Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: [Wireless coexistence for industrial automation]
Date Submitted: [15 January 2013]
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Re: [Interest group deliverables for January 2013 meeting as listed in 15-12-0689-01-0sru-ig-sru-january-2013-agenda]

Abstract: [The document provides the requirements and views of industrial automation applications for wireless devices and a vision of how automatic / collaborative coexistence management can be standardized]

Purpose: []

Wireless coexistence for industrial automation

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Topics

- Definitions
- Existing Coexistence mechanisms
  - Manual Coexistence Management (IEC 62657-2
  - LBT and other simple mechanisms
  - Integration Technologies (EDDL, FDT, FDI, etc.)
- Vision of collaborative mechanisms
  - Controlled Area
  - Public area
  - Reconfigurable Radio Systems (RRS)
    - Cognitive radio,
    - SDR

Coexistence, Coexistence management

- Coexistence is a key problem which has to be solved in order to provide reliable (best effort is not enough!) wireless communication in industrial automation.
- Coexistence management is independent of a certain frequency spectrum or a communication technology.

Definitions of Coexistence

- according to IEEE Std 802.15.2-2003:

  The **ability** of one system to perform a task in a given shared environment where other systems have an ability to perform their tasks and may or may not be using the same set of rules.

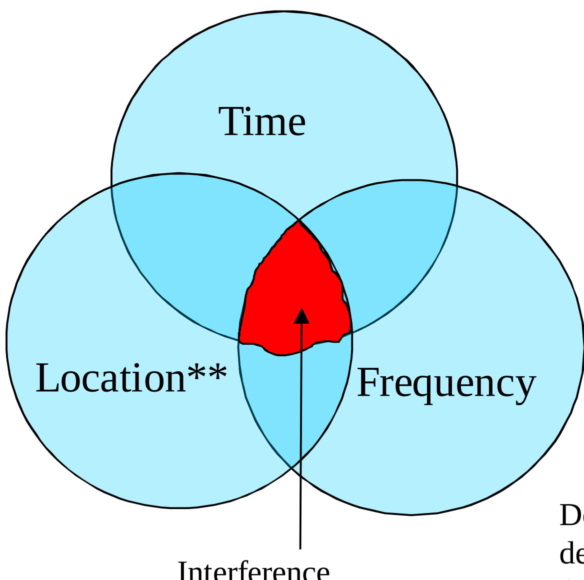
- according to IEC 62657-2:

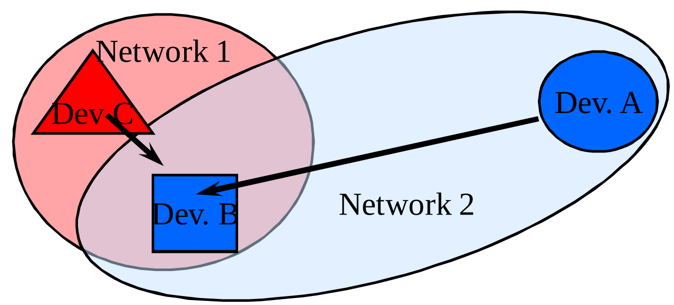
  state in which all wireless communication solutions sharing a common media fulfill all their application communication requirements

Definitions of Interference

The **coexistence state is off if** all of the following conditions are fulfilled for any wireless solution:

- the signals overlay in **frequency** domain with other systems **and**
- the signals overlay in **time** domain with other systems **and**
- the signal to **noise ratio** (location & energy) is below the required level.





Device B is interfered but
devices A and C cannot detect this!
(Hidden node and exposed node problems)

**Location = f{energy, coding, antenna, etc.}

Coexistence according to IEC 62657-2

- is a **dynamic state** within an environment (not a characteristic of a wireless solution)
- means that **all wireless solutions** involved fulfil their tasks
- depends on the requirements of the **application** and the resulting **wireless solution**
- can be assessed using **characteristic parameters**
- has to be **planned, monitored and maintained**

Industrial Automation

- Industrial Automation has an enormous potential for innovations – while wireless solutions are an essential driver for innovations.
- For Industrial Automation there are different, standard-based and complementary wireless solutions existing that fulfill the special industrial requirements since many years (e.g. IEC 62591 using IEEE 802.15.4e; IEC 61784-1, CPF3 using IEEE 802.15.1 and IEEE 802.11.
- The harmonized standard used for certification in Europe is EN 300 328. It has been revised and the current version (EN 300 328 V 1.8.1) does not allow to fulfill all Industrial Automation requirements at time.

Technical Background

- Wireless based Industrial Automation uses the license-free 2,4 GHz-band, because
  - it's above typical industrial interferences (welding processes, inverters, ..)
  - it has acceptable propagation properties, transmit power up to 100mW, offers sufficient bandwidth
  - it offers flexible, timely usage
  - further users of this band are e.g. consumers, IT, logistics
- Worldwide similar regulation conditions for this band are unique.
- Global availability, which enables uniform, competitive products and use cases for the free world market.
- Different wireless solutions are used and coexist in the 2,4-GHz-band for Industrial Automation since many years.
- Industrial Automation has special requirements for the behavior of communication like reliability, robustness, timely behavior, deterministic, etc.
- These requirements are perfectly fulfilled, especially in coexistent operation.

Regulatory Background in EU

- R&TTE* directive article 3.2 (European law) demands:
  - efficient use of spectrum
- TCAM** decides in the 26th meeting (2008), to revise the standard for product conformance in the following points: (TCAM demands [2]; [3])
  - Not to exclude devices other than wide band transmission systems,
  - Assure that in case of congestion users of the spectrum will be granted equal access.
  - Verifiable mechanisms to mitigate interference, notably by specifying the requirements for a medium access protocol in greater detail.
- European Telecommunications Standards Institute (ETSI)
  - Responsible for standardization of specifications for product conformance in Europe (CE sign)
  - Harmonized Standard EN 300 328 V1.8.1 (2012-04) - Electromagnetic compatibility and Radio spectrum Matters (ERM); Wideband transmission systems; Data transmission equipment operating in the 2,4 GHz ISM band and using wide band modulation techniques; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

*** R&TTE: Radio and Telecommunications Terminal Equipment**

**** TCAM: Telecommunication Market Surveillance Committee in the EU**

What is ETSI?

ETSI World Class Standards

About ETSI

- Produce Information and Communications Technologies (ICT) standards
  - fixed, mobile, radio, converged, broadcast and Internet technologies
- Officially recognized by the European Commission (EC) as a European Standards Organization
- Based on membership
  - full member, associate member, observer
  - membership fee derived from annual turnover
- Almost 700 member organizations from 60 countries worldwide
  - administrations, network operators, manufacturers, users, etc.
- Work carried out in Technical Committees and Working Groups
  - members contribute and participate directly to standardization
- Standards made available for free

3

*** European Telecommunications Standards Institute**

Source: IEC/SC65C Ad hoc Meeting Industrial Wireless, Ottawa, Canada, July 21 - 22, 2008

Current Situation (until end of 2012)

Equipment conforming to current EN 300 328 v1.7.1

- Performance requirements of Industrial Automation are fulfilled:
  - High reliability and simultaneously operation with full coexistence between multiple and various systems
  - Predictable spectrum access in a well defined time for all systems
  - Efficient use of spectrum by managing the RF-covered area with commonly used planning tools
- Property rights are used as legal basis to manage the area
- Efficient use of spectrum is state of the art in Industrial Automation:
  - Inside the managed area the RF situation is under control. RF from outside is considered in the planning.
  - Outside of the managed area interference is avoided by planned decay of the RF power below the effective limits given by EN 300 440 (up to 10dBm).
- Automation Industry endorses the TCAM task
  - equal access to the band with graceful degradation

Shortcomings of New Standard

Equipment conforming to new EN 300 328 v1.8.1

- Proof of concept was not done within ETSI
- Efficient use of spectrum is not achieved
  - System behavior is not predictable – dead lock situations and oscillatory states may occur.
- Unequal access to spectrum (MU Formula)
  - Narrow band systems are discriminated as they are not considered adequately in the medium utilization formula.
  - Adaptive devices have to back off in case of interference (denial of service attack, …)
  - Low cost systems with limited computing power or limited economical resources have no equal chance to access the medium.

Consequences

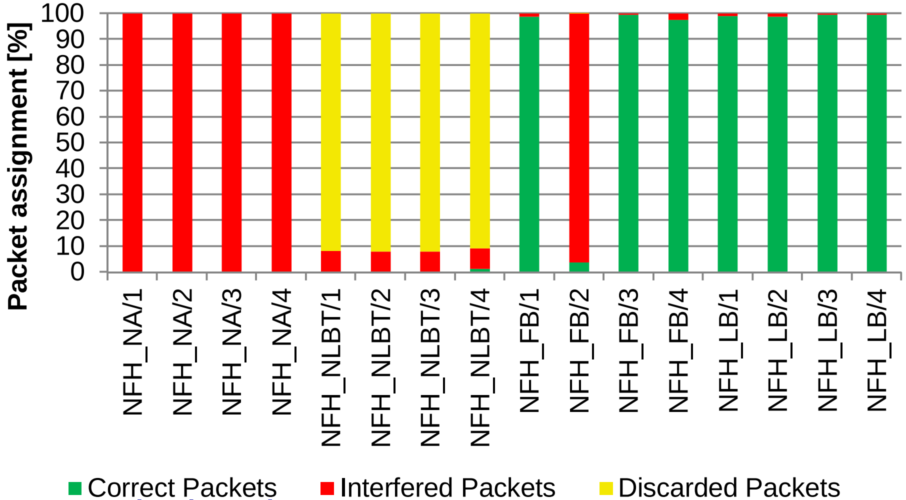
- EN 300328 v1.8.1 is approved since mid of 2012 and is now an European Community law with an transition time for the previous std V1.7.1 of 3 years (in 2015)
- This new law will be detrimental to the operation of all IEEE 802.15.4 radios

But …

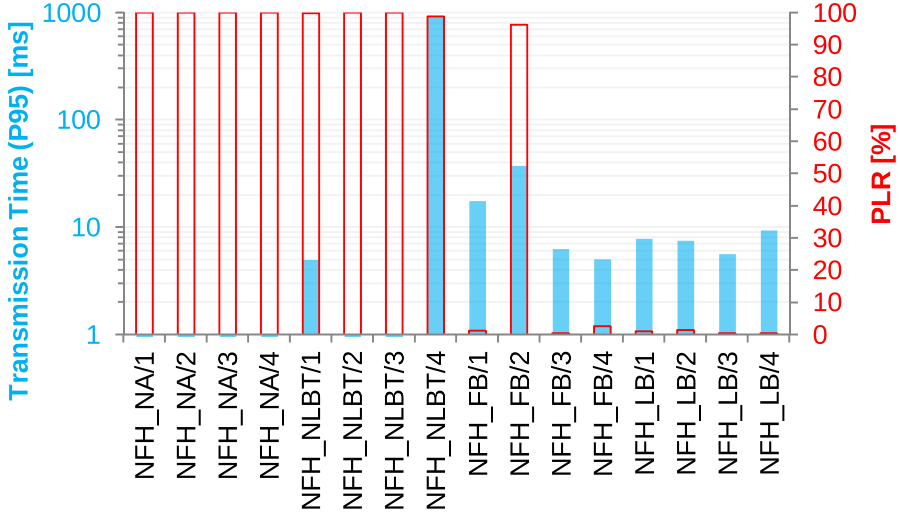
- New work item was started in 01/12 by ETSI (EN 300328 v1.9.1) in order to satisfy Industrial Automation requirements
- But requires „automatic adaptive mechnisms per device“

Example for Inefficient Use of Spectrum

Packet transmission statistics:



Transmission time:



Simulation:

- 16 non-frequency-hopping devices
- 4 different access mechanisms
- 100 % medium access request
- 5 ms packet length

Observation:

Non-adaptive (NFH_NA) devices:

No successful transmission

Non-listen-before-talk (NFH_NLBT) devices:

Barely successful transmissions

Frame-based (NFH_FB) devices:

Non predictable transmissions

Load-based (NFH_LB) devices:

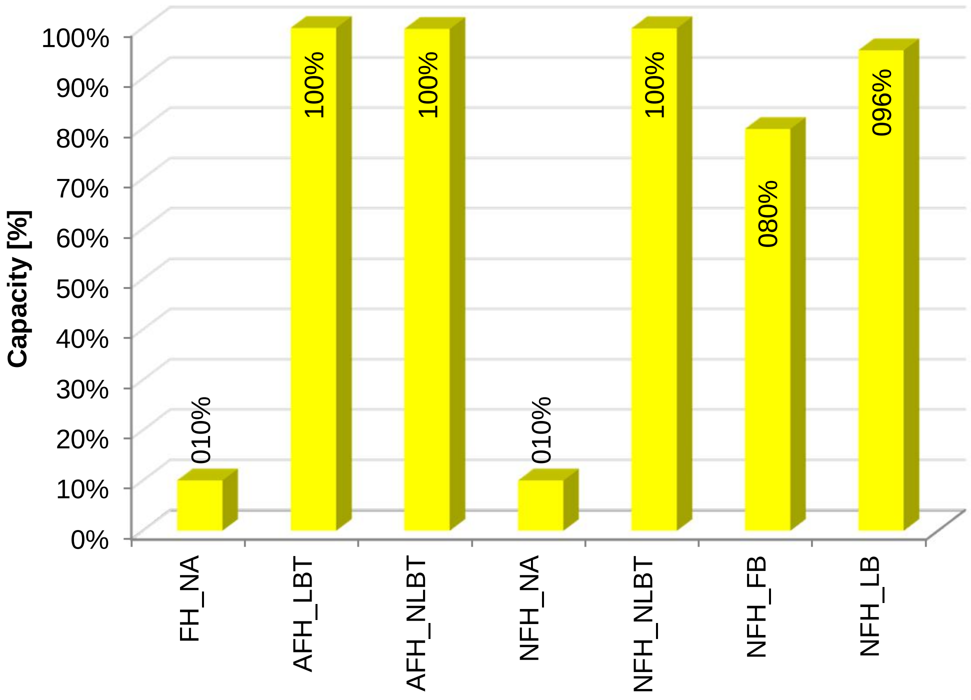
Successful transmissions

Concerns:

- Medium is heavily loaded with damaged packets: Waste of spectrum.
- Load based systems have a superior success rate:
- Unequal spectrum access

Source: ifak e.V. Magdeburg

Example for Unequal Access to Spectrum



FH Frequency Hopping
AFH Adaptive Frequency Hopping
NFH Non-Frequency Hopping

Calculated available capacity without congestion

$$c = \frac{t_{ON\,\max}}{t_{ON\,\max} + t_{OFF\,\min}}$$

Analysis:
- Non adaptive devices are discriminated
- Adaptive devices are treated unequaly

Concerns:
- Equal sharing of spectrum is not achieved
- Even adaptive devices differ by 20%

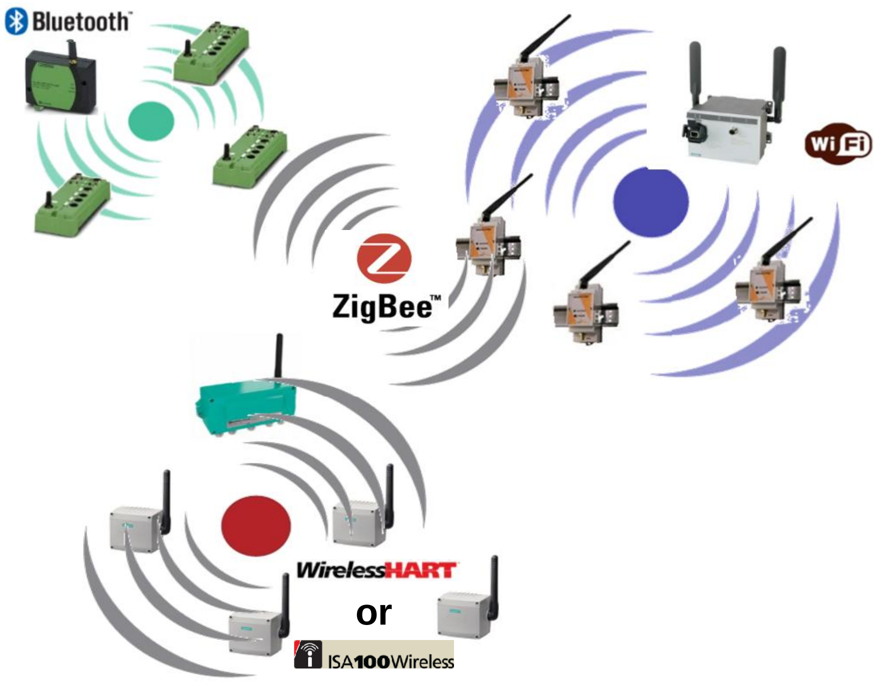
Consequences:
- Devices with adaptivity on system level, e.g. Wireless HART, ISA 100 and others are discriminated

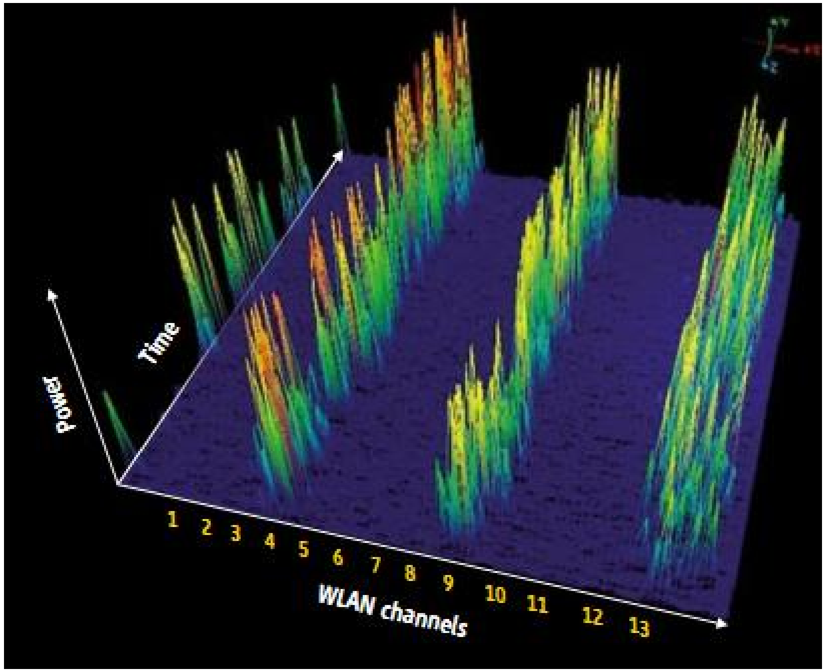
Open question:
- How is equal access achieved in the presence of other transmitters, e.g. permanently transmitting EN 300 440 devices?

Source: ifak e.V. Magdeburg

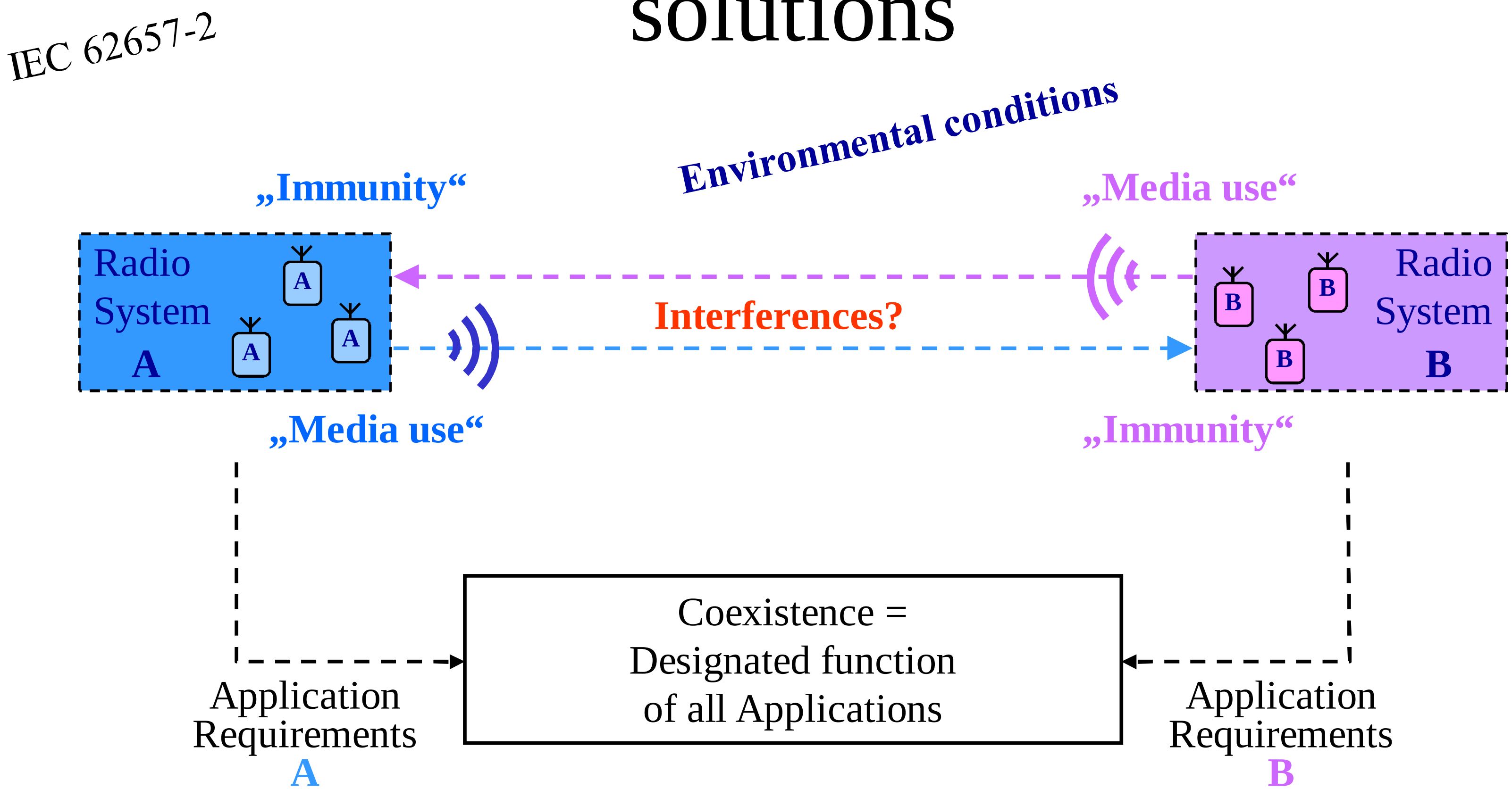
Current Coexistence model of IA-Industry

To achieve best spectrum efficiency and best coexistence, a **<u>Coexistence Management</u>** on system level according to IEC 62657-2 is in use.





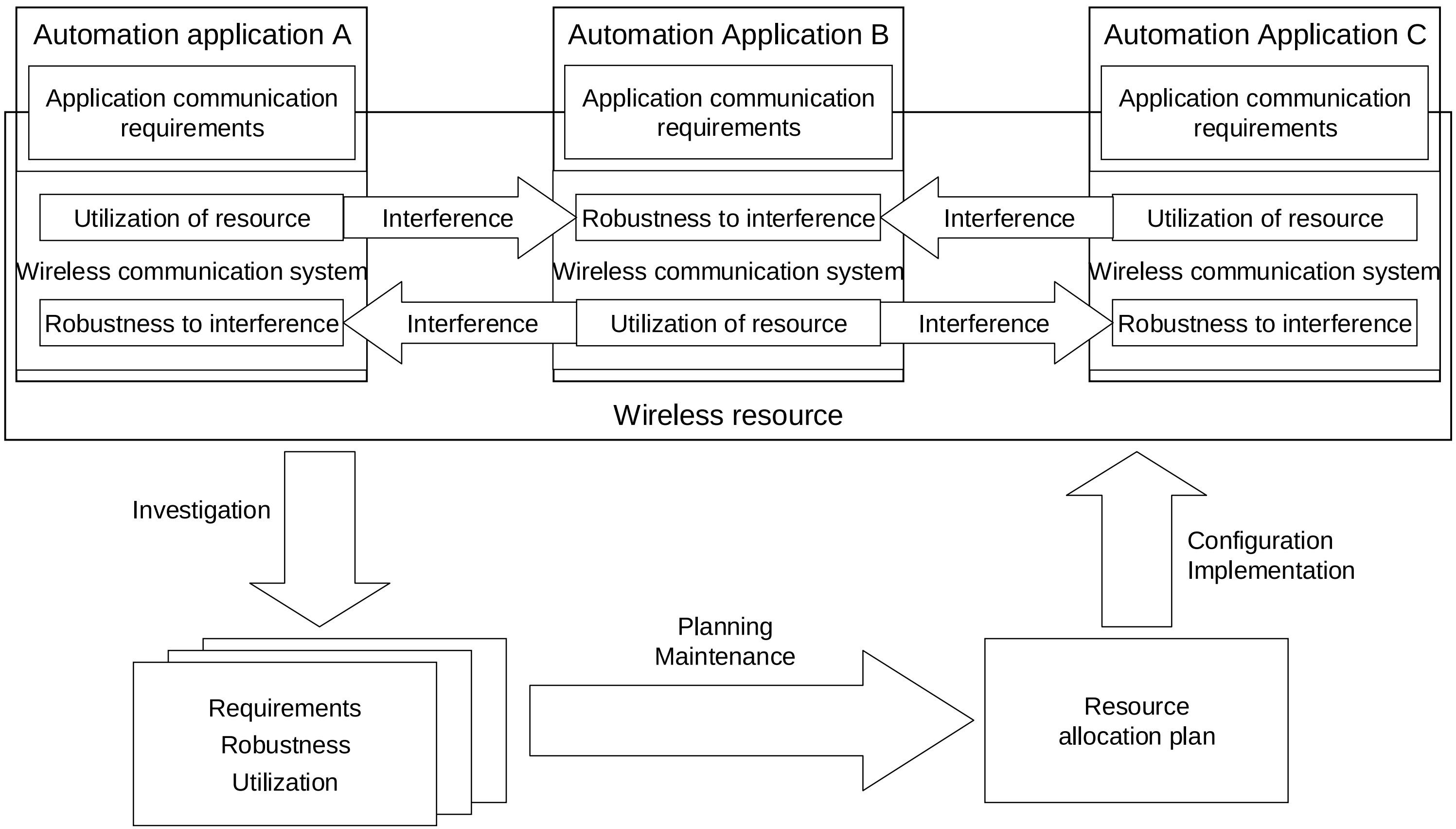
Coexistence management of wireless solutions



Source: www.ZVEI.org*

Coexistence management of wireless solutions

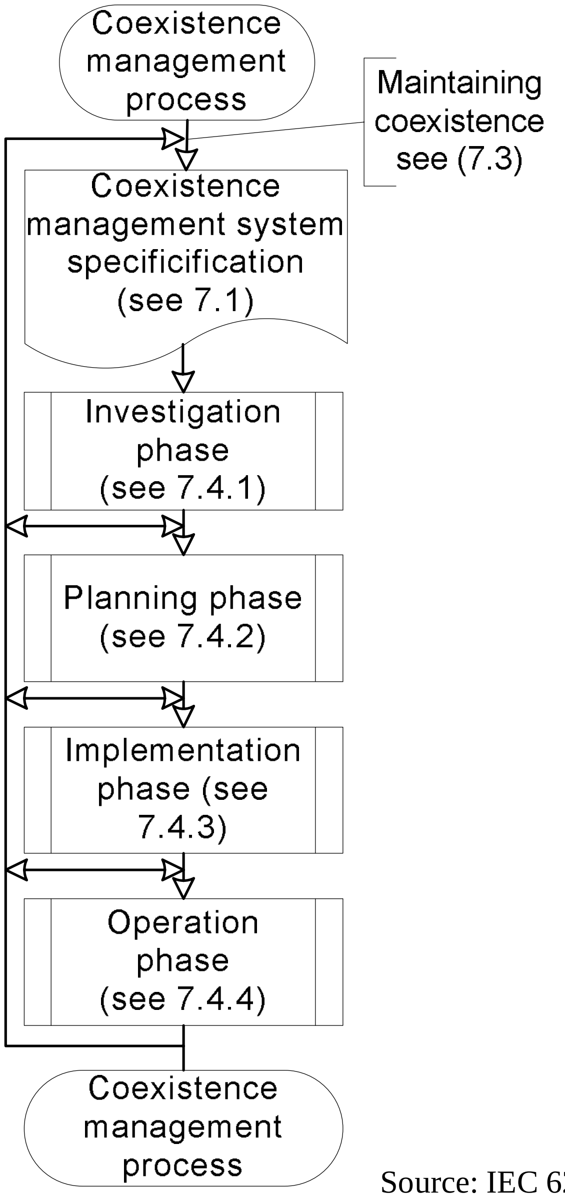
IEC 62657-2



Source: IEC 62657-2

Flow chart of the coexistence conceptual model

IEC 62657-2



Source: IEC 62657-2

Levels of compatibility

	“Incompatible“	“Coexistent“	“Interconnectable“	“Interworkable“	“Interoperable“	“Interchangeable“
Dynamic performance						✓
Application functionality					✓	✓
Parameter semantics					✓	✓
Data types Data access				✓	✓	✓
Communication interface			✓	✓	✓	✓
Communication protocol		✓	✓	✓	✓	✓

Application profile

Communication profile

Source: IEC 61804-2

Definitions of profiles

Feature	Description
Communication profile	
Communication protocol	This feature is defined by all protocols of layer 1 to 7 of the OSI reference model, i.e. from the physical medium access to the application layer protocol.
Communication interface	This feature is defined by the communication service definition of application layer including the services and the service parameters. Additional mapping mechanisms can be necessary. The dynamic performance of the communication system is part of this feature.
Application profile	
Data types	This feature is defined by the data type of the block data input, data output or parameter).
Parameter semantics	This feature is defined by the characteristic features of the data (for example, this can be data name, data descriptions, the data range, the substitute value of the data, the default value, persistence of the data after power loss and deployment).
Application functionality	This feature is defined by specifying the dependencies and consistency rules between the variables inside the blocks. This is done in the data description part or in a separate behaviour section.
Dynamic performance	This feature is defined by time constraints which influence the data or the general device behaviour. For example, the update rate of a process value can influence block algorithms.

Source: IEC 61804-2

- **Incompatibility / Interfered**
  - Inability of two or more devices to work (together) in the same distributed application.

    NOTE Incompatibility can result from differences in application functionality, data semantic, data types, communications interface, or even communications protocols used by the affected devices. Incompatible devices may even interfere with, or prevent, each other's proper communication or functioning (possibly even destructively), if placed in the same distributed application network.
- **Coexistence**
  - Ability of two or more devices, regardless of manufacturer, to operate independently of one another in the same communications network, or to operate together using some or all of the same communications protocols, without interfering with the functioning of other devices on the network.

    NOTE It is not necessary to have an agreement regarding the communication services. Application- and system-specific programming in one or both devices is generally required in order for coexistent devices to work together in the same distributed application.
- **Interconnectability**
  - Ability of two or more devices, regardless of manufacturer, to operate with one another using the same communications protocols, communication interface.

    NOTE The devices allow data exchange without agreements about the data types. A data type conversion may be necessary. Unique application-specific programming in one or both devices is generally required for interconnectable devices to function together in the same distributed application.

Source: IEC 61804-2

- **Interworkability**
  - Ability of two or more devices, regardless of manufacturer, to support the transfer of device parameters between devices having the same data types of the data inputs, data outputs and parameters.

    NOTE If a device is replaced with a similar one of a different manufacture, it can be necessary to reprogram the application. The distributed application must be designed to accommodate the unique functionality and dynamic responses of the interworkable devices used in the implementation.
- **Interoperability**
  - Ability of two or more devices, regardless of manufacturer, to work together in one or more distributed applications. The data input, data output, parameters, their semantics and the application-related functionality of each device is so defined that, should any device be replaced with a similar one of different manufacture, all distributed applications involving the replaced device will continue to operate as before the replacement, but with possible different dynamic responses.

    NOTE Interoperability is achieved when both a field device and a system support the same combination of mandatory and optional parts of the same standard. Manufacturer-specific extensions in field devices or systems from different manufacturers may prevent interoperability.
- **Interchangeability**
  - Ability of two or more devices, regardless of manufacturer, to work in one or more distributed applications using the same communications protocol and interface, with the data and functionality of each device so defined that, if any device is replaced with another of the interchangeable devices, any distributed applications involving the replaced device will continue to operate as before the replacement, including identical dynamic responses of the distributed applications.

Source: IEC 61804-2

History of Coexistence in IEEE 802

- IEEE 802.11 was introduced in 1997 for WLAN operating in unlicensed frequency band
- IEEE 802.15 was formed in 1999 to develop standards for WPAN, often operating in unlicensed bands
- IEEE 802.15.2 was formed in 2000 to address issue of coexistence of WLAN and WPAN, primarily 802.11b and 802.15.1 (i.e. Bluetooth)
- IEEE 802.19 Wireless Coexistence Technical Advisory Group (TAG) was formed in 2001 to address wireless coexistence across all of IEEE 802

IEEE802.15.2

- The IEEE 802.15 Coexistence Task Group 2 (TG2) for Wireless Personal Area Networks developed a Recommended Practices to facilitate coexistence of Wireless Personal Area Networks™ (802.15) and Wireless Local Area Networks (802.11).
- The document name is “*IEEE 802.15.2-2003 IEEE Recommended Practice for Telecommunications and Information exchange between systems – Local and metropolitan area networks Specific Requirements - Part 15.2: Coexistence of Wireless Personal Area Networks with Other Wireless Devices Operating in Unlicensed Frequency Band*” and the task group is now in hibernation until further notice.
- The Task Group developed a Coexistence Model to quantify the mutual interference of a WLAN (IEEE802.11 FHSS and DSSS) and a WPAN (IEEE802.15.1, aka Bluetooth).
- The Task Group also developed a set of Coexistence Mechanisms to facilitate coexistence of WLAN and WPAN devices.

IEEE802.15.2 – Coexistence mechanism

There are two categories of coexistence mechanisms: collaborative and non-collaborative.

- Collaborative coexistence mechanisms exchange information between two wireless networks. That is in this case a collaborative coexistence mechanism requires communication between the IEEE 802.11 WLAN and the IEEE 802.15 WPAN. The exact implementation of this link is not covered by the standard.
- Non-collaborative mechanisms do not exchange information between two wireless networks automatically. These mechanisms are only applicable after a WLAN or WPAN are established and user data is to be sent.

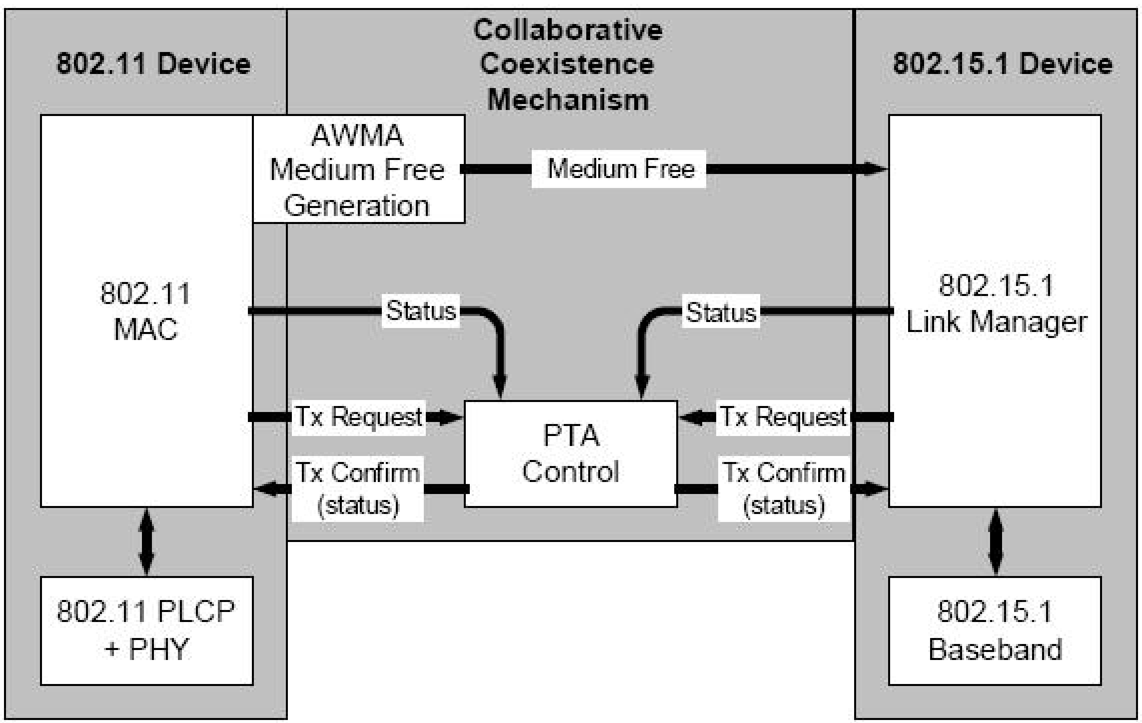
IEEE802.15.2 – Coexistence mechanism

- The three collaborative coexistence mechanisms defined in this std consist of two MAC sublayer techniques (see Clause 5 and Clause 6) and one PHY layer technique (see Clause 7).
- Both MAC sublayer techniques involve coordinated scheduling of packet transmission between the two wireless (WLAN and WPAN) networks.
- The PHY layer technique is a programmable notch filter in the IEEE 802.11b receiver to notch out the narrow-band IEEE 802.15.1 interferer.

Name	Type	Clause/Annex
Alternating wireless medium access	collaborative	Clause 5
Packet traffic arbitration	collaborative	Clause 6
Deterministic interference suppression	collaborative	Clause 7
Adaptive interference suppression	non-collaborative	Clause 8
Adaptive packet selection	non-collaborative	Clause 9
Packet scheduling for ACL links	non-collaborative	Clause 10
Packet scheduling for SCO links	non-collaborative	Annex A
Adaptive frequency-hopping	non-collaborative	Annex B

IEEE802.15.2 – Coexistence mechanism

- Alternating wireless medium access: AWMA and Packet traffic arbitration: PTA are handled by a “Collaborative Coexistence Mechanism”.
- Equivalent to the “Frequency Management System”.



IEEE802.15.2 – Coexistence mechanism

- Non-collaborative mechanisms described in this std are based on (notice that are all based on BT characteristics!):
  - **ADAPTIVE INTERFERENCE SUPPRESSION**. A mechanism based solely on signal processing in the physical layer of the WLAN.
  - **ADAPTIVE PACKET SELECTION AND SCHEDULING**. IEEE 802.15.1 systems utilize various packet types with varying configurations such as packet length and degree of error protection used. By selecting the best packet type according to the channel condition of the upcoming frequency hop, better data throughput and network performance may be obtained. In addition, by carefully scheduling packet transmission so that the IEEE 802.15.1 devices transmit during hops that are outside the WLAN frequencies and refrain from transmitting while in-band, interference to WLAN systems could be avoided/minimized and at the same time increase the throughput of the IEEE 802.15.1 systems.
  - **ADAPTIVE FREQUENCY-HOPPING (AFH)**. IEEE 802.15.1 systems frequency hop over 79 channels (in the U.S.) at a nominal rate of 1600 hops/second in connection state, and 3200 hops/second in inquiry and page states. By identifying the channels with interference, it is possible to change the sequence of hops such that those channels with interference ("bad" channels) are avoided. From traffic type and channel condition, a partition sequence is generated as input to the frequency re-mapper, which modifies hopping frequencies to avoid or minimize interference effects.

IEEE802.15.2 – Interference model

- Symbol corruption (Symbol Error Rate, SER) is estimated according to the SIR, defined to be the signal power/noise power ratio, where
  a) signal power is determined according to wanted signal transmit power, ans path loss (distance);
  b) noise power is the sum over all interferers of interferer transmit power, as a function of path loss (interferer distance), and spectrum factor (TX modulation type, RX modulation type, frequency offset).
- The spectrum factor represents the combined effects of transmitter and receiver masks and the frequency offset (i.e. the frequency distance of center frequency of channels where TXs occur)

IEEE802.15.2 – Interference model

- SER(SIR) is derived analytically (it is supposed to be a quantity known from literature).
- BER (Bit Error Rate) is calculated from the SER.

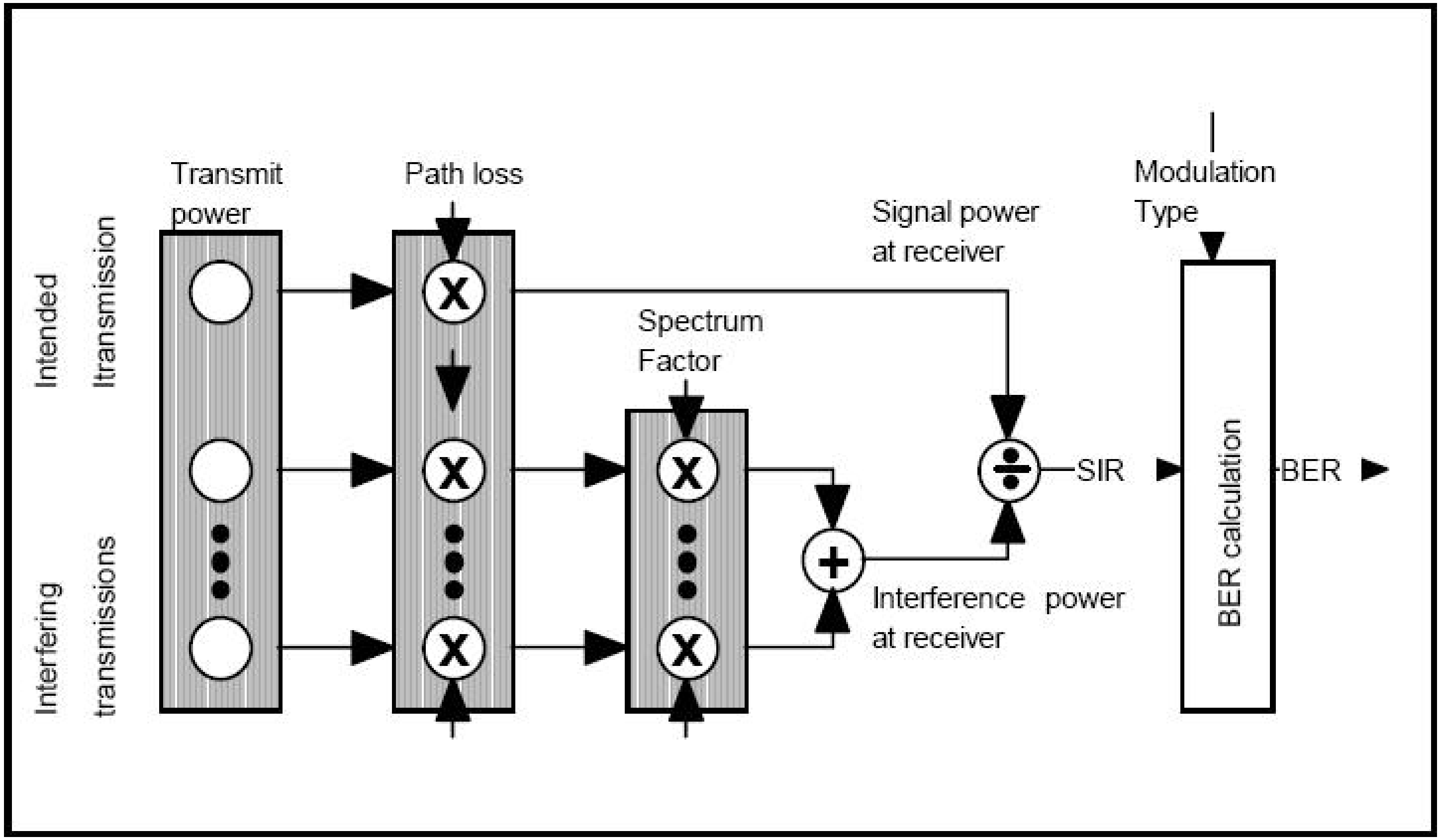


Figure C.3—BER calculation

IEEEP802.19

- The IEEE 802.19 Wireless Coexistence Working Group (WG) develops standards for coexistence between wireless standards of unlicensed devices.
  - The IEEE 802.19 WG reviews coexistence assurance (CA) documents produced by working groups developing new wireless standards for unlicensed devices.
    - The CA document is a study showing how well a proposed wireless standard, planned for unlicensed operation, coexists with current standards.
  - **802.19 TG1: PAR Scope:** *The standard specifies radio technology independent methods for coexistence among dissimilar or independently operated TV Band Device (TVBD) networks and dissimilar TV Band Devices.*

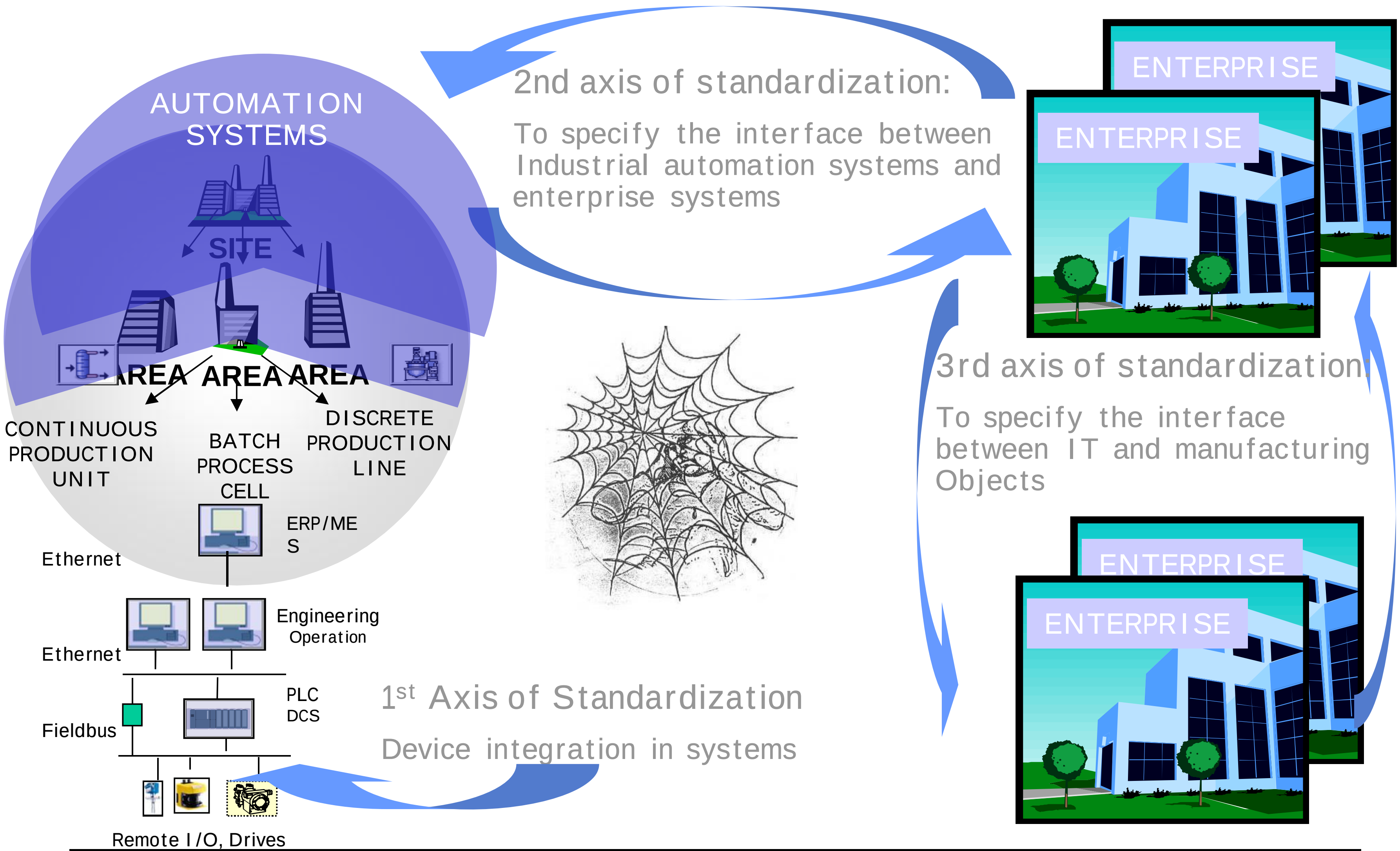
History of Coexistence in IEC SC65C

- 2001: SC65C/WG7 circulated the 65C/269/CDV of project IEC 61804-1 with a definition of COEXISTENCE (generic). Publication in 2003.
- 2006: It became obvious that multiple wireless communication networks would be established in the world wide industrial automation market and that some of them would be standardized. With that came the need and possibility for COEXISTENCE of the different solutions.
- 2009: Start of project COEXISTENCE with 65C/564/NP and setup in 65C/WG17, see 65C/572/RVN.
- 2011: Published the IEC/TS 62657-2 and started to convert the TS to an IS. Started new project IEC/TS 622657-1 “Wireless communication requirements and spectrum considerations”

IEC TC65 expertise

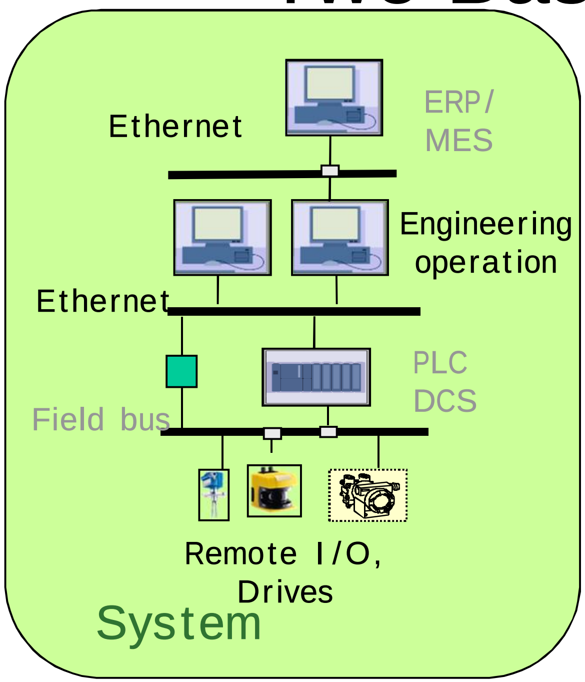
- 65A: System aspects like Functional safety IEC 61508.
- 65B: Devices used in industrial process measurement and control
- 65C: Network communication incl. Installation, security, safety, coexistence
- 65E: Representation of device properties and functions, methodologies and applications supporting automation of engineering processes.

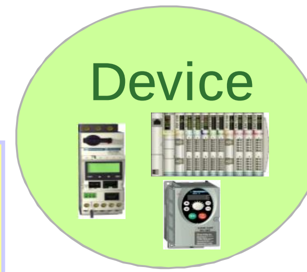
SC65E : Devices and integration in Enterprise system



SC65E 1st axis of standardization: The device integration in systems

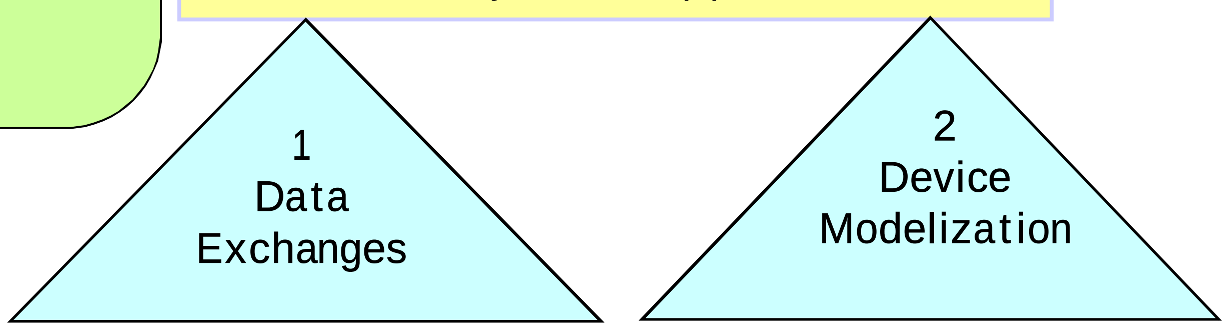
- Two Basics



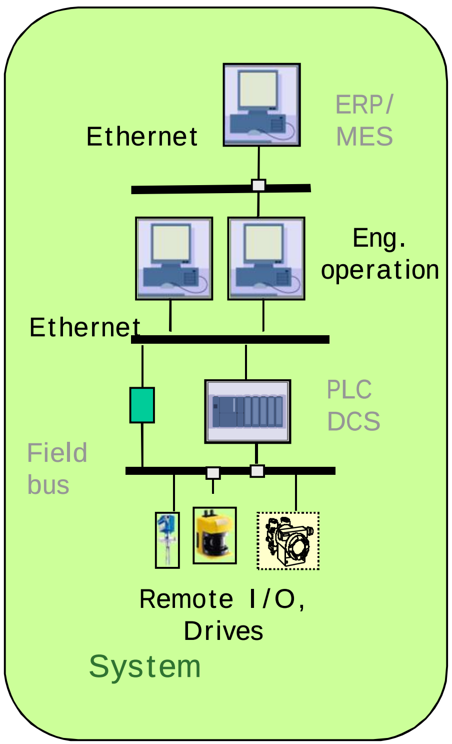


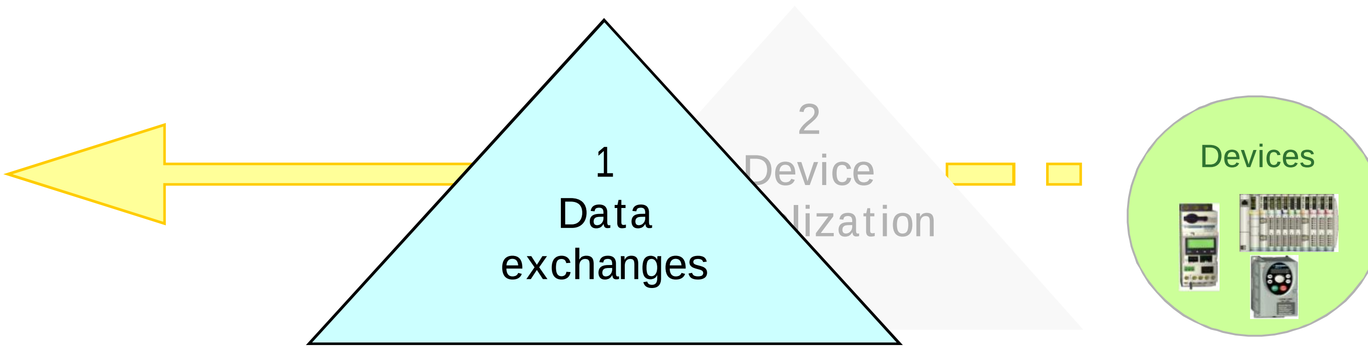
The **Device integration** is based first on the exchange of data between devices and control systems or engineering tools (1)

The exchange of data between Devices and control systems and engineering tools can run smoothly only when both the information to be exchanged and the use of this information have been clearly defined. (2)



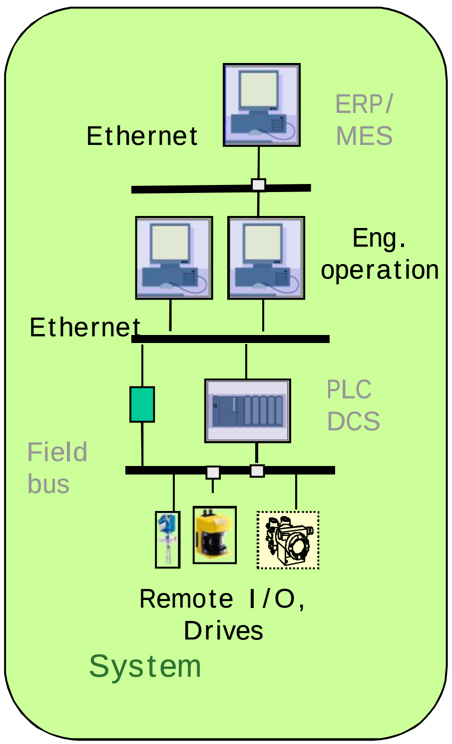
Device integration in systems: Data exchanges

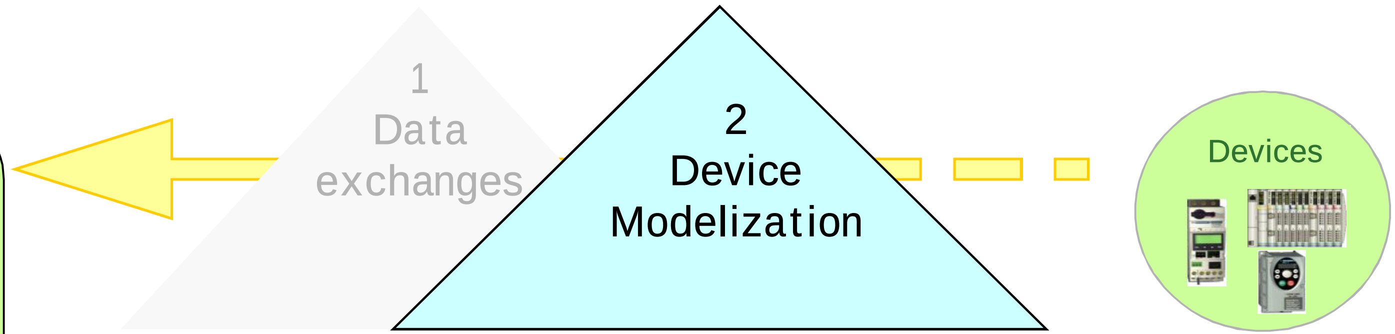




- Communication protocols SC 65C/TC57:
  IEC 61158, IEC 61784, IEC 61918, IEC 61850
  - Wireless e.g.
    - WirelessHART: IEC 62591 Ed.1.0
    - WIA-PA: IEC 62601 Ed.1.0
- Web services e.g.
  - W3C,
  - OASIS...

Device integration in systems: Device modelization





- ➢ Description of the information to be exchanged
- ➢ Definition of the use of this information

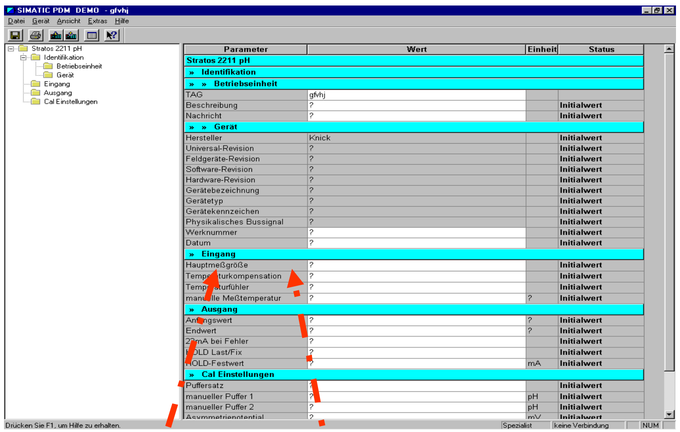
  - ➢ Device description guideline IEC/ISO 62390
  - ➢ Information models IEC SC65E
    IEC 61804-3 EDDL, IEC 62453 FDT
  - ➢ Common Interface definition IEC SC65E
    IEC 62541 OPC-UA Definition of a common interface

EDDL a device modelization standard IEC 61804

- EDDL a generic language of description capable of describing
  - device parameters and their dependencies;
  - device functions, for example, simulation mode, calibration;
  - graphical representations, for example, menus ;
  - interactions with control devices ;
  - graphical representations ;
  - persistent data store.
- EDDL allows a host system to both configure as well as monitor devices on-line
  - EDDL is to be used to create Electronic Device Description (EDD)
  - EDDL ,a standard text editor easy to learn, like Visual Basic.
- EDD a computer readable file that the Host application reads in order to learn how to retrieve information from the field devic**e**
  - EDDs are text based files
  - It is in a compressed binary format
  - It is not executable code → Easy integration and removal
  - Existing EDDs can be used as a basis for a new device, learning by doing.

Flow transmitter EDD example

Table view of parameterisation tool



Analog Input Function Block : Parameter table

Relative Index	Parameter Name	Object type	Data type	Store	Size	Access	Parameter usage/ Type of transport	Default values	Down-load order	Mandatory Optional (Class A, B)
... Standard Parameter see General Requirements										
Additional Physical Block Parameter for Analog Input Function Block										
10	OUT	Record	DS-33	D	5	r (**)	O/cyc	measured of the variable, state	-	m (A,B)
11	PV_SCALE	Array	Float (*)	S	8	r,w	C/a	-	1	m (A,B)
12	OUT_SCALE	Record	DS-36	S	11	r,w	C/a	-	3	m (B)
13	LIN_TYPE	Simple	Unsigned8	S	1	r,w	C/a	0	2(#)	m (B)
14	CHANNEL	Simple	Unsigned16	S	2	r,w	C/a	-	-	m (B)
16	PV_FTIME	Simple	Float	N	4	r,w	C/a	0	-	m (A,B)
17	FSAFE_TYPE (***)	Simple	Unsigned8	S	1	r,w	C/a	1	-	o (B)
18	FSAFE_VALUE	Simple	Float	S	4	r,w	C/a	-	-	o (B)
19	ALARM_HYS	Simple	Float	S	4	r,w	C/a	0.5 % of range	-	m (A,B)
21	HI_HI_LIM	Simple	Float	S	4	r,w	C/a	max value	4.1	m (A,B)
23	HI_LIM	Simple	Float	S	4	r,w	C/a	max value	4.2	m (A,B)
25	LO_LIM	Simple	Float	S	4	r,w	C/a	min value	4.3	m (A,B)
27	LO_LO_LIM	Simple	Float	S	4	r,w	C/a	min value	4.4	m (A,B)
30	HI_HI_ALM	Record	DS-39	D	16	r	C/a	0	-	o (A,B)
31	HI_ALM	Record	DS-39	D	16	r	C/a	0	-	o (A,B)
32	LO_ALM	Record	DS-39	D	16	r	C/a	0	-	o (A,B)
33	LO_LO_ALM	Record	DS-39	D	16	r	C/a	0	-	o (A,B)
34	SIMULATE	Record	DS-50	N	6	r,w	C/a	disable	-	m (B)
35-44	reserved by PNO									m (A,B)
45	first manufacture specific parameter									o (A,B)

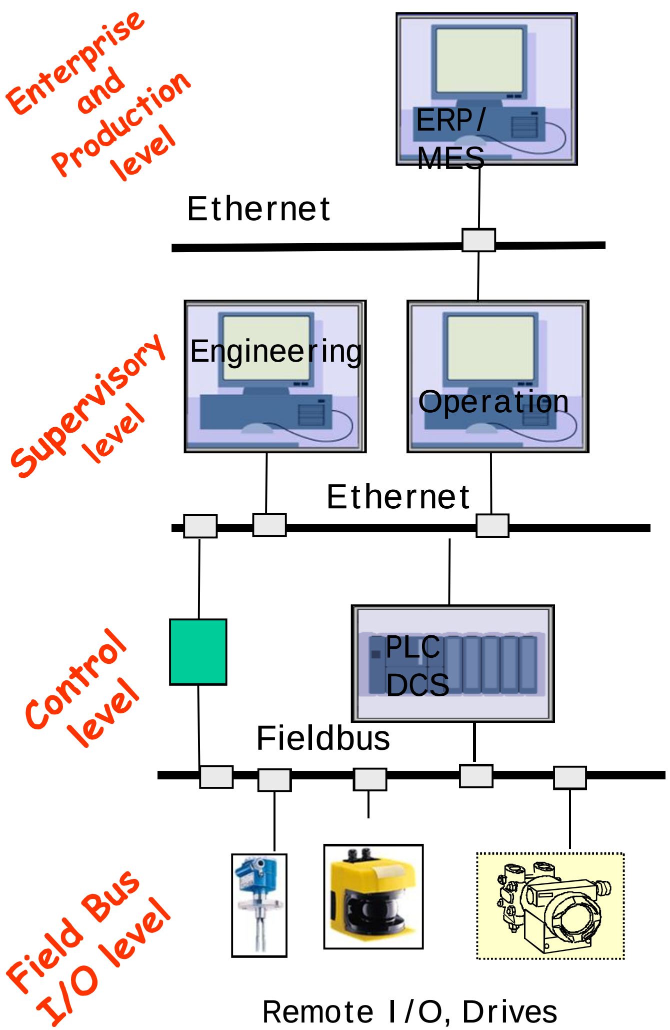
EDD text for one variable

```
VARIABLE hi_hi_limit
{
  LABEL     "HI_HI_LIM";
  HELP                "High prior upper limit";
  CLASS     INPUT;
  TYPE                FLOATING_POINT
            {

            DEFAULT_VALUE=OUT_SCALE100;
                      MIN_VALUE = 0
                      MAX_VALUE = 100
            }
}
```

Flow transmitter

Automation Architecture and models



Common technologies

Enterprise Mgt
IT
Data bases

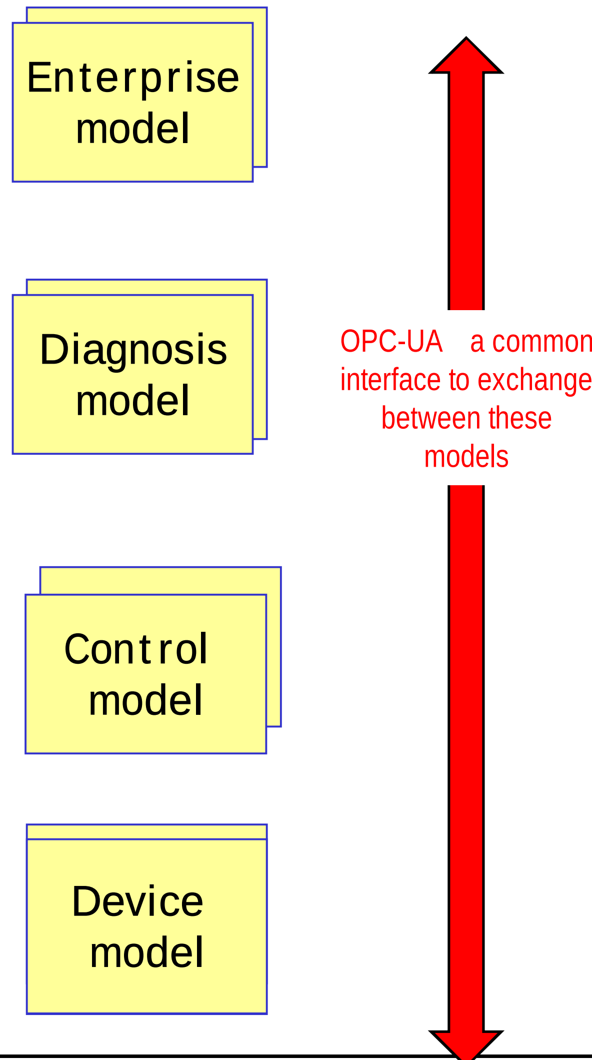
Visualisation system
C++, C#, Java,
Web-Techn.
XML, OPC, FDT

Communication system
Ethernet/TCP/IP

Control execution
IEC 61131, IEC 61499

Communication system
Fieldbus, Ethernet

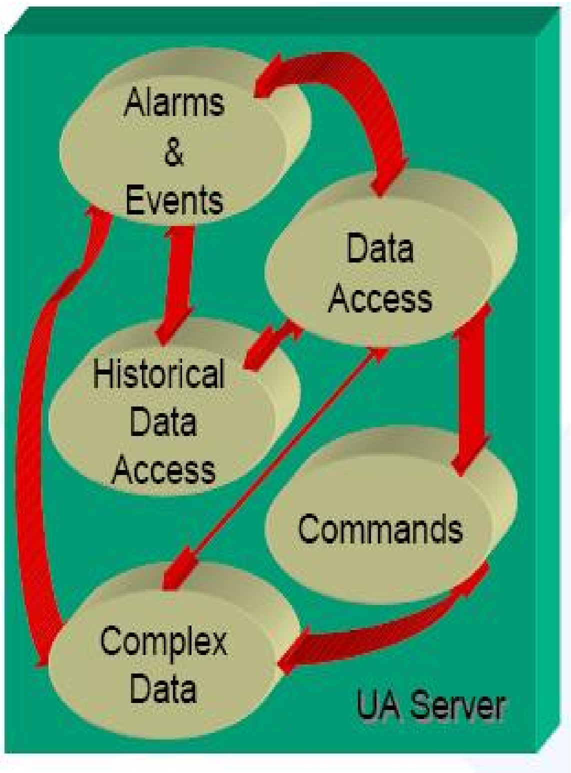
Device Profiles
EDD, GSD, EDS,
Embedded programs



OPC – UA (Unified Architecture) IEC SC65E standard (IEC 62541-x)

- A Standard to Deliver Interoperability Device to Device
  - Address the SC65E 1st Axis of standardization “Device integration in systems”
  - A client server architecture
  - Client applications using OPC UA server to have access to device information e.g. process data, product data and diagnostic information
- A standard to deliver interoperability Device to the Enterprise
  - Address the SC65E 2nd Axis of standardization “To fill the gap between Industrial automation systems and enterprise systems”
  - OPC – UA widely used to connect shop floor to enterprise applications which are two different worlds with different terminology and technical languages, different computer systems, different organizational cultures

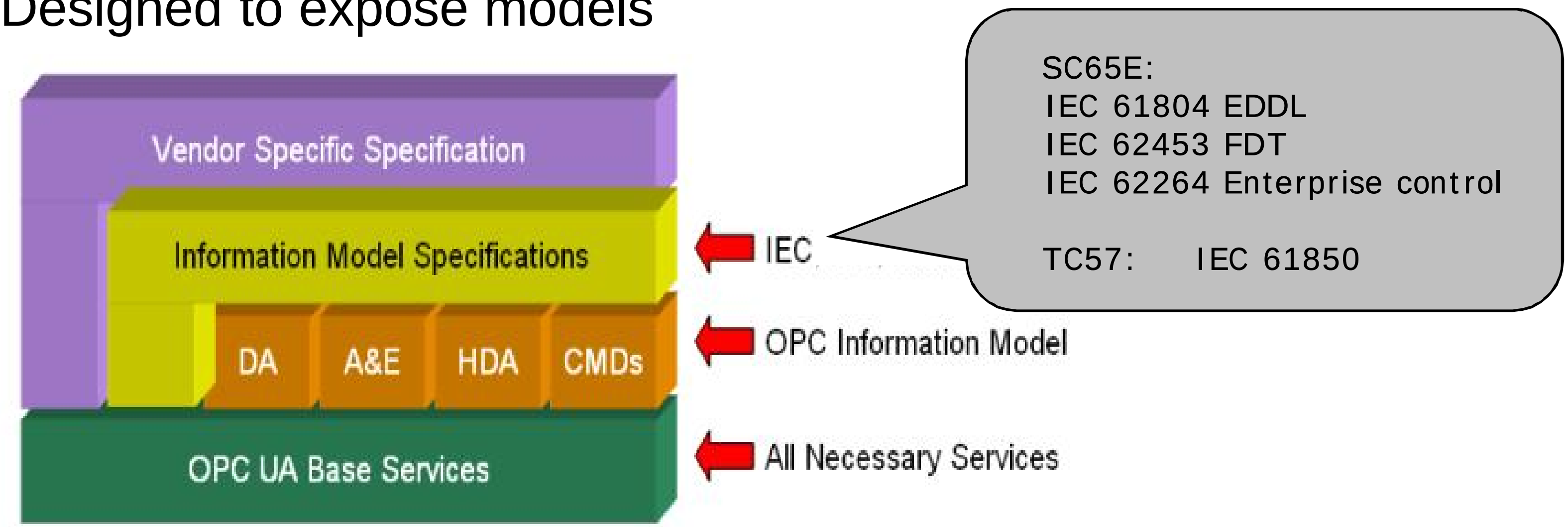
OPC UA
The common interface in Automation Plants



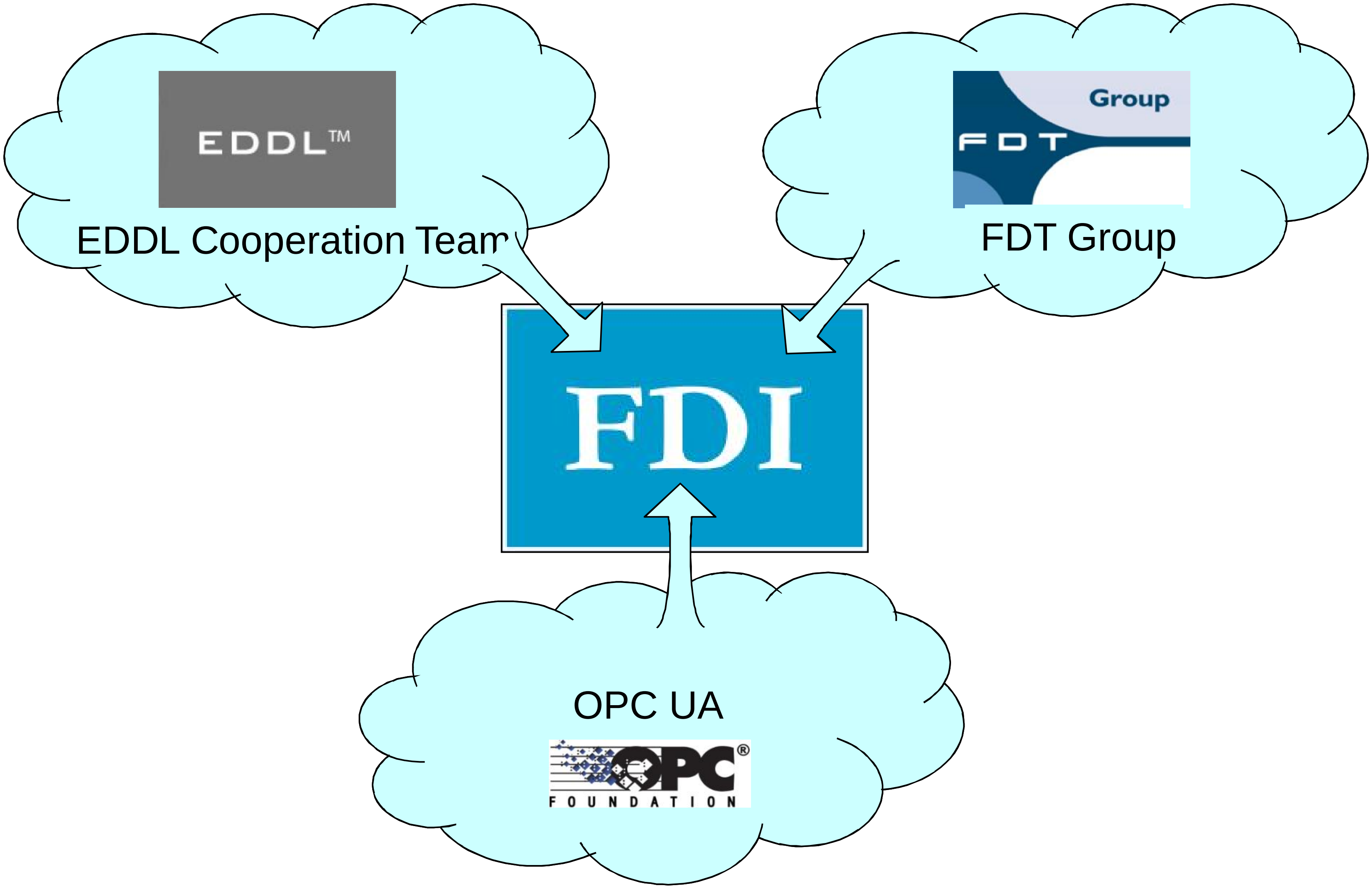
- OPC UA provides a common interface definition for different usage models
  - Integrate existing OPC specifications
  - Data access, Alarms and events….
- Address known shortcomings as Robustness and Security
  - Designed for easy (optional) redundancy of both clients and servers
  - New security Model
- Service Oriented Architecture (SOA)
  - Based on standards for the Web (XML, WSDL, SOAP, WS)
- No longer so Microsoft centered.
  - Migrate from DCOM to .NET Comms

OPC-UA (Unified Architecture) benefits

- To leverage collaboration with other industry standards organizations
  - Eliminate confusion between multiple standards
  - Facilitate resolution of overlapping Multiple Standards
  - Facilitate other standards being successful adopted.
- OPC-UA focus on defining
  - How to move the information models without restrictions from these other industry standards organizations that define the semantics of the content.
  - Bridging the integration gap between legacy and state- of-the- art automation and enterprise solutions
  - Designed to expose models

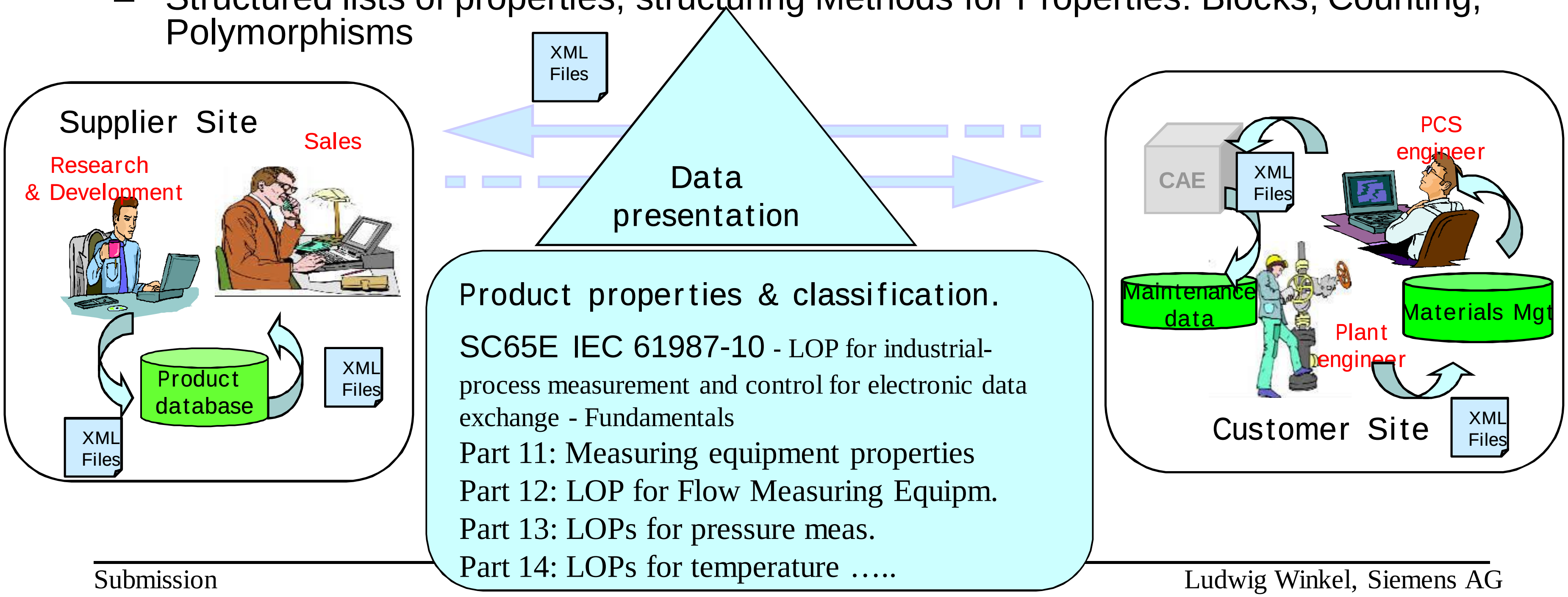


FDI as cooperation of three technologies



SC65E 3rd Axis of standardization: To fill the gap between IT and manufacturing

- Standardization of the transactions handled electronically To allow both the customers and the suppliers of the devices to optimize their processes and workflows
  - e.g. Framework, Contracts, Orders, Offers…
  - Information is described and expressed in a form that can be exchanged electronically => XML files
- Standardization of the device properties in a component data dictionary.
  - Device classification
  - Structured lists of properties, structuring Methods for Properties: Blocks, Counting, Polymorphisms



Product Data of a Automation Asset - Transmitter Device "Example"

- **Product are more and more intelligent…but complex**
  - e.g. Product Data for a Pressure Instrument (SC65E WG2 IEC 61987-11)

Mechanical and Constructive Properties

- Length of the Sensor Cell
- Diameter of the Sensor Cell
- Sensor Cell Material
- Weight of the Sensor
- Dimension of the Housing (length, wide, high)
- Material of the Housing
- Vibration Protection
- Local Display
- Local Operator Panel

etc.

Function Properties

- Threshold Level
- Event Signalling
- Linearisation Curve
- Compensating Function
- Time Stamp Function
- Self Calibration
- Fail Safe Mode
- etc.

Performance Properties

- Measuring Time
- Cycle Time
- Filter Time
- Communication Intervall
- Start up Time
- Wake up Time
- Energy Consumption

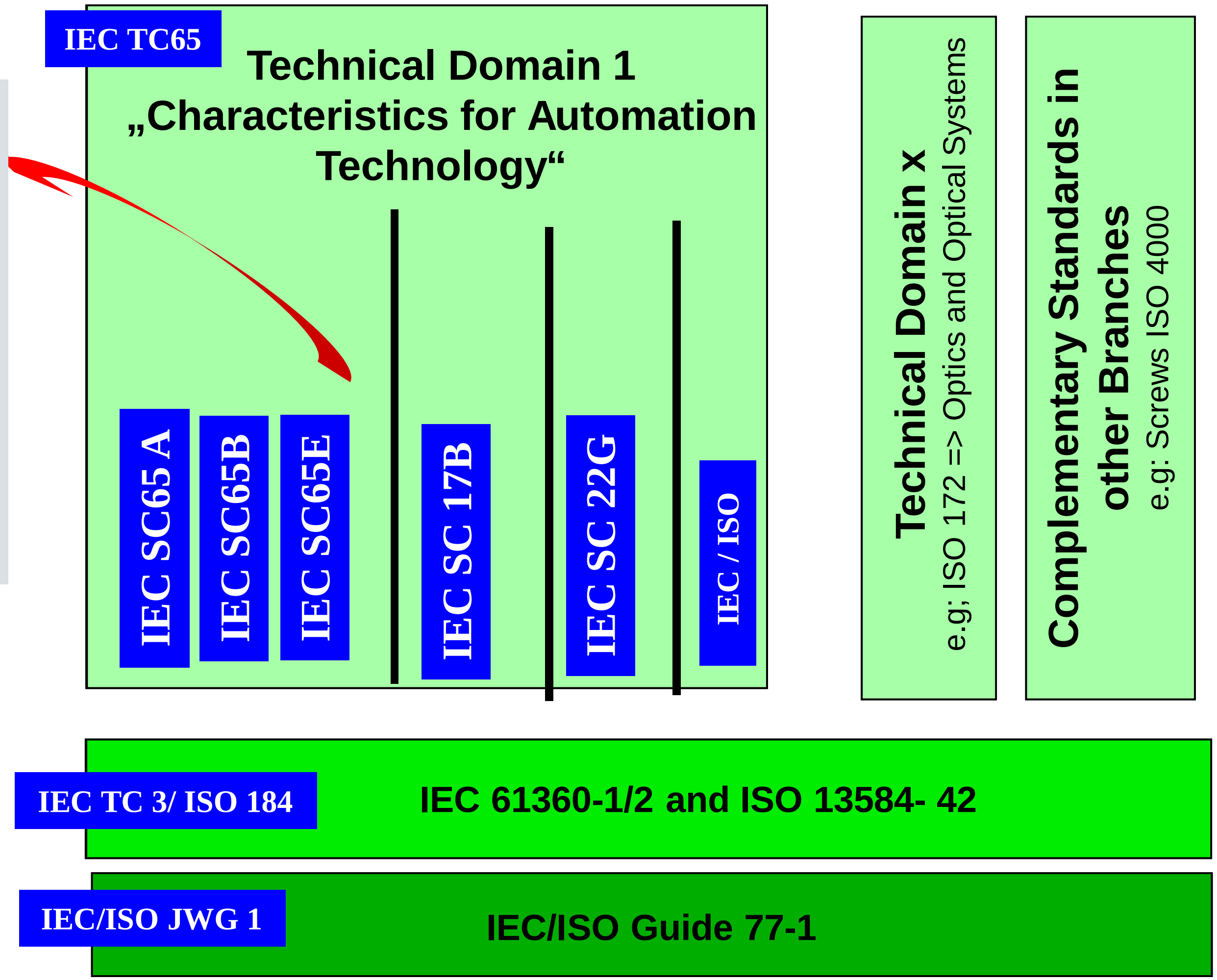
etc.

Product properties and classification: Standardization is moving forward IEC 61987-x

- **IEC SC65E** IEC 61987-xx
  - Part 10: Concepts
  - Part 11 Sensors
  - Part 12 Actuators
- **IEC SC17B** Low Voltage Switchgear in preparation
- **IEC SC 22G** Drives in Consideration
- ….

IEC SC 3D IEC 61360 Data repository + Data model

ISO TC 184 SC4 ISO 13584 Data model



IEC SC3D : IEC 61360 – Data Base - Online

International Electrotechnical Commission

IEC 61360 - Component Data Dictionary

Home | Browse | Search | Export | Help

Class tree

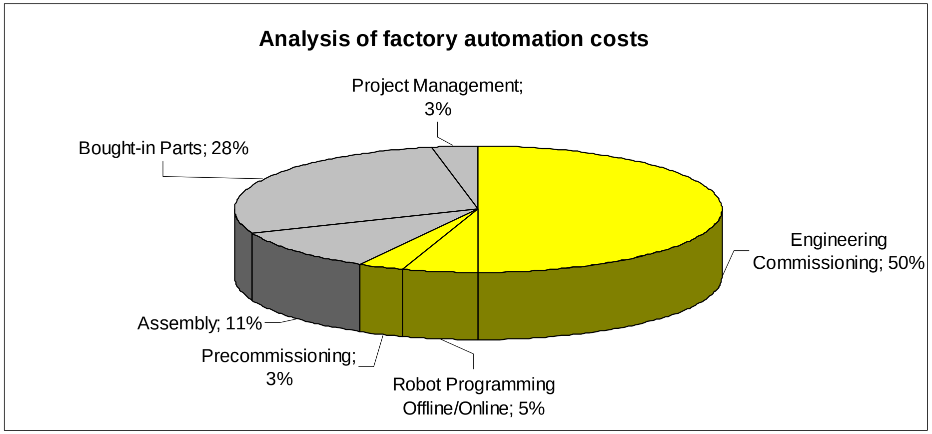
- **Components**
  - Electric/electronic components
    - Amplifiers
    - Antennas
    - Batteries
    - Capacitors
    - Conductors
    - Delay lines
    - Diode devices
    - Filters
    - Integrated circuits
    - Inductors
    - Lamps
    - Liquid crystal displays
    - Optoelectronic devices
    - Oscillators
    - Piezoelectric devices
    - Resistors
    - Sensors
    - Transformers
    - Transistors
    - Trigger devices
    - Tubes
    - Tuners
    - Microwave components
    - Printed wiring circuits
    - Fibre optics
    - Spark gaps
    - Resonators
  - Electromechanical components
  - Magnetic parts
- **Materials**
- **Geometry**
- **Features**

Property definition

Identity number:	AAE065
Version number:	005
Revision number:	03
DET class:	E44 (impedance)
Name:	**tangent of loss angle**
Alternative names:	dissipation factor
Symbol:	tan δ
Short name:	tan$d
Definition:	The tangent of the loss angle of a capacitor at specified frequency and at reference conditions.
Note:	The tangent of the loss angle is equal to the equivalent series resistance divided by the capacitive reactance.
Remark:	(IEC 60418-3(III.9) (1976)): The rotor should be set at minimum and maximum positions for the tan delta test on variable capacitors. IEC requires the voltage to be specified. N.B. Reciprocal of tan delta is quality factor Q.
Units:	1
Level:	nom
Data type:	level
Format:	NR3..3.3ES2
Data value:	real measure
Definition source ref:	IEC/TC40(Sec)2250(02.96) (1986)
Conditions:	AAE029 frequency AAE995 reference conditions
Applicable in classes:	AAA020
Status level:	Standard
Published in:	IEC 61360-4
Published by:	IEC
Proposal date:	1997-04-01
Release date:	1997-01-01
Version date:	1996-08-01
Version release date:	1997-01-01

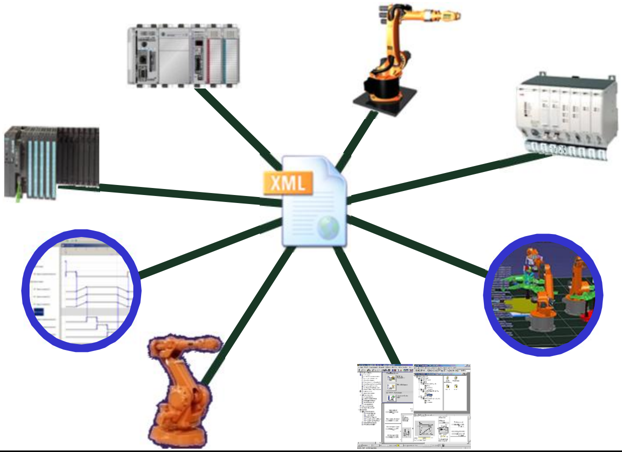
Interoperability still an objective for the SC65E AutomationML a work item to answer user requirements

- In factory automation engineering is cost driver number one
  - In a heterogeneous tool landscape data exchange between the corresponding tools is an important factor
  - Proprietary and numerous interfaces between tools lead to gaps in passing over information and thus result in an engineering process with poor efficiency.



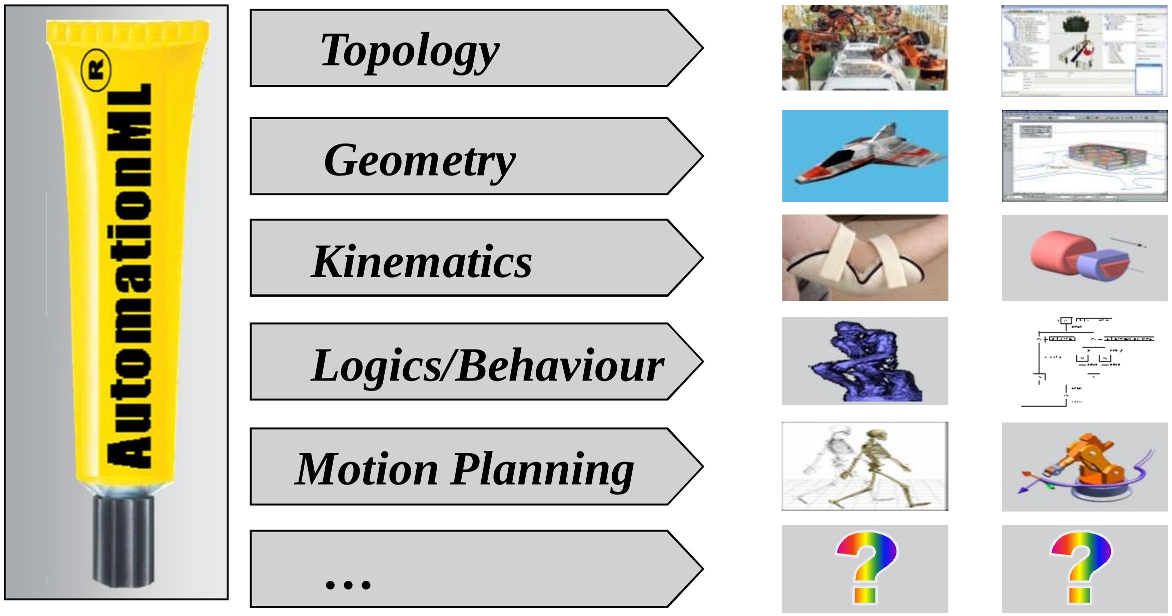
Source: Cost structure analysis of robotics and controls, AIDA 2005

- AutomationML will close the gaps between production design and shopfloor
  - through interoperability between tools
  - for all phases of the engineering process, based on one lossless and scalable data format



AutomationML describes mechatronical objects with all aspects

- AutomationML will become the glue for seamless automation engineering
  - e.g. between CAE-tools and PLC-programming tools)



- AutomationML will be soon an IEC standard IEC 62714-1
  - Don't hesitate , join us !...

Reconfigurable Radio System (RRS)

- New spectrum frequencies and RRS should NOT be construed as alternatives to our industrial presence in 2.4 GHz. They should be in addition to a usage of areas with Coexistence Management (CM) in 2.4 GHz.
- RRS offer unprecedented optimization and propagation possibilities and can extend CM.
- RRS can provide additional mechanisms for a future EN 300328 V1.9.0, assuming that RRS are proper for IA.
- EC mandate **M/512 EN: "***RRS, in particular Software Defined Radio (SDR) and Cognitive Radio (CR) technologies have been investigated in the commercial, public safety and military areas. While each area has specific operational and technical requirements, a consistent approach should bring benefits for all areas.*"

If this EC mandate has been issued 2012-11-19. It addresses CEN, CENELEC and ETSI to specify harmonized standards.

Vision

- Devices and / or networks collaborate by using an **automatic coexisting management**
  - Parameters defined in IEC 62657-2 plus ad-ons are distributed
  - An arbiter (central or distributed) will assign spectrum
  - Coexistence is monitored and maintained continuously.

Possible next Steps

1. In industrial automation plans can be assumed a controlled area for the usage of wireless devices/networks.
   - This makes it easier versus a public area without any information of the wireless devices/networks joining and disappearing.
   - Existing communication networks like PROFInet and tools like EDDL, OPC, FDI, etc. can be used to describe and distribute the information.
   - The challenge is the definition of an arbiter.

Possible next Steps

2. Generalize the industrial automation approach to public usage of wireless devices/networks.
   - ➢ The challenge is the specification of an application requirement of public devices, which are typically unknown without any plan and schedule.
     - A solution for this could be an approach like PROFInet uses for real-time and best effort TCP/IP traffic in a common network:
       time slicing!
       - for those using automatic adaptive mechanisms get access to the scheduled high efficient „real-time slot, and the other have to live with the best effort slot.