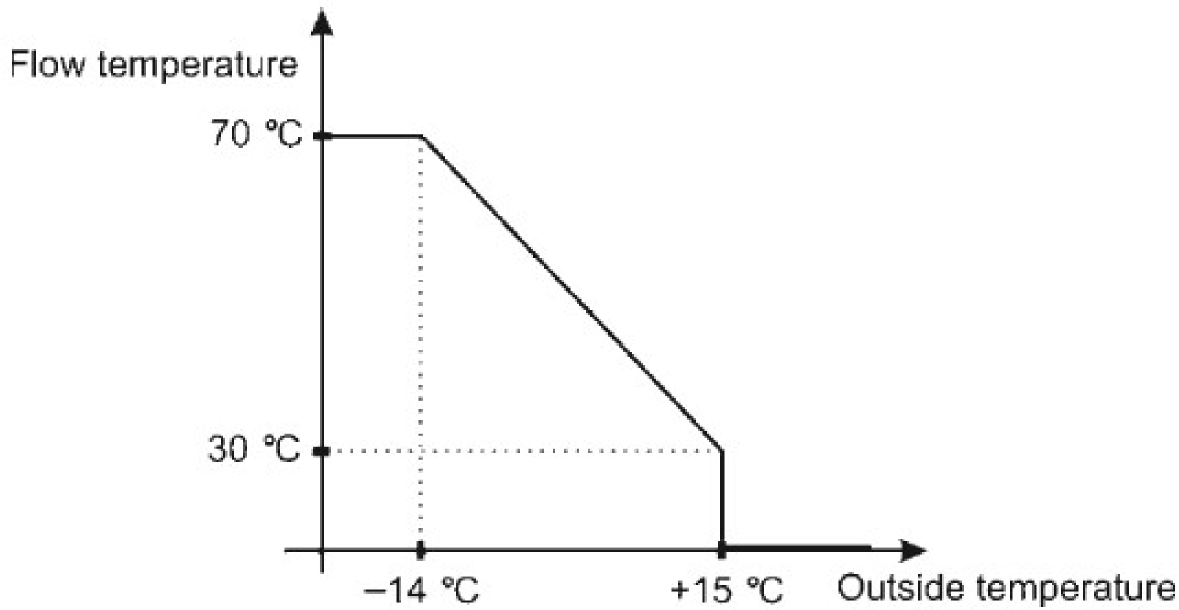


Fig. 1.13 Demand-driven setpoint adjustment

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.

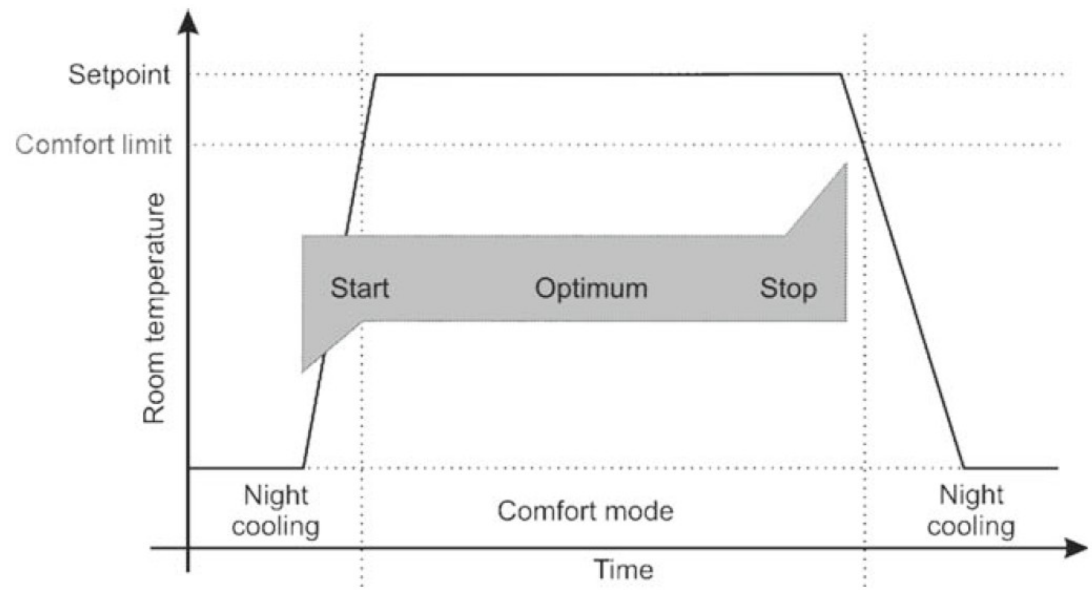


Fig. 1.14 Optimum start/stop

“Demanda Contratada”

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

e.g., Demenada Contratada com a CEB!

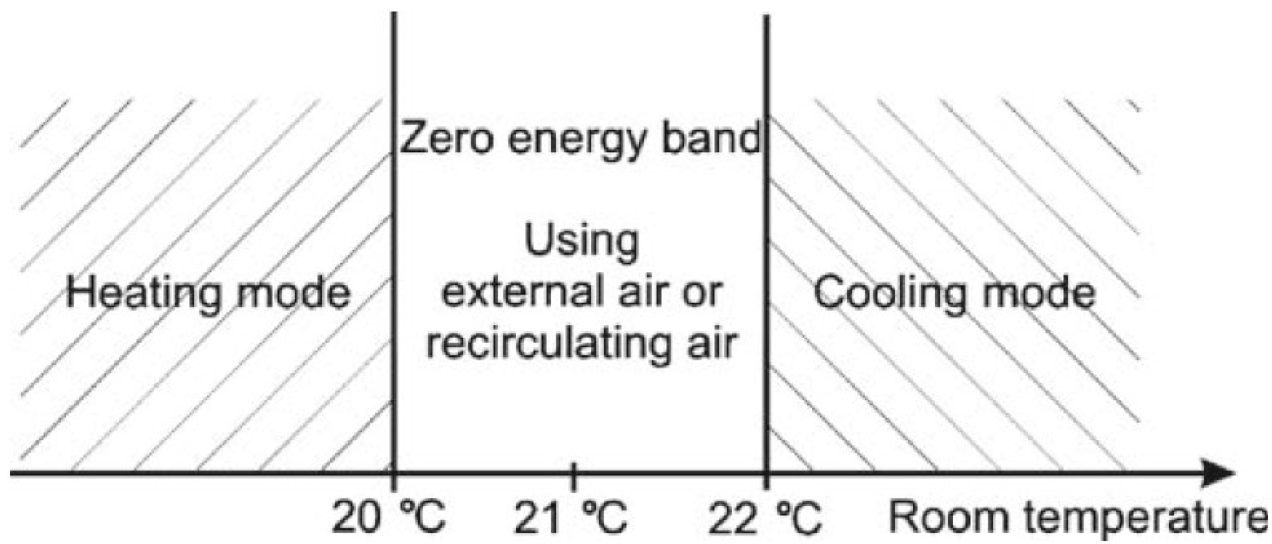


Fig. 1.15 Zero-energy band control

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

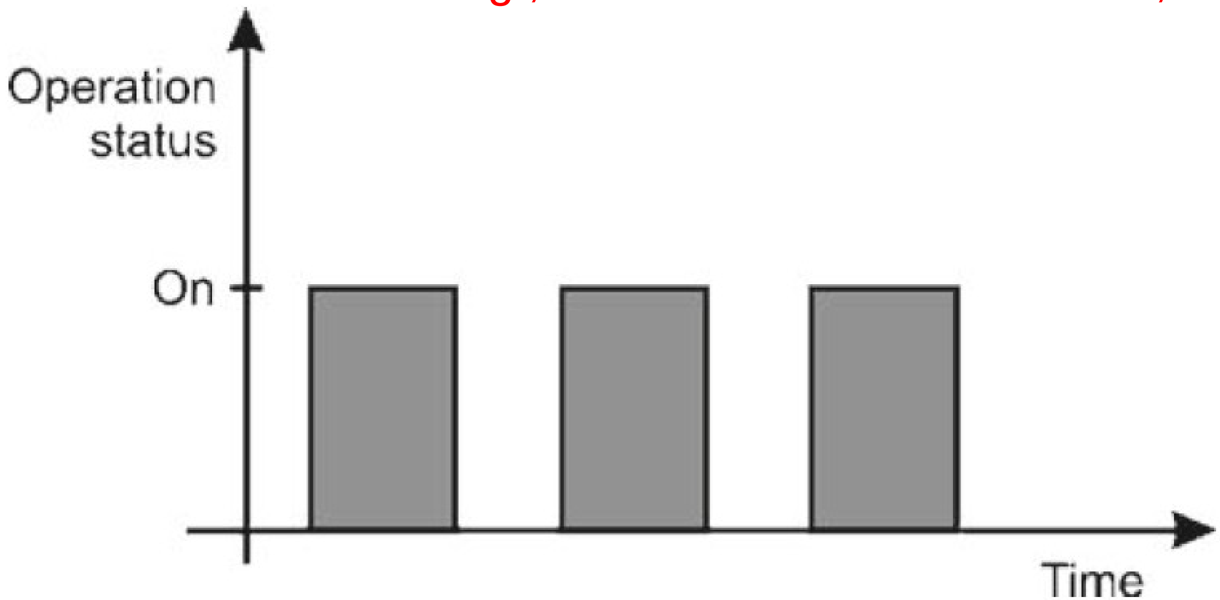


Fig. 1.16 Duty cycling

Energy Management (para demanda contratada)

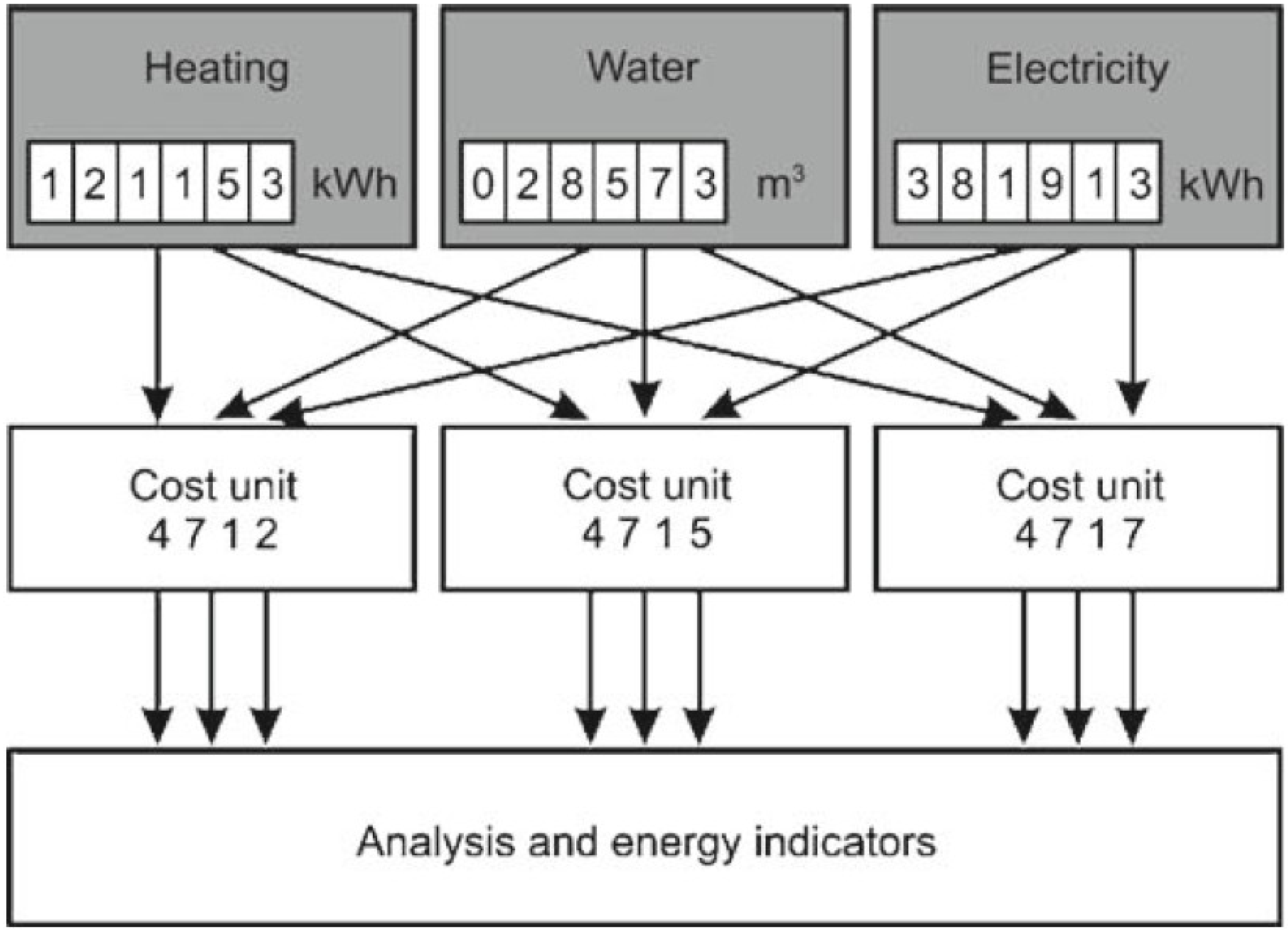


Fig. 1.17 Energy control (energy management function)

Limiting Peak Demand

Demanda contratata - Tarifação diferenciada

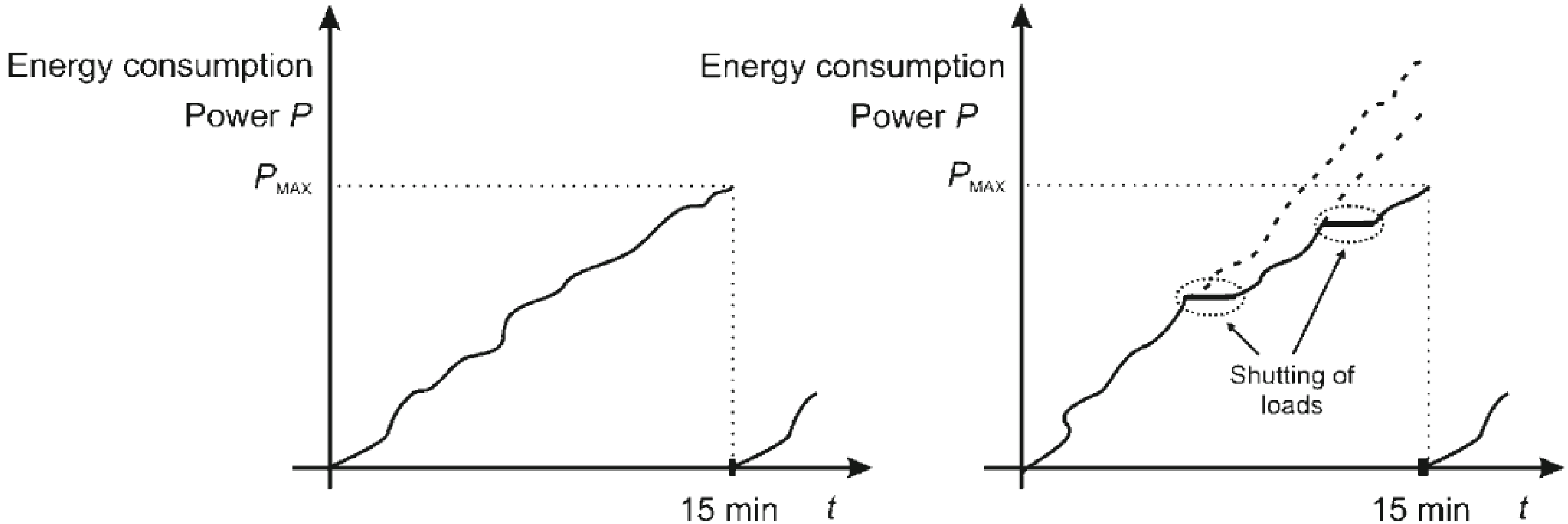


Fig. 1.18 Limiting peak load (energy management function)

Automação Predial – Merz – Cap. 1

Hierarchical structure of building automation

bus systems are used for different functions.

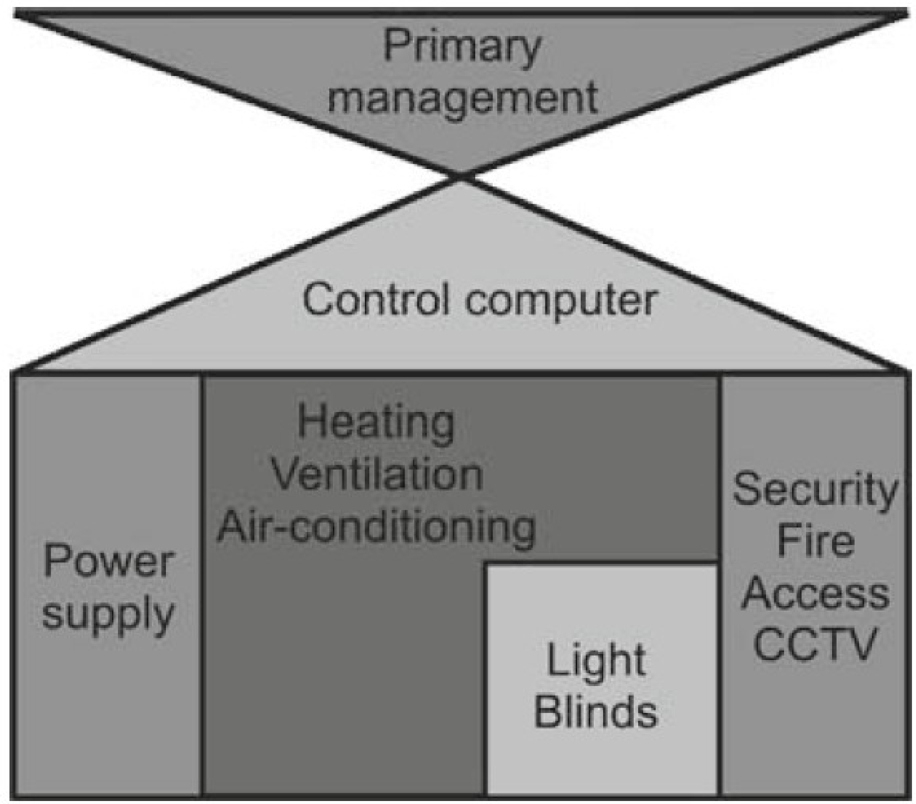


Fig. 1.19 Areas of use of bus systems and networks in a building

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.

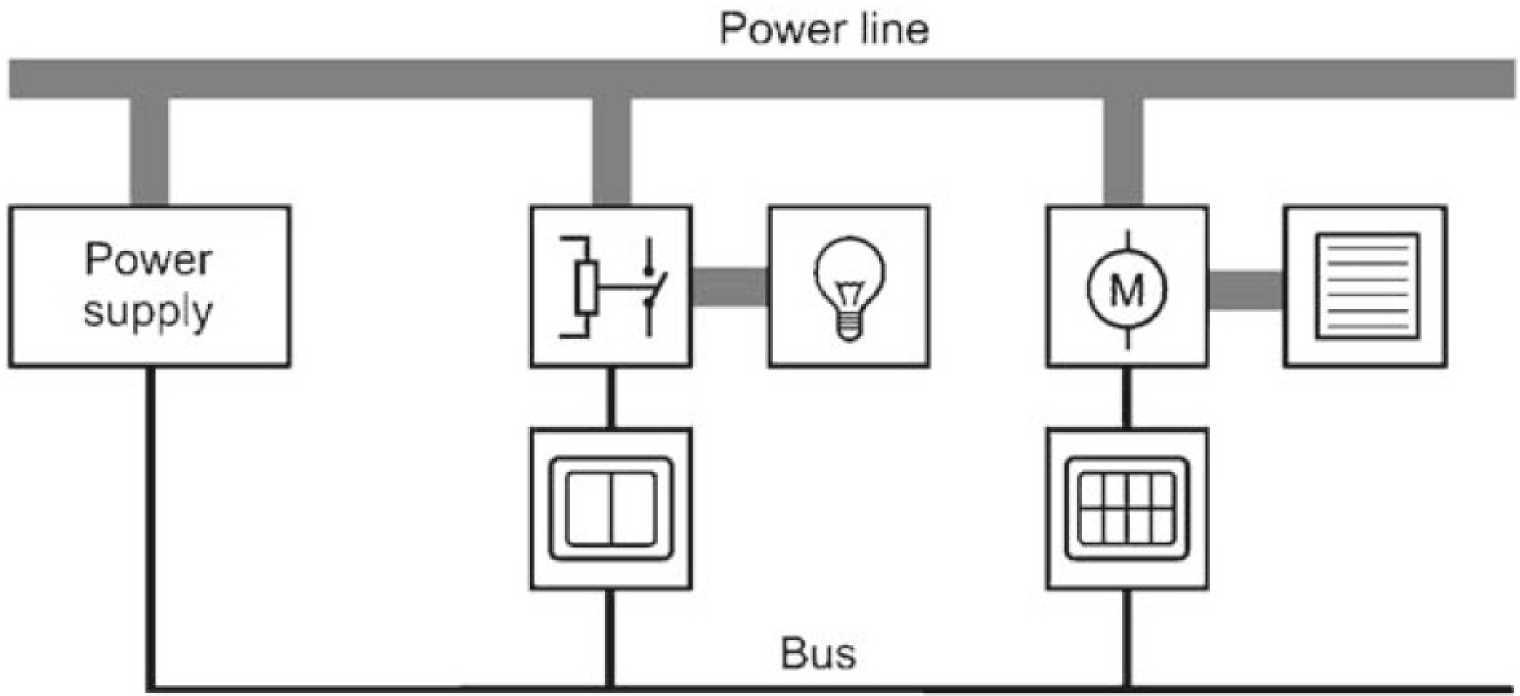


Fig. 1.20 KNX used for lighting control

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.

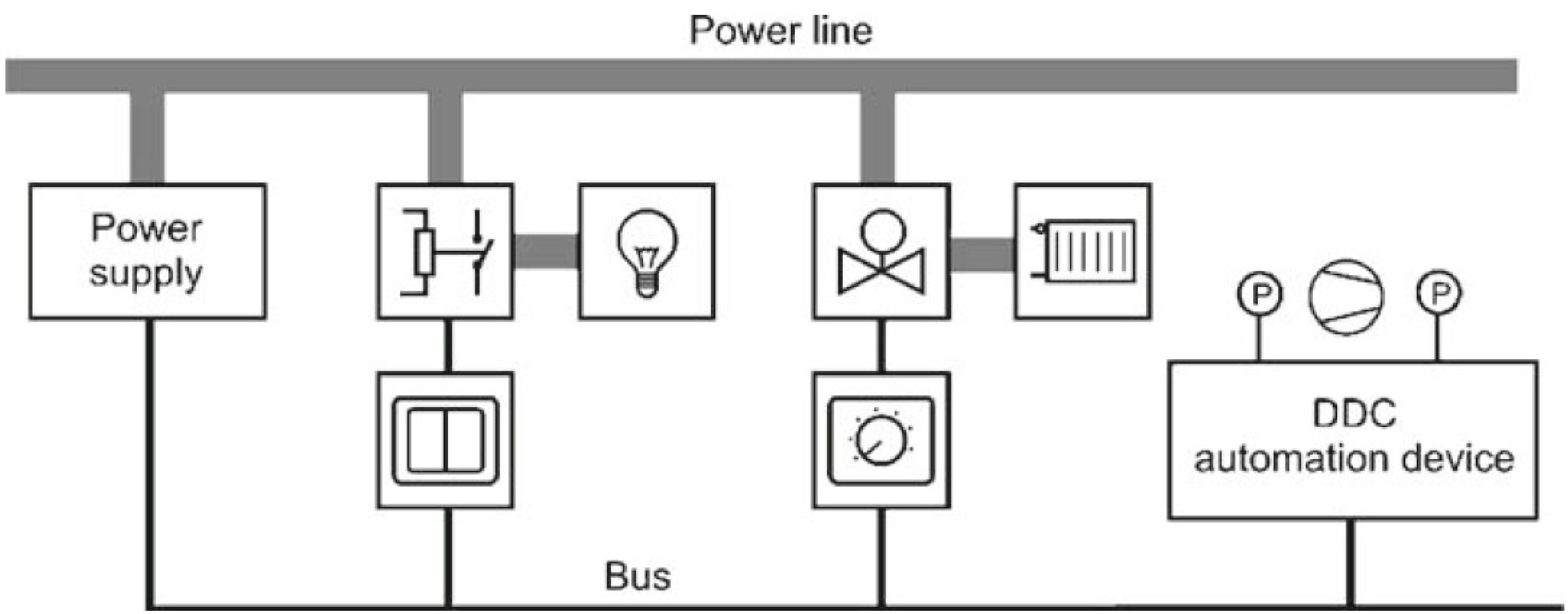


Fig. 1.21 System structure of LonWorks

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.

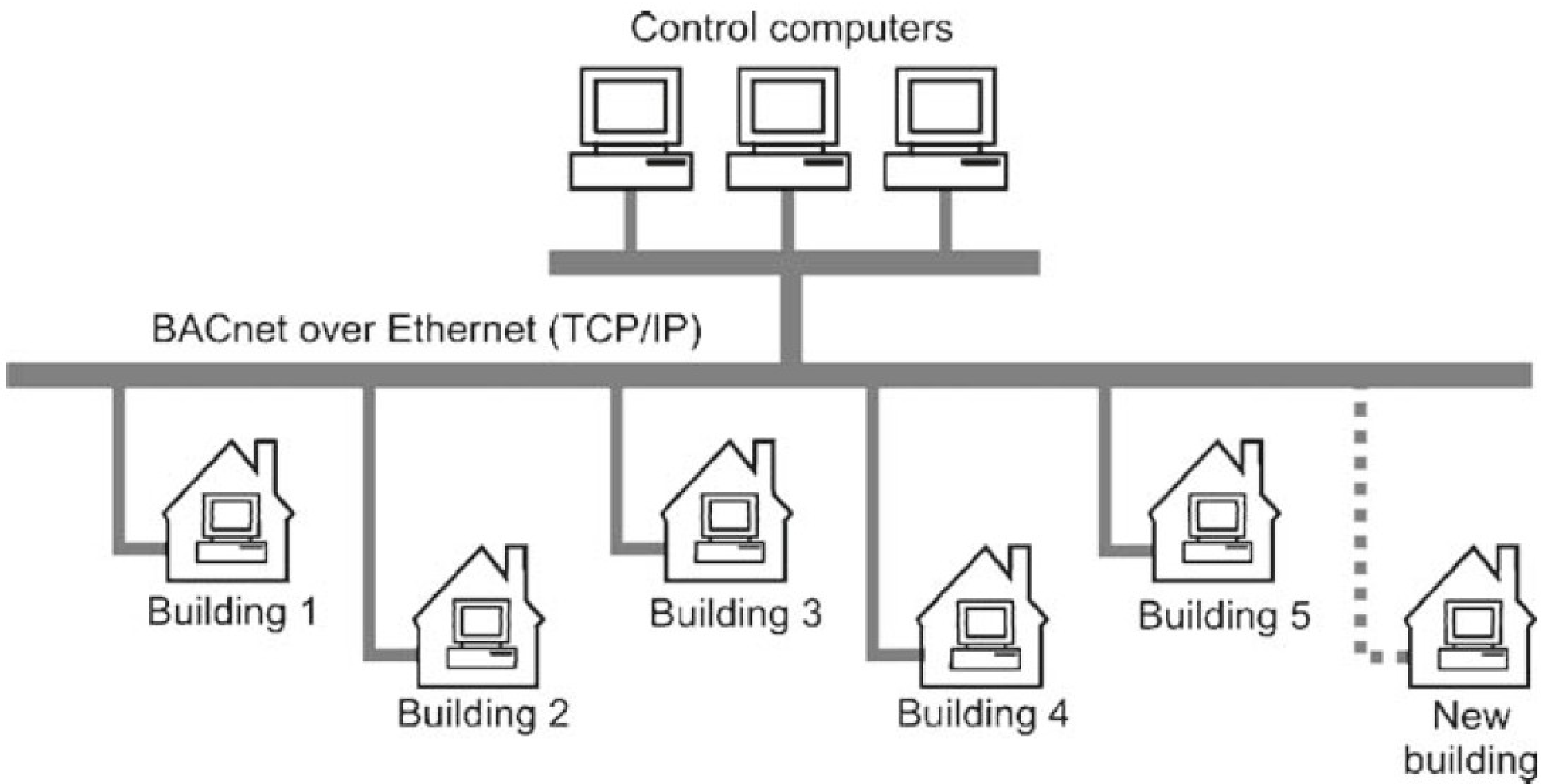


Fig. 1.22 Data exchange between remote buildings

Current Standards

Many proprietary bus systems and networks on the market, but only a few. Figure 1.23 shows the standards in 2006.

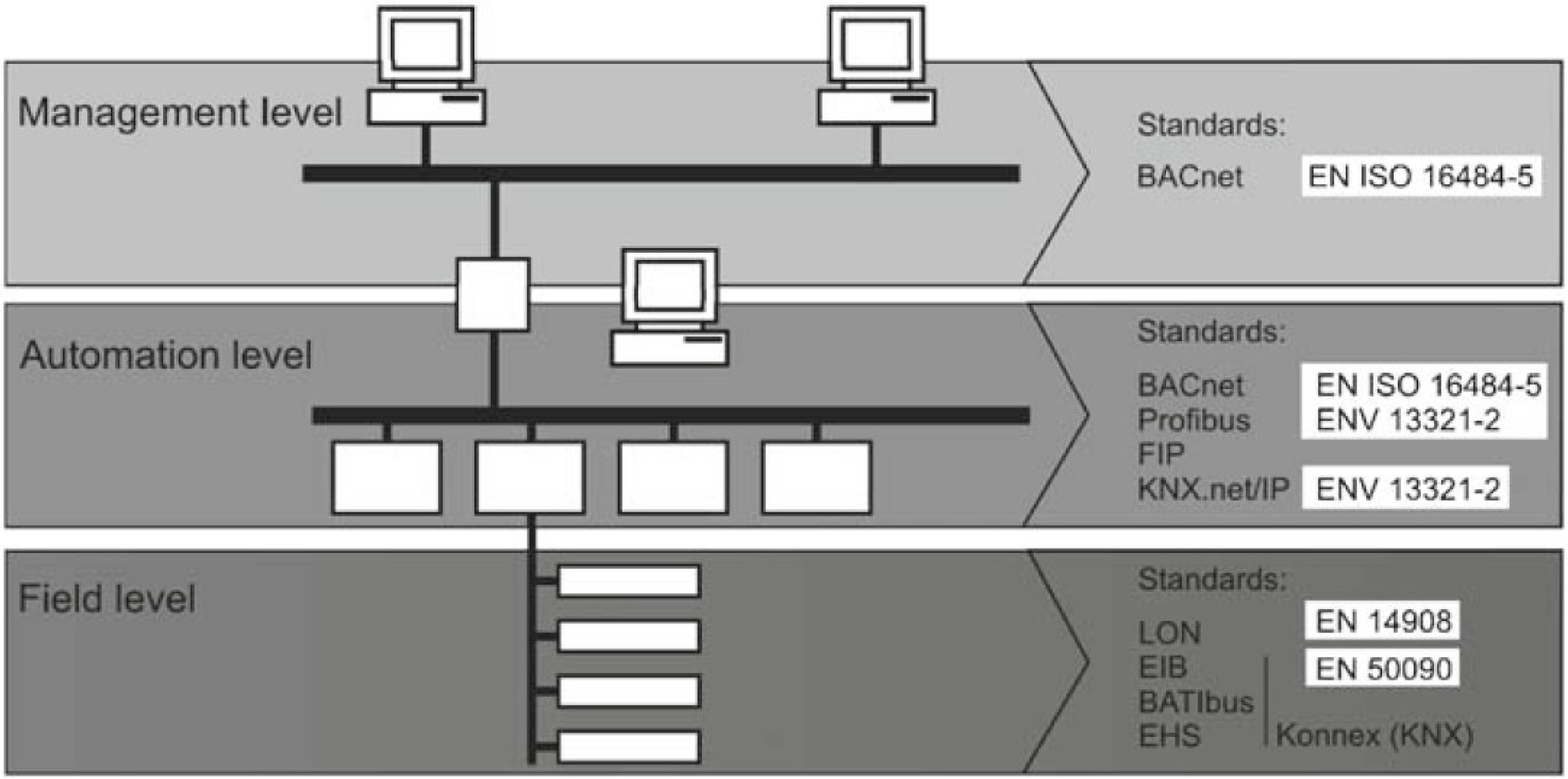
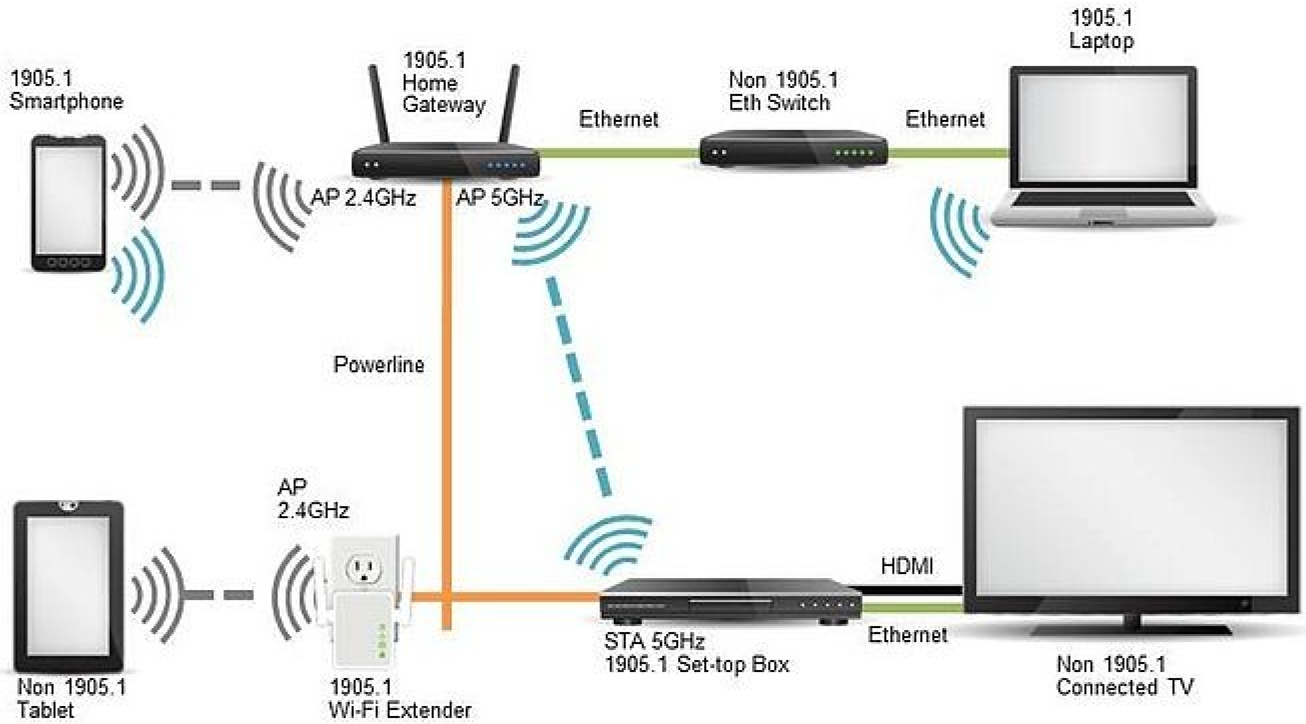


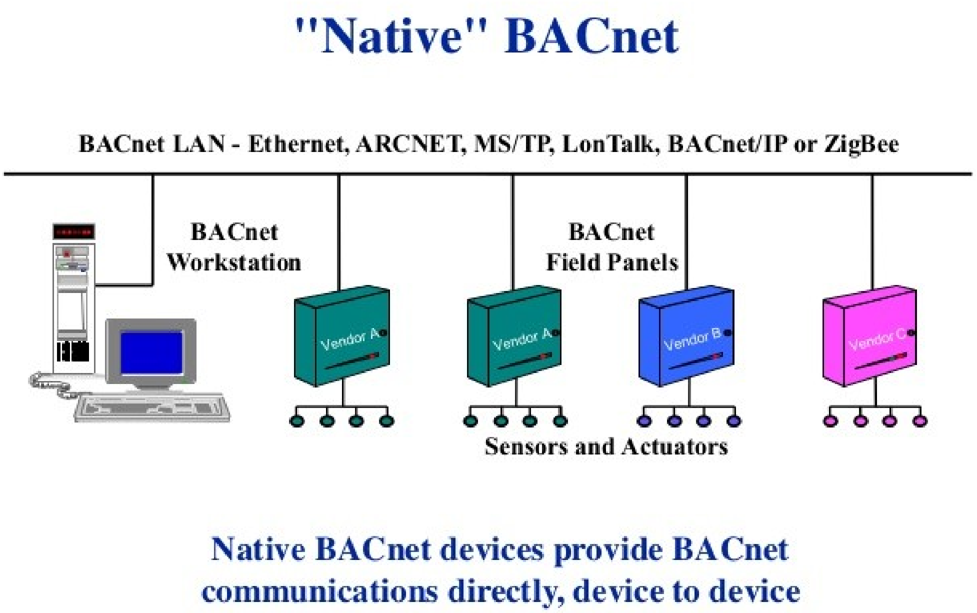
Fig. 1.23 Standardized bus systems and networks in building automation

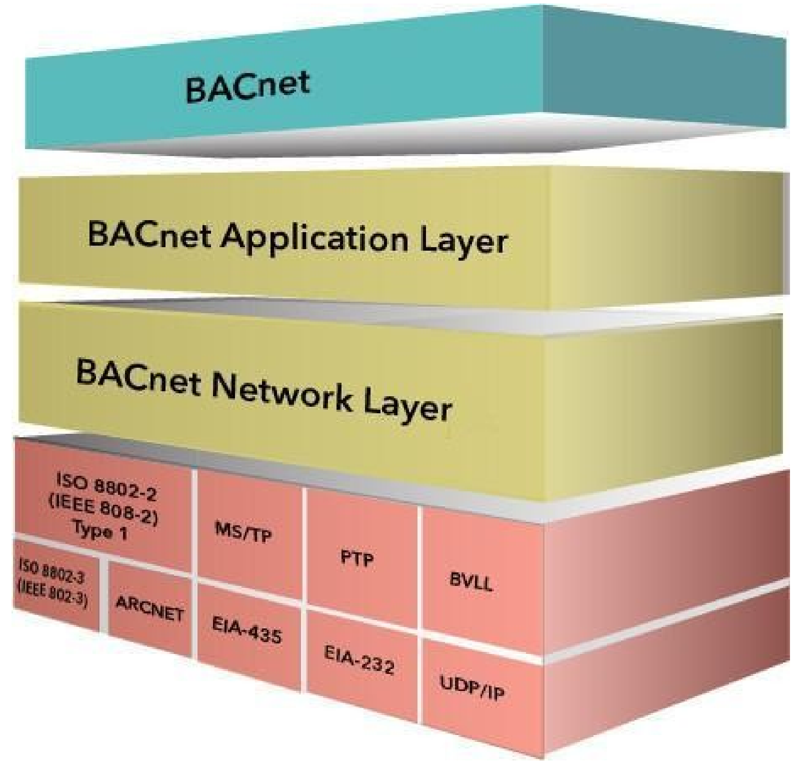
Current Standards – IEEE 1905

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.



ANSI, ISO 16484-5

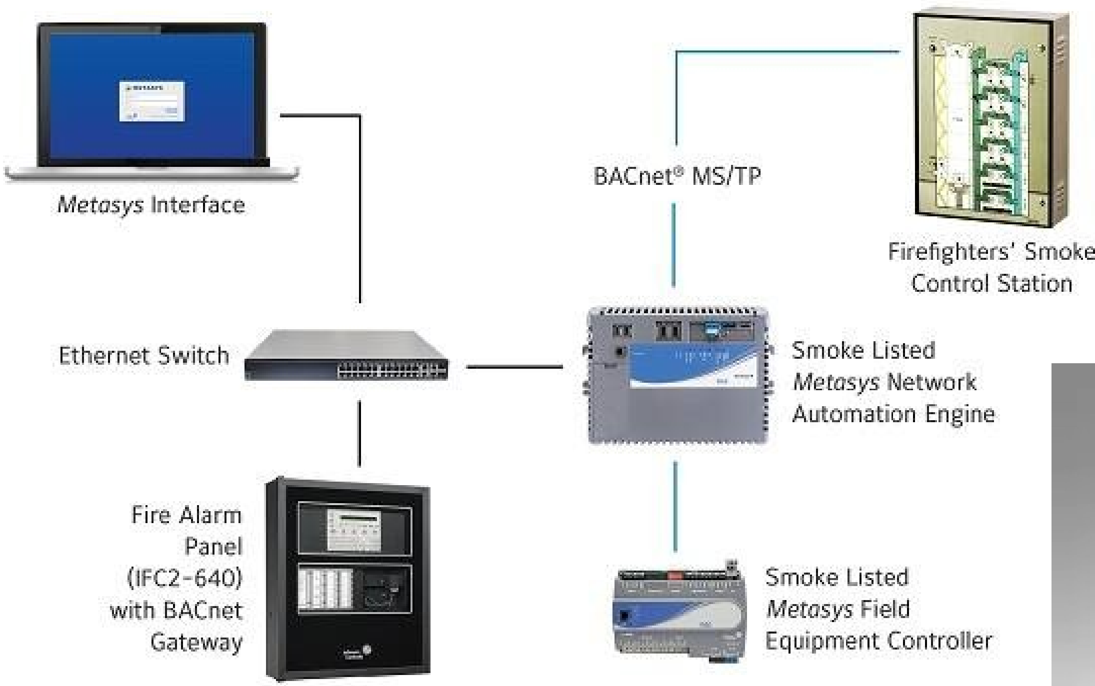




BACnet - A Data Communication Protocol for Building Automation and Control Networks.
American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE),
BACnet is an **American** national standard, a **European** standard, a national standard in more than 30 countries, and an **ISO** global standard.

Metasys

Johnson Controls



(Merz,2009)

2 The Basics of Industrial Communication Technology

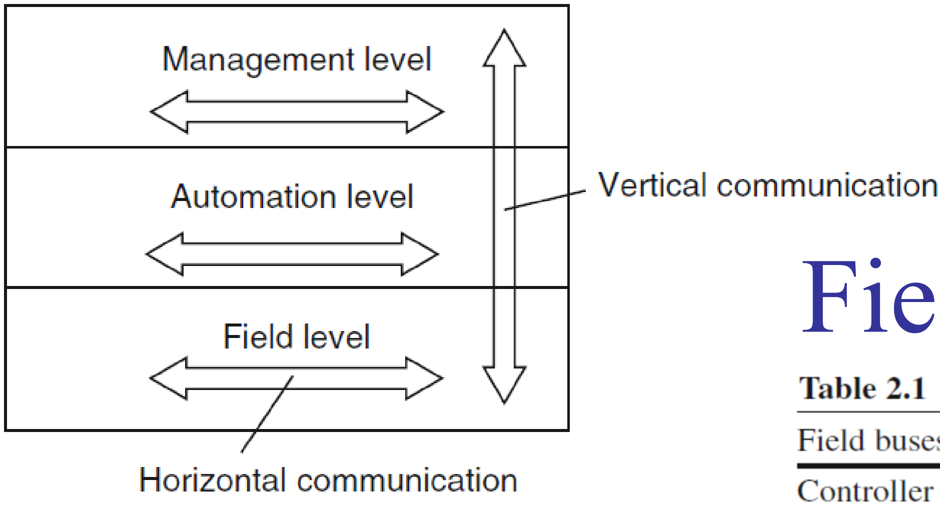


Fig. 2.1 Horizontal and vertical communication in the three-tier building automation model

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

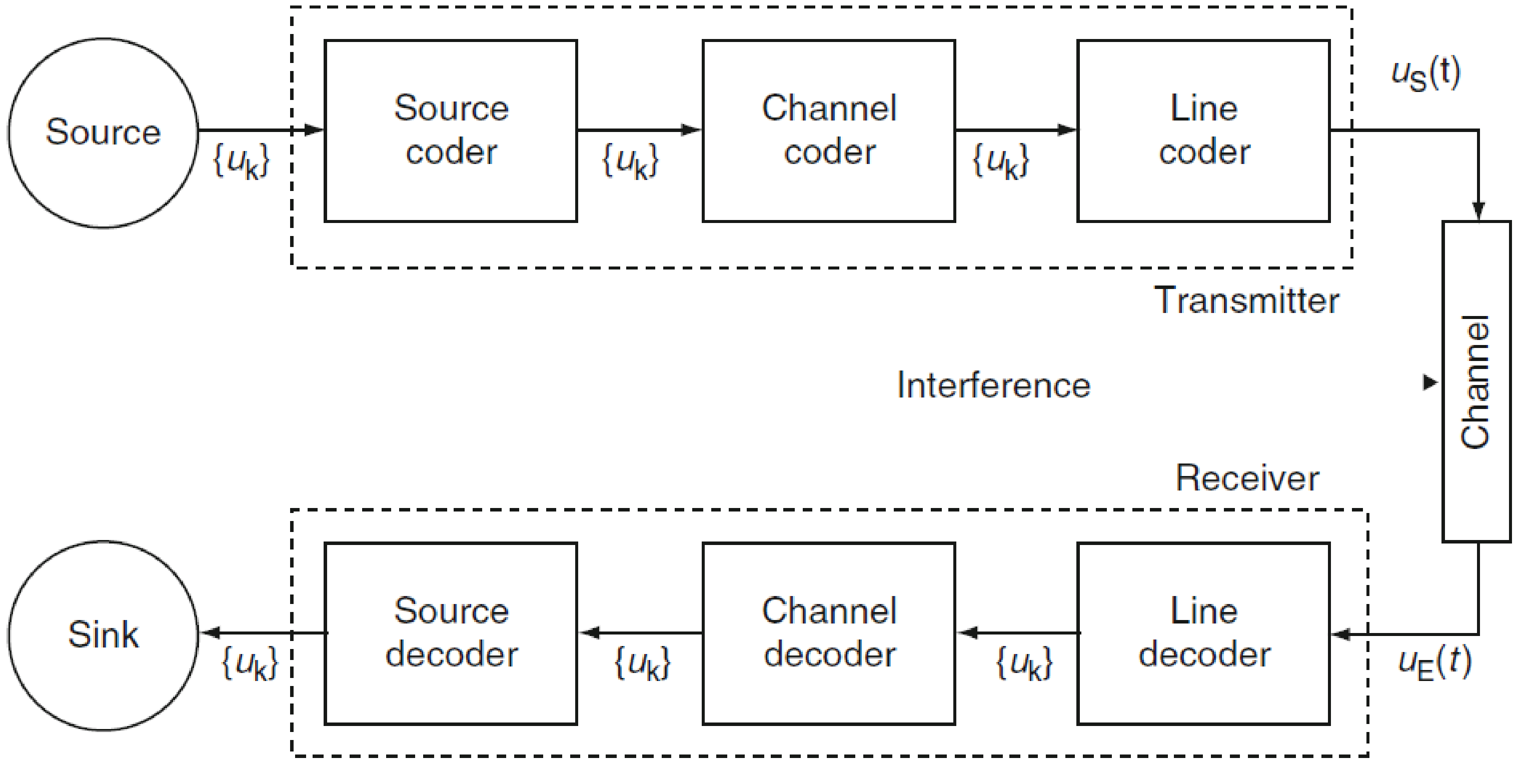


Fig. 2.2 The basic structure of a digital data transmission system

(Merz,2009)

2.2 Digital Data Transfer: Important Terms and Definitions

Table 2.5 The transmitter and receiver components and their respective tasks

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

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

+Criptography

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

Ex. Shannon-Fano source coding

Original
B C A D A
1011 1100 1010 1101 1010 (octetos)

Shannon-Fano
110 10 0 111 0

(Merz,2009)

2.2Parity Check

Parity Check

Paridade par: 0100 0011 **1**
Paridade impar: 0100 0011 **0**

Block Parity Check

10101110 *1* 01011101 *1* 11000000 *0* 01101000 *1* 01011011 *1*
45 bits are sent instead of 32 bits. (4+1)x*(8 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:

$1-0=1,\ 1-1=0,\ 0-1=1$ 0-0 = 0

Remainders are not carried (see Table 2.7)

Ex: 11 0101 1011
CRC polynomial: k=4, 1 0 0 1 1

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

```
 1 1 0 1 0 1 1 0 1 1 0 0 0 0 : 1 0 0 1 1 = 1 1 0 0 0 0 1 0 1 0
-1 0 0 1 1
   1 0 0 1 1
  -1 0 0 1 1
             1 0 1 1 0
            -1 0 0 1 1
               1 0 1 0 0
              -1 0 0 1 1
                 1 1 1 0 Remainder
```

The resultant check-bit sequence is: 1110.

Transmit:
11 0101 1011 **1110**

Receive:
11 0101 1011 1110/$_2$**10011**
= 1110

2.2 Line (canal) Coding/Decoding

NRZ

Non-Return-to-Zero

KNX

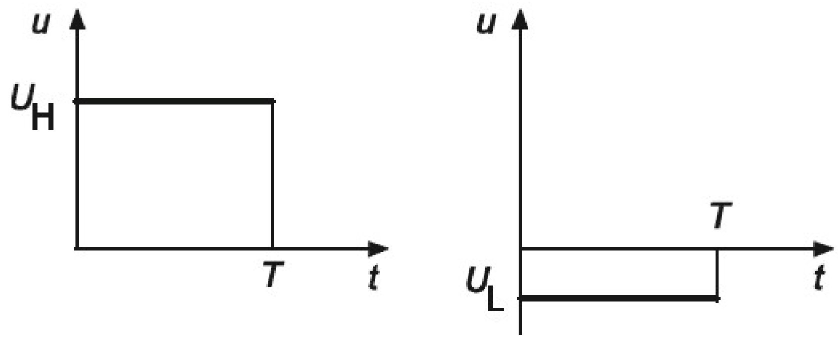


Fig. 2.3 NRZ code signal elements

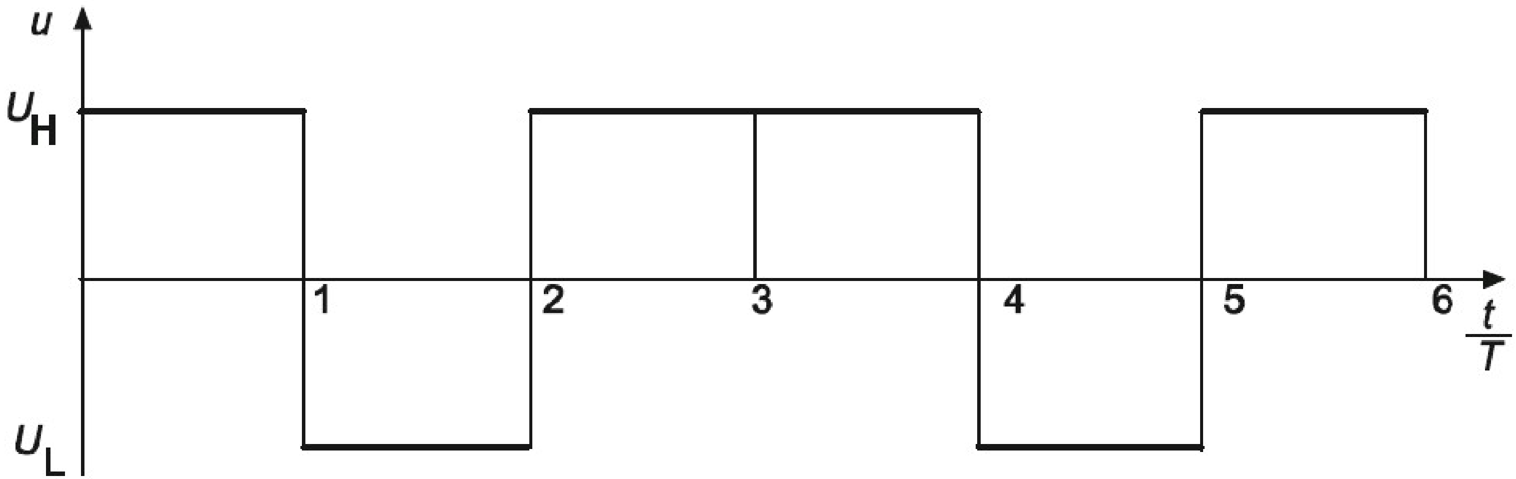


Fig. 2.4 An NRZ coded RS-232 voltage signal

0 1 0 0 1 0

(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 coding!

Ethernet LANs

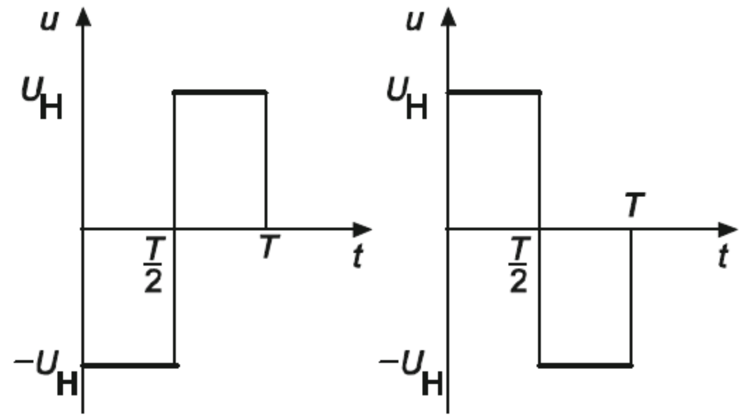


Fig. 2.5 Signal elements in the Manchester code

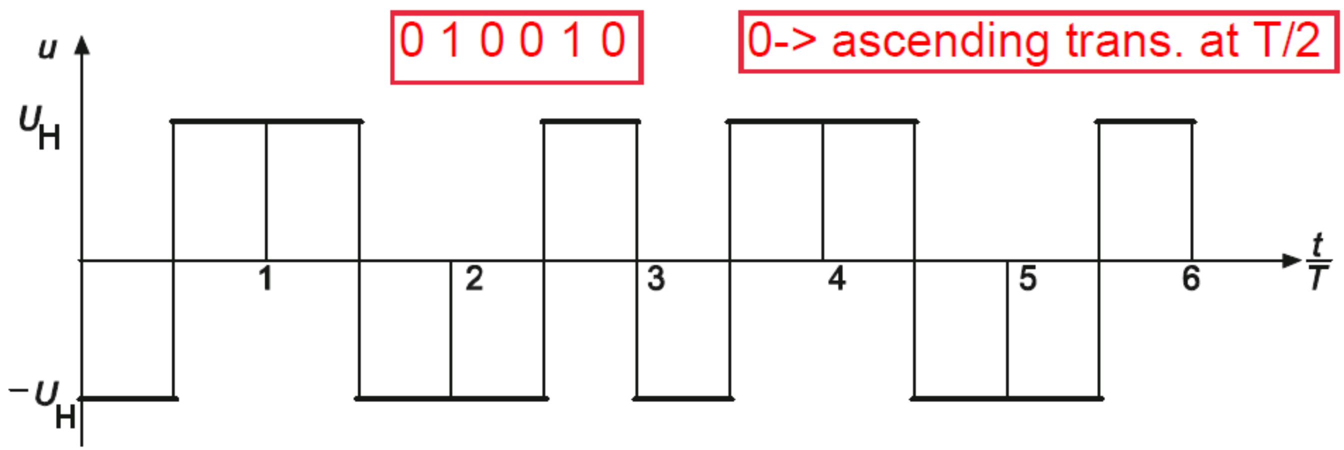


Fig. 2.6 Example of the Manchester code (Biphase-L)

(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

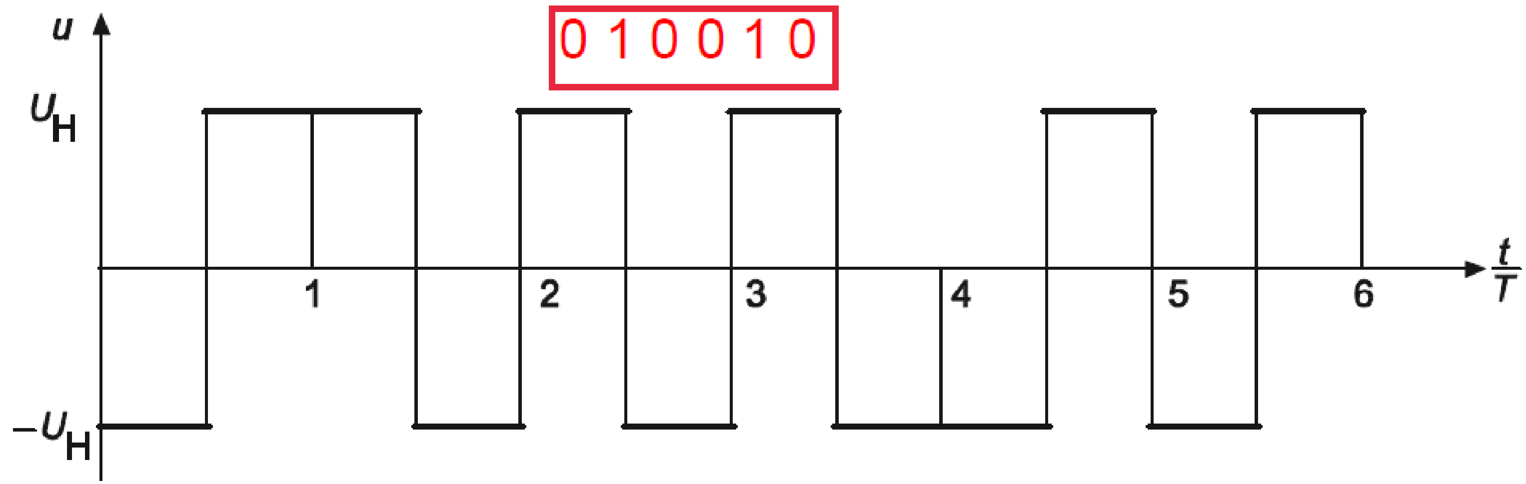


Fig. 2.8 An example of Differential Manchester coding

(Merz,2009)

2.2.4 ISO/OSI Reference Model

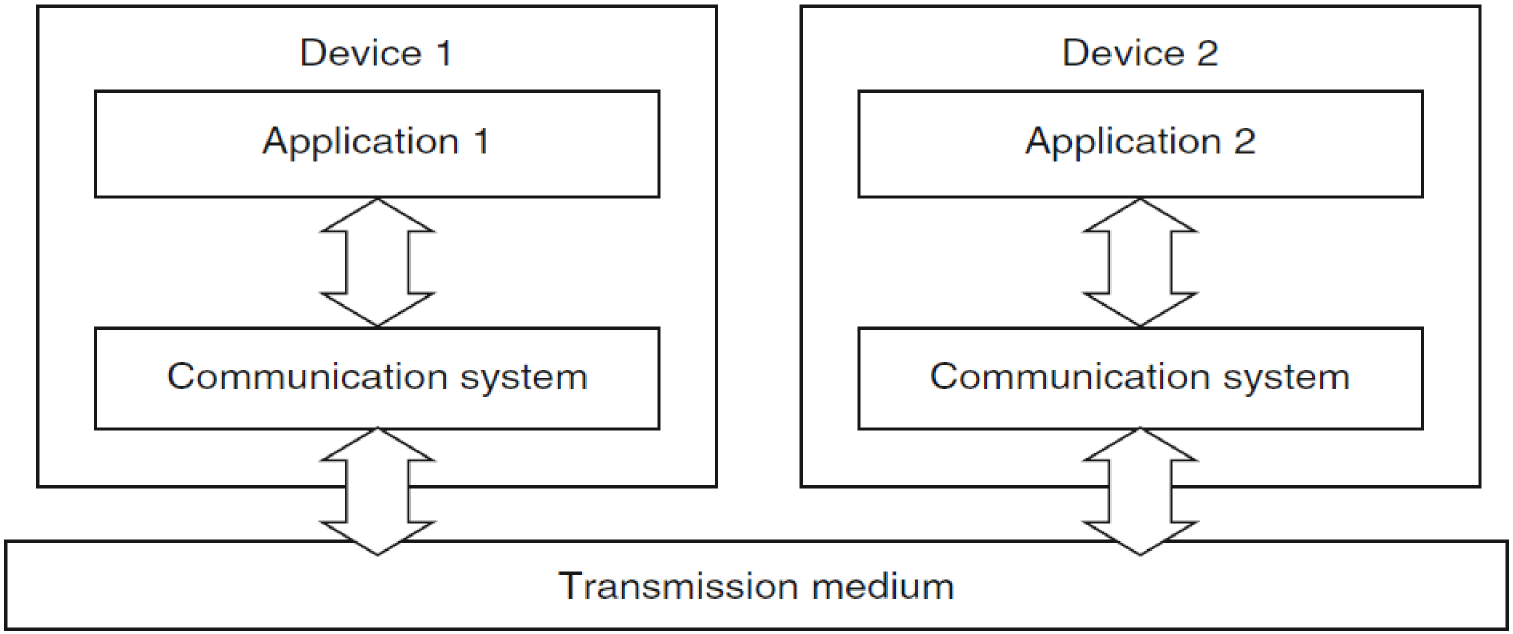


Fig. 2.10 Applications and communication systems from two communication devices

(Merz,2009) 2.2.4 ISO/OSI Reference Model

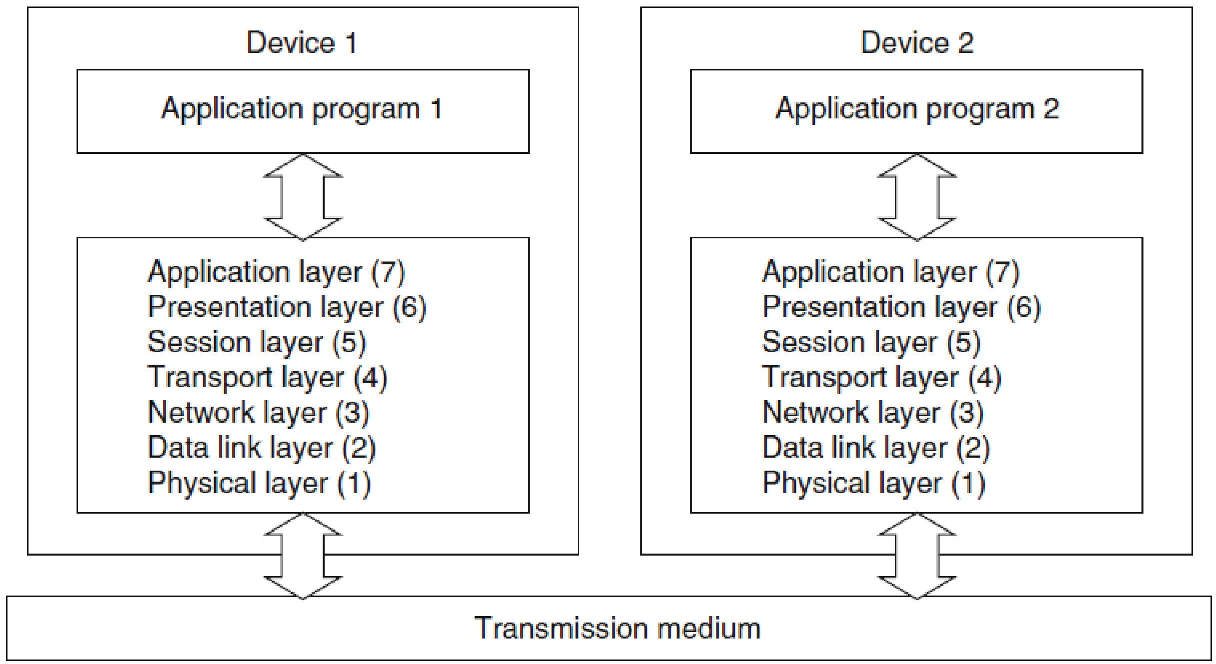


Fig. 2.11 The seven OSI layers

(Merz,2009) 2.2.4 Network Topology

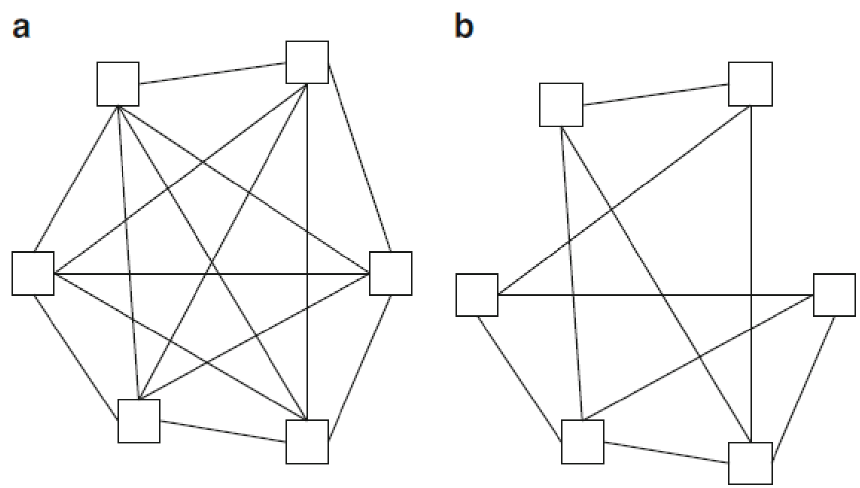


Fig. 2.12 A full (a) and partial (b) mesh topology

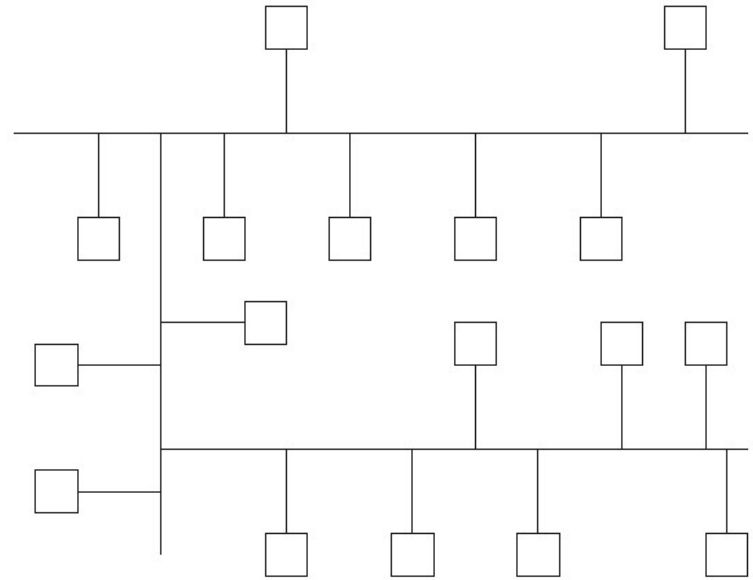


Fig. 2.14 Tree topology

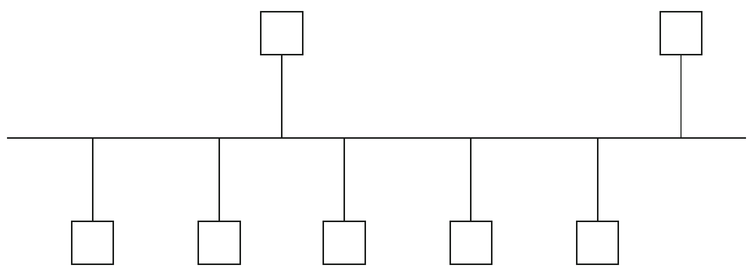


Fig. 2.13 Bus topology

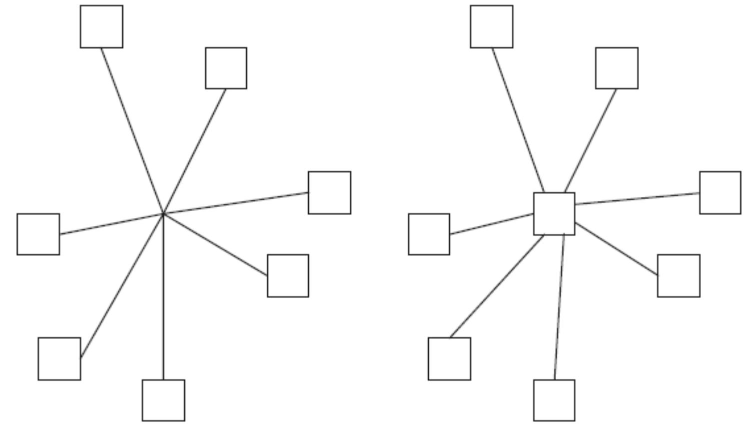


Fig. 2.15 Star topology (a) without a central station and (b) with a central station

(Merz,2018) 3

EIBA, BatiBUS and EHSA joined to form the Konnex Association

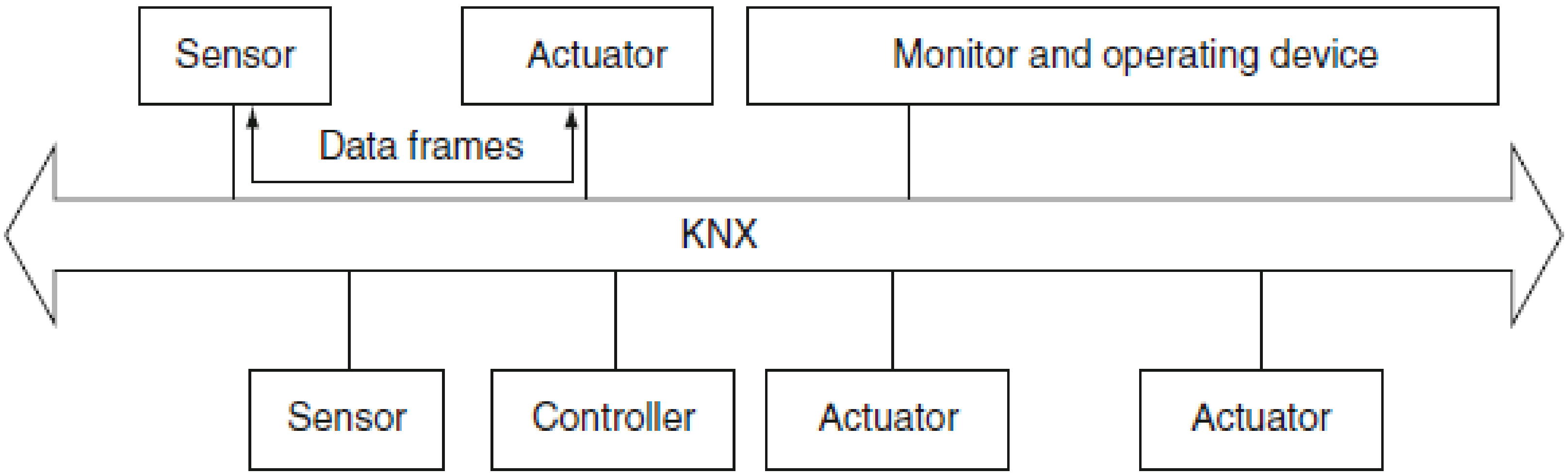


Fig. 3.1 Building control devices connected over Konnex

(Merz,2018) 3 KNX

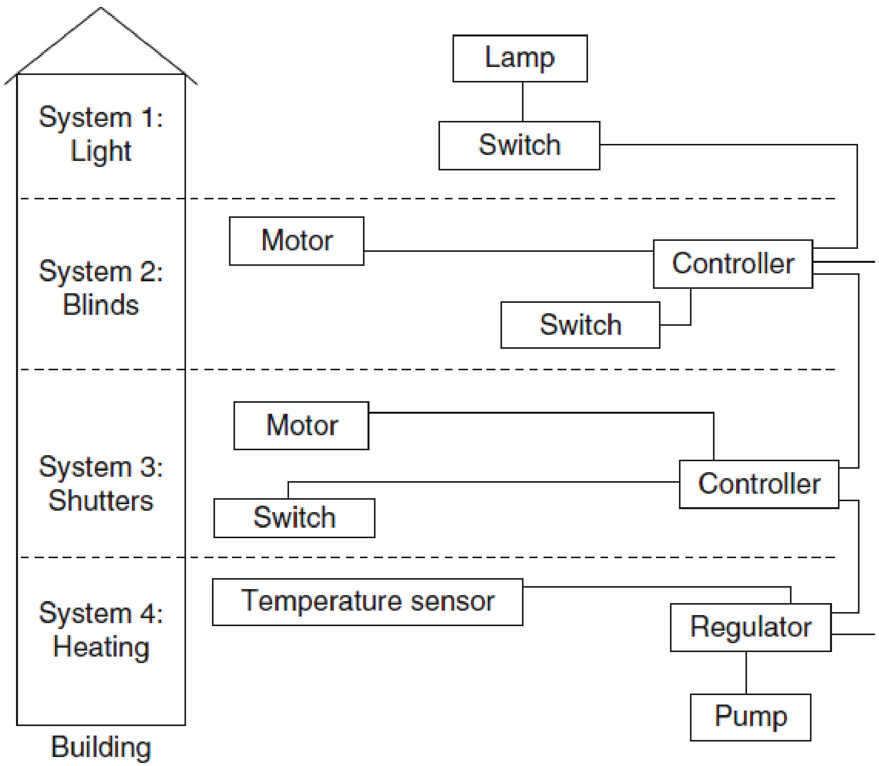


Fig. 3.2 Conventional building technology – separate systems, high cabling costs

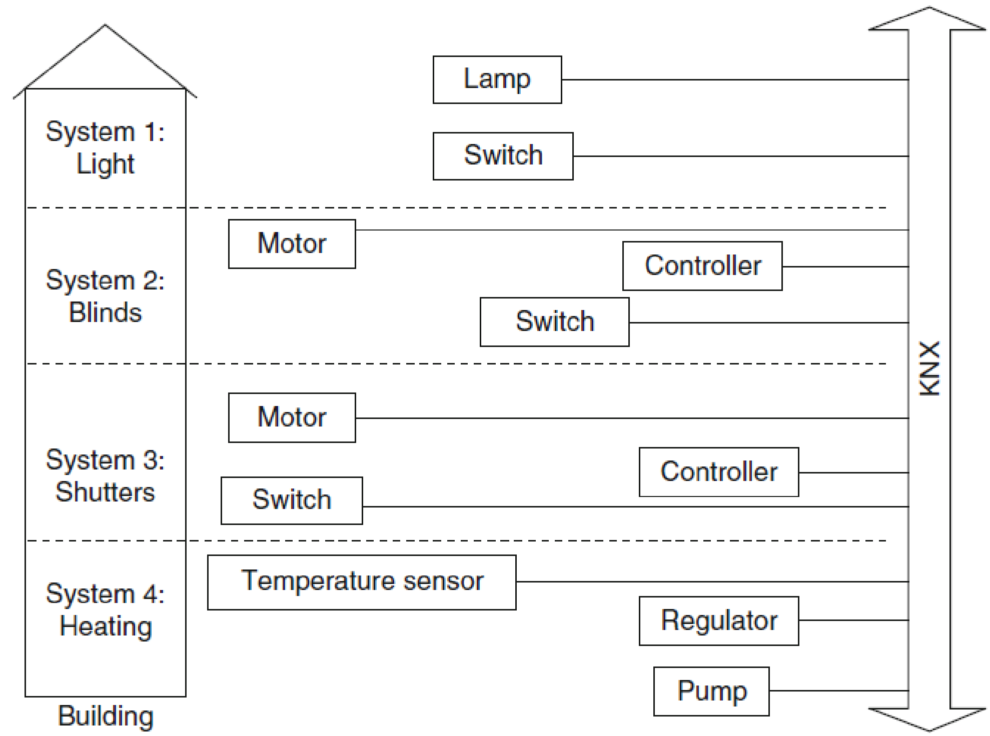


Fig. 3.3 Building control with KNX – integrated systems, lower cabling costs

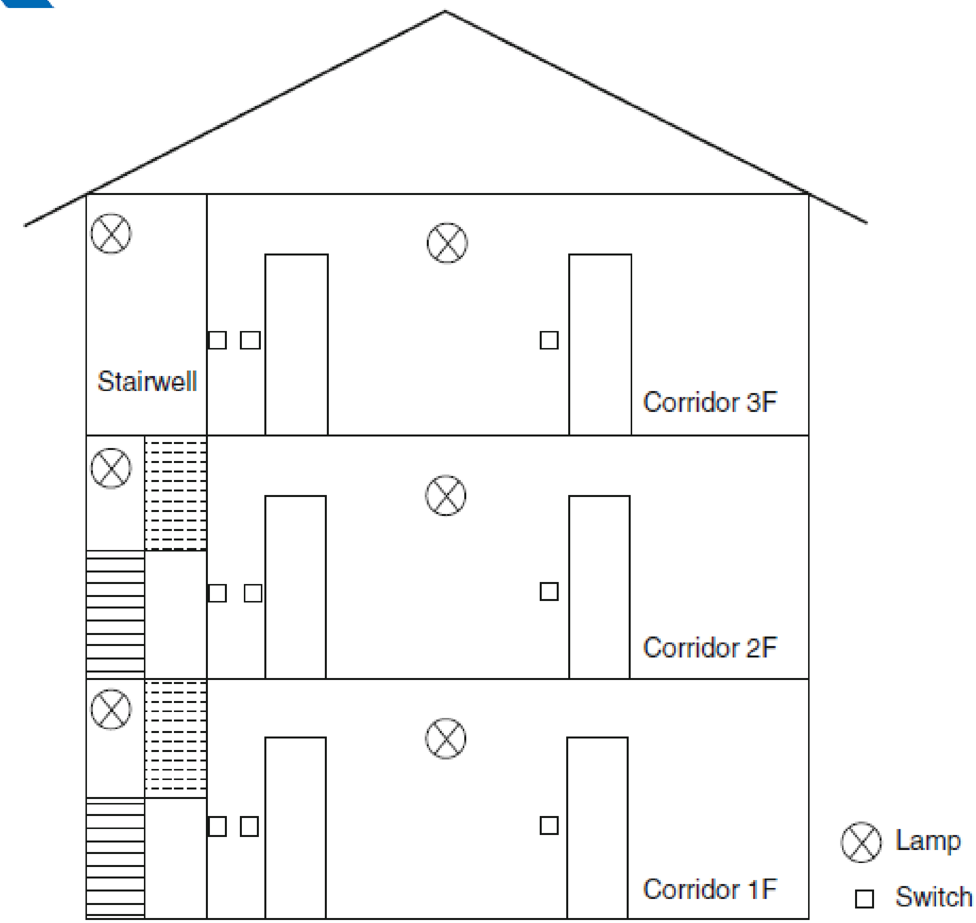


Fig. 3.3 An apartment building with stairwell and corridor lighting

3.2 Conventional Installation

Fig. 3.4 Unipolar and bipolar on/off switches

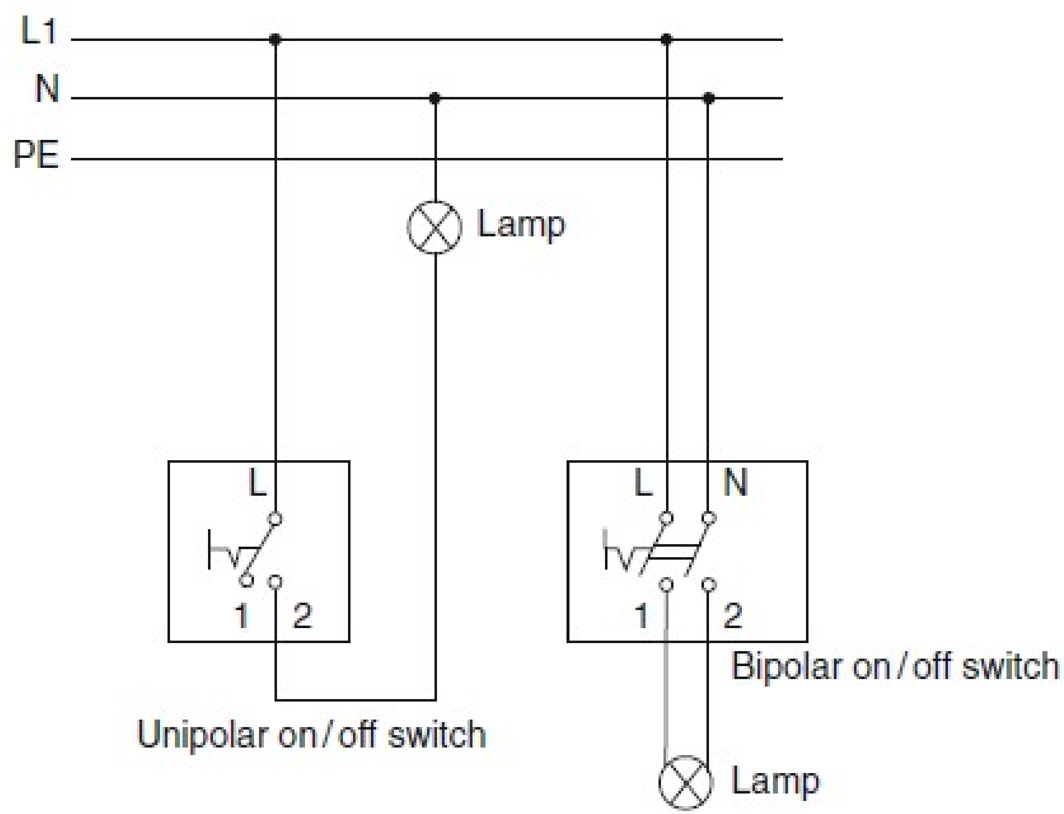


Table 3.1 On/off switch functions as shown in Fig. 3.7

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

(Merz,2018) 3.2

Changeove

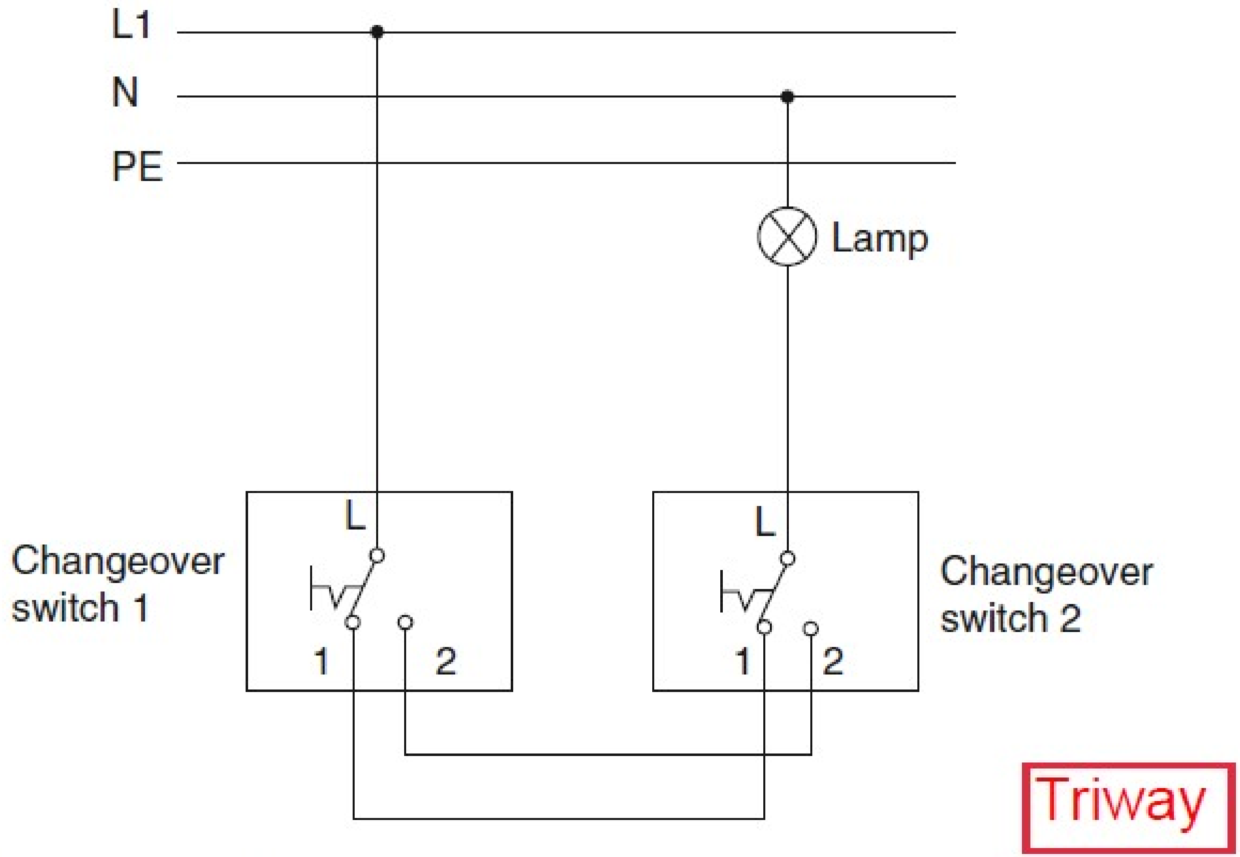


Fig. 3.8 A changeover switching circuit

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

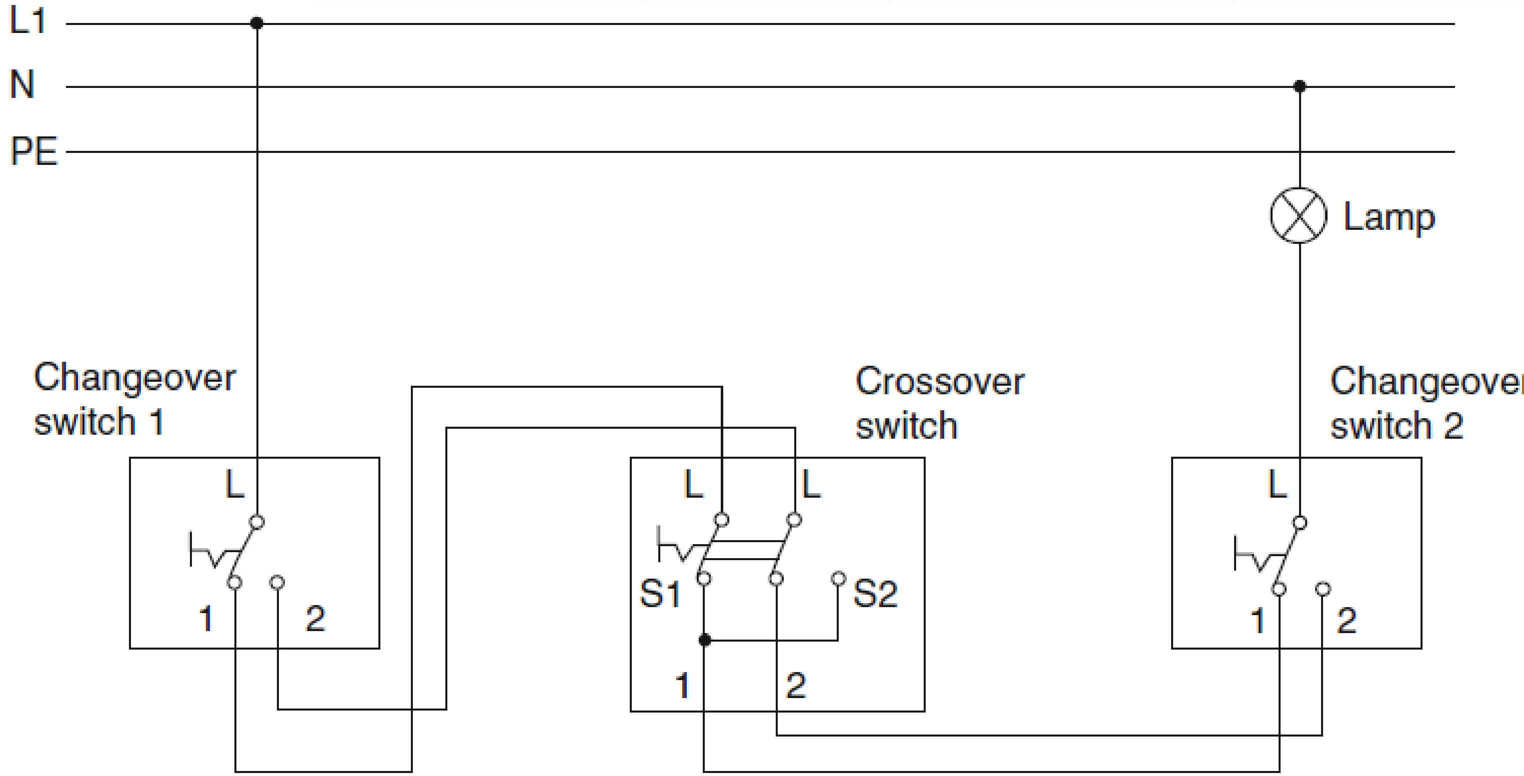
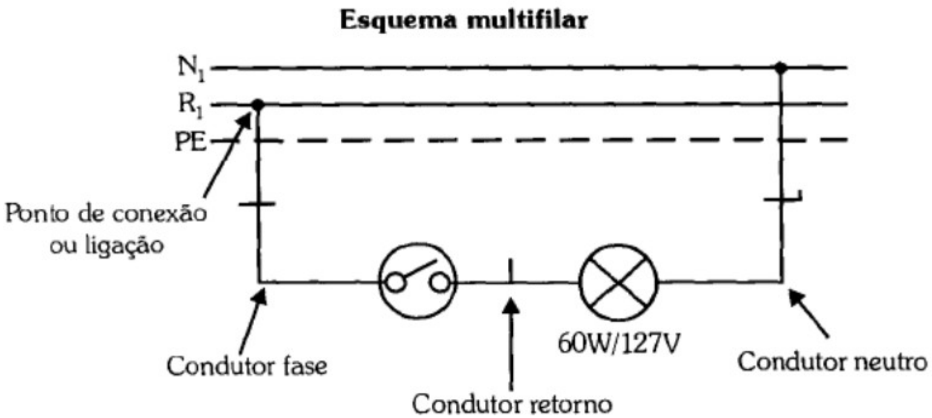
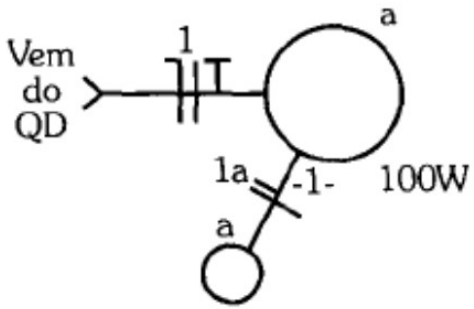


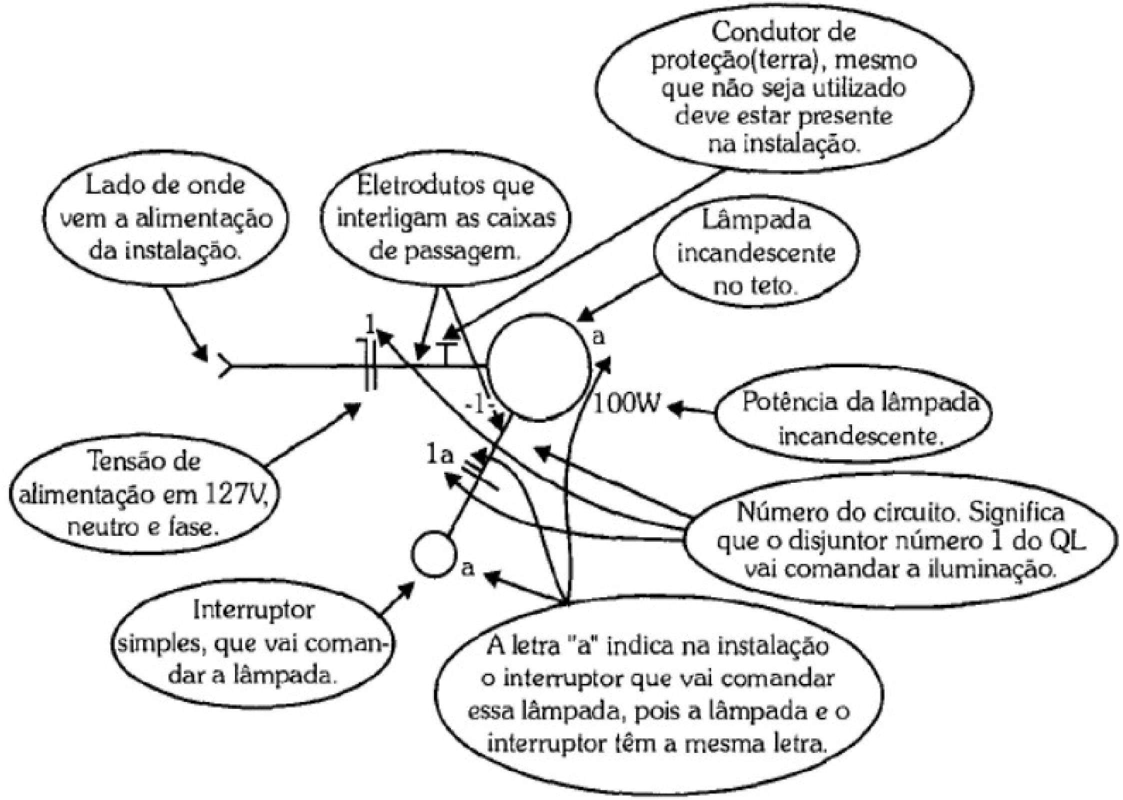
Fig. 3.9 A crossover switching circuit

Fourway

3.2 Diagrama Unifilar

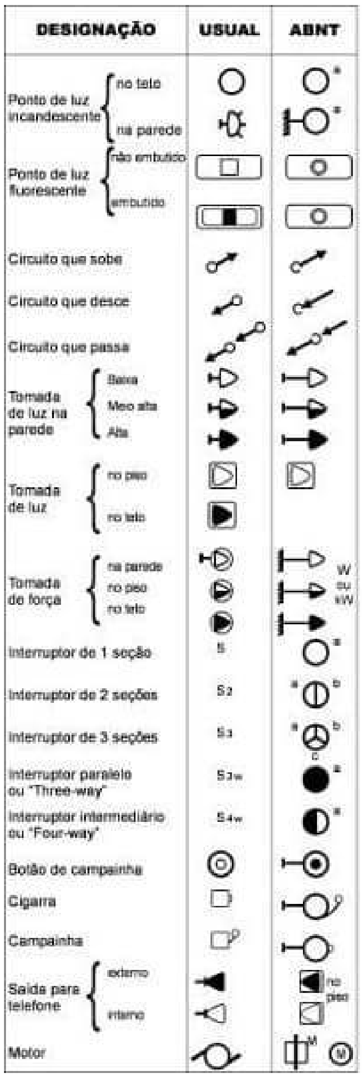


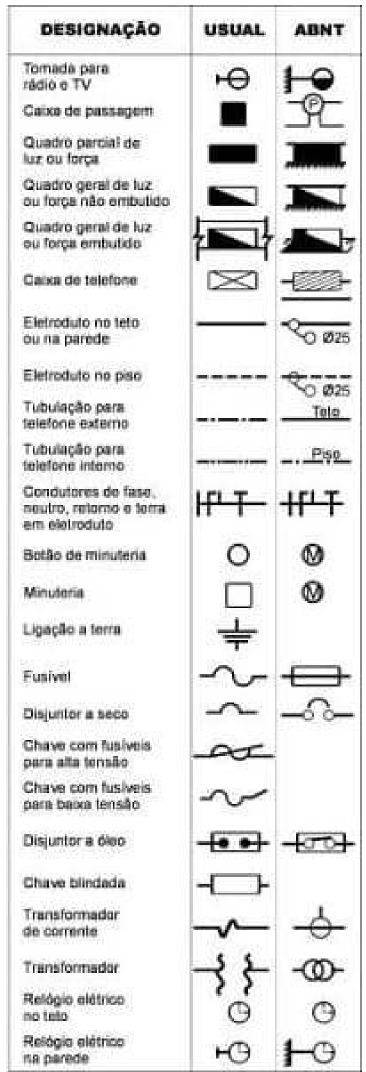


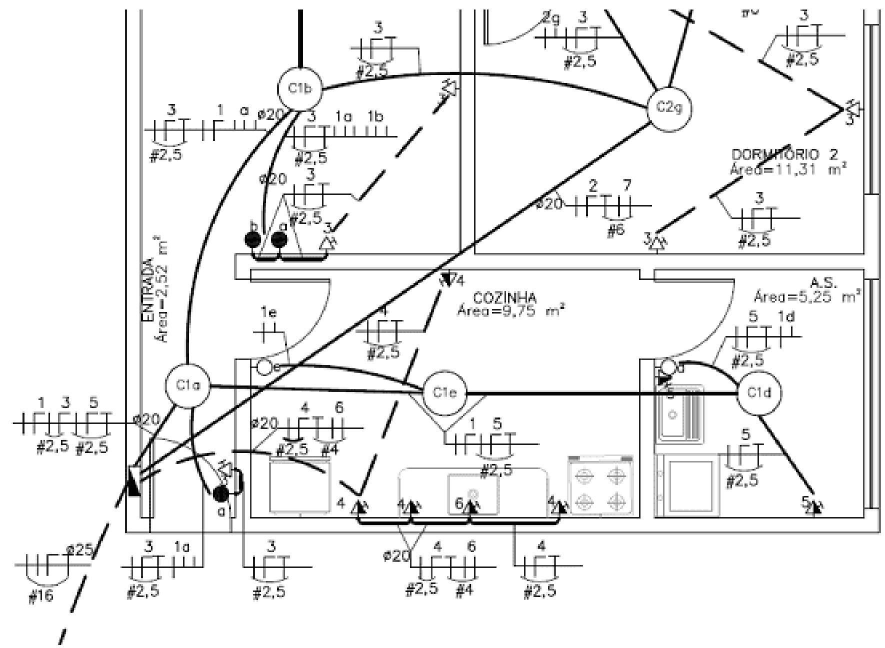


http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

3.2 Simbologia Elétrica ABNT 5410

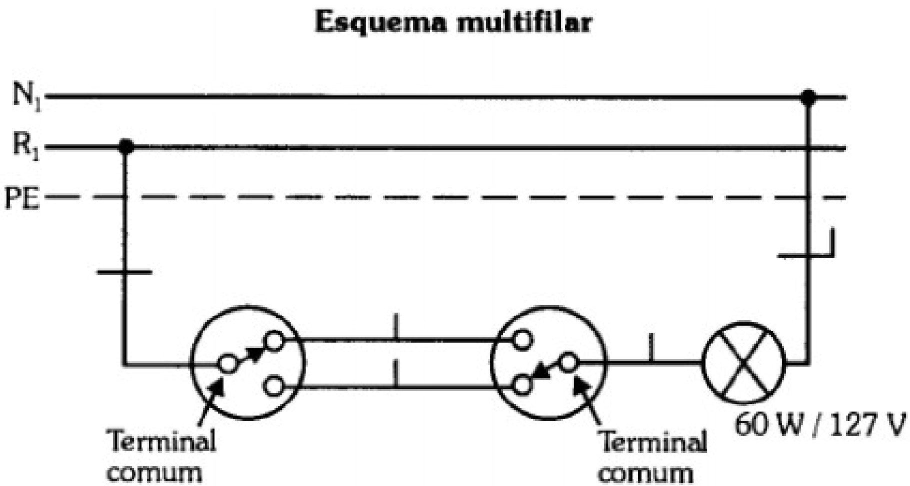


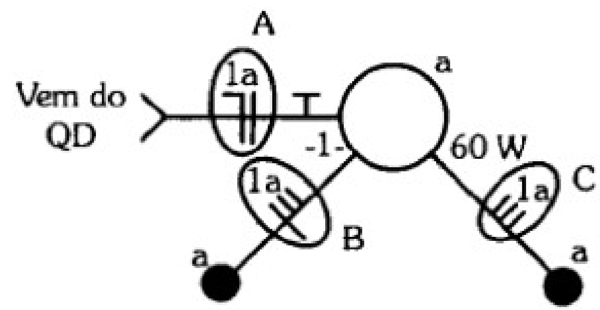




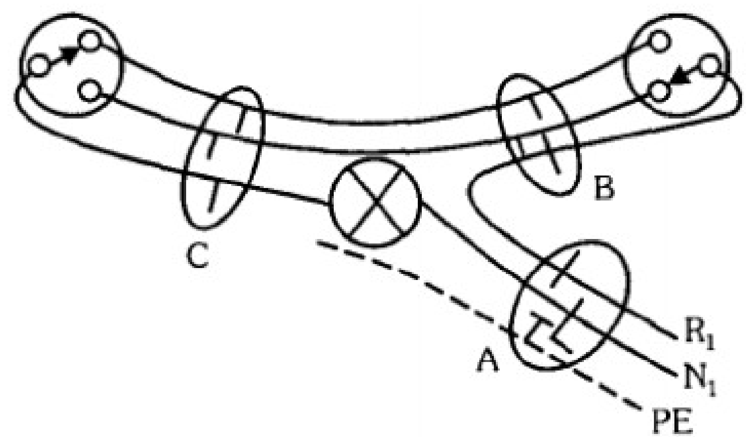
https://www.vivadecora.com.br/pro/iluminacao/instalacao-eletrica/

3.2 Triway





De forma prática temos:



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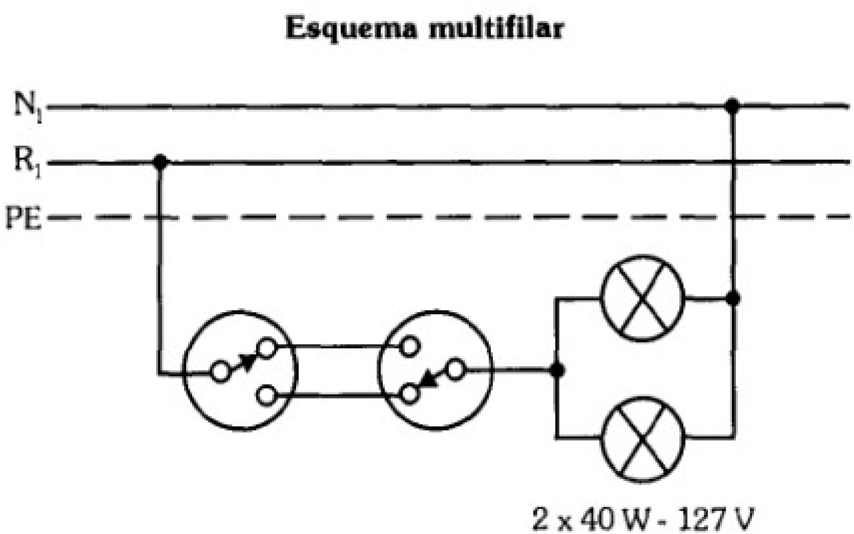
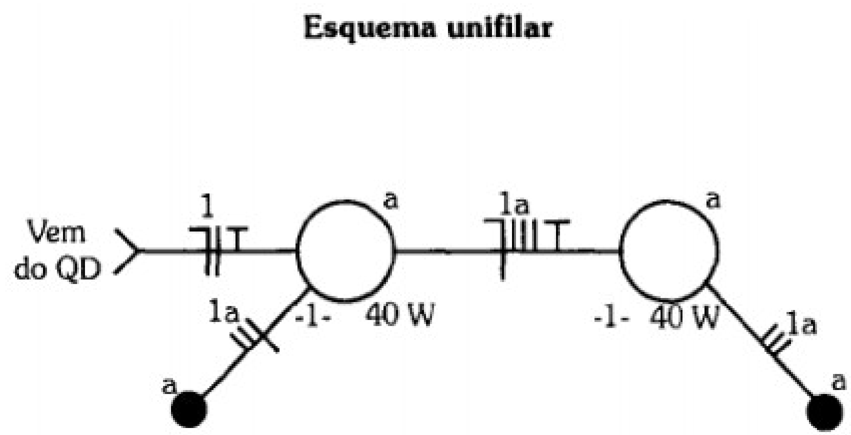
3.2 Triway





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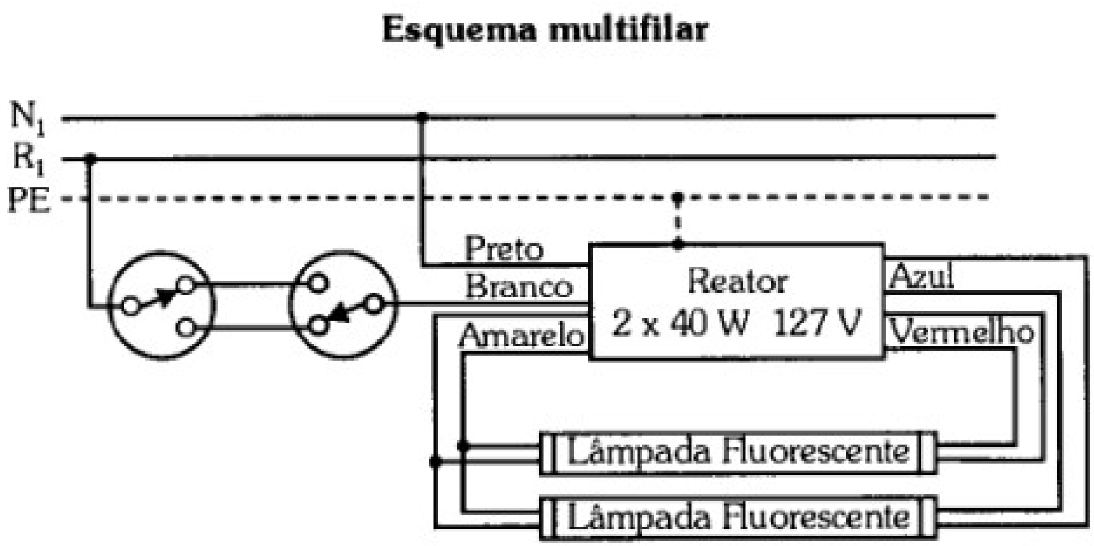
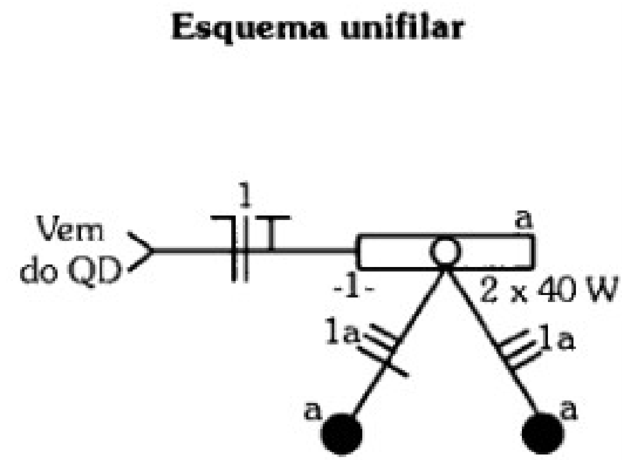
3.2 Triway

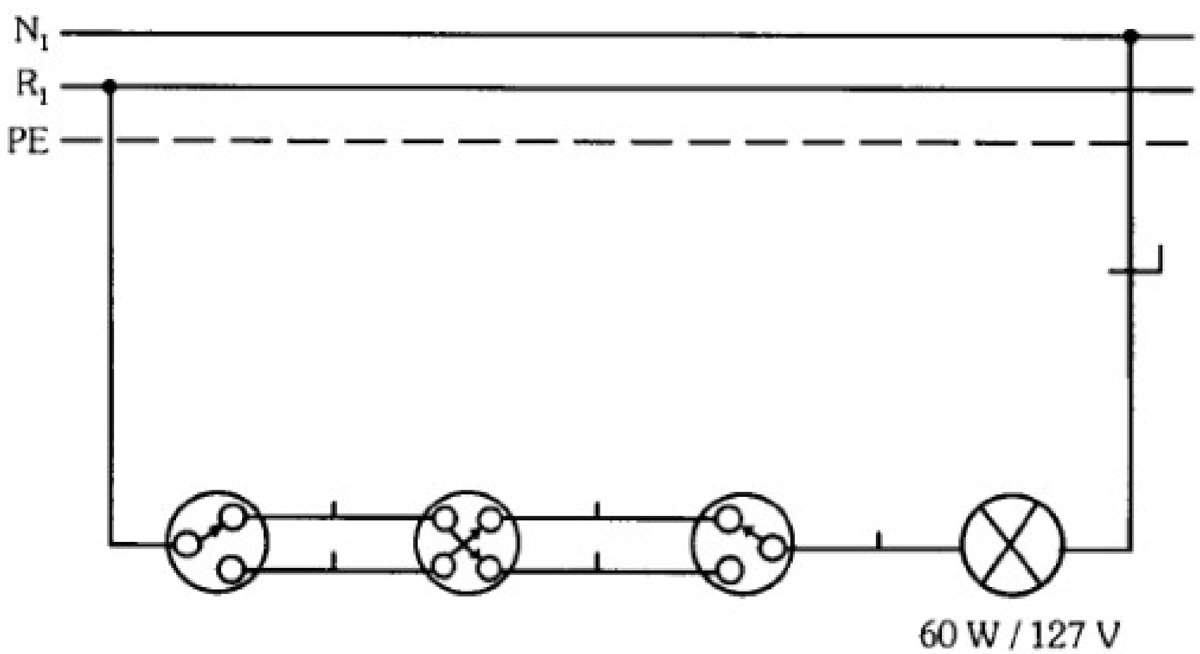




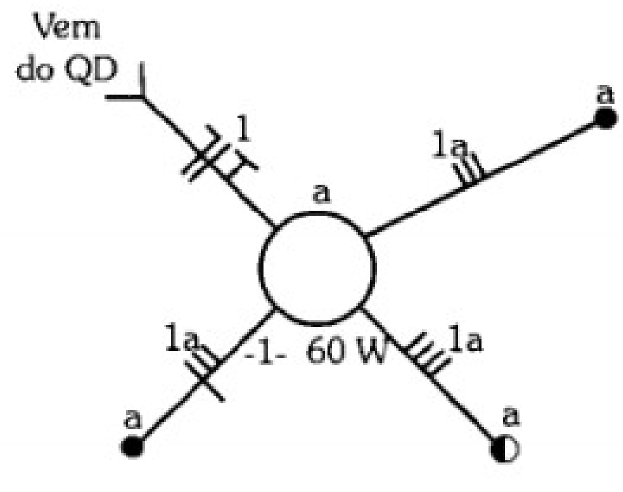
http://joinville.ifsc.edu.br/~luis.nodari/Materiais%20de%20Apoio/Pronatec/eletricidade_2mod_ajustes.pdf

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

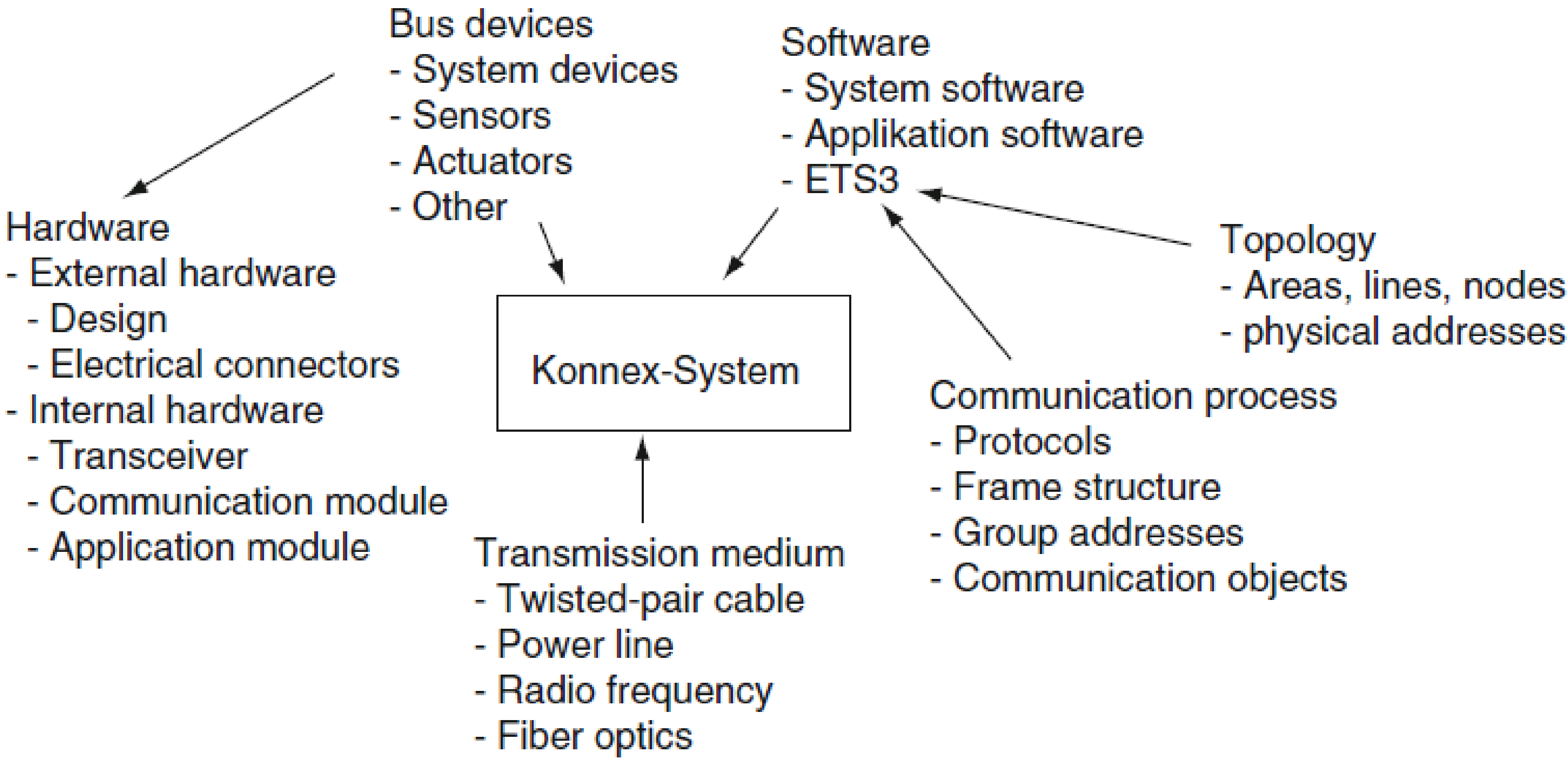


Fig. 3.11 Overview of KNX

(Merz,2018)

3.4 KNX Devices

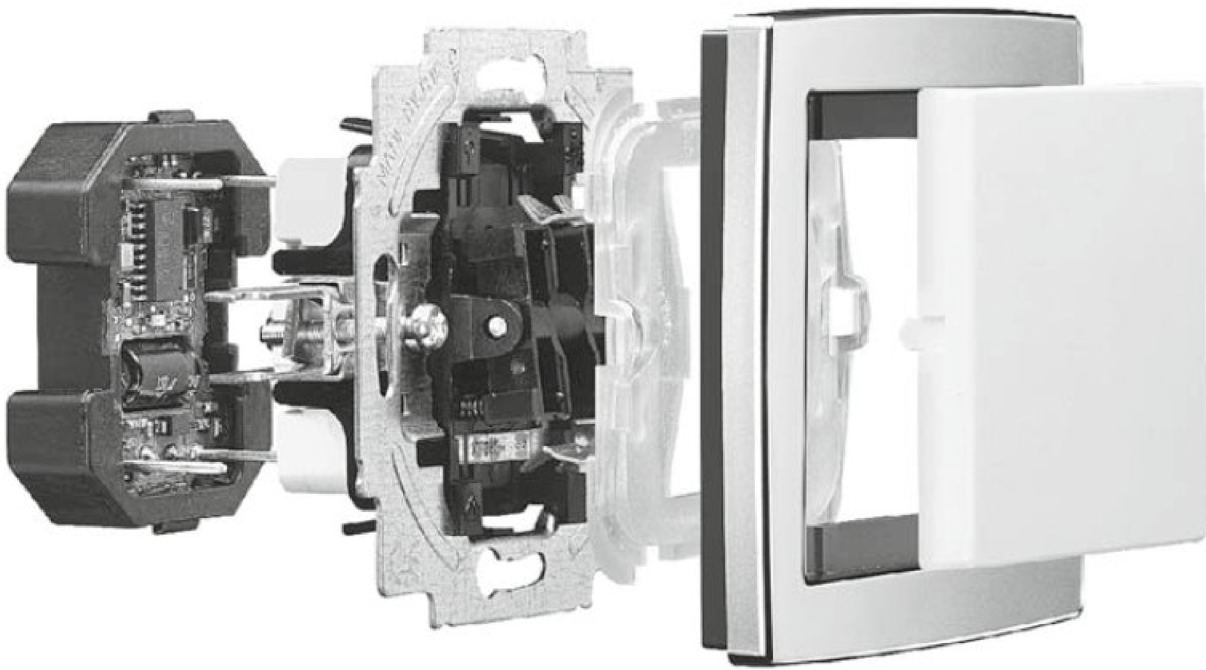


Fig. 3.12 A modular KNX.PL device [Busch-Jaeger Elektro]

(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

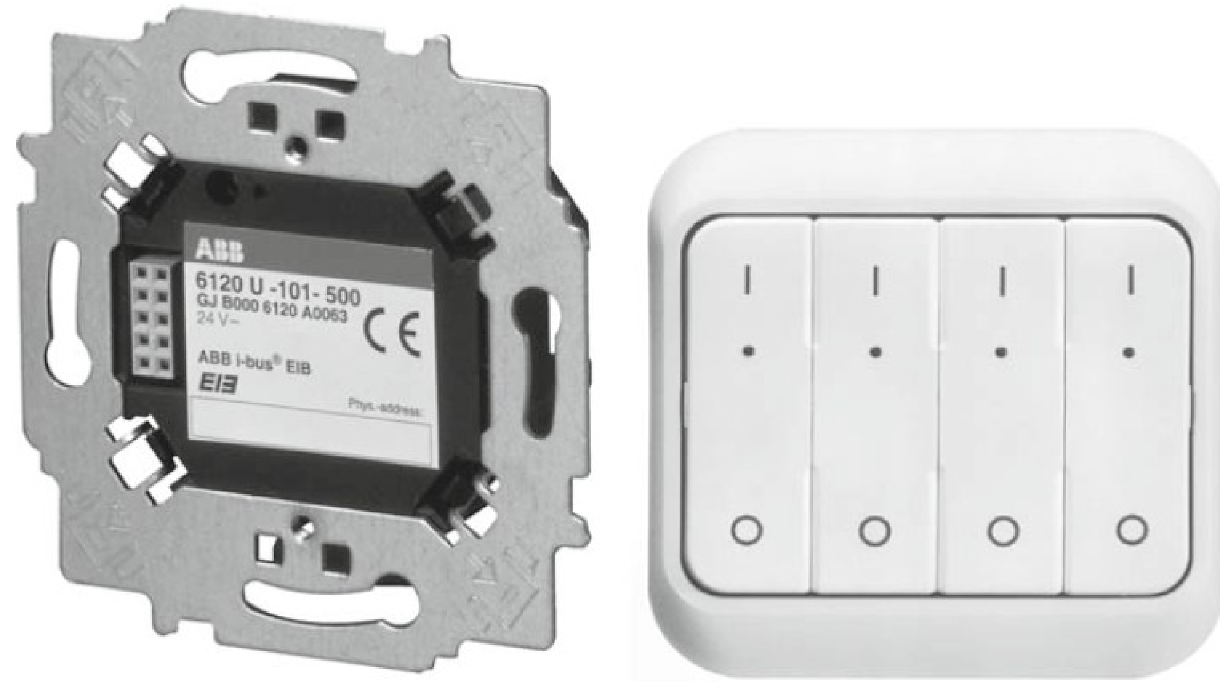


Fig. 3.15 A bus coupler (BC) and four-gang switch sensor [ABB06]

(Merz,2018) 3.4 KNX Devices

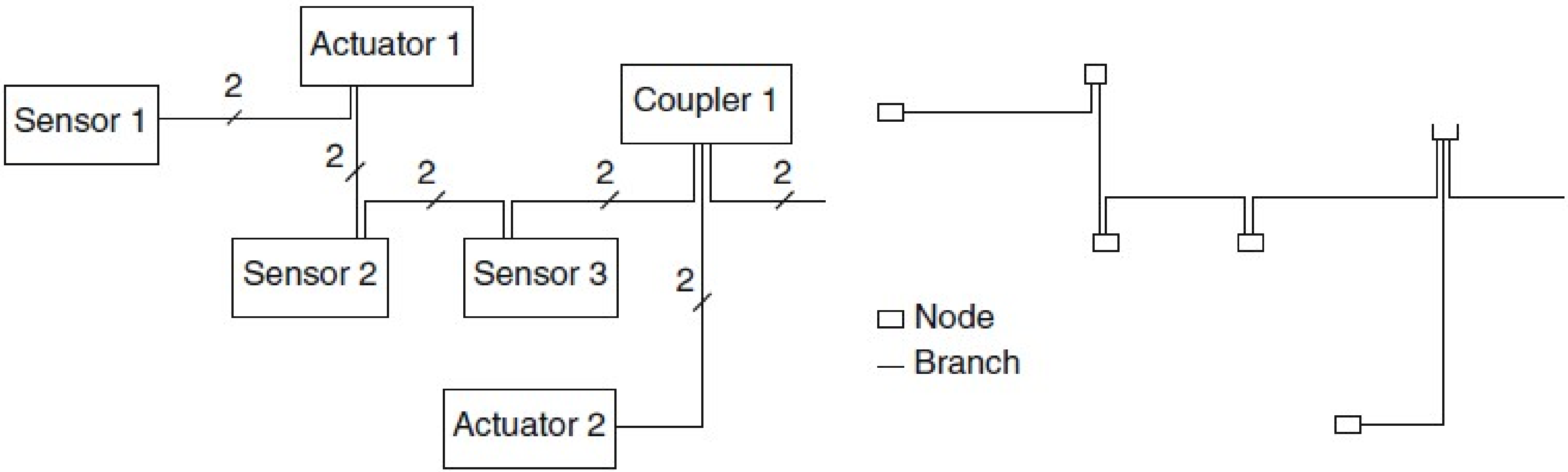


Fig. 3.16 Example of topology. A KNX system (left) and its network (right)

(Merz,2018)

3.5 KNX Topology]

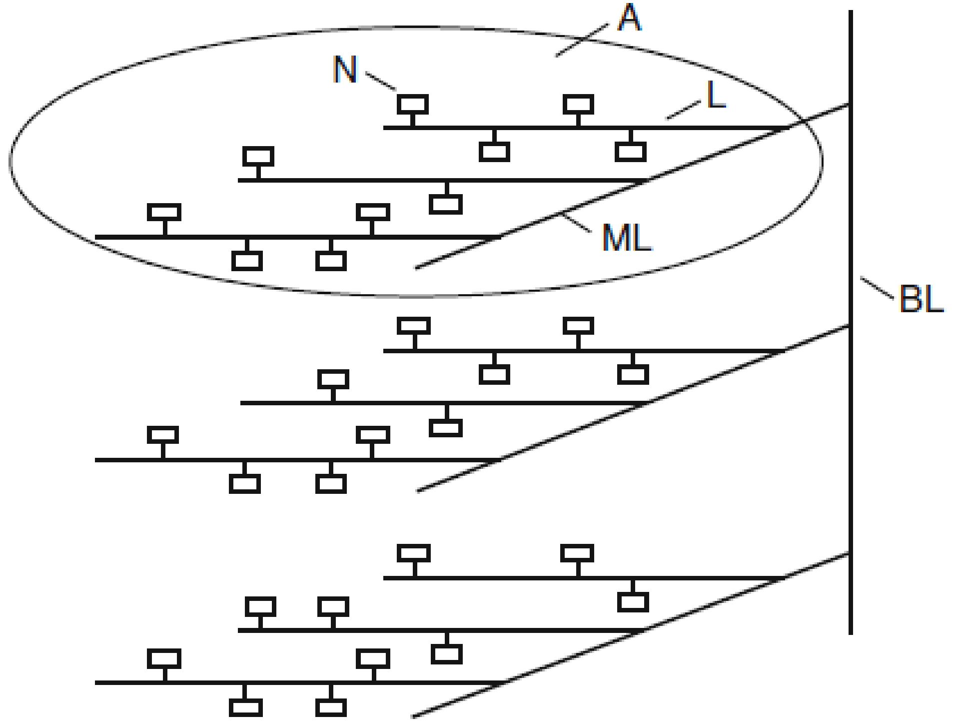


Fig. 3.17 KNX tree topology

Nodes, Lines and Areas

(Merz,2018) # 3.5 KNX

Fig. 3.18 Coupler [ABB06]

3.5 KNX

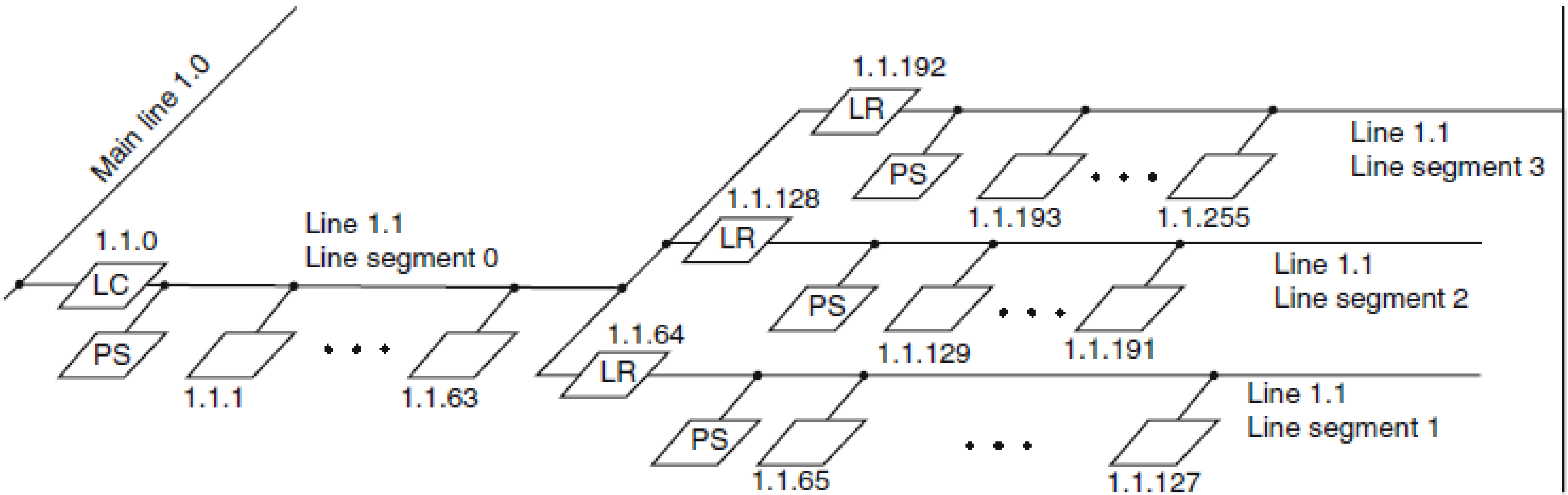


Fig. 3.19 A line with three line repeaters and four segments

(Merz,2018) 3.5

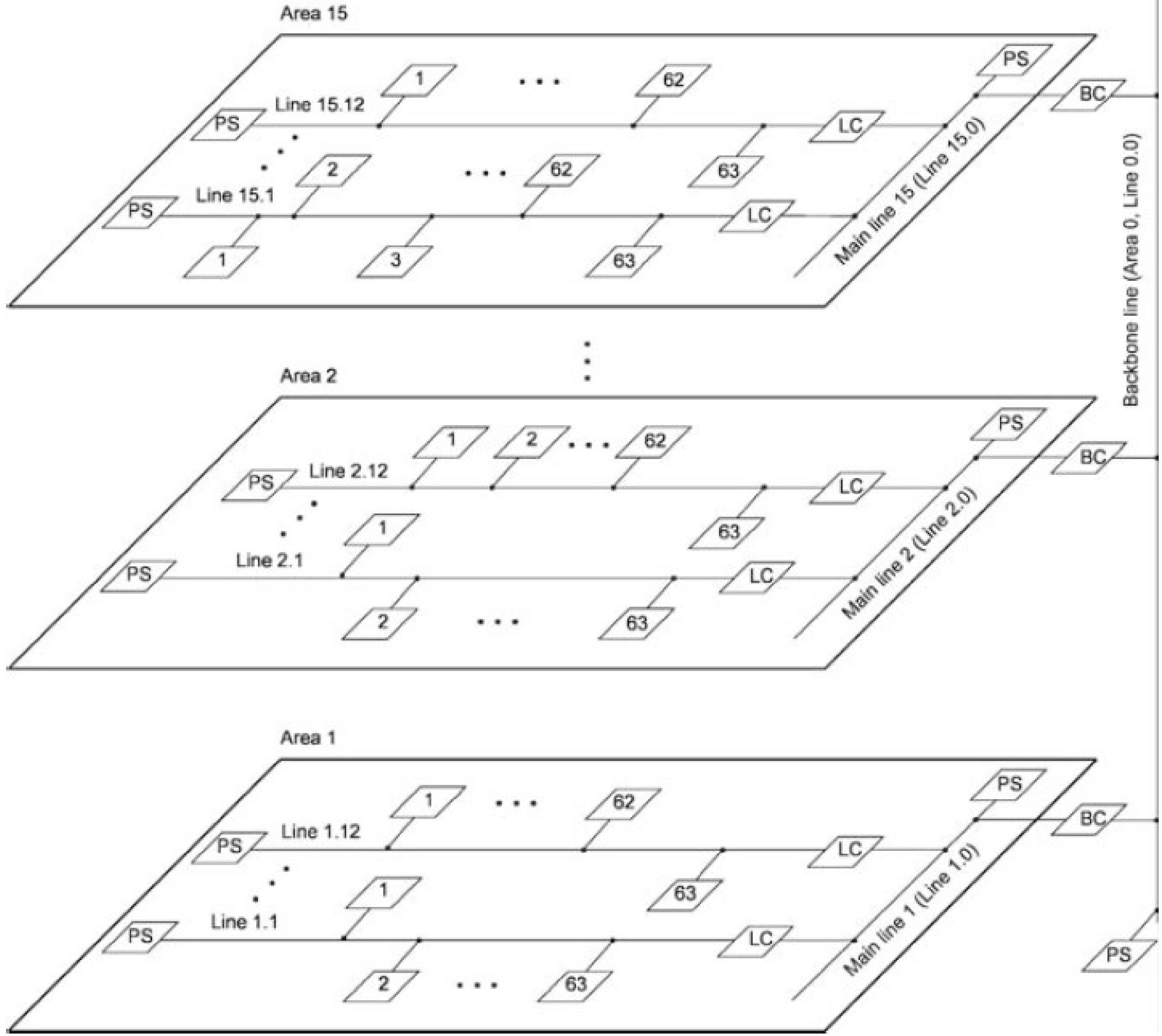


Fig. 3.20 Topology of an KNX system with 11,535 devices

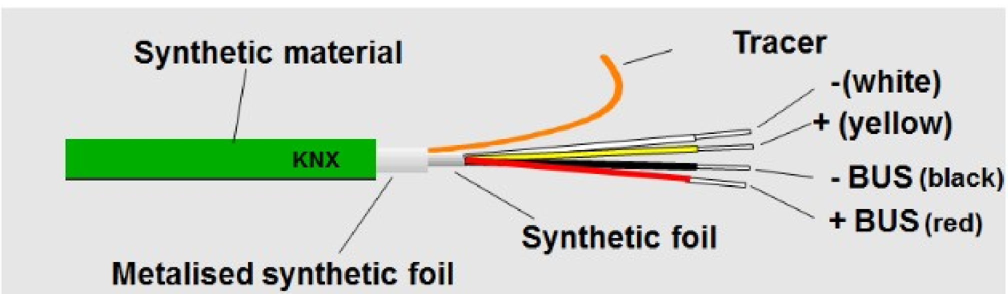
3.4 Transmission Media

- 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)

Most common media: Twisted pair ($)

YCYM 2×2×0.8	J-Y (St) Y 2×2×0.8 VDE 0815
Fixed installation: dry, humid and wet rooms; wall-mounted, flush-mounted, in conduits; outdoor (if protected against direct sun radiation);	Fixed installation: dry and humid industrial sites: wall-mounted, flush-mounted and in conduits Outdoor: flush-mounted and conduits
Test voltage: 4 kV according to EN 50090	Test voltage: 2,5 kV according to EN 50090



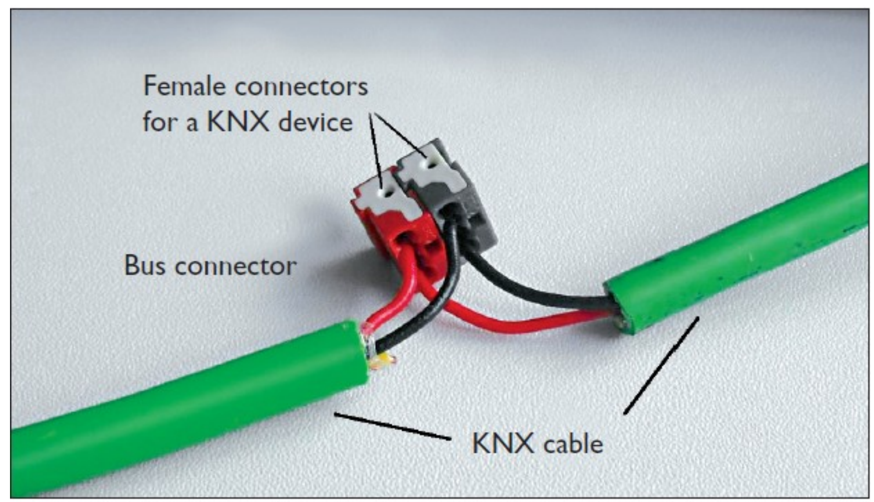
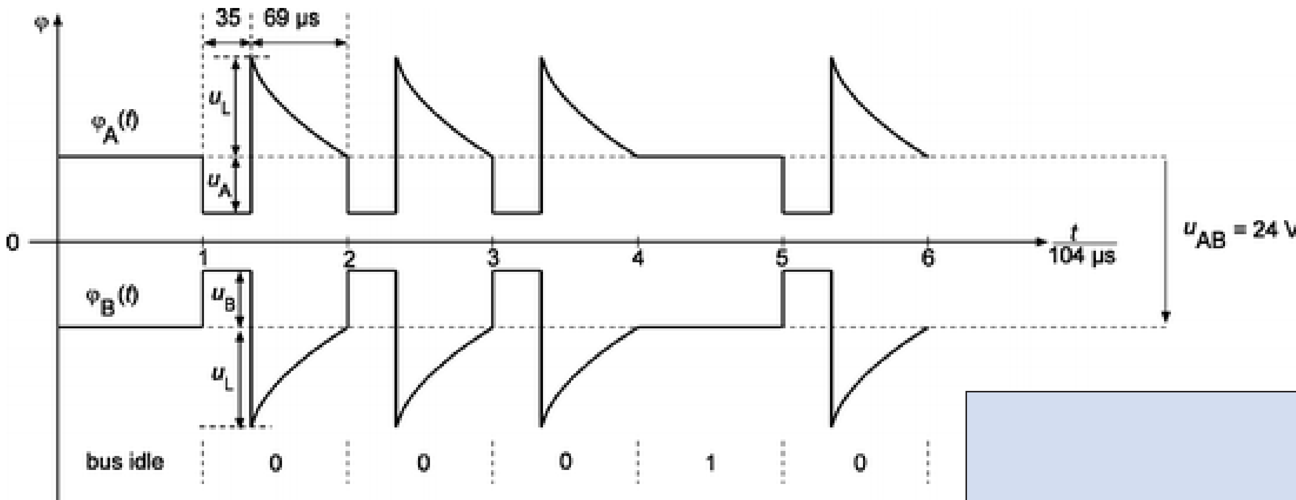


Figure 8. *Bus terminal with incoming and outgoing bus cable*

3.4 KNX.TP – Signal Coding



Choke (Inductor):

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

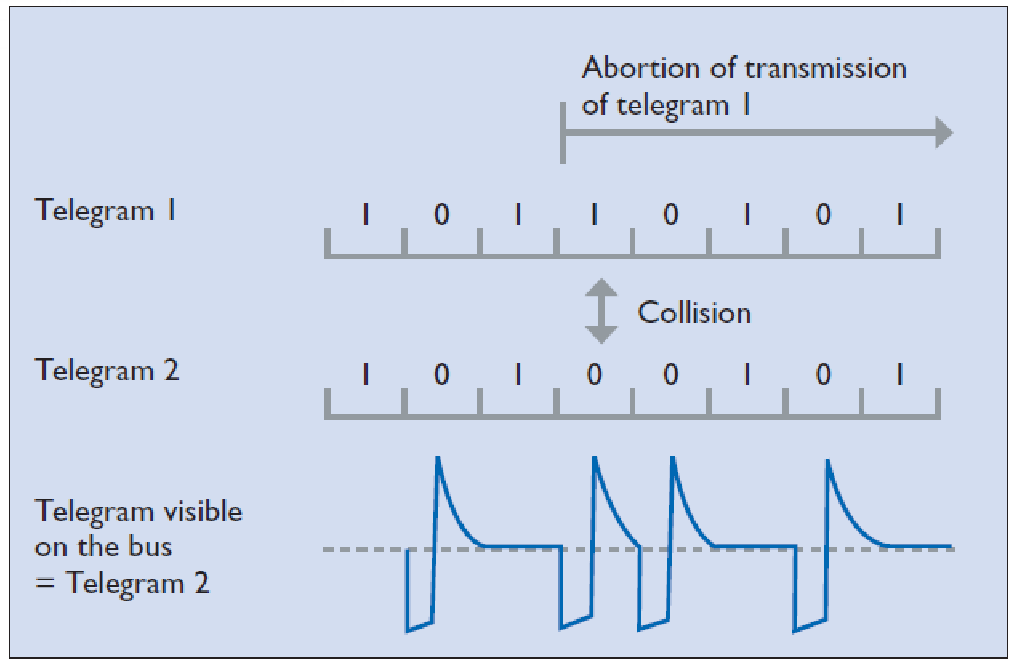


Figure 9. *Collision avoidance in KNX TP*

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:

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

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

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

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

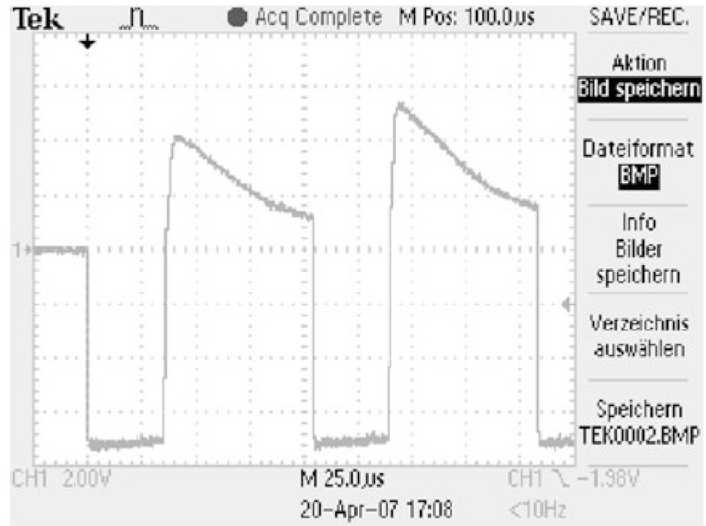
$$u_{ref} \le u_e \le (u_{ref} + 13\ V)$$

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

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

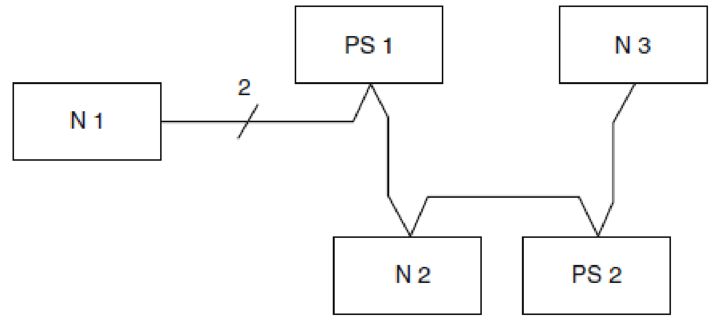
If a zero-bit is sent prior to a one-bit, a linear voltage drop can occur at the one-bit signal element during the bit period T_{bit}. In order to safely identify the one-bit, the following conditions have to be met:

- 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: $(u_{ref} - 2\ V) \le u_{AB} \le (u_{ref} + 0.3\ V)$



Bitrate:
T_{bit} = 104 us
$R_{bit} = 1/T_{bit}$ ~ 9615 bit/s ~ 9.6 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.

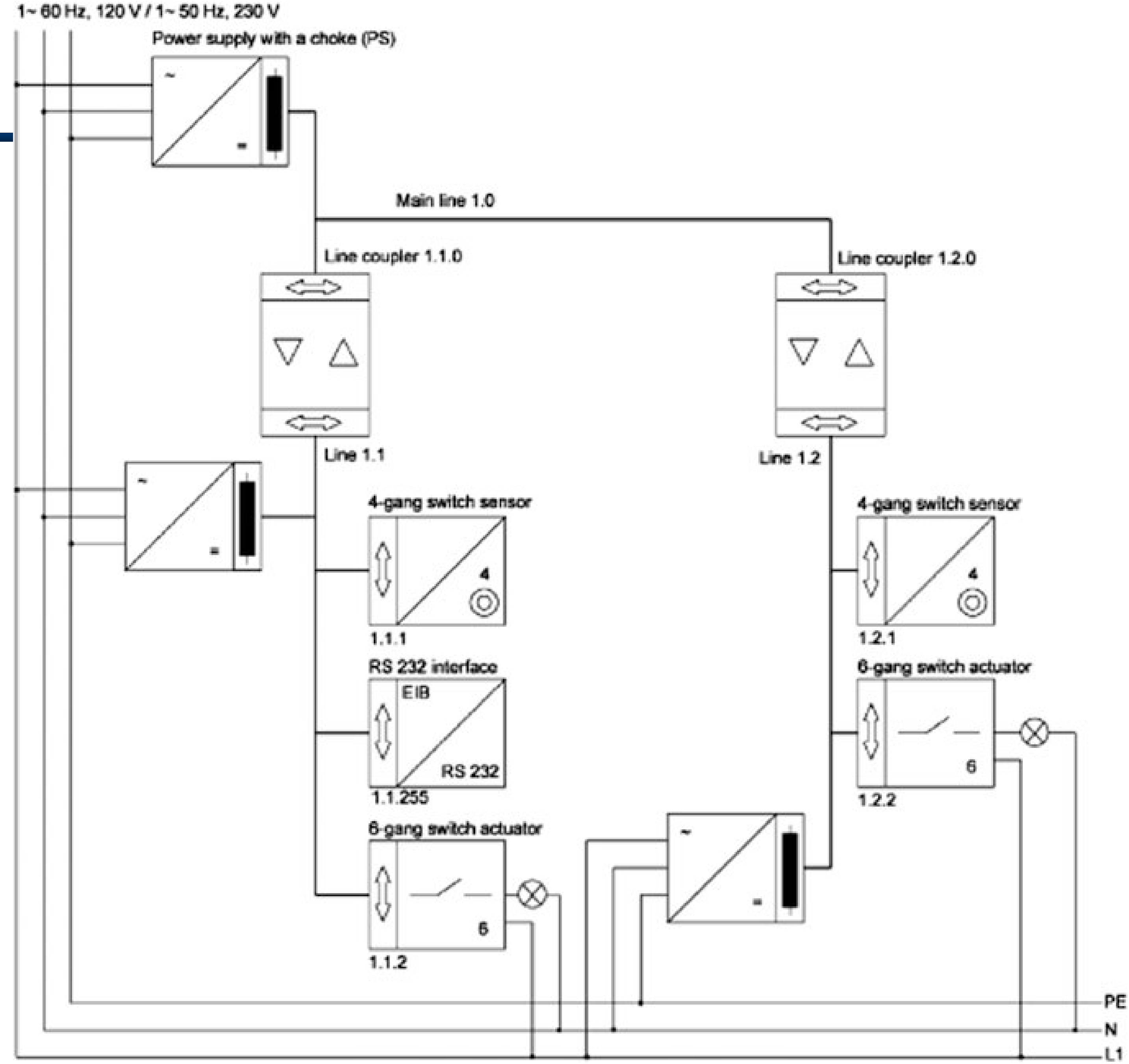
• The length of cable between the two bus devices that are the furthest apart (e.g., N1 and N3 in Fig. 3.21) must be no more than 700 m.

• 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



3.7 Adressing 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 Adressing 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

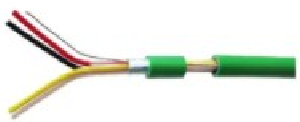
High byte								Low byte							
D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0
0	M3	M2	M1	M0	G2	G1	G0	S7	S6	S5	S4	S3	S2	S1	S0
Main group					Middle group			Subgroup							

- $2^4 = 16$ 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$ 935^{44}

em 12x R$ 88^{86}

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$ 23^{33} sem juros

Frete grátis

Interface Usb Eib/knx Tapko Uim-knx 42 Dinrail

R$ 749^{99}

em 12x R$ 62^{50} sem juros

Frete grátis

Fonte De Energia Com Função Bus Elsner Knx Ps640+

R$ 1.700

em 12x R$ 141^{67} sem juros

Frete grátis

Gateway Knx/dali Hager Mod:tya670d

R$ 1.045

em 12x R$ 87^{12} sem juros

Frete grátis

Sensor Para Automação Residencial Theben Knx Luna 131 S

R$ 1.200

em 12x R$ 100 sem juros

Frete grátis

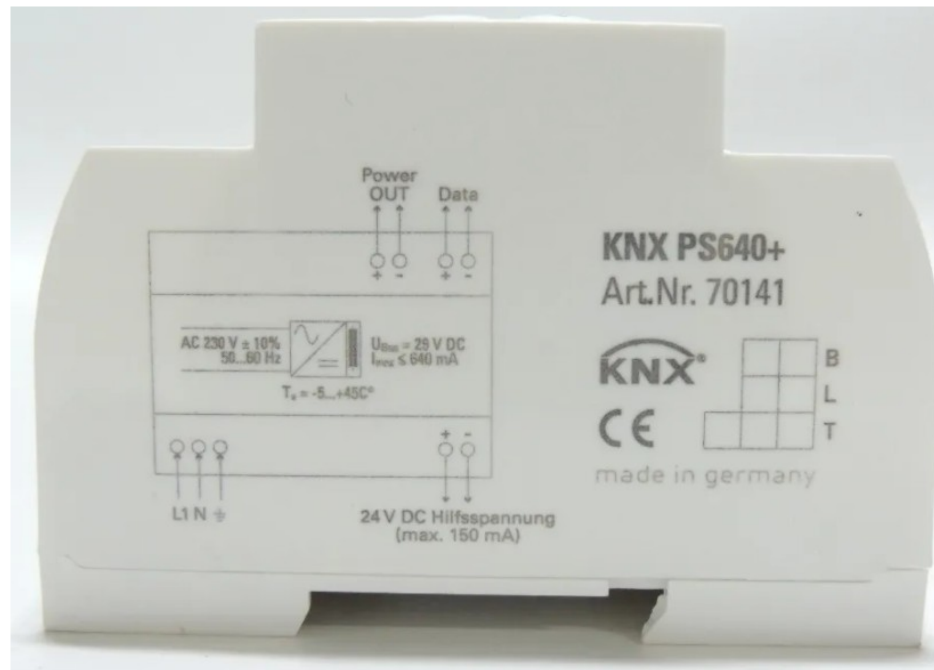
Projeto KNX – “Mercado Livre”

Fonte De Energia Com Função Bus Elsner Knx Ps640+

R$ 1.700

em 12x R$ 141[67] sem juros

Frete grátis



Projeto KNX – “Mercado Livre”

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

R$ 1.340

em 12x R$ 111[67] sem juros

Frete grátis

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

R$ 950

em 12x R$ 79[17] 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$ 87[12] 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

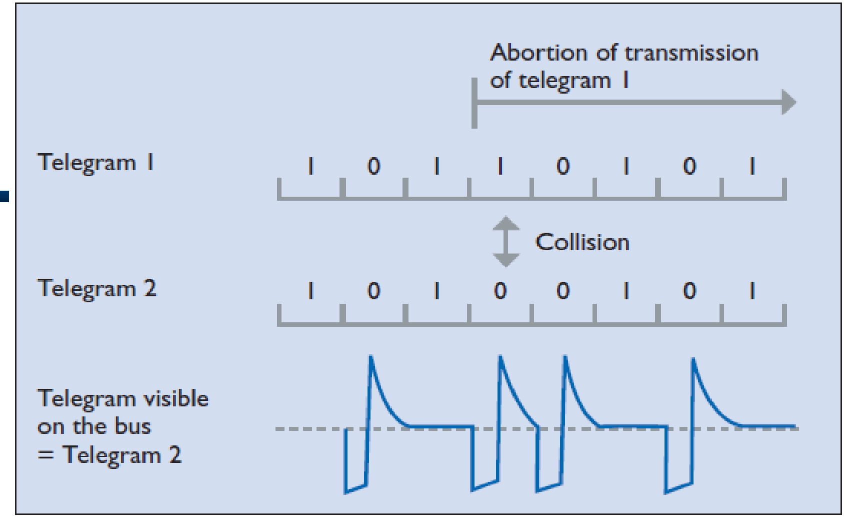


Figure 9. *Collision avoidance in KNX TP*

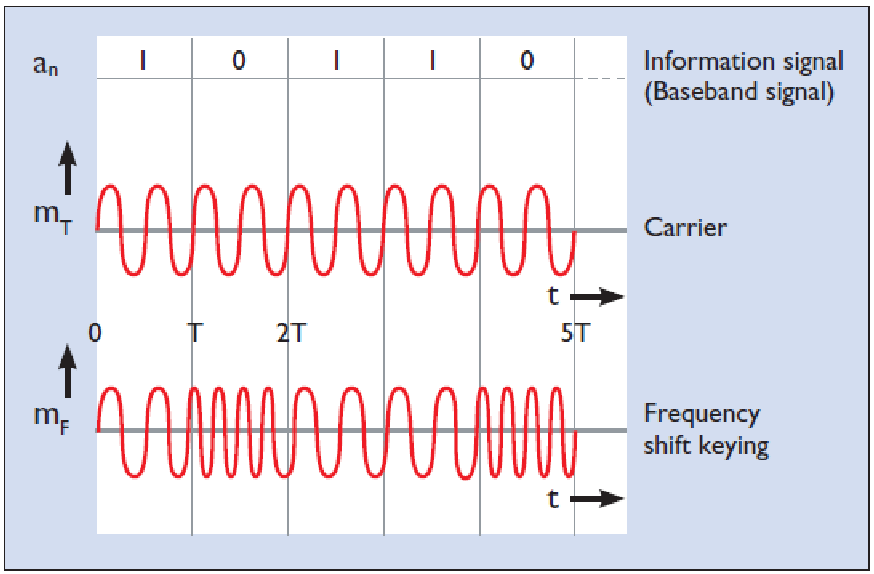
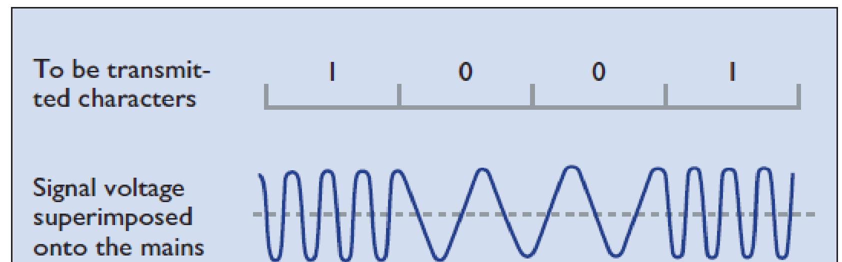


Figure 12. *Frequency modulation and signal in KNX RF*



PL 110 – 110 kHz FSK, 1200 bits/s

Figure 10. *Signal shape in KNX PL*

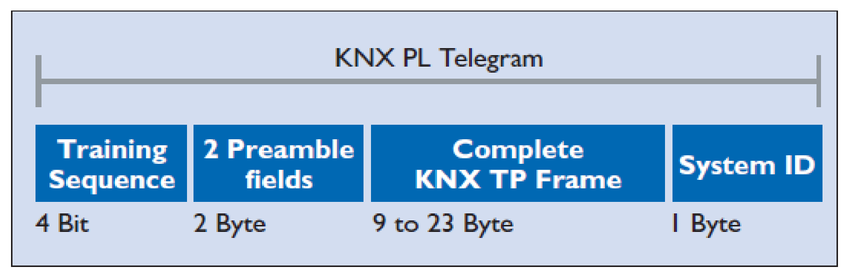


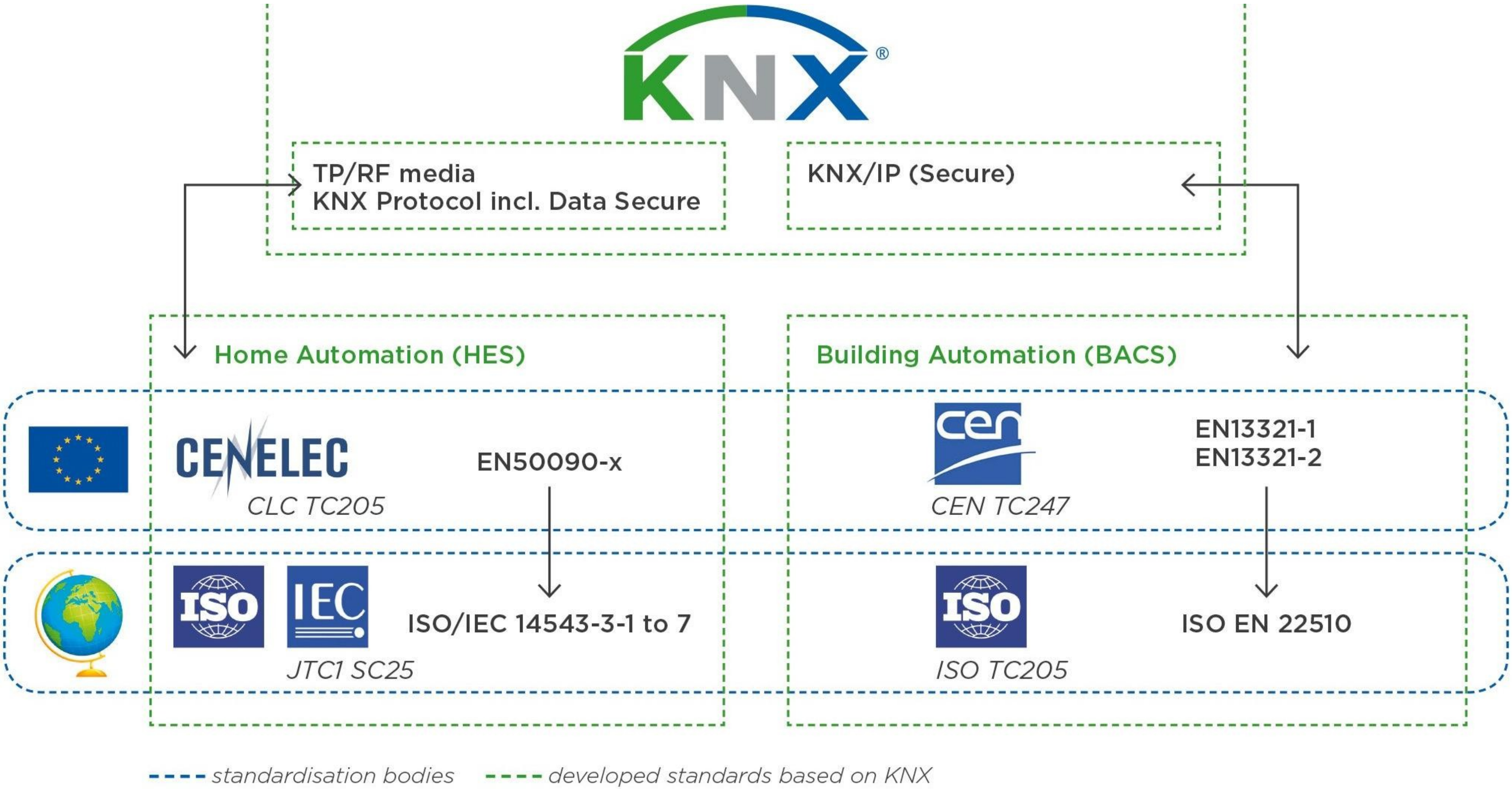
Figure 11. *Telegram structure in KNX PL*

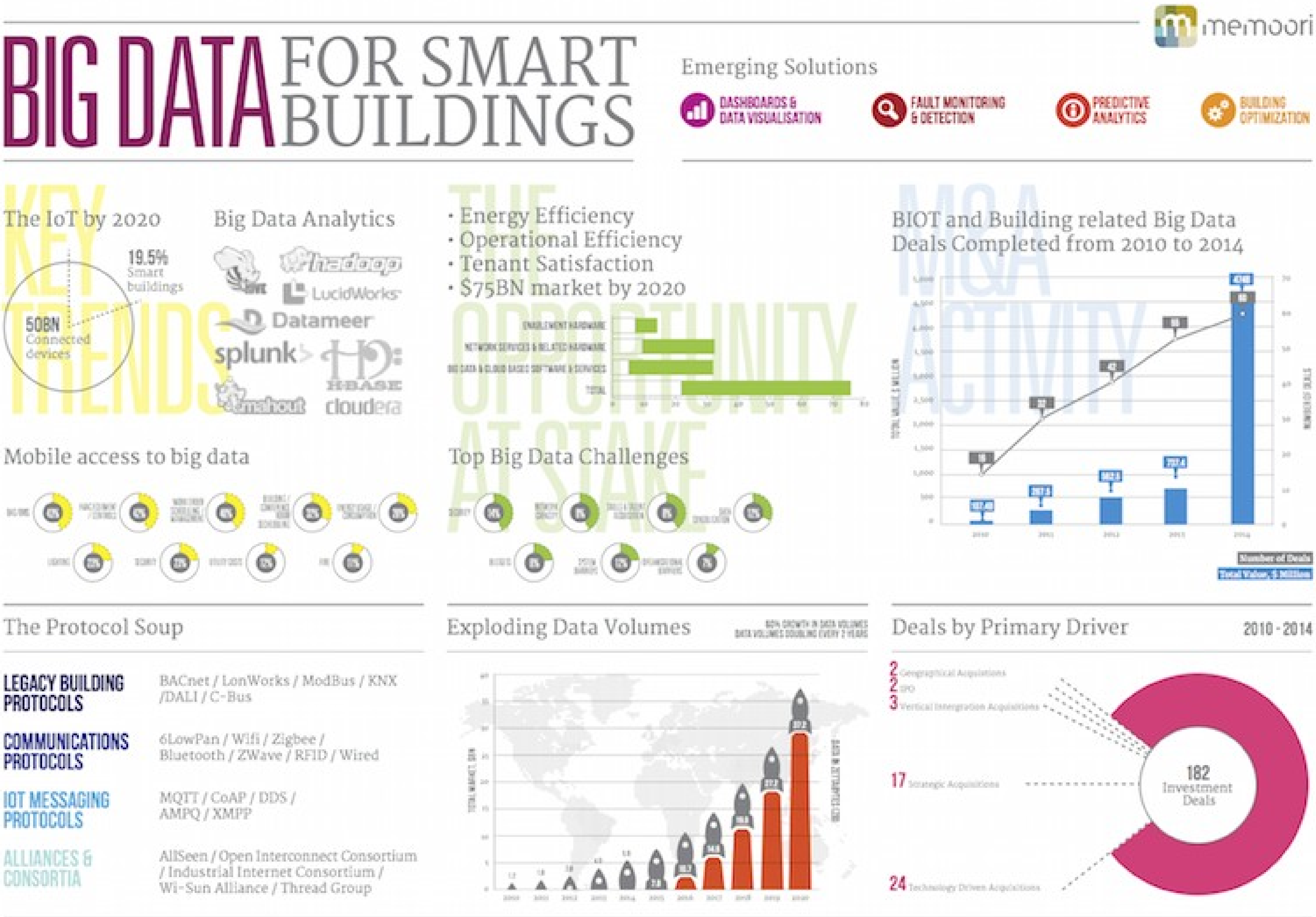
*868.3 MHz FSK,
modulated by ±48 kHz to ±80 kHz (1 and 0)
*ISM - Industrial Scientific and Medical frequencies

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

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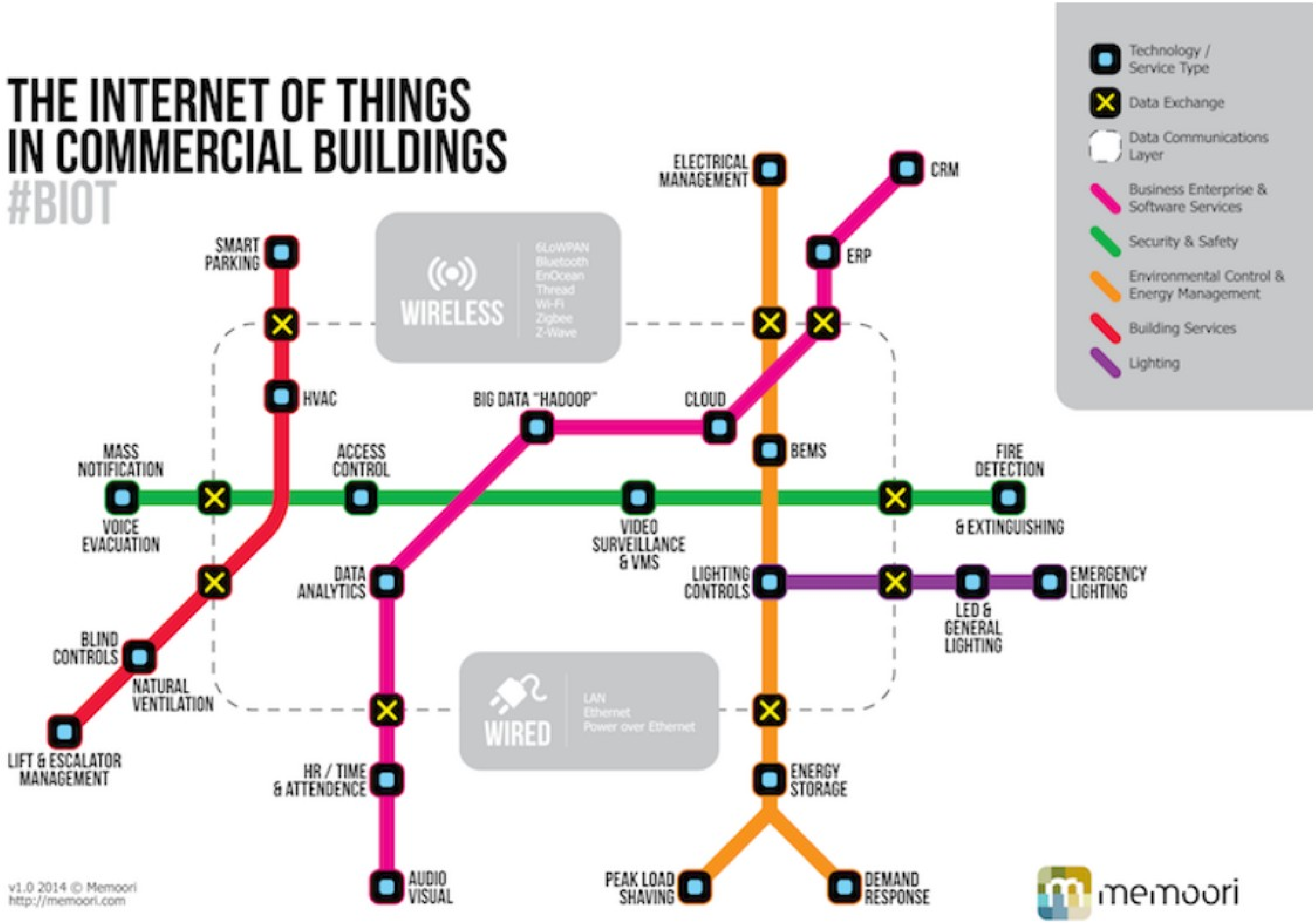
Deals by Primary Driver
2010-2014
182 Investment Deals
2
2
3
17
24


THE INTERNET OF THINGS
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#BIOT
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Data Exchange
Data Communications Layer
Business Enterprise & Software Services
Security & Safety
Environmental Control & Energy Management
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Lighting
WIRELESS
6LoWPAN
Bluetooth
EnOcean
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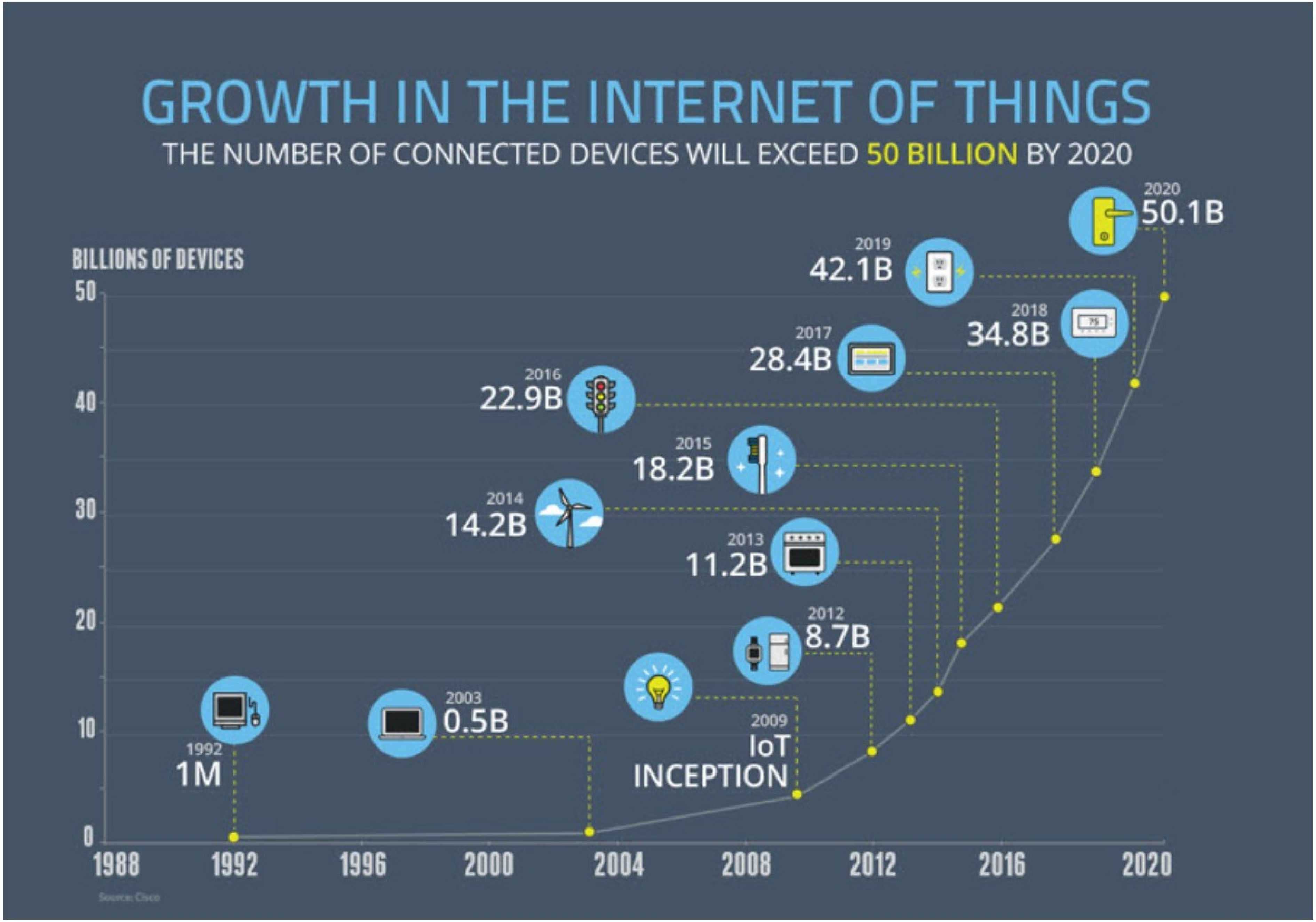

Credit: Enterprise Irregulars

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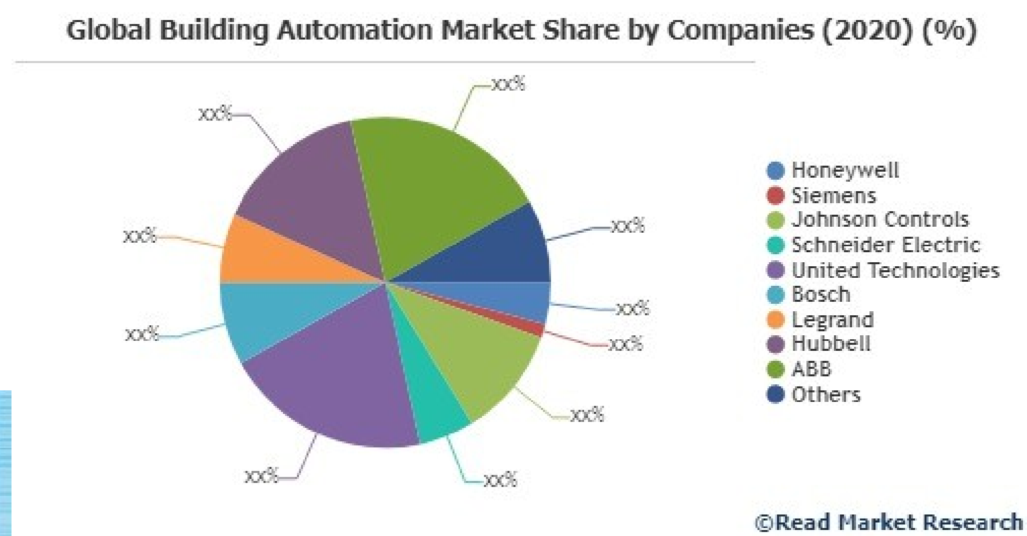

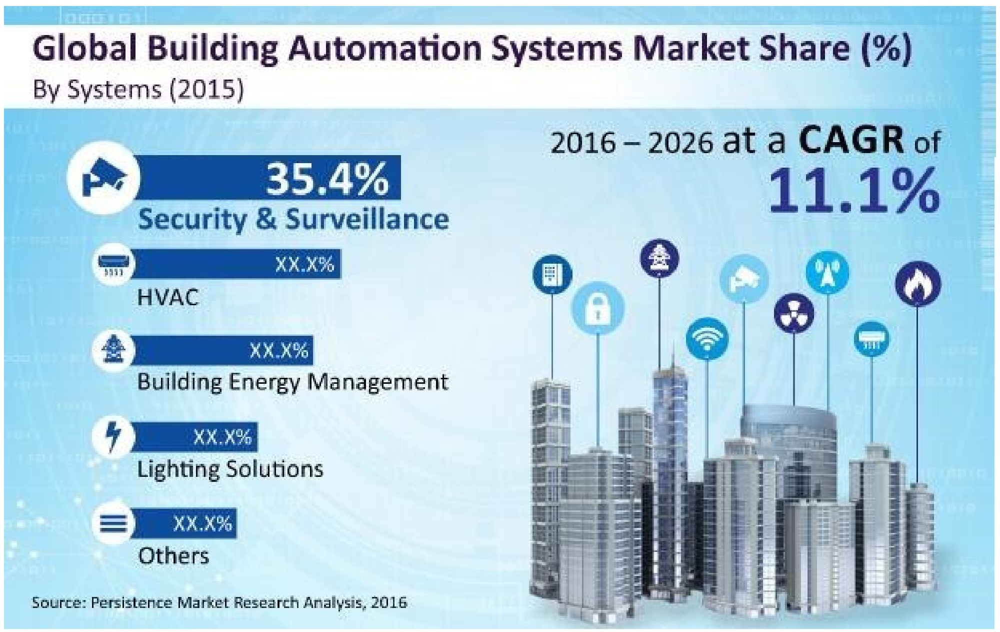

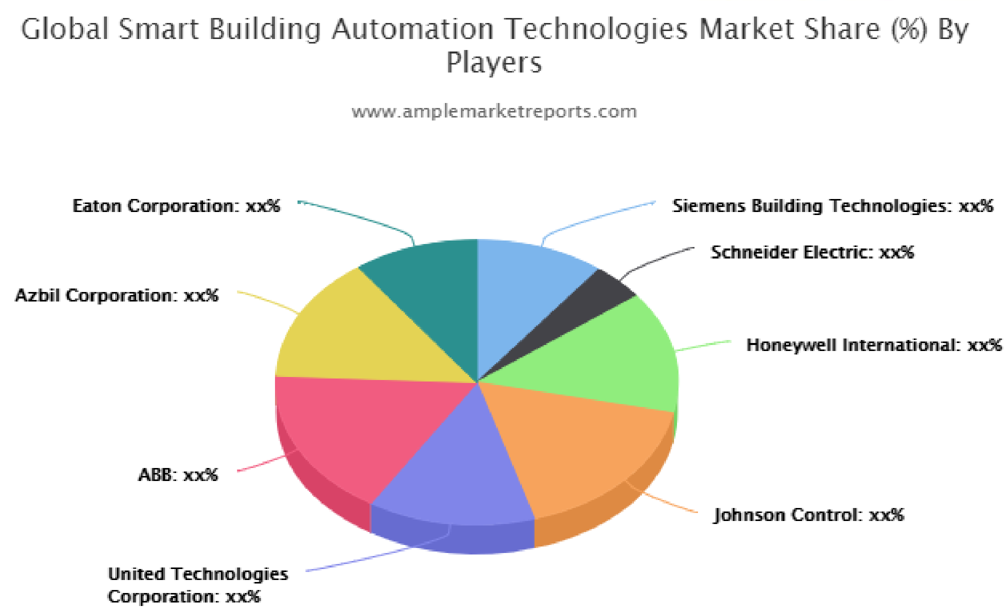

CAGR refere-se à taxa de crescimento anual composta


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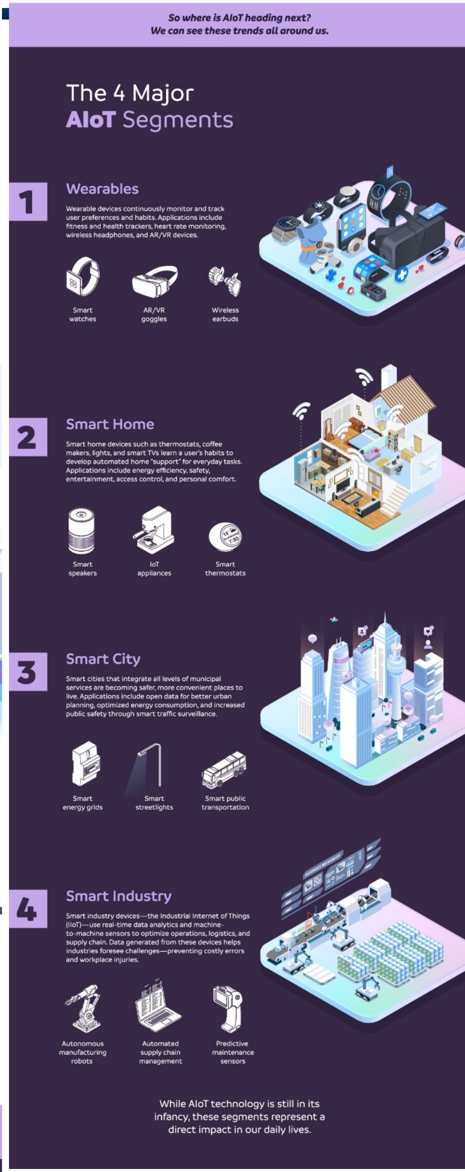
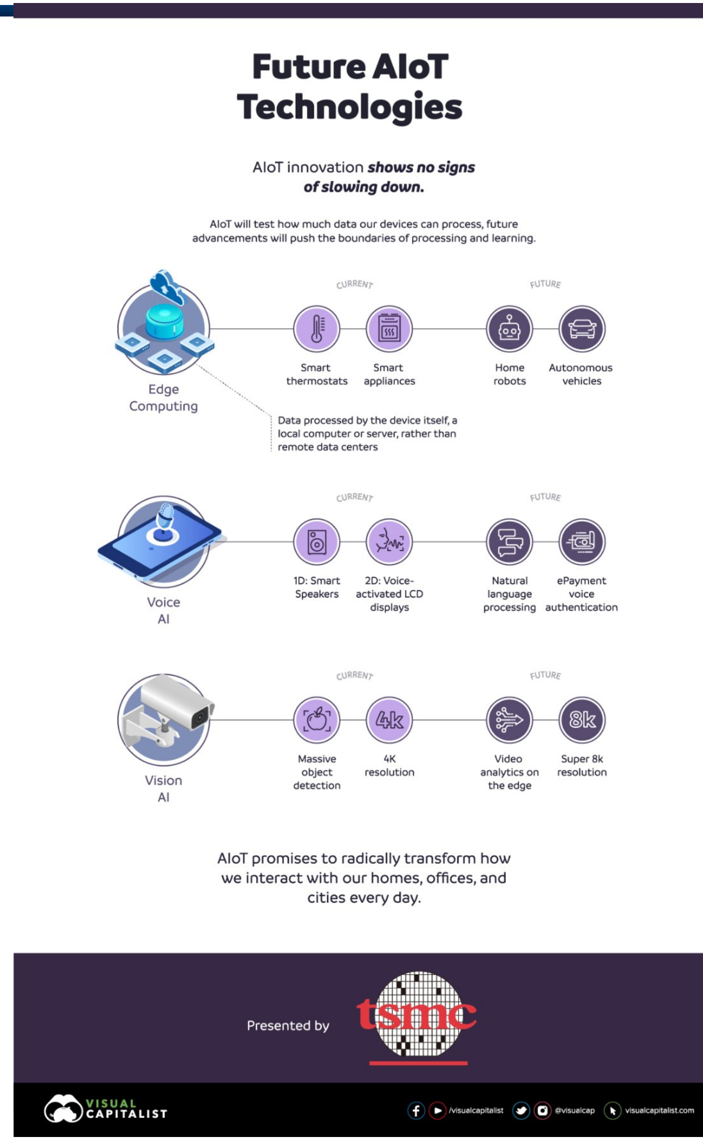
03 Internet of Things evolves into Intelligence of Things as AI-enabled devices move closer to autonomy
04 Integration between AR glasses and smartphones will kick-start a wave of cross-device applications
05 A crucial part of autonomous driving, driver monitoring systems will skyrocket in popularity
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 AiP 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
5G
6G
AR
HPC
AiP
Micro LED TV

AIoT: Artificial Intelligence of Things





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KNX Telegram

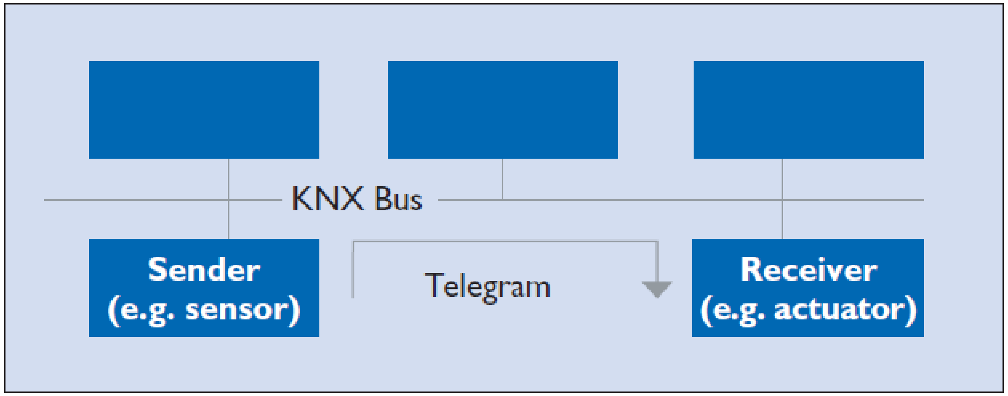


Figure 4. *Sensor/actuator principle*

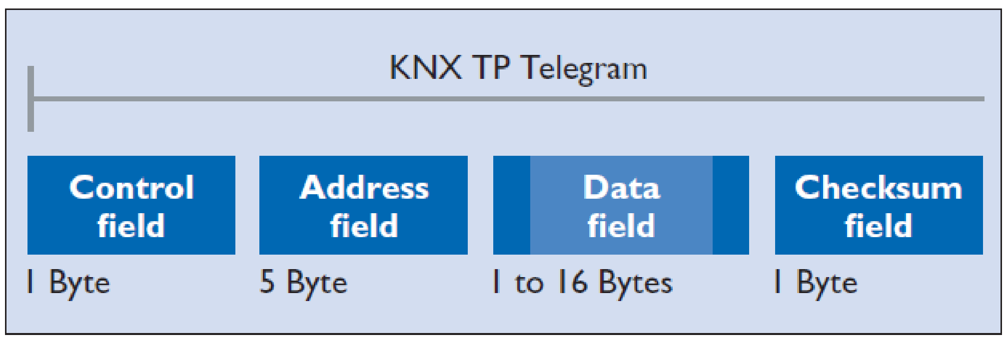


Figure 7. *Telegram structure in KNX TP*

KNX Telegram

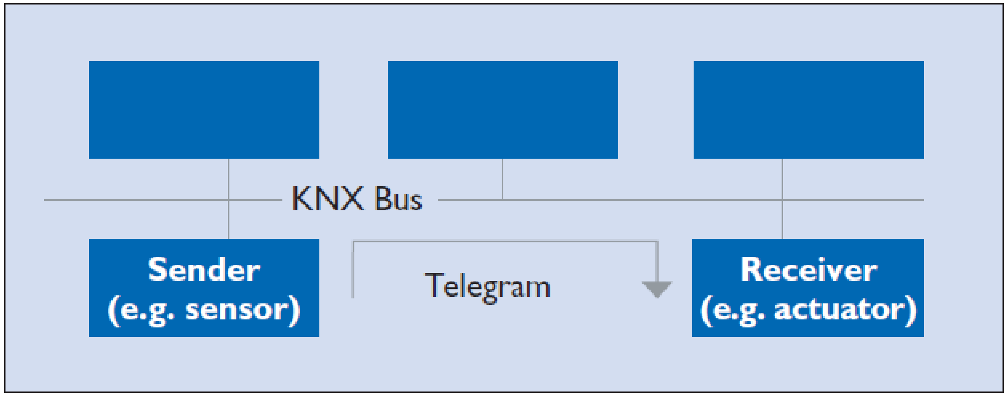


Figure 4. *Sensor/actuator principle*

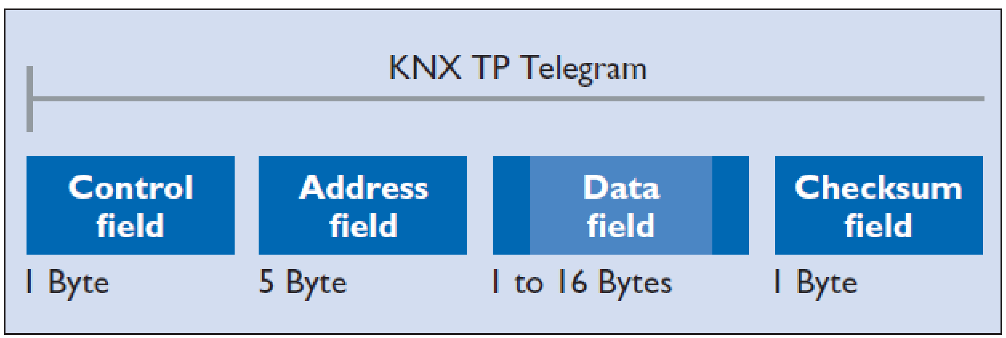


Figure 7. *Telegram structure in KNX TP*

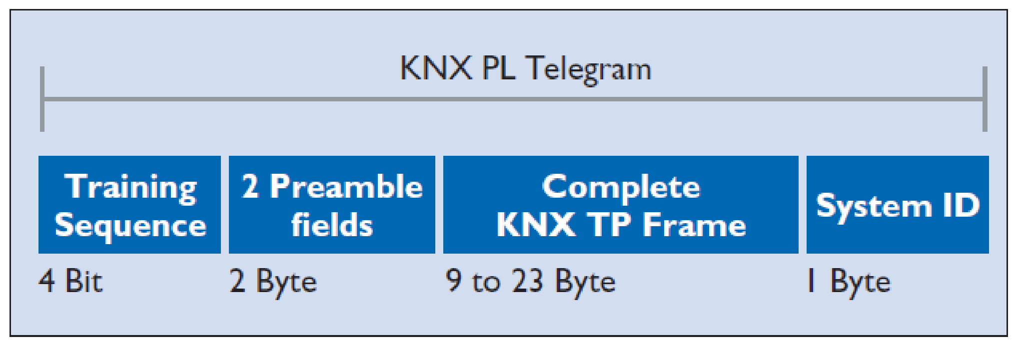


Figure 11. *Telegram structure in KNX PL*

KNX Telegram

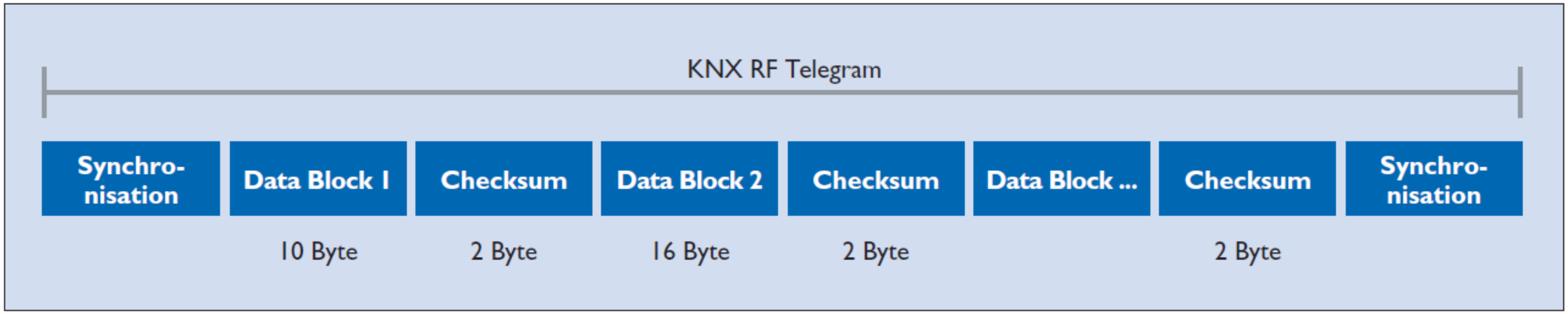


Figure 13. Telegram structure in KNX RF

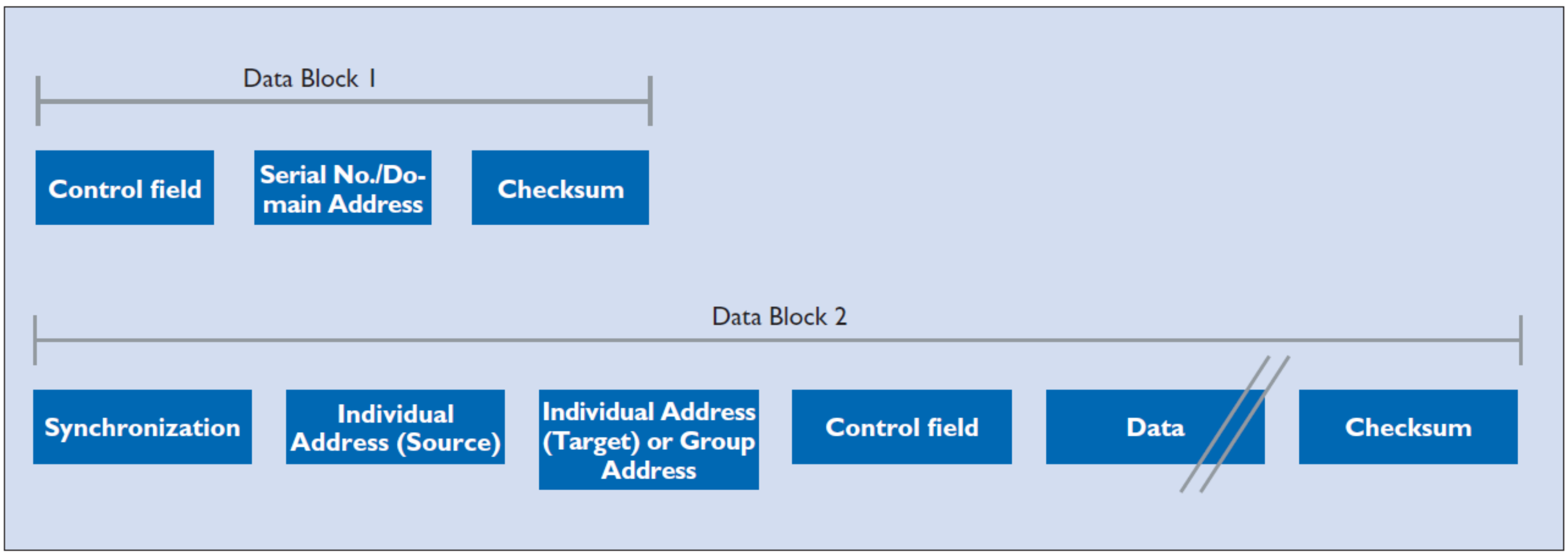


Figure 14. Data blocks in a KNX RF telegram

KNX Telegram

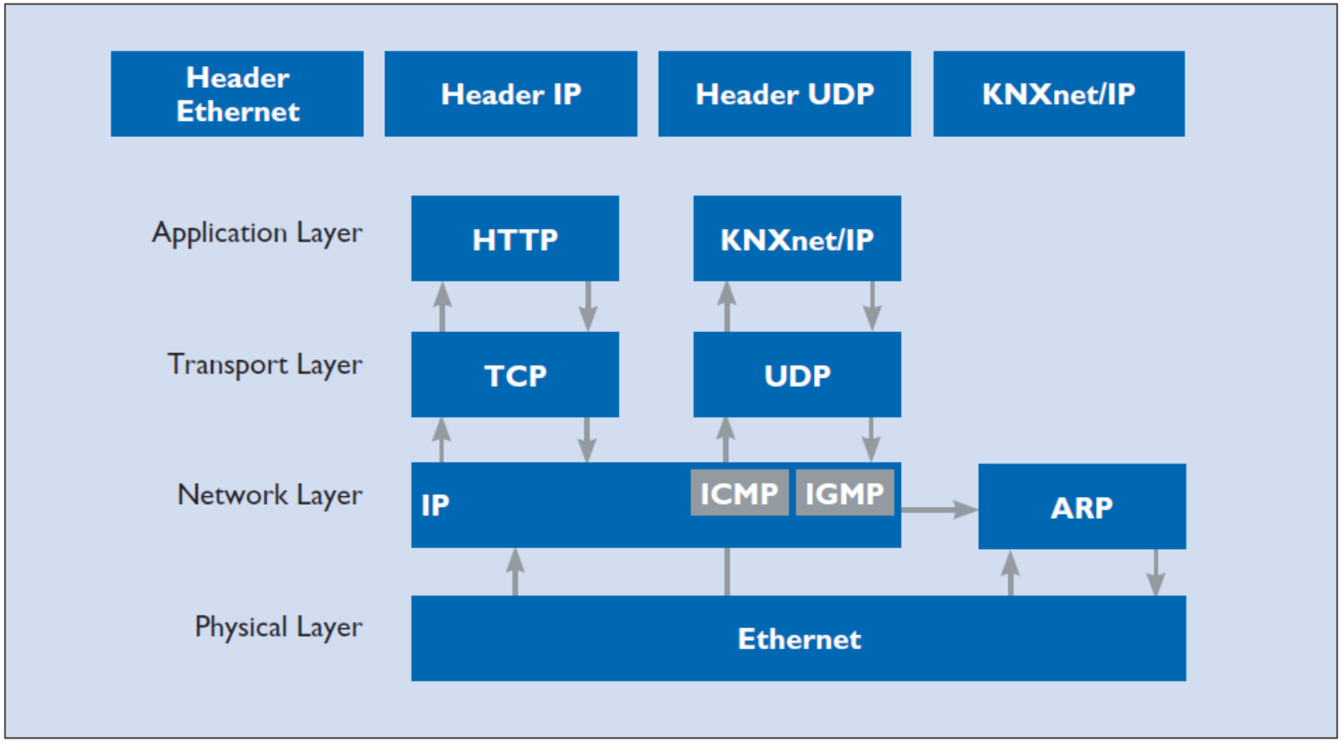


Figure 15. *KNXnet/IP in the OSI reference model*

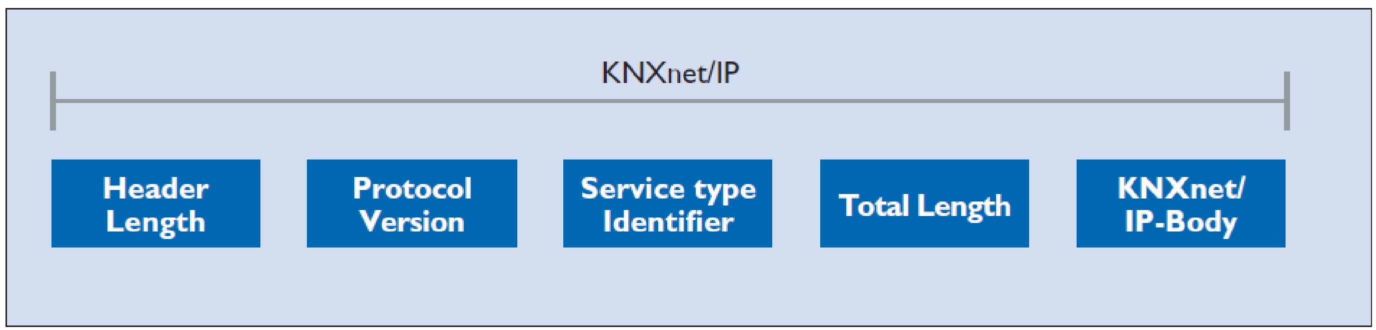


Figure 16. *KNXnet/IP telegram*

KNX Topology

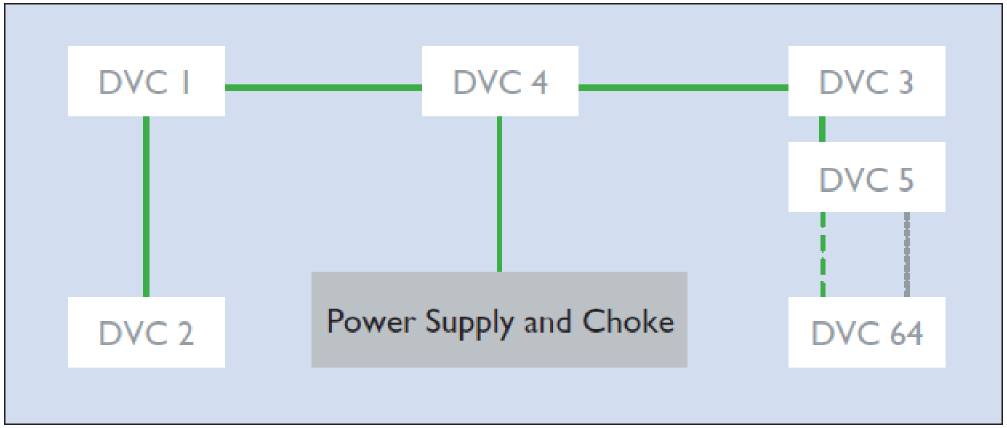


Figure 19. KNX TP line

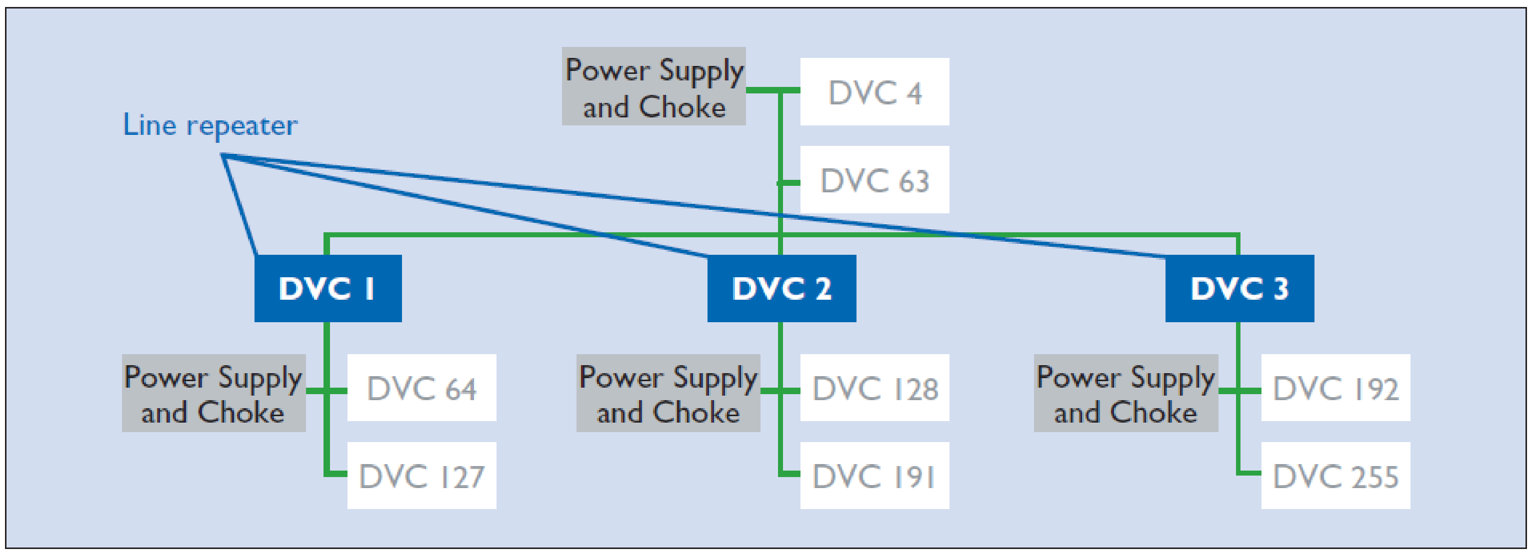


Figure 20. Maximum length of a line in KNX TP

KNX Topology

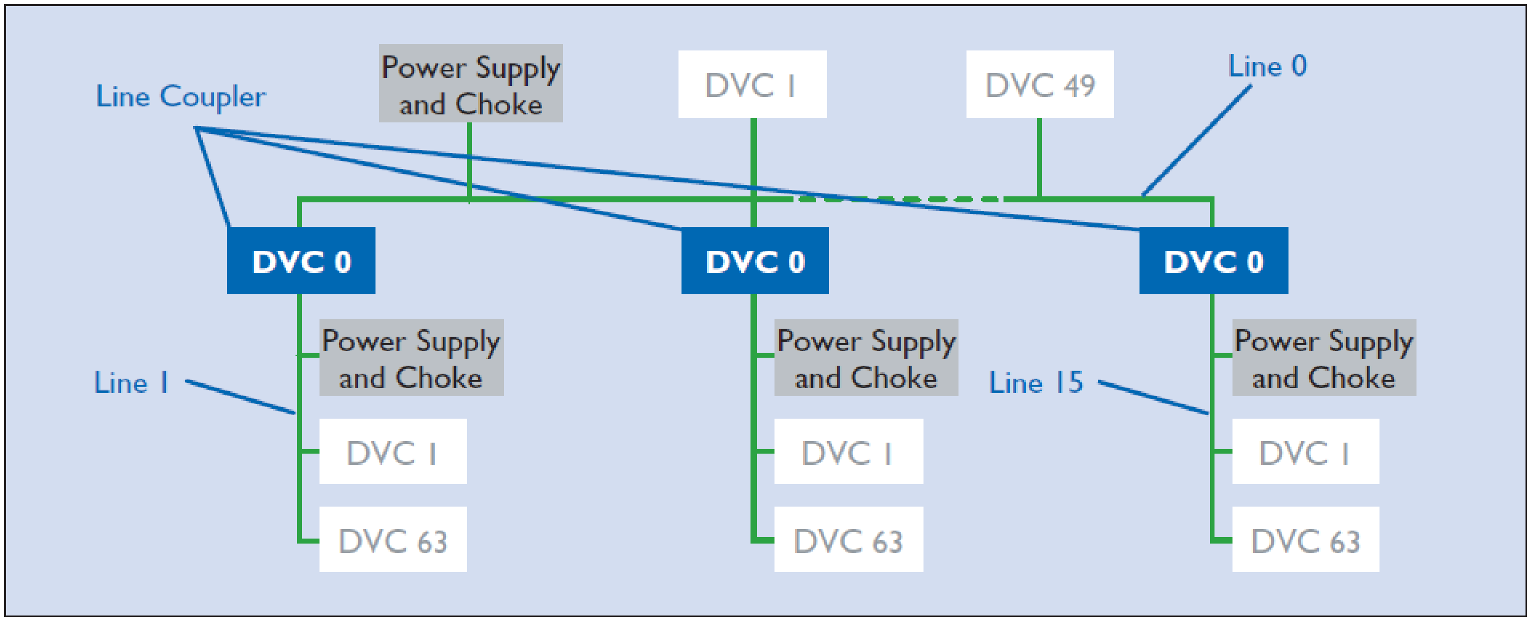


Figure 21. *An "area" in KNX TP: up to 15 lines can be coupled via a main line.*

KNX Topology

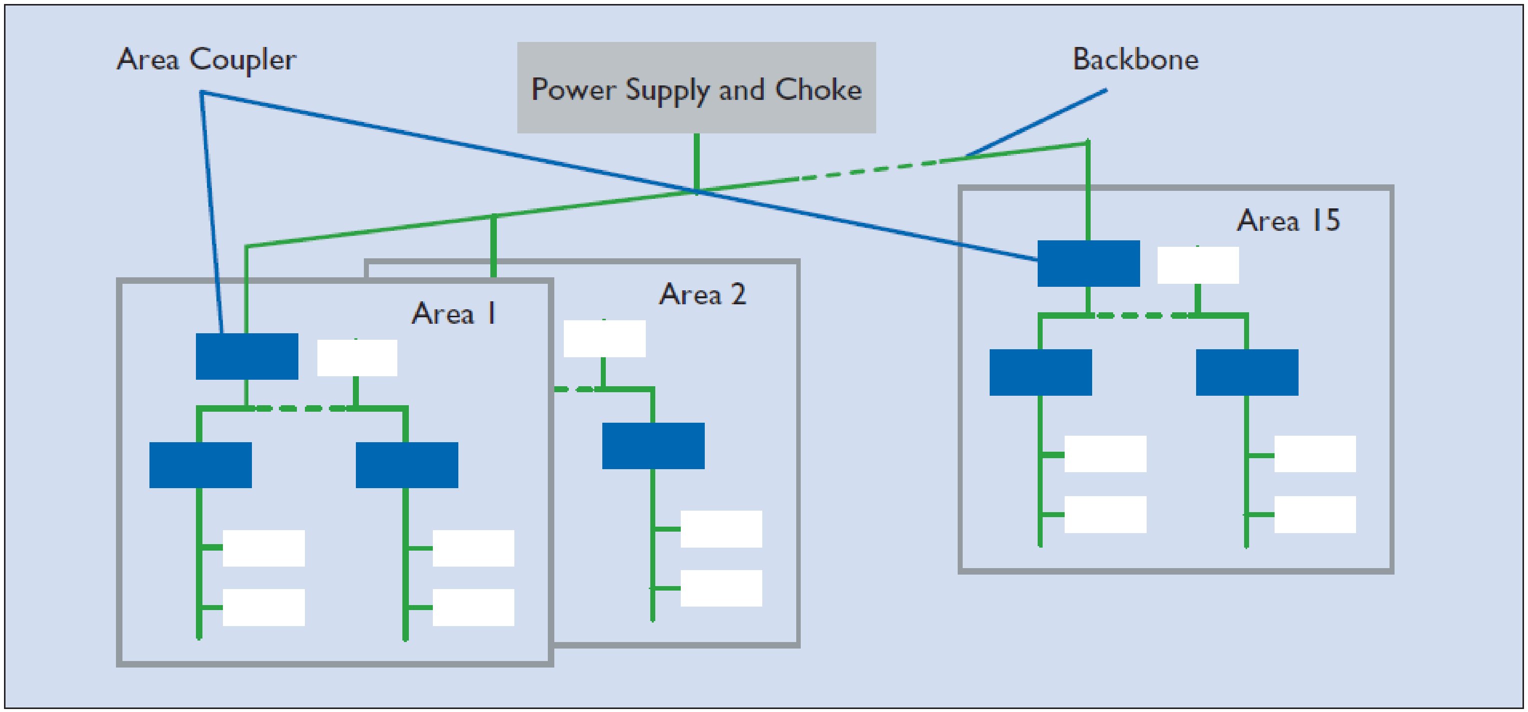
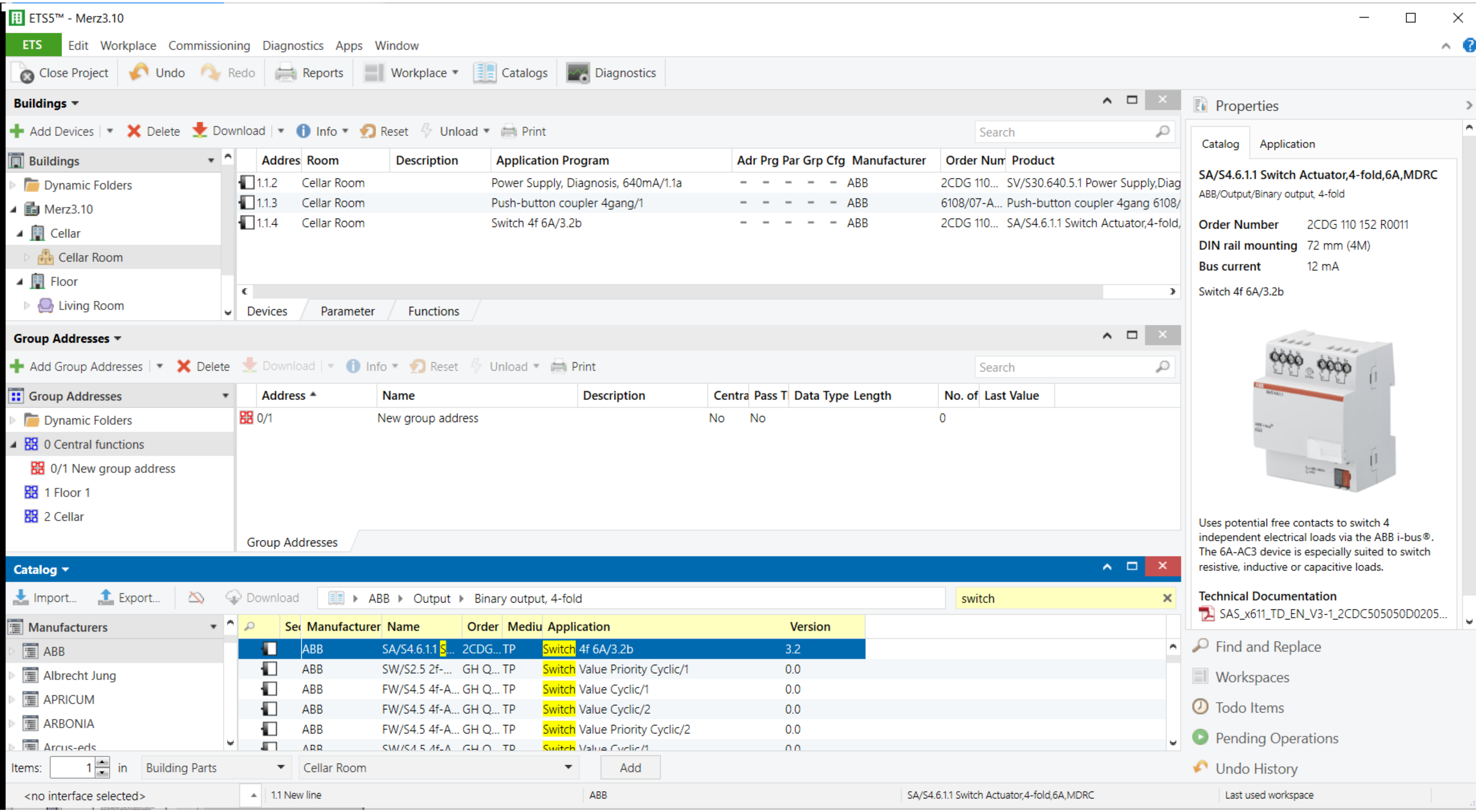


Figure 22. Up to 15 areas can be coupled via area couplers in KNX TP.

ETS5 – Engineering Tool Software



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 softwareç.

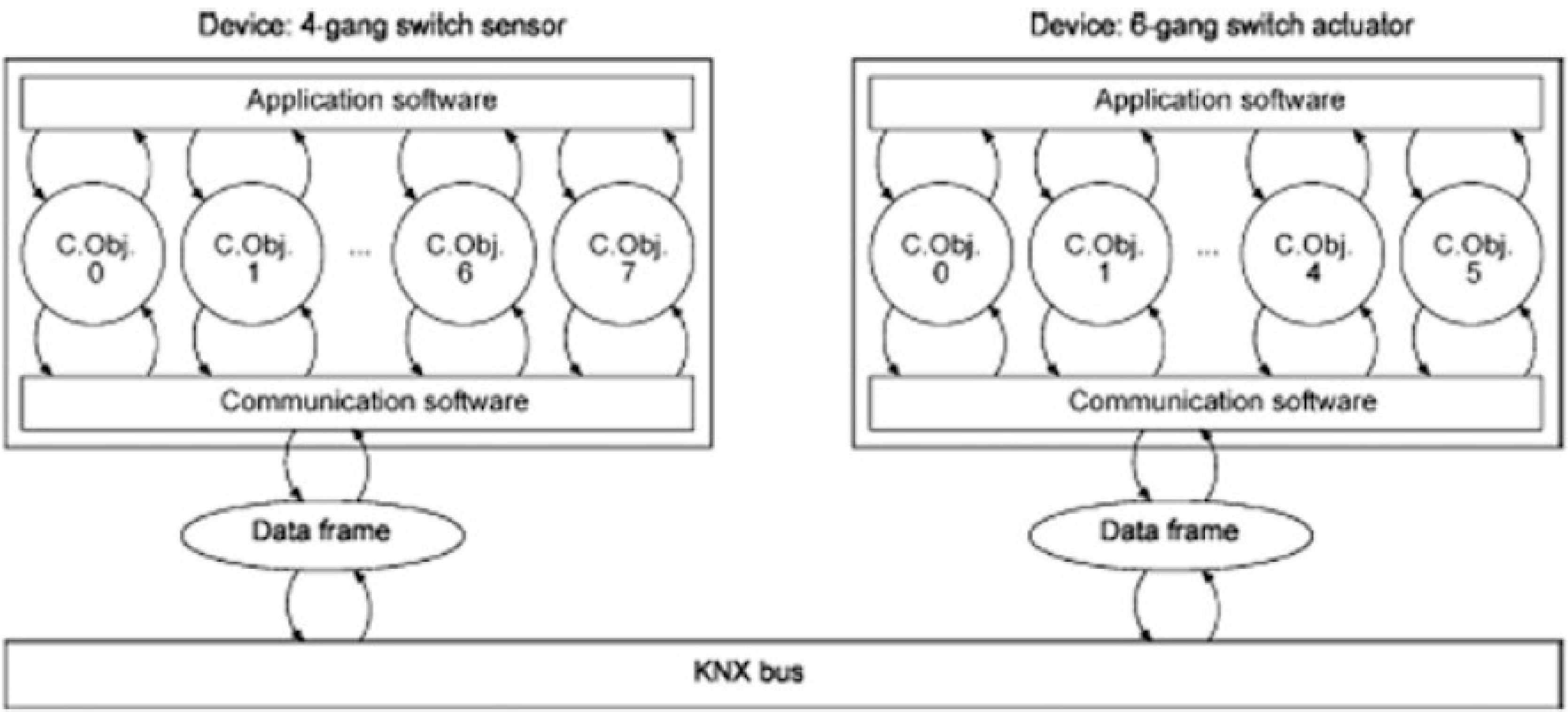


Fig. 3.23 Communication Object of a four-gang Switch Sensor and a six-gang Switch Actuator

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

• 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.

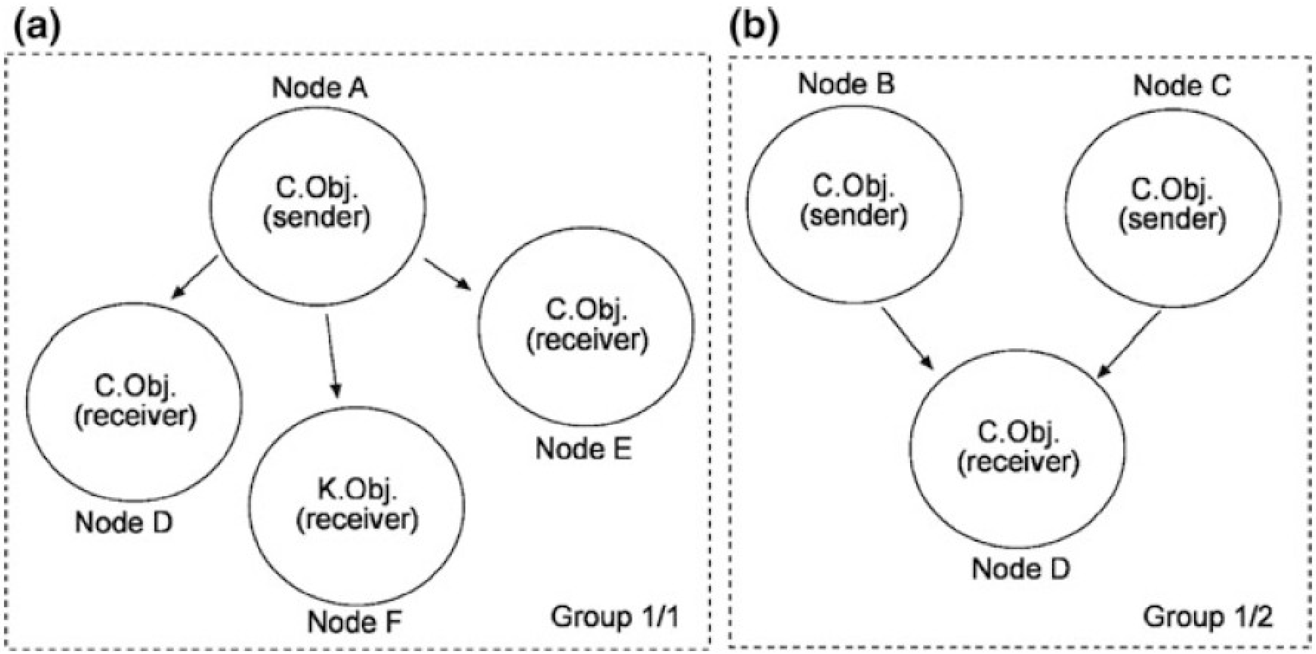


Fig. 3.24 Groups with sender and receiver communication objects

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

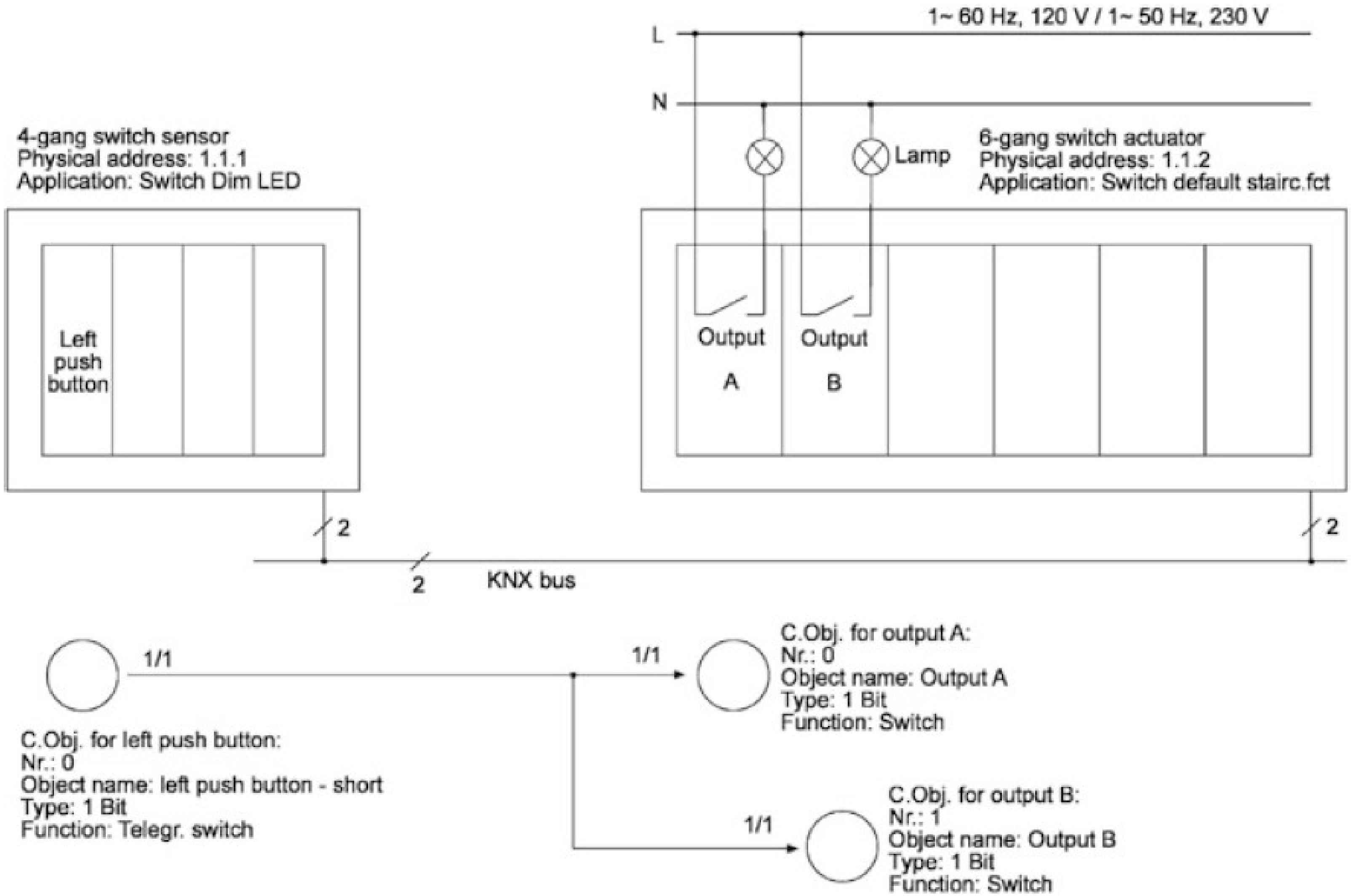


Fig. 3.26 Assigning communication objects to a group address

3.9 EIS – EIB Internetworking Standard

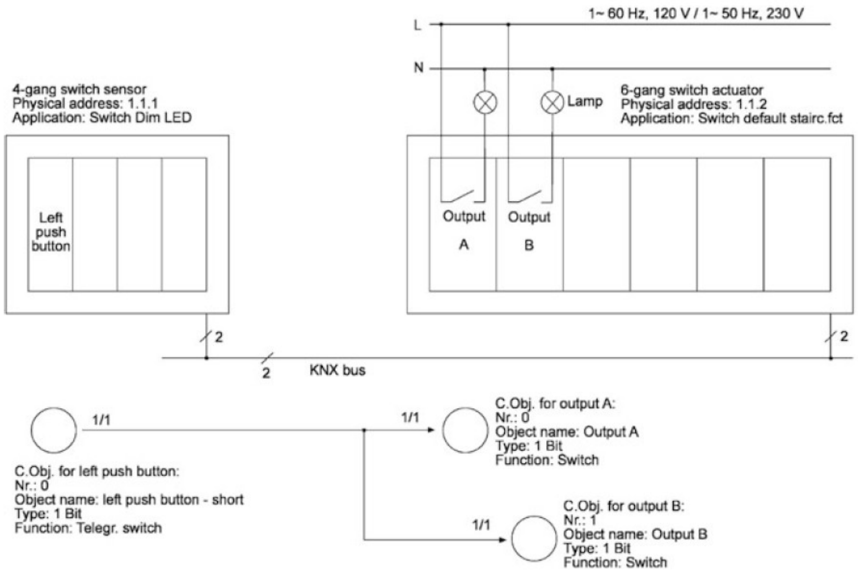


Fig. 3.26 Assigning communication objects to a group address

• 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

3.9 EIS – Switching Command

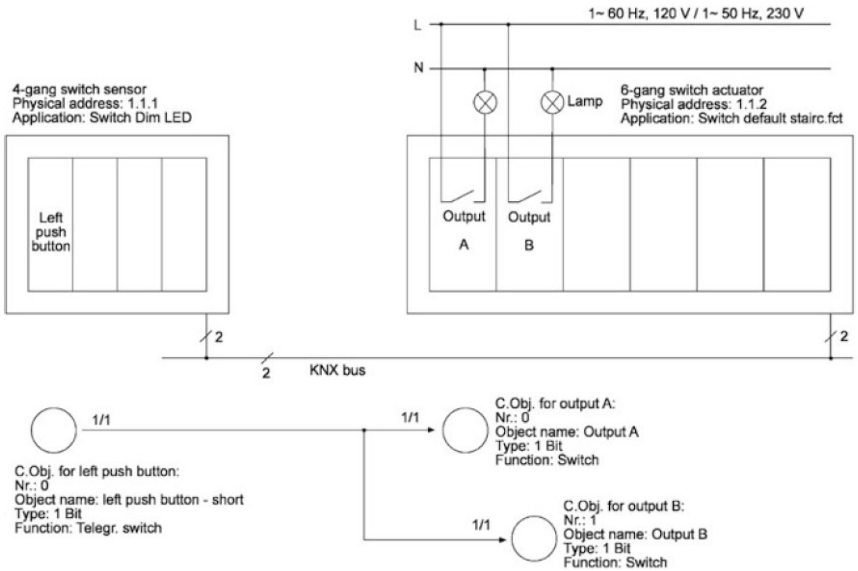


Fig. 3.26 Assigning communication objects to a group address

- 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 B9	D0 B8	D7 B7	D6 B6	D5 B5	D4 B4	D3 B3	D2 B2	D1 B1	D0 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

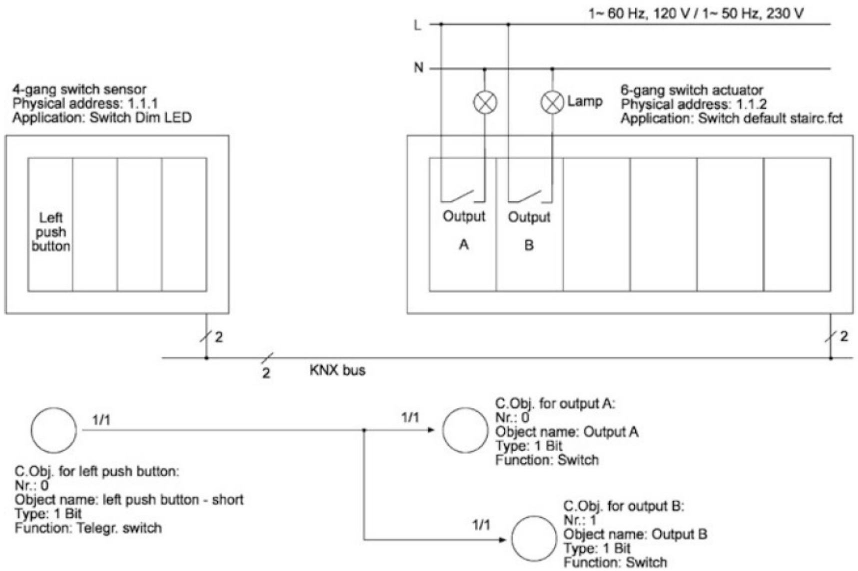


Fig. 3.26 Assigning communication objects to a group address

• Bits B9, B8, B7 and B6 contain 0010 corresponding to the service A_GroupValue_Write—writing in a C.Obj.
• 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.

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 B9	D0 B8	D7 B7	D6 B6	D5 B5	D4 B4	D3 B3	D2 B2	D1 B1	D0 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.

3.9 EIS – Dimming Command

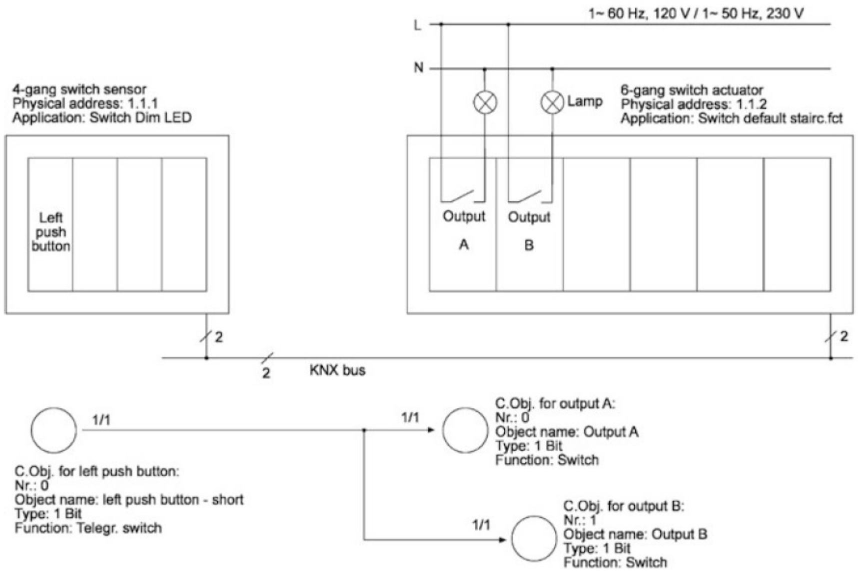


Fig. 3.26 Assigning communication objects to a group address

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  – Bit D3 contains the dimming information. A one bit means increase brightness and a zero bit means decrease brightness
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Byte 6								Byte 7								Command
MSB							LSB	MSB							LSB	
D7	D6	D5	D4	D3	D2	D1 B9	D0 B8	D7 B7	D6 B6	D5 B5	D4 B4	D3 B3	D2 B2	D1 B1	D0 B0	
0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	Dimming

3.9 EIS – Dimming Command

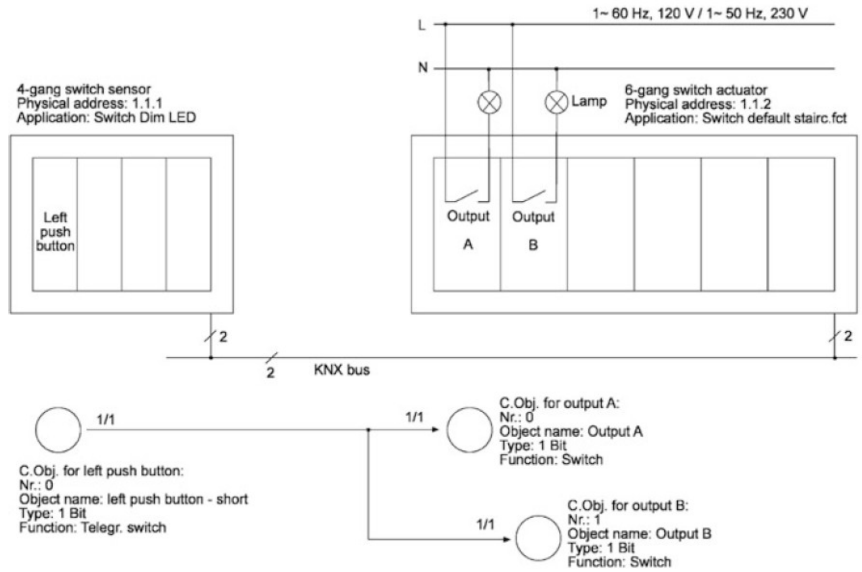

Fig. 3.26 Assigning communication objects to a group address

- Bits B9, B8, B7 and B6 contain 0010 corresponding to the service A_GroupValue_Write—writing in a C.Obj.
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– 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

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D7	D6	D5	D4	D3	D2	D1 B9	D0 B8	D7 B7	D6 B6	D5 B5	D4 B4	D3 B3	D2 B2	D1 B1	D0 B0	
0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	Dimming

3.9 EIS – Dimming Command

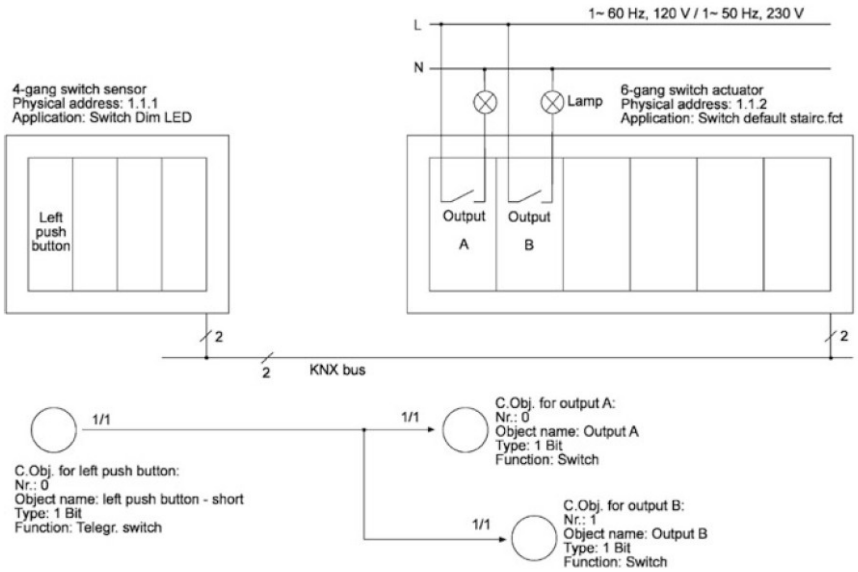

Fig. 3.26 Assigning communication objects to a group address

- Bits B9, B8, B7 and B6 contain 0010 corresponding to the service A_GroupValue_Write—writing in a C.Obj.
- 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
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0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	Dimming

3.8 CSMA/CA

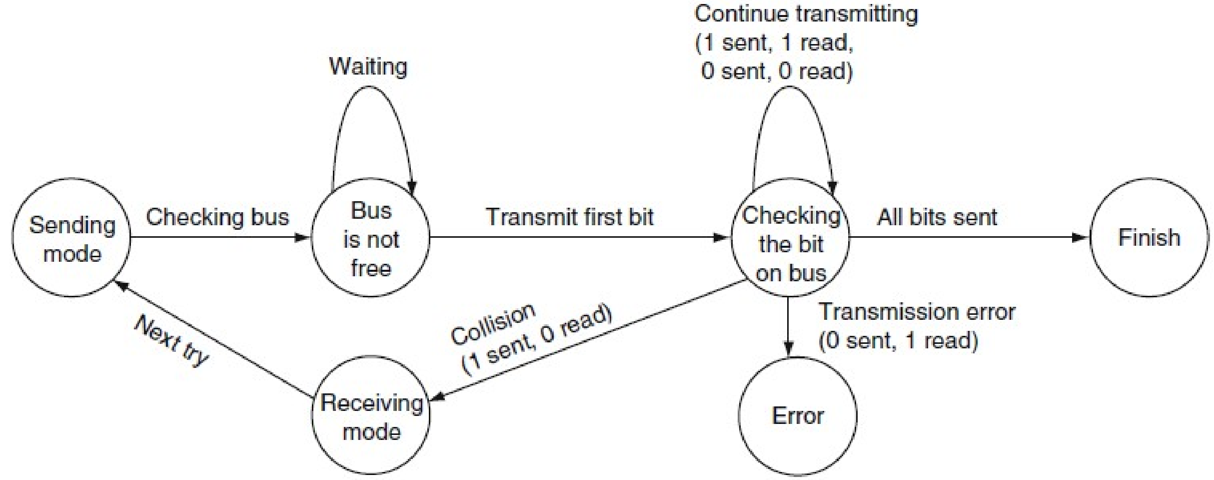


Fig. 3.28 Status diagram for the CSMA/CA protocol

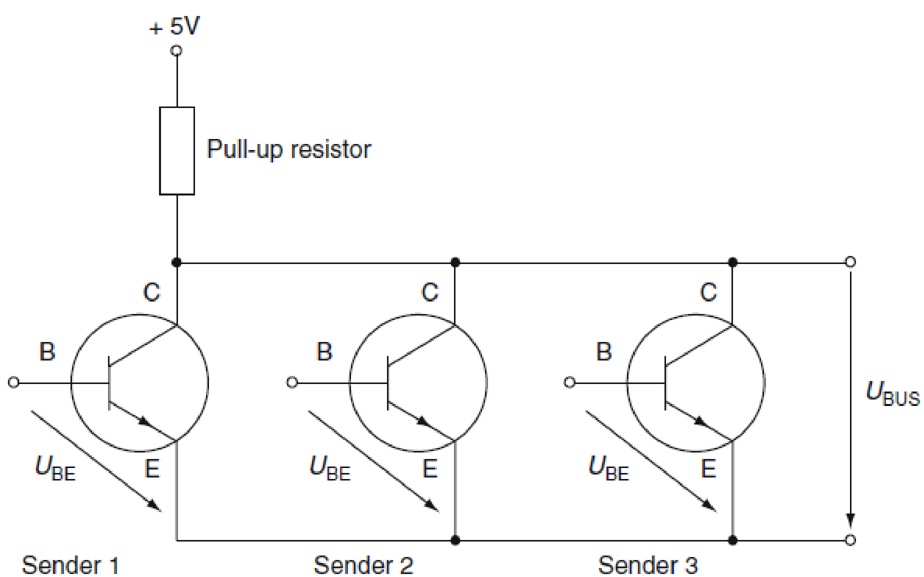


Fig. 3.27 Wired-AND switching: dominant and recessive bits

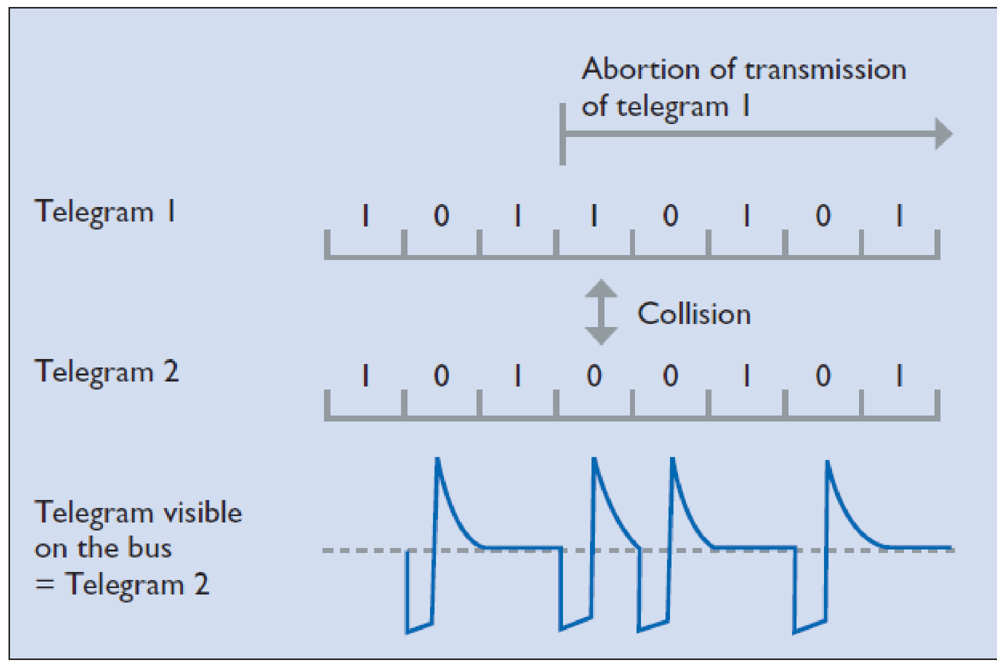


Figure 9. *Collision avoidance in KNX TP*

Simulador KNX-Virtual: KV

help.knx.org/kv

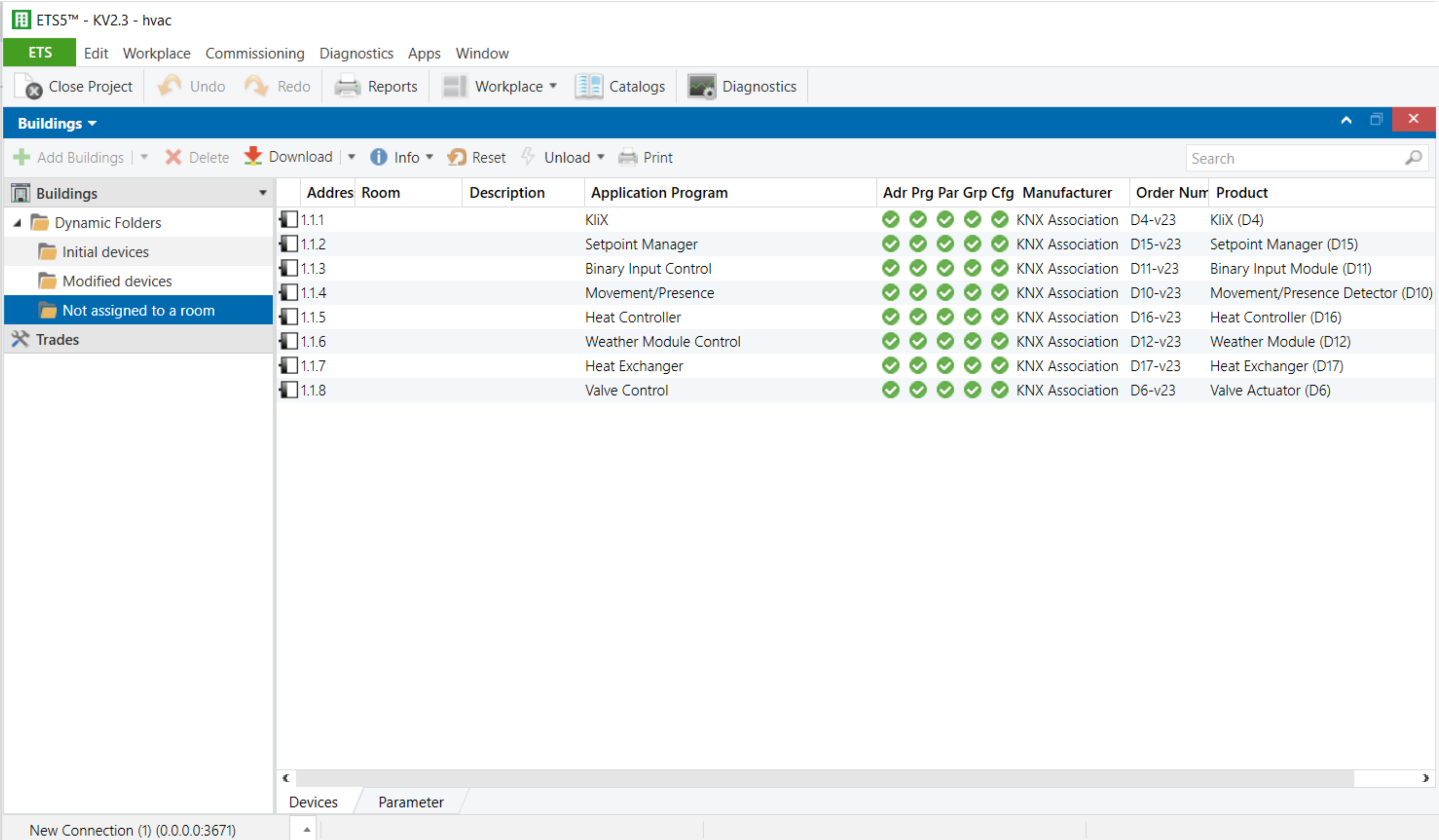
KNX Virtual

Get Started	Examples
User Guide	How-to
Help	Release notes

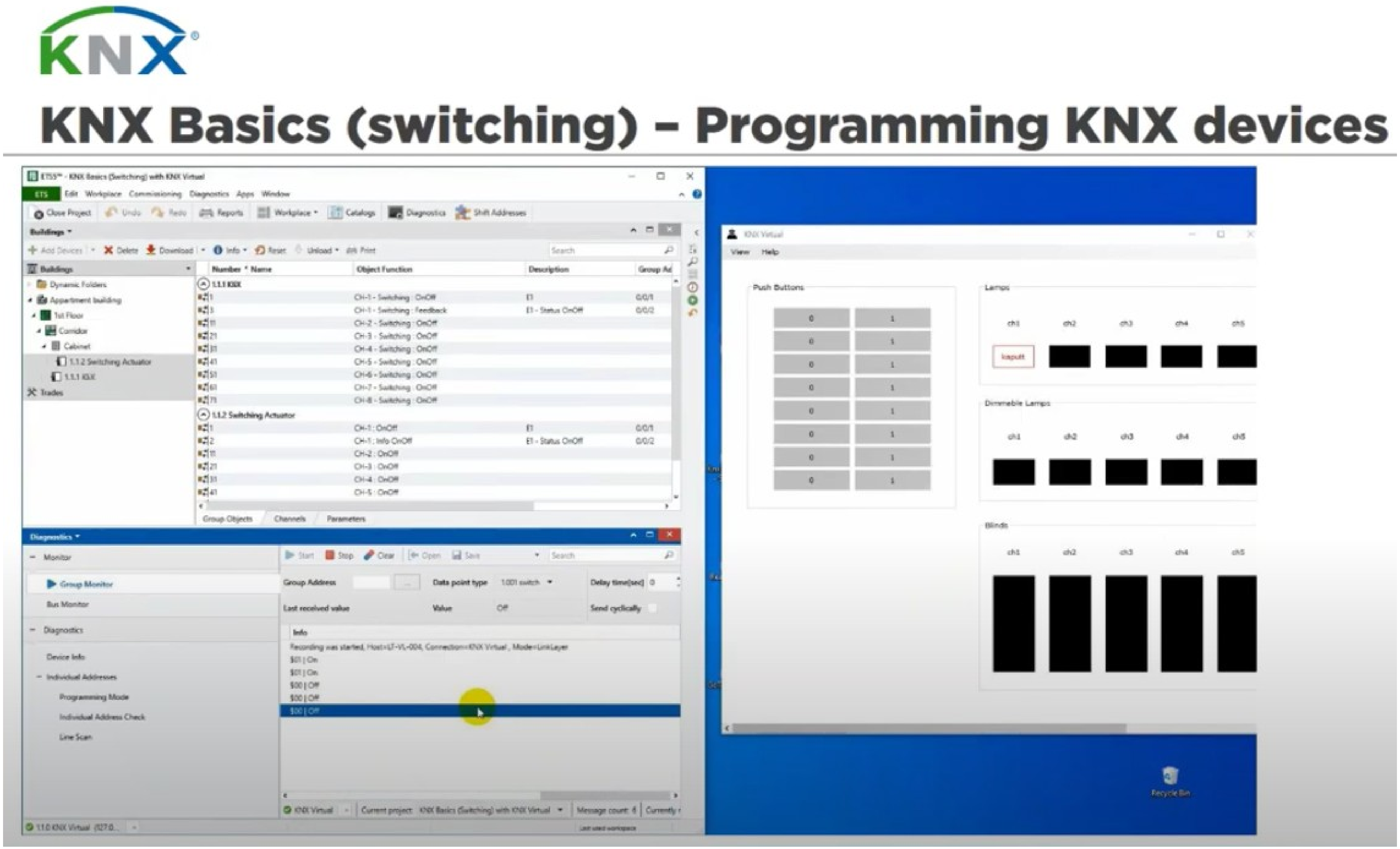
Examples

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

Simulador KNX-Virtual: KV



Simulador KNX-Virtual: KV



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?

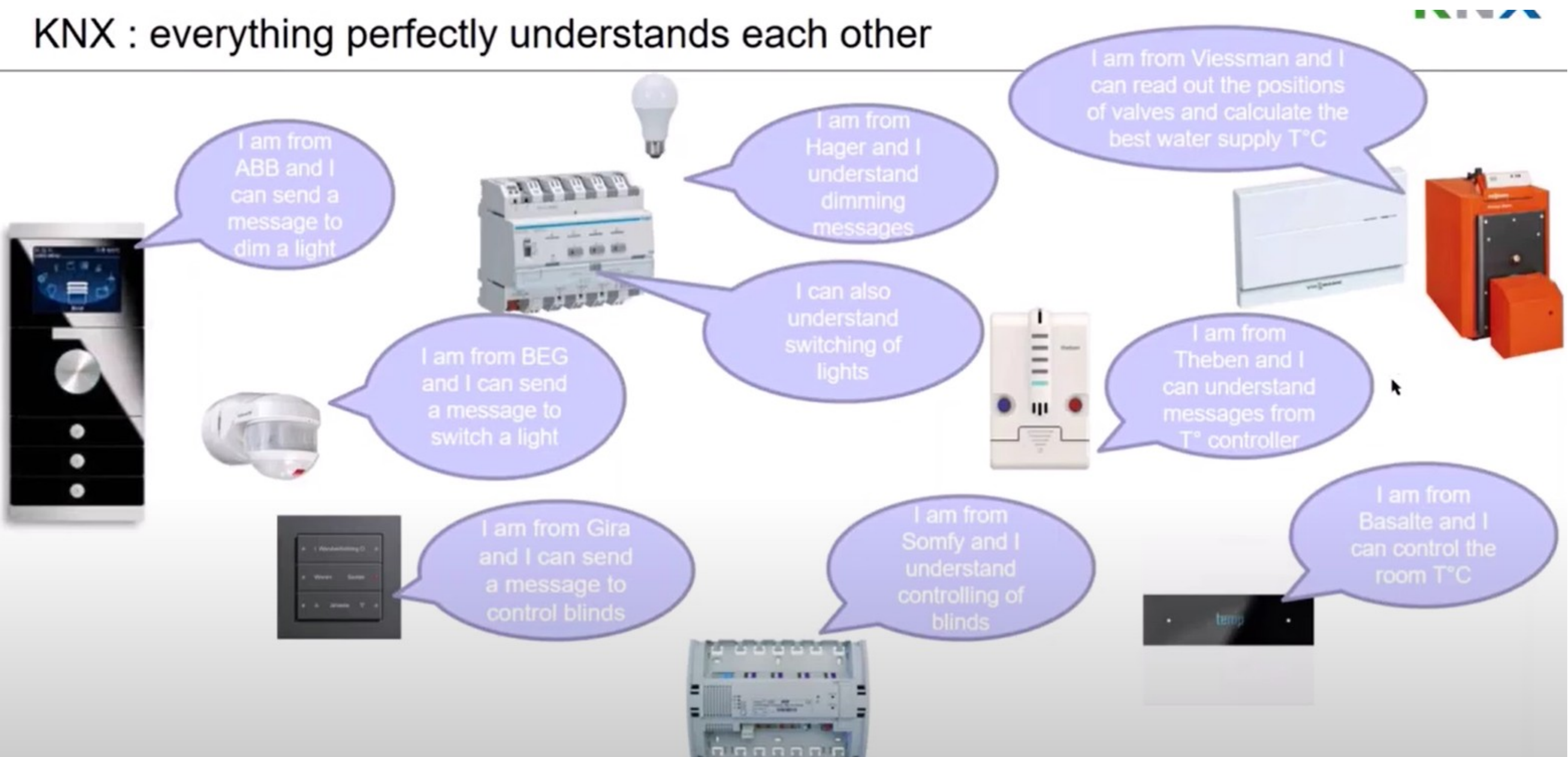
How will KNX IoT allow to connect to KNX installations?

How will the installer see this in ETS?

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)



KNX 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
    - Realizing an all off when leaving the house
    - Changing the set point temperature in a room etc.

BUT: what is the added benefit apart from linking devices? Which of my customers pay me for this effort?

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

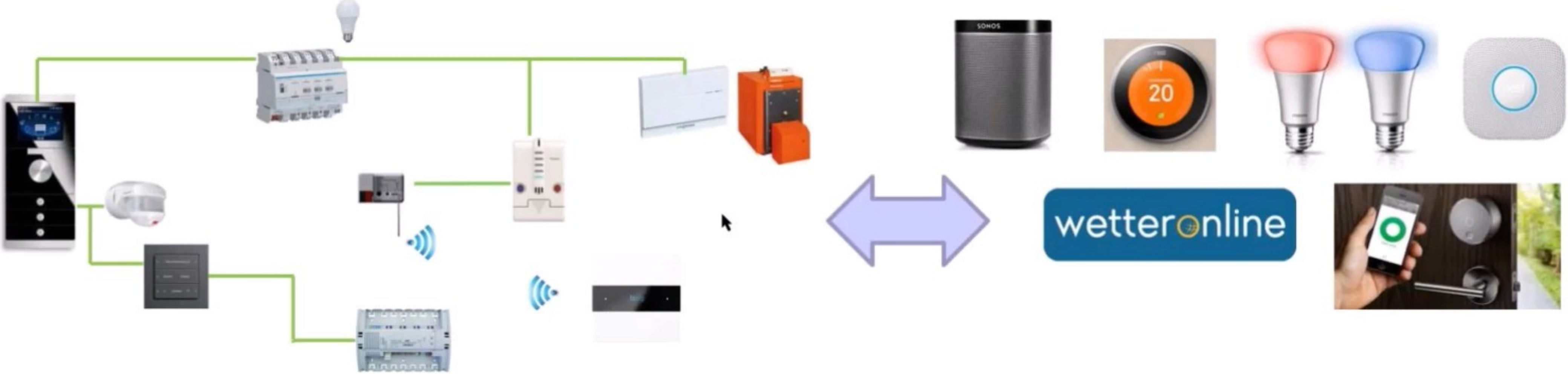
Data is the new oil → As installer I create data that could be interesting to others, but is it beneficial for myself ??

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:

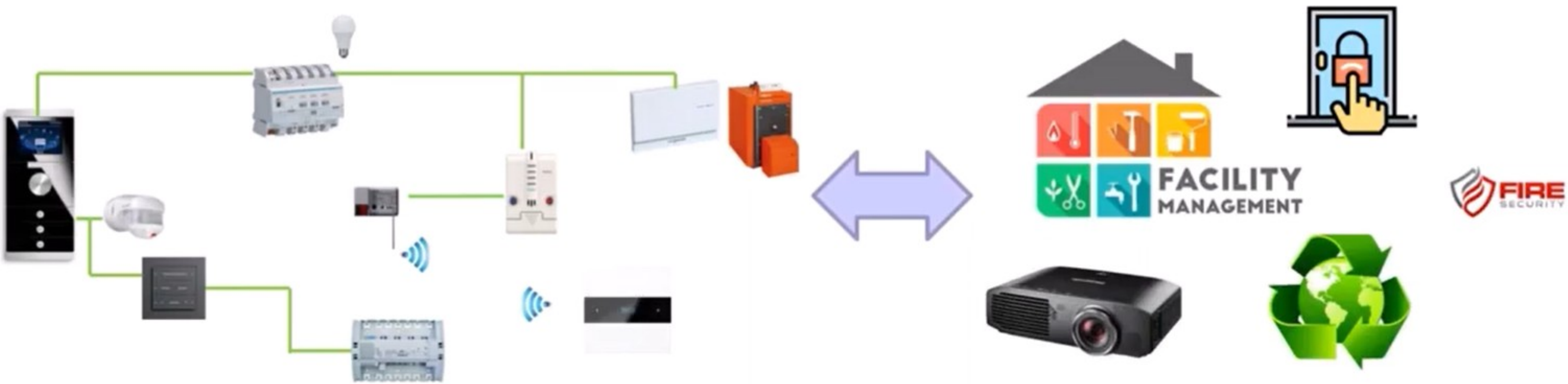
- KNX is not a closed system and integration is easily possible
- His investment in KNX pays off and is future proof (will be able to integrate future solutions as well)
- I would preferably not like to be responsible for this integration (better the customer)
  - I would like to just hand over the KNX project to the customer and be done (better calculable)
  - the warranty on my work should preferably not be void when the customer integrates these consumer products

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:

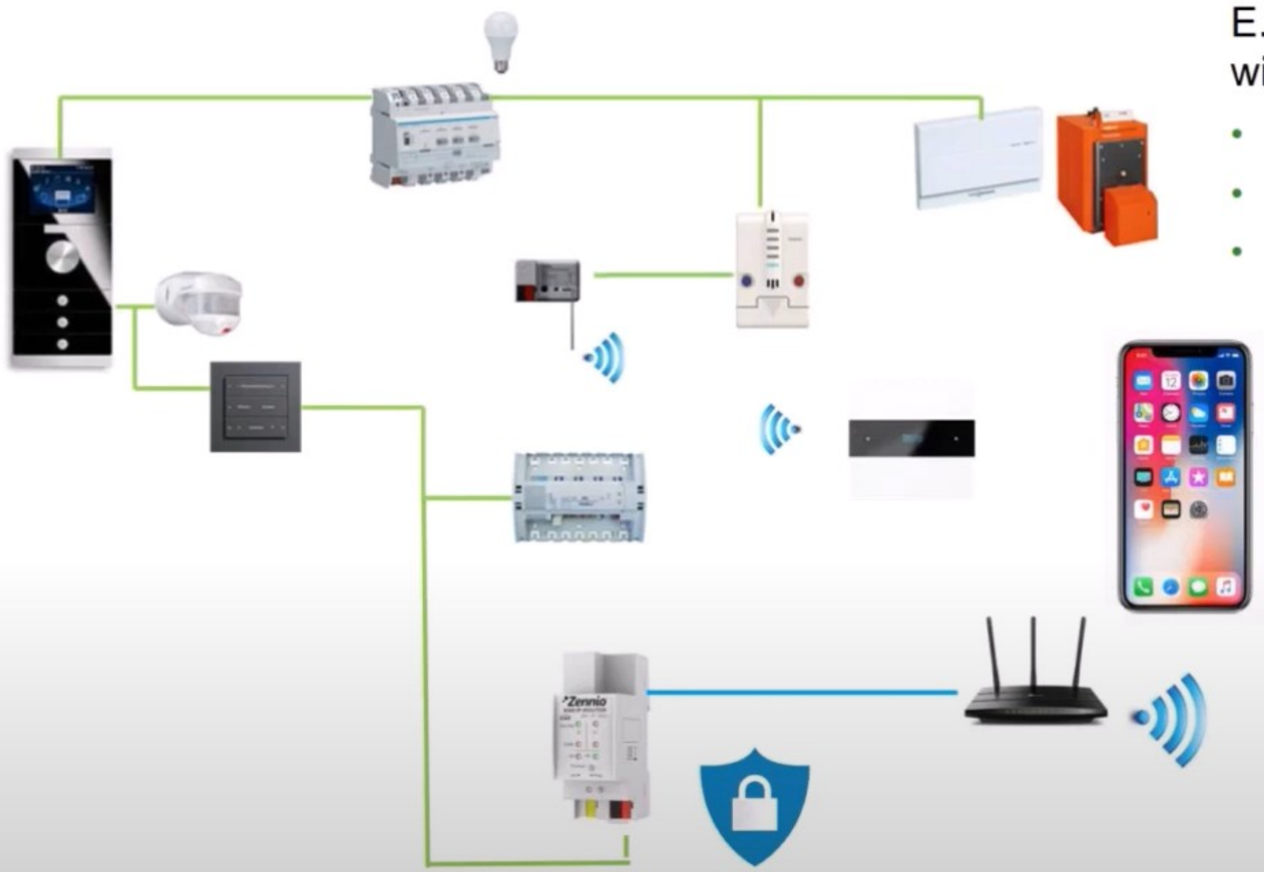
- Same arguments as before
- I would like to make sure that the customer only has access to data that he should be entitled to, not the entire communication
- I would hope as system integrator that such devices implement an interface that can easily talk to KNX without being KNX compatible

KNX IoT

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

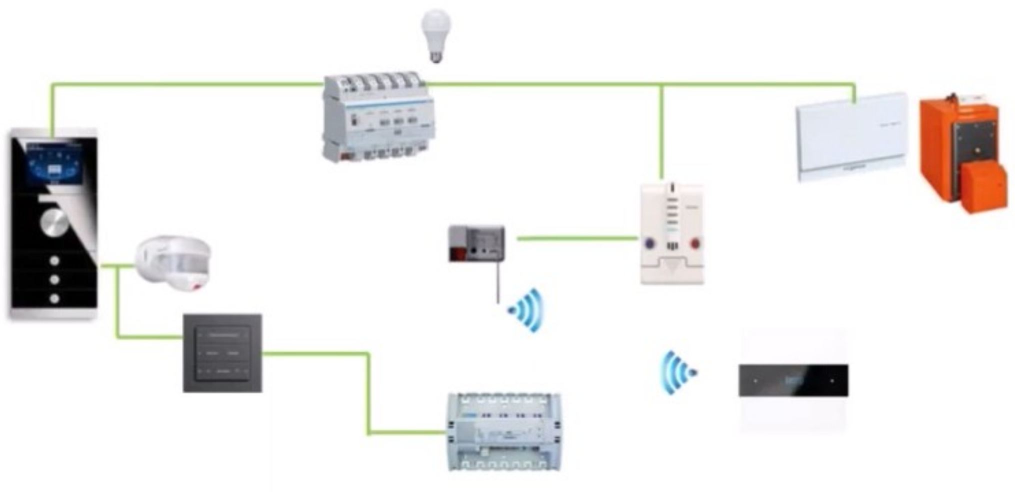
- RS232
- USB
- KNXnet/IP Interface
  - However data always offered “KNX style” – if you want to understand our messages “Read the specs” and convert them to your messages
  - Every information entered into ETS needs to be re-entered in “thing” wanting to access the data (or has to make proprietary use 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
  - Some device groups were never KNX enabled as too cumbersome to develop (ETS support not desired, TP not right medium, …)

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

The world has moved on – new requirements



The world of Information Technology & Internet of Things

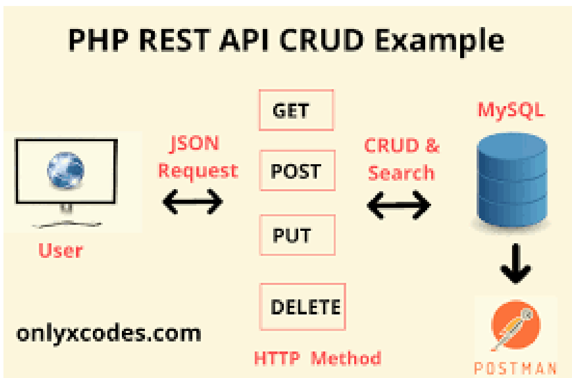
- Simply wants the data → and please in a format that we can understand
- Wants to collect it only with protocols known to them and commonly used
    - provide a REST interface to your system and I will collect it with http or via websockets
- Wants to fetch the data in a secure way
- Perfect WIN-WIN: we keep our own world and can still interact with others

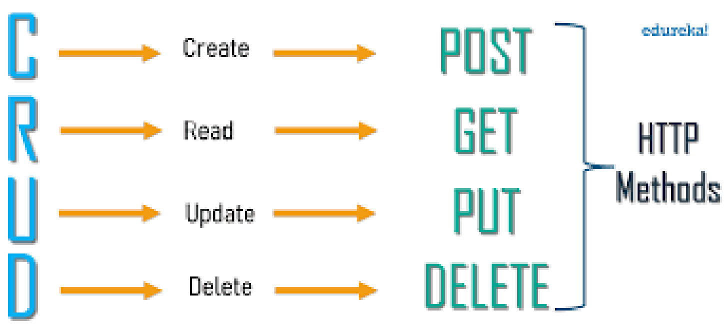
REST - CRUD

{ REST }

Representational State Transfer

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



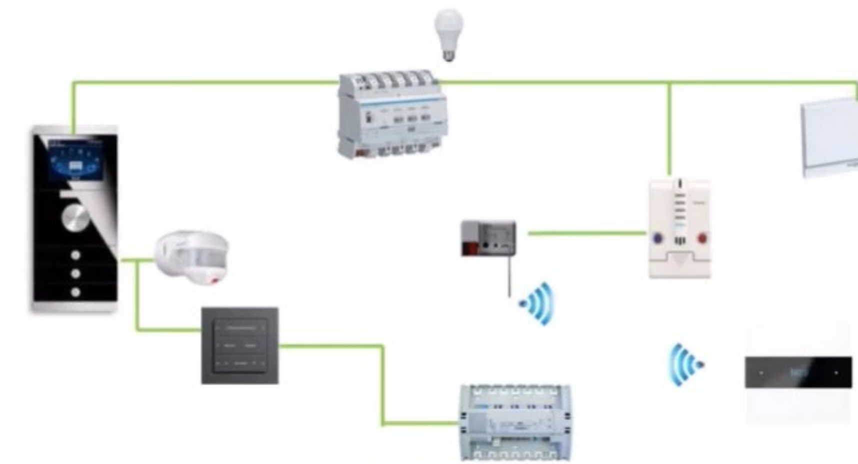


KNX IoT

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

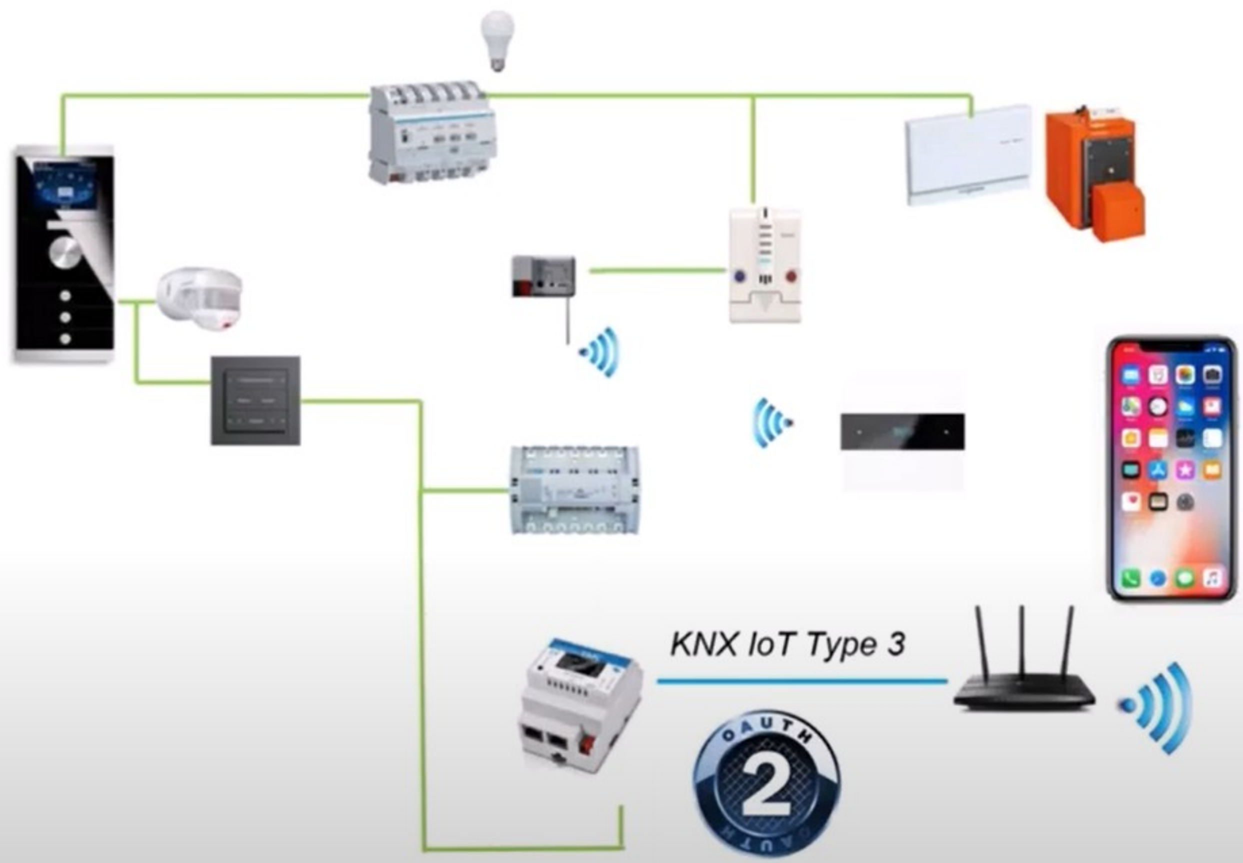
- Convert into format that does not change so often and is machine interpretable: describe the “KNX World” as an Ontology (structured way to document meaning of data) and export ETS project info as Linked Data (in JSON-LD format)
- Currently available as separate online converter (will be integrated in ETS)
- Can be more easily mapped to other solutions – more easy to query the data

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

Fulfilling the new requirements – how?



Make use of RESTful Web Services to collect the data ("KNX IoT Type 3")

- One single KNX standardized solution for all KNX manufacturers (not like KNX Web Services, offering three different possibilities: OPC UA, BACnet WS and OblX)
- Information on/asking questions about
  - Topology (building, room, floors)
  - Implemented functionality with standardized semantics
- Data protected by IT security mechanisms (not KNX specific like KNX Secure)
- Create as a first step a static Interface
  - Open API (widely available tools)
  - versioned

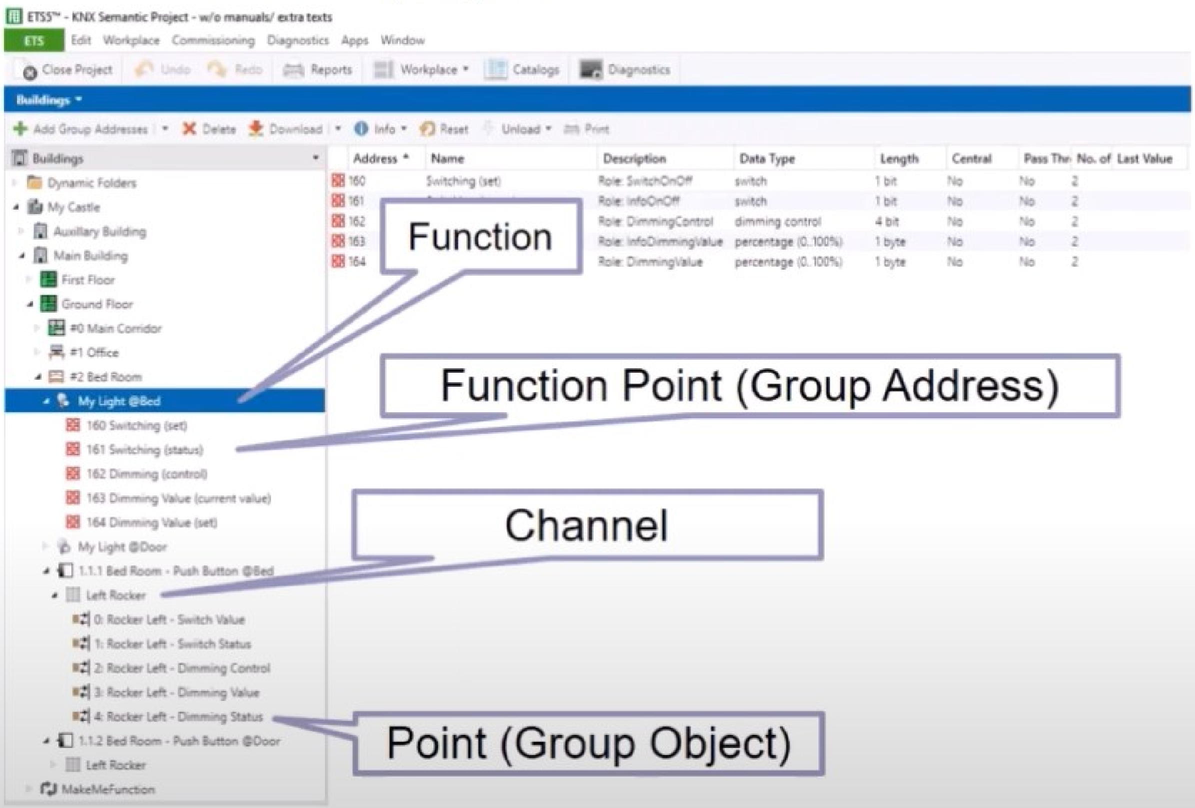
KNX IoT

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



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 semantical data will also already be included

➔ this extra data could also help improve the planning stage of KNX projects ➔ less friction between planner and installer

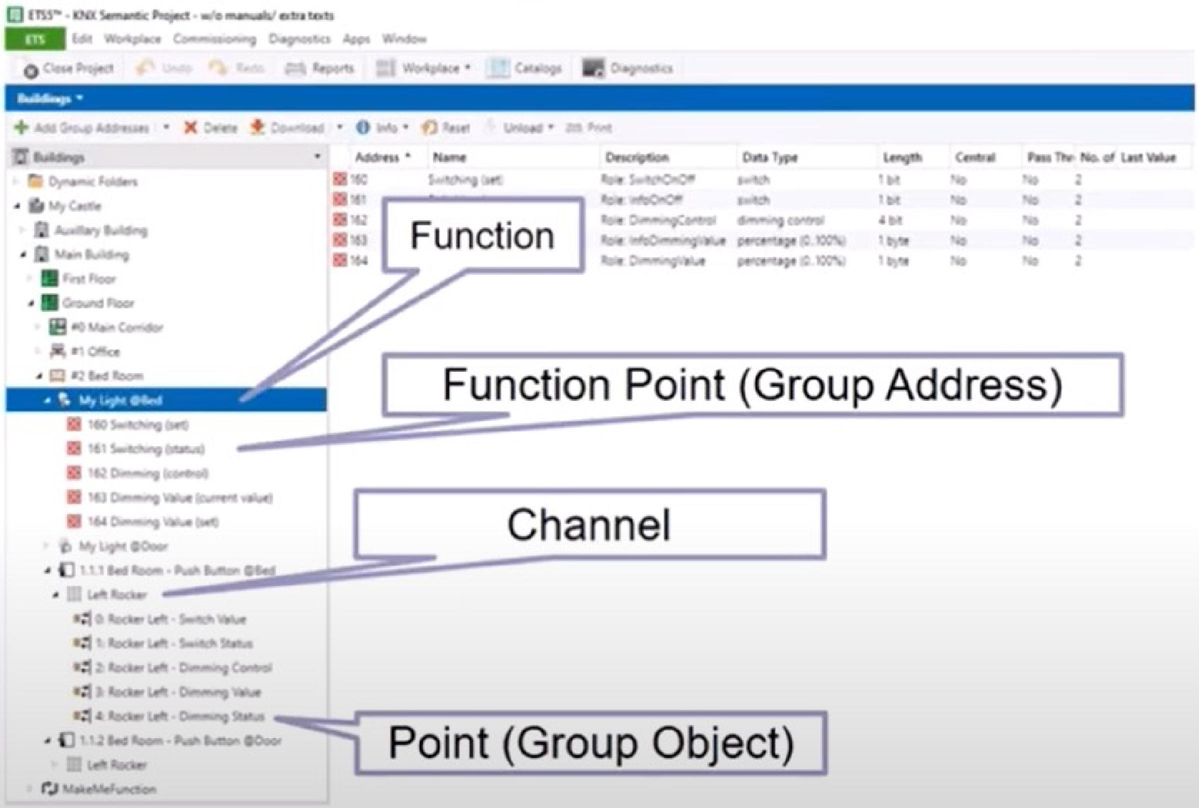
KNX IoT

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



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*
- *When making the export to the KNX IoT Interface, this extra semantical data to be exposed on the API will be added*

KNX IoT

Unleashing a wealth of available KNX data!

(Joost Demarest - KNX, 2020)

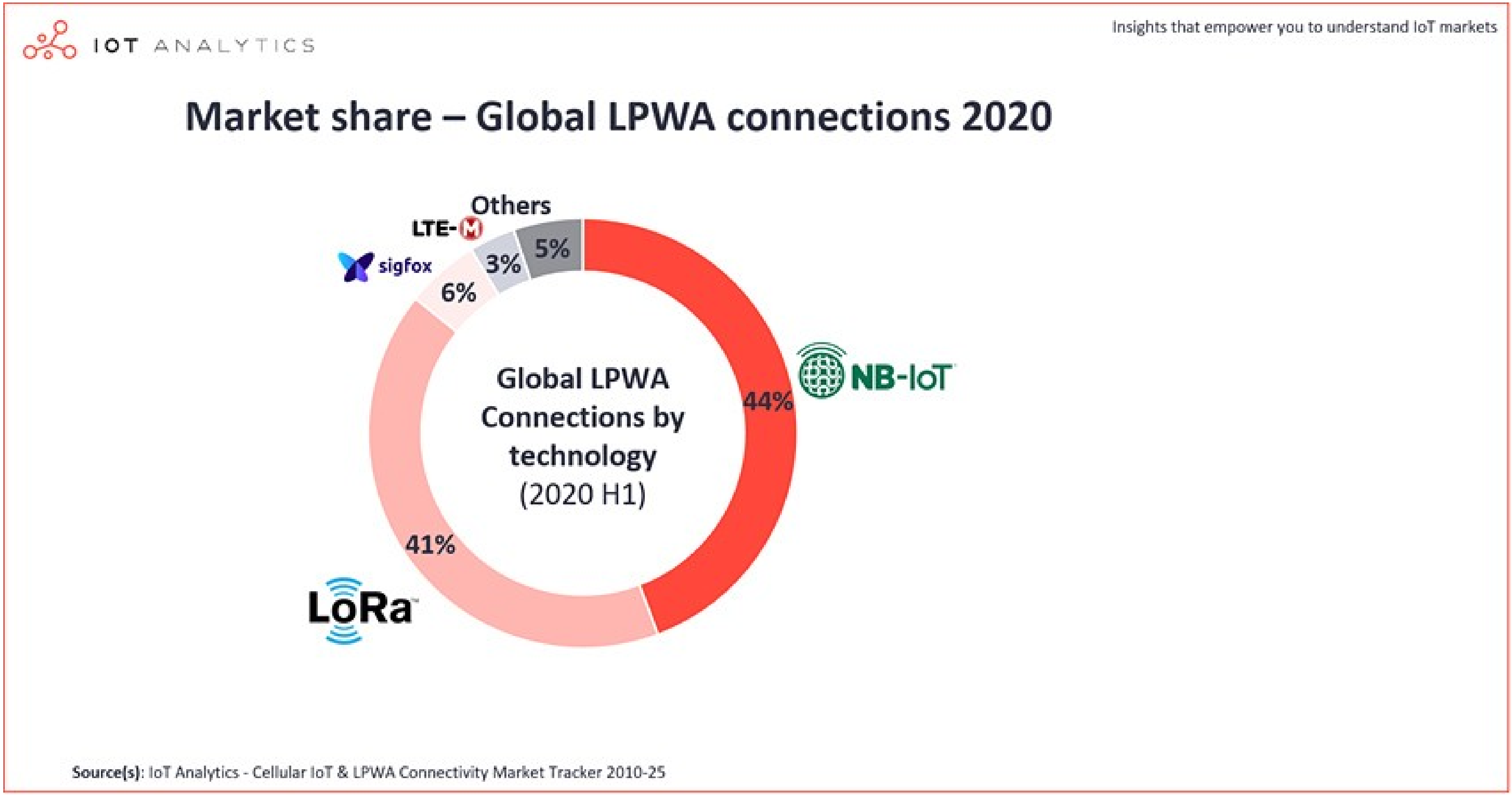
Summary of KNX IoT Benefits

- *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*
- *If semantic data becomes part of the KNX product data, planning of a KNX installation can be considerably simplified (less friction losses)*

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

IoT - ZigBee

IoT - LoRa


IOT ANALYTICS
Insights that empower you to understand IoT markets
Market share – Global LPWA connections 2020
Others
LTE-M
sigfox
5%
3%
6%
NB-IoT
44%
Global LPWA
Connections by
technology
(2020 H1)
41%
LoRa
Source(s): IoT Analytics - Cellular IoT & LPWA Connectivity Market Tracker 2010-25