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Industrial-process measurement, control and automation — Reference model for representation of production facilities (digital factory)

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National foreword

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Industrial-process measurement, control and automation – Reference model for representation of production facilities (digital factory)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –

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FOREWORD

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IEC 62794, which is a technical report, has been prepared by IEC technical committee 65: Industrial-process measurement, control and automation.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
65/499/DTR	65/508/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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0 INTRODUCTION

0.1 Rationale for the digital factory reference model

A number of efforts have addressed the development of business and manufacturing enterprise models to aid in understanding the different aspects of the enterprise to improve enterprise operations. Additionally, enterprise-control system models have been developed to support the production operations, but gaps remain in the development of models to bridge from the manufacturing system design environments to the process, equipment, and devices used in the manufacturing operations.

In the enterprise models, various initiatives have addressed the complexity of modelling the manufacturing and business enterprise by delineating the different domains, dimensions, and views associated with the people, processes, and resources used to achieve the enterprise mission. Those activities that endeavour to identify various distinct aspects for separation of concern have been called “modelling the digital enterprise”. The resultant efforts have developed a universe of discourse that provides common terms and constructs to describe the manufacturing and business enterprise. By using similar modelling approaches, a model for the “digital factory” is envisioned.

While the approaches of the modelling activities vary according to the scope of the effort, there are some common characteristics to the modelling approaches that can be drawn upon to expedite the understanding of the modelling concepts.

Interoperability in the digital factory is a prime area of focus for developing concepts for the subset of activities of the digital enterprise. These concepts are important to the digital factory for making and delivering products and services.

NOTE Enterprise modelling concepts are further described in standards referenced in the Bibliography (for example ISO 15704, ISO 11354-1).

Some entities of the digital enterprise may exchange information with entities of the digital factory or may need information about the automation assets and their relationships.

0.2 Approach to the digital factory

A general concept is developed for the automation assets and their relationships, as well as relationships to other assets as a base for a digital factory reference model. This conceptual model of the automation assets supports an electronic representation for utilization in the design of process plants, manufacturing plants or even building automation.

Work started more than 10 years ago with the idea to replace paper data sheets with an electronic description of electronic components (as a list of properties), and to use it in software tools for electronic wiring and assembly (for example when designing electronic boards). Additionally, concepts were developed for profiling of devices, in order to describe parameters and behavioural aspects to facilitate integration and reduce engineering costs, providing guides for standards developers.

NOTE 1 See device profile guideline (IEC/TR 62390).

These efforts were to address interoperability barriers encountered in designing a process or manufacturing plant due to inconsistencies in the information and data describing those automation assets to be deployed in the facility. To overcome those barriers, specific solutions addressing the business, process, service, and information (data) are needed. An approach to addressing these conceptual aspects is proposed to develop an automation asset model.

Digital factory repositories will save these electronic descriptions of the automation assets, together with other aspects and the technical disciplines associated with any process of the digital factory that use the automation assets. Activities (such as engineering, configuration, and maintenance) associated with the digital factory will access, update, and use the master data in these repositories in order to support the whole plant lifecycle. This allows a consistent information interchange between all processes involved.

Figure 1 shows an example of a digital factory, with the various IEC, ISO and ISA committees involved in related standards.

NOTE 2 Within the digital enterprise, the ISO TC 184 scope of work focuses on the design, manufacturing, and processing applications and the lifecycle and supply chain aspects of the systems. These systems support the applications; especially the interoperability, the integration and the architectures of the applications as well as the supporting systems and environments (e.g. see ISO 15704 for the requirements of enterprise reference architectures and methodologies).

NOTE 3 Several IEC and ISO standards provide methodologies for describing master data and exchange of information about automation assets involved in the manufacturing applications. These standards address different levels and aspects of the automation lifecycle from procurement to installation and operation. Examples of these are IEC 61360-1 and IEC 61360-2, ISO 22745, and ISO 8000, which may be used to describe properties of electric and automation devices.

NOTE 4 Actual properties of automation devices are being specified in the IEC 61987 series, as well as in IEC 62683on low-voltage switchgear and controlgear. Other TC's in charge of automation assets outside the scope of TC 65 (for example SC 22G “adjustable speed drive systems incorporating semiconductor power converters”) are invited to use this framework and contribute within their scope.

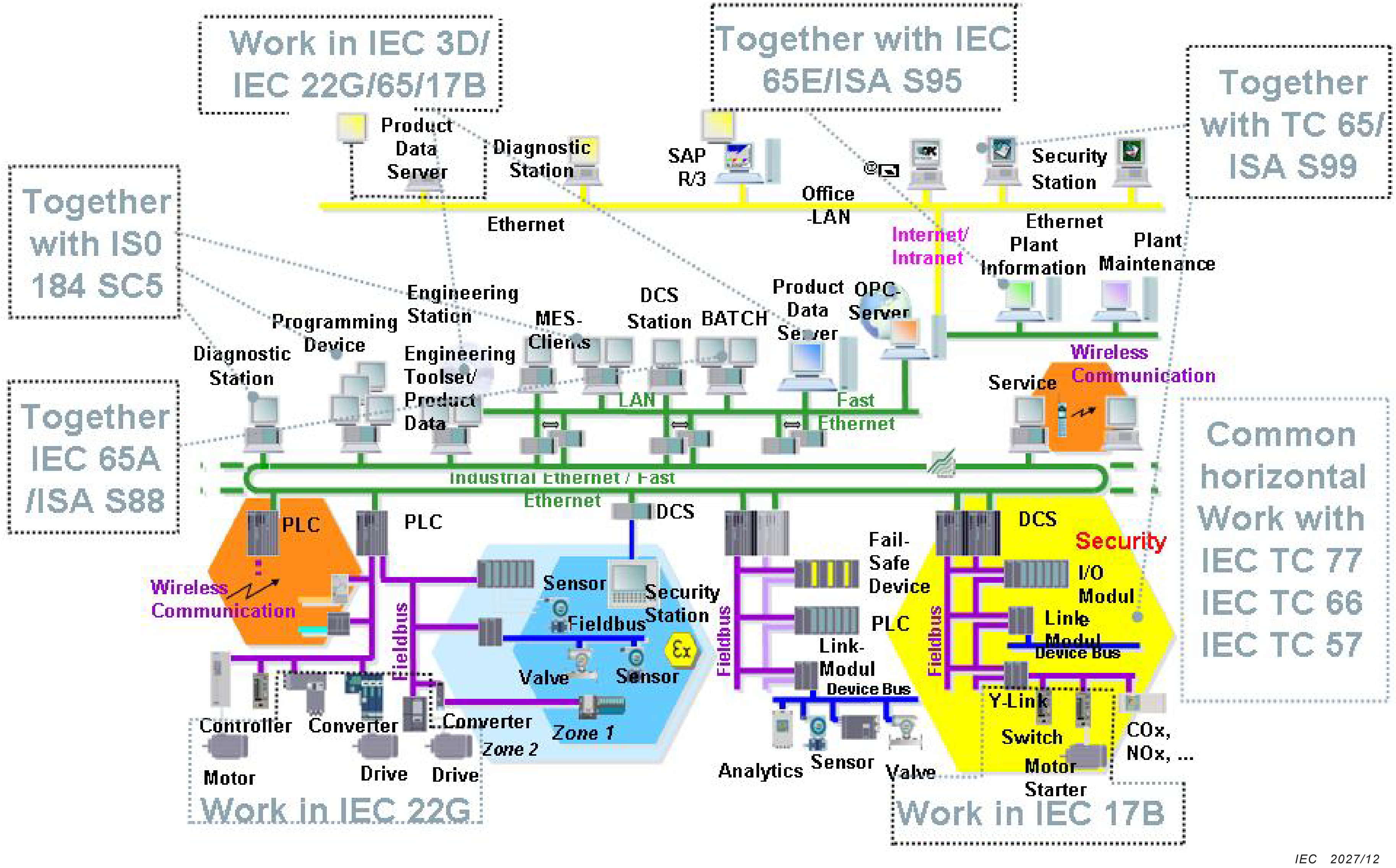


Figure 1 – The digital factory and related standard activities

INDUSTRIAL-PROCESS MEASUREMENT, CONTROL AND AUTOMATION –

Reference model for representation of production facilities (digital factory)

1 Scope

This Technical Report describes a reference model which comprises the abstract description for:

- automation assets;
- structural and operational relationships.

NOTE Examples of automation assets are machines, equipment, devices and software.

The reference model is the basis for the electronic representation of certain aspects of a plant. It covers the systems (excluding facilities) used to make products, but it does not cover raw production material, work pieces in process, nor end products.

The corresponding information which is stored in digital factory repositories represents aspects of the digital factory. This information may be used throughout the plant lifecycle. The reference model may be applied to process plants, manufacturing plants or even building automation.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62683[1], *Low-voltage switchgear and controlgear – Product data and properties for information exchange*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

NOTE Relationships between definitions are shown in Annex A.

3.1.1
activity
lifecycle activity
set of tasks for a specific purpose

EXAMPLE Corresponding automation activities are design, asset selection or asset configuration. Examples of lifecycle activities are engineering or maintenance.

1 To be published.

3.1.2
asset
physical or logical object owned by or under the custodial duties of an organization, having either a perceived or actual value to the organization

Note 1 to entry: In the case of industrial automation and control systems the physical asset that has the largest directly measurable value may be the equipment under control.

[SOURCE: IEC/TS 62443-1-1:2009, 3.2.6]

3.1.3
attribute
characteristic of a property or a BE relationship

EXAMPLE Units is an attribute of the Width property.

Note 1 to entry: A property will typically have several attributes, while a BE relationship may not have any.

3.1.4
automation asset
asset used in a manufacturing or process plant to construct the production facility

Note 1 to entry: It includes structural, mechanical, electrical, electronic elements (e.g. controllers, switches, starters, contactors, drives, motors, pumps, network) as well as software elements related to the physical assets (e.g. firmware, operating systems, communication firmware, user program, batch software to run recipes, often used recipes). These elements cover components, devices, machines, control systems, but not the plant itself. It does not include financial assets, human resources, raw process materials, energy, work pieces in process, end products.

Note 2 to entry: Automation assets may be parts of a more complex asset.

3.1.5
basic element
BE
collection of properties that represent similar aspects of an automation asset

EXAMPLE Some basic elements are construction, function, performance, location and business element.

3.1.6
basic element relationship
BE relationship
electronic representation of an association between two basic elements

3.1.7
digital factory repository
DF repository
DFR
electronic description of an actual factory, in accordance with the digital factory model

3.1.8
digital factory
DF
generic model of a factory that represents basic elements, automation assets, their behaviour and their relationships

Note 1 to entry: This generic model may be applied to any actual factory.

3.1.9
master data
data held by an organization that describes the entities that are both independent and fundamental for that organization and that it needs to reference in order to perform its transactions

Note 1 to entry: Organization in this context refers to the use of information in the DF repository .

[SOURCE: ISO 8000-102:2009, 11.1, modified by adding Note 1 to entry.]

3.1.10
object
entity with a well-defined boundary and identity that encapsulates state and behaviour

Note 1 to entry: State is represented by attributes and relationships, behaviour is represented by operations, methods, and state machines. An object is an instance of a class.

[SOURCE: IEC/TR 62390:2005, 3.1.19]

3.1.11
property
characteristic common to all members of an object class

[SOURCE: IEC 61987-10:2009, 3.1.22; ISO 22745-2:2010:2010, B.2.2;
ISO/IEC 11179-1:2004, 3.3.29]

3.1.12
technical discipline
area of technical expertise applied to a specific set of activities

EXAMPLE Examples of technical disciplines are electrical wiring, pipe layout, automation, mechanic

3.2 Symbols and abbreviated terms

For the purposes of this document the following symbols and abbreviated terms apply.

3.2.1 General symbols and abbreviated terms

AI analogue input

AO analogue output

BE basic element

CPU computer programmable unit

DF digital factory

DFR digital factory repository

PLC programmable logic controller

3.2.2 Symbols and abbreviated terms used by the reference model

B business element

C construction element

F functional element

L location element

P performance element

d data transfer

pe permanent relationship

rt at a relative time

sp at a specific time

st start action

t at a period

tp temporary relationship

3.3 Conventions

3.3.1 Representation of basic elements

Basic elements of the reference model (specified in 5.2) are represented in the relevant figures using squares of various colours, with associated identifiers. These same identifiers are also used within the following text to refer to specific basic elements.

Conventions for corresponding colours and identifiers are listed in Table 1.

Table 1 – Conventions for representation of basic elements

Basic element	Identifier	Graphical representation
Construction	*C*	Blue square
Function	*F*	Yellow square
Performance	*P*	Red square
Location	*L*	Green square
Business	*B*	Gray square

3.3.2 Representation of relationships

Relationships between the basic elements (*C*, *F*, *P*, *L*, *B*) of the reference model (specified in 5.3) are represented in the relevant figures using the following general conventions.

- Relationship type: structural relationships are indicated by a line between two elements, operational relationships are indicated by a unidirectional or bidirectional arrow between two elements.
- Duration attribute: permanent relationships are indicated by solid lines or arrows, temporary relationships by dotted lines or arrows.

Further conventions for the representation of the attributes of a structural relationship are listed in Table 2.

Table 2 – Conventions for representation of structural relationships optional attribute

Timing attribute values	Graphical representation
None	No additional item
At a specific time	"sp" with a time value over the line
At a relative time	"rt" with a time value over the line
At a period	"t" over the line, with an index referring to a predefined period/phase

Further conventions for the representation of the attributes of an operational relationship are listed in Table 3.

Table 3 – Conventions for representation of operational relationships optional attributes

Timing attribute values	Operation attribute values[a]	Graphical representation
None	Unidirectional action	"st" (for action start) above the unidirectional arrow
	Unidirectional data transfer	"d" (for data transfer) above the unidirectional arrow
	Bidirectional data transfer	"d" (for data transfer) above the bidirectional arrow
At a specific time	Unidirectional action	"st" (for action start) above the unidirectional arrow, and "sp" and a time value over the arrow line
	Unidirectional data transfer	"d" (for data transfer) above the unidirectional arrow, and "sp" and a time value over the arrow line
	Bidirectional data transfer	"d" (for data transfer) above the bidirectional arrow, and "sp" and a time value over the arrow line
At a relative time	Unidirectional action	"st" (for action start) above the unidirectional arrow, and "rt" and a time value over the arrow line
	Unidirectional data transfer	"d" (for data transfer) above the unidirectional arrow, and "rt" and a time value over the arrow line
	Bidirectional data transfer	"d" (for data transfer) above the bidirectional arrow, and "rt" and a time value over the arrow line
At a period	Unidirectional action	"st" (for action start) above the unidirectional arrow, and "t" over the arrow line, with an index referring to a predefined period/phase
	Unidirectional data transfer	"d" (for data transfer) above the unidirectional arrow, and "t" over the arrow line, with an index referring to a predefined period/phase
	Bidirectional data transfer	"d" (for data transfer) above the bidirectional arrow, and "t" over the arrow line, with an index referring to a predefined period/phase

[a] Additional operation values and corresponding identifiers may be specified at a later time.

3.3.3 Representation of views

Views of automation assets are represented in the relevant figures by boxes surrounding the associated basic elements.

4 Overview of the digital factory model and repository

In legacy automation systems, the information is mostly captured in paper documents or in bundled electronic format, without individual access to information elements such as information describing properties of automation assets (for example data sheets). Besides, available electronic information is exchanged using proprietary formats.

The concept of the reference model is that all information on automation assets is available under a common format. Corresponding information includes properties of these assets (see Figure 2).

NOTE 1 Common formats such as IEC 61360-2, ISO 13584-42 or ISO 22745 can be used.

EXAMPLE Examples of properties are “housing length” or “device weight”.

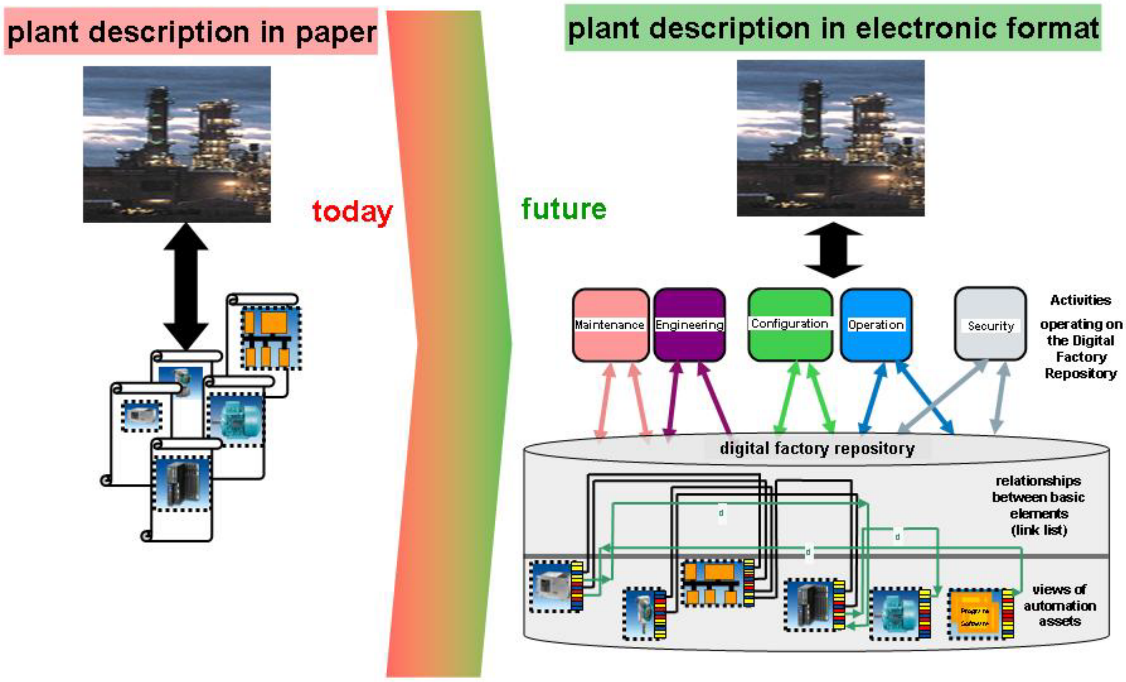


Figure 2 – Transition from legacy systems to new electronic approach

This information can be stored in a DF repository.

Three different interoperability approaches can be used:

a) integrated,

b) unified, and

c) federated.

NOTE 2 ISO 11354-1:2011, 4.4 describes different interoperability approaches.

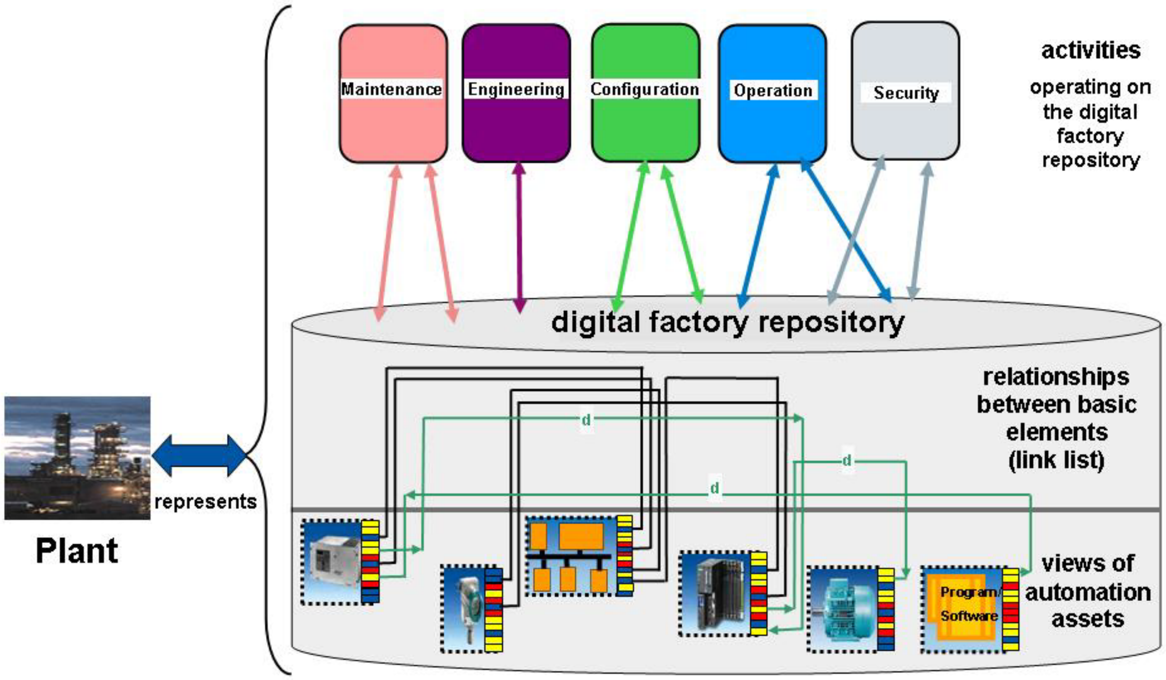
This document describes a federated approach to develop a DF repository.

NOTE 3 The integrated approach is most desirable but can require engineering for legacy systems.

The asset information stored in the DF repository can be used by several system functions performed by activities.

Throughout the plant lifecycle, data will be added, deleted or changed in the DF repository. The DF repository should always contain up to date information of the plant (see Figure 3 for an overview).

NOTE 4 This will remove the need for paper documents, which are difficult to keep consistent with changes made, and therefore paper documents cannot reflect precisely the reality of the physical plant.



IEC 2029/12

Figure 3 – Overview of the DF repository, automation assets and activities

Additional conceptual viewpoints are used to describe different aspects of the DF repository.

NOTE 5 Conceptual viewpoints are described in ISO 15704.

Information in the DF repository should be:

- portable, information should be easily exchanged between various systems;
- traceable, source of the information should be identifiable;
- extendable, information should be able to be augmented with properties for use in various life cycle phases, and different viewpoints.

NOTE 6 ISO 8000 describes the requirements for exchange of "master data", i.e. the information about the automation asset.

5 Reference model concepts

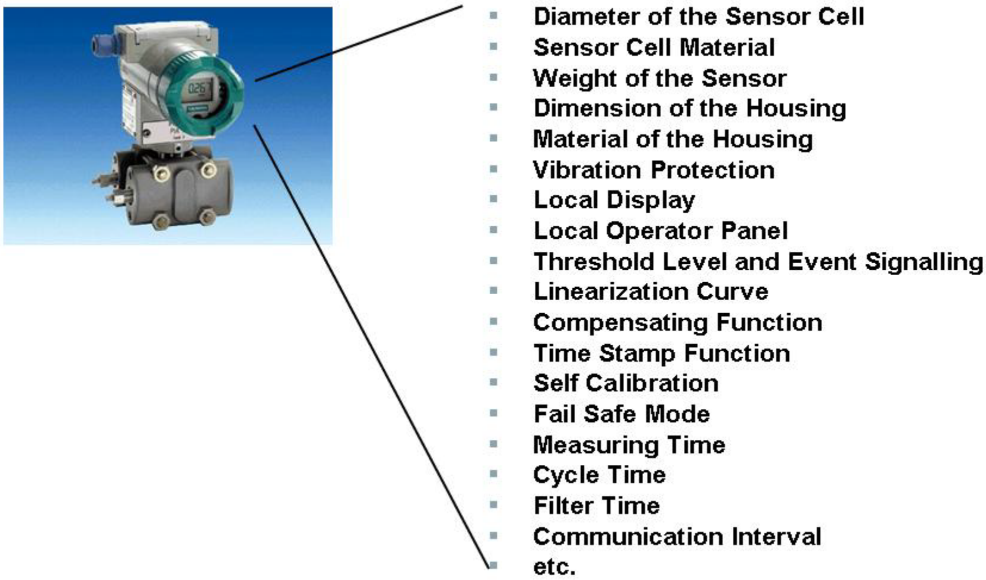
5.1 Properties

5.1.1 General

Characteristics of an automation asset are described by properties. A unique concept identifier (code) is required for each property.

NOTE A more rigorous treatment of the properties for automation assets is described in the ISO 8000 series.

Figure 4 shows an example of an instrument together with its list of properties.



IEC 2030/12

Figure 4 – Example of properties of an automation asset

5.1.2 Property attributes

A property is defined by its attributes.

Examples of attributes are:

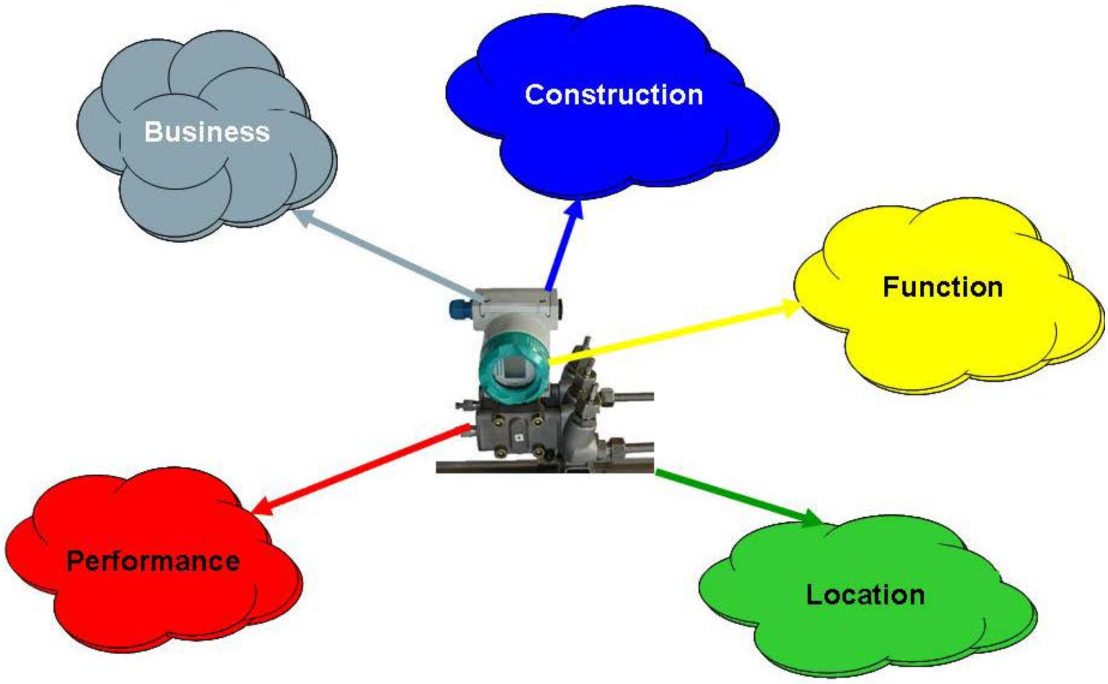
- code;
- version number;
- revision number;
- preferred name;
- preferred letter symbol;
- definition;
- source of the definition;
- note;
- remark;
- formula;
- figure;
- data type;
- property type classification code;
- unit of measure;
- value list.

NOTE This example is based on IEC 61360-2 and ISO 13584-42 cataloguing schema. ISO 22745 uses the concept of identification guides for specific cataloguing schemes.

The property is uniquely identified by its code, which facilitates the translation of language dependent attributes.

5.2 Basic elements

The concept of basic elements is used for the grouping of properties for a specific purpose or viewpoint of the automation assets, as shown in Figure 5.



IEC 2031/12

Figure 5 – Viewpoints on properties of an automation asset

There are five types of basic elements, which are listed below. A particular automation asset is represented by at least one type of basic element, but does not necessarily need all types of basic elements specified in this subclause:

- Construction (*C*) reflects the mechanical information (e.g. dimensions, housing) or constructional properties (e.g. type of connectors);
- Function (*F*) reflects the functional aspects supported by the automation asset (e.g. application functions, operating functions, tasks);
- Performance (*P*) reflects the characteristics of the functional aspects (e.g. rated values, cycle time or start times, threshold levels, energy consumption);
- Location (*L*) indicates the position of the automation asset in the plant (e.g. relative location, absolute location, global position coordinate, location identification for specific domains);
- Business (*B*) reflects the commercial aspect properties of the automation asset (e.g. price, delivery time or quantity in a package unit).

NOTE 1 The function element "*F*" is similar to the concepts defined in the device profile guideline (see IEC/TR 62390).

NOTE 2 The details of the business element "*B*" is out of the scope of IEC 62794.

Individual instances of the basic elements need to be uniquely identified.

EXAMPLE *F1* and *F2* indicate two different software functions.

Figure 6 is an example of grouping properties for an automation asset (sensor device).

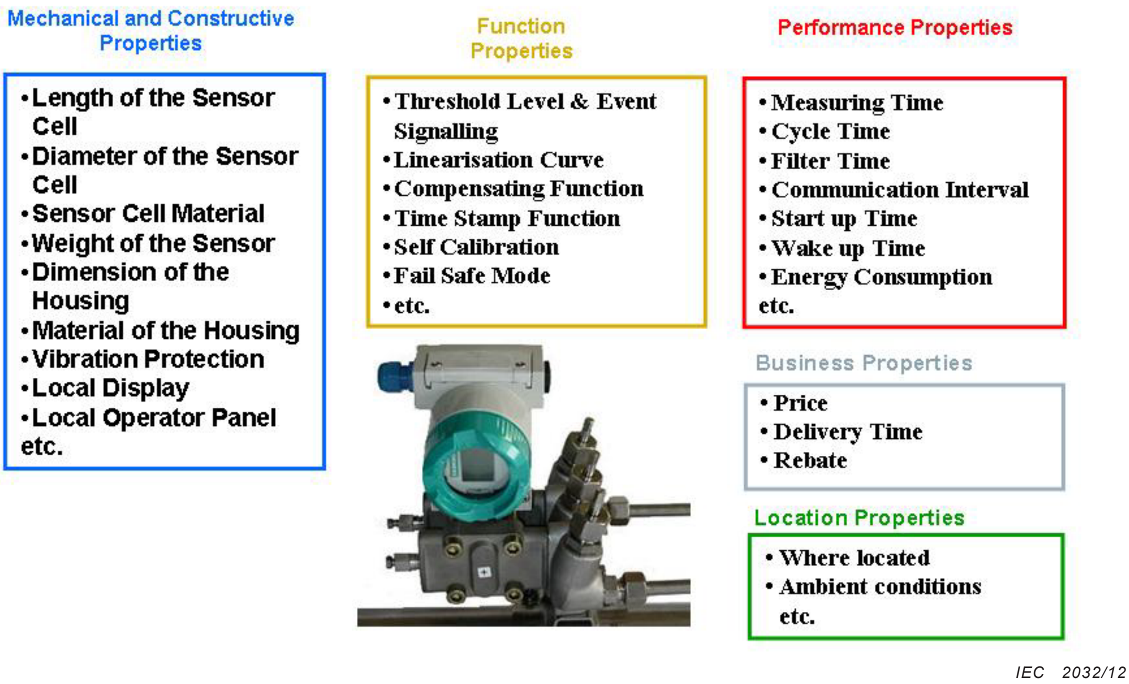


Figure 6 – Grouping of properties for an automation asset

5.3 Relationships between basic elements (BE relationships)

5.3.1 General

The reference model provides an overall description of the structures of the automation assets and relationships between the automation assets.

The five types of basic elements *C*, *F*, *P*, *L*, and *B* are related with each other. as shown in Figure 7. Several relationships may be established between two basic elements, or relationships may be established between a set of basic elements and another set of basic elements (n to m relationship).

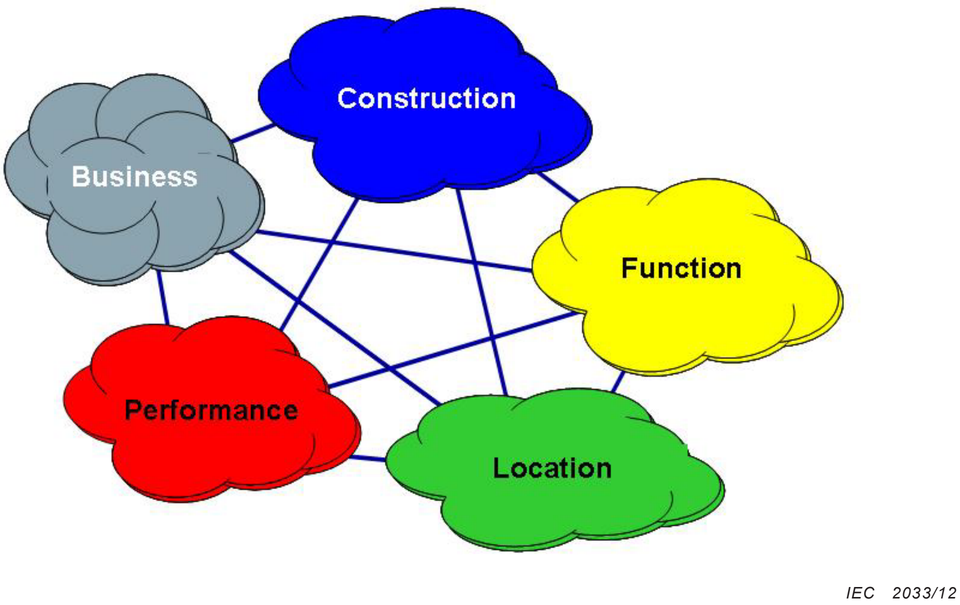


Figure 7 – Relationships between basic elements

BE relationships have four attributes listed below, and further specified in 5.3.2 to 5.3.5:

- relationship type specifies whether the BE relationship is structural or operational;
- duration specifies whether the BE relationship is permanent or temporary.
- timing indicates when a BE relationship will be established and when it will be de-established;
- operation specifies whether the BE relationship represents a data transfer (unidirectional or bidirectional), or the start of an action.

All possible combinations of relationship types and their graphical representation are defined in 5.3.6.

5.3.2 Relationship type attribute

5.3.2.1 General

Two types of BE relationships may exist in a digital factory:

- structural type;
- operational type.

A complete model of the automation asset should include both structural and behavioural aspects (see ISO 15704:2000, 6.3.14.2). The BE relationship type concept defined in this document is for the structural and operational aspects only, within or between the automation assets.

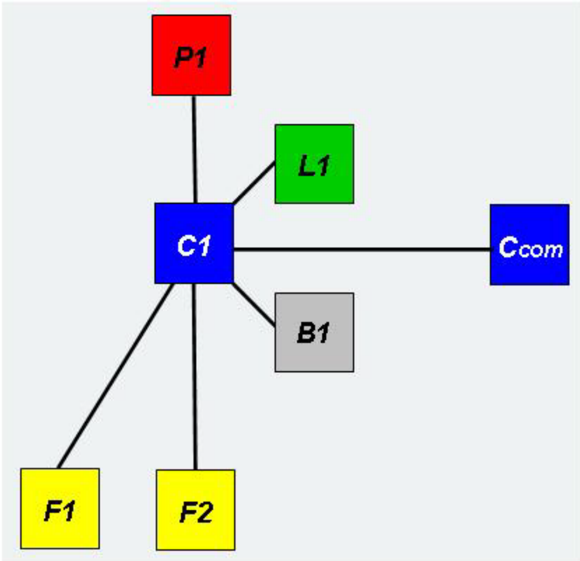
5.3.2.2 Structural relationship type

The structural relationship type describes how basic elements are organized within or between automation assets.

The following example shows how the reference model can be applied to view the structural information for a single PLC.

In
Figure 8 a view of the automation asset PLC consists of hardware *C1* with associated application software *F1* and *F2*.

The PLC, with an additional communication board *Ccom*, is located at the position *L1* and has a performance *P1*, as well as associated business properties *B1*.



IEC 2034/12

Figure 8 – Example view of the structural relationships for a single PLC

5.3.2.3 Operational relationship type

The operational type describes the information and action flow between the basic elements, within or between automation assets.

The operational relationship type is of the kind:

- information flow to or between (unidirectional or bidirectional data transfer);
- action to (e.g. start of a program).

The nature of an operational relationship may be indicated using the operation attribute.

The example in Figure 9 shows how the reference model can be applied to describe structural and operational information for three devices (a sensor, a controller and an actuator).

The three devices have hardware *C2*, *C3* and *C4*. Each device has a different location element *L2*, *L3* and *L4*, different business elements *B2*, *B3* and *B4* and performance elements *P2*, *P3*, and *P4*. Each device has an attached software function *F1*, *F2*, *F3*. The functional elements *F1*, *F2* and *F3* have an operational relationship.

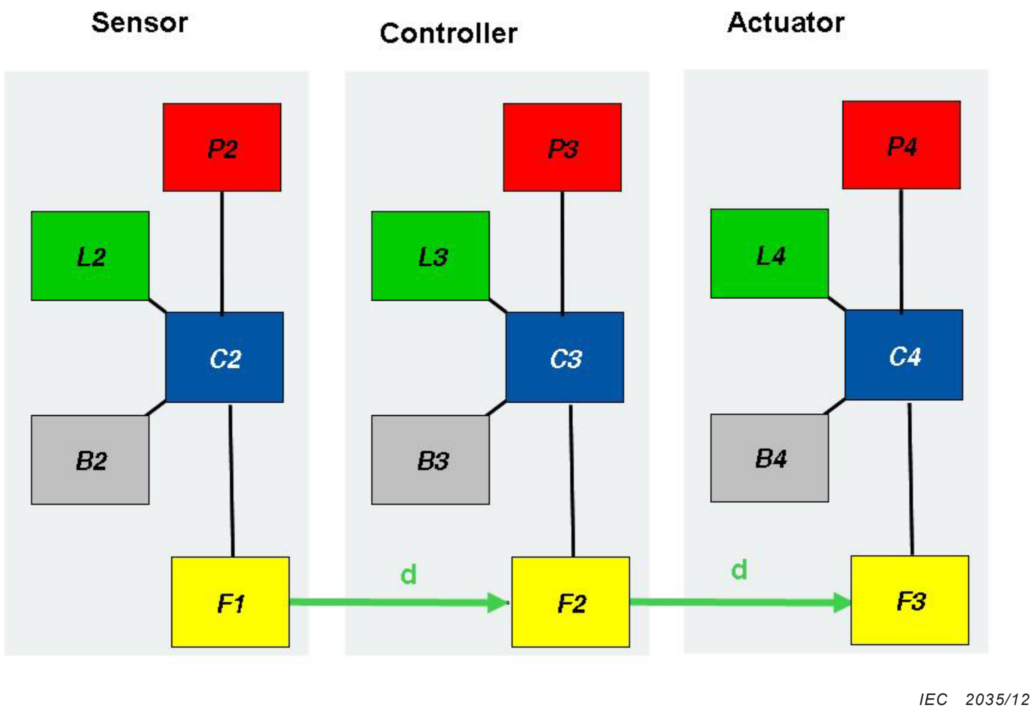


Figure 9 – Example view of operational relationships of distributed functions

5.3.3 Duration attribute

The duration attribute is mandatory and specifies whether a structural or operational relationship is permanent or temporary. Temporary means that a relationship may be added or removed after a certain time or phase (otherwise it is permanent).

Figure 10 shows examples of both permanent and temporary structural relationships.

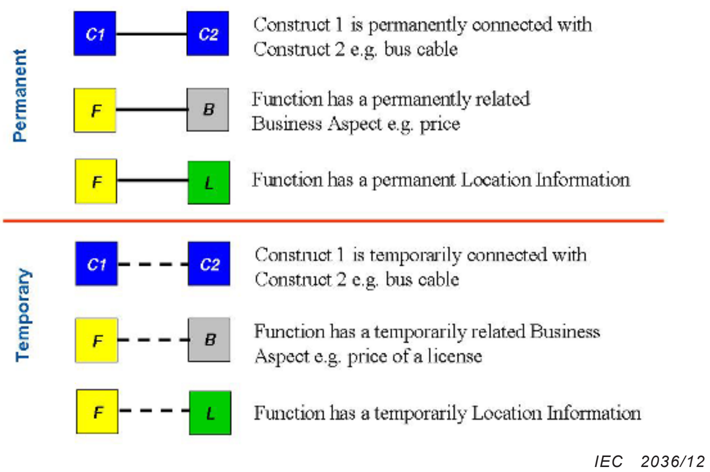


Figure 10 – Examples of structural relationship types (permanent and temporary)

Figure 11 shows examples of both permanent and temporary operational relationships.

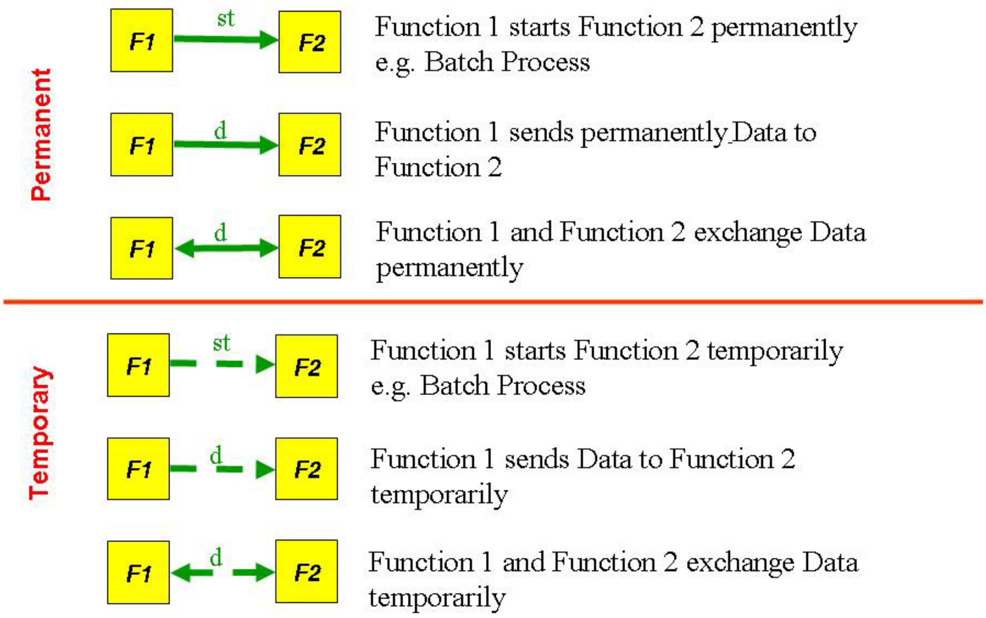


Figure 11 – Examples of operational relationship types (permanent and temporary)

5.3.4 Timing attribute

The timing attribute is optional. For some relationship types it may be necessary to indicate when a relationship will be established and when it will be de-established, based on a timing attribute. If present, this attribute is indicated by the character “t”, with additional suffixes.

Three main options may exist:

- At an absolute time

  The time is based on an absolute time of the international timing system. Use of the absolute time may be indicated by an “a” suffix, and the actual time may be specified after an equal symbol.

  EXAMPLE 1 An absolute time of 8:00 (CET) on March 6th, 2012 would be indicated by (UTC time): t_a = 2012-03-06T07:00:00Z.

- At a relative time

  Use of the relative time may be indicated by an “r” suffix, and the actual duration may be specified after an equal symbol, together with the corresponding unit.

  EXAMPLE A relative time of 3 hours after the shift start would be indicated by: t_r = 3 h.

- At a period

  The period is based on a lifecycle activity. Use of a time period may be indicated by an index next to the “t” character, referring to a given lifecycle activity in a correspondence list.

Figure 12 shows an example of relationships using “period” timing attributes. It uses *t1* for the activity “manufacturing”, *t2* for the activity “engineering” and *t3* for the activity “operation”.

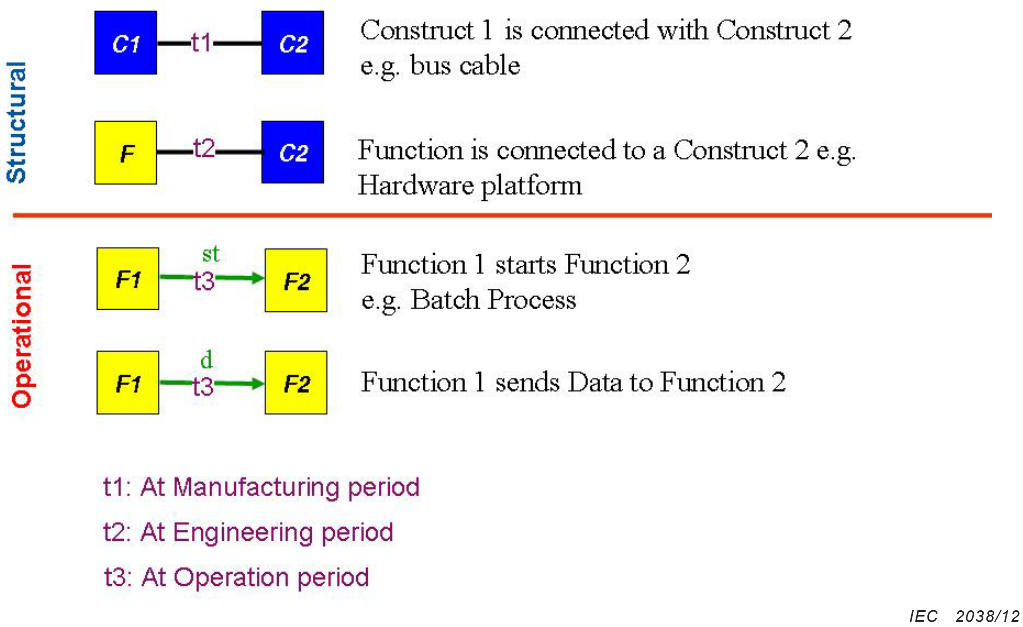


Figure 12 – Example of relationships with timing attributes

5.3.5 Operation attribute

The operation attribute is optional and only applies to operational relationships. It further specifies the nature of an operational relationship, i.e. whether it represents a data transfer (unidirectional or bidirectional), or the start of an action.

NOTE Additional operation options can be specified at a later time.

5.3.6 Valid combinations of relationship attributes

5.3.6.1 General

Table 4 specifies all valid combinations of relationship attributes.

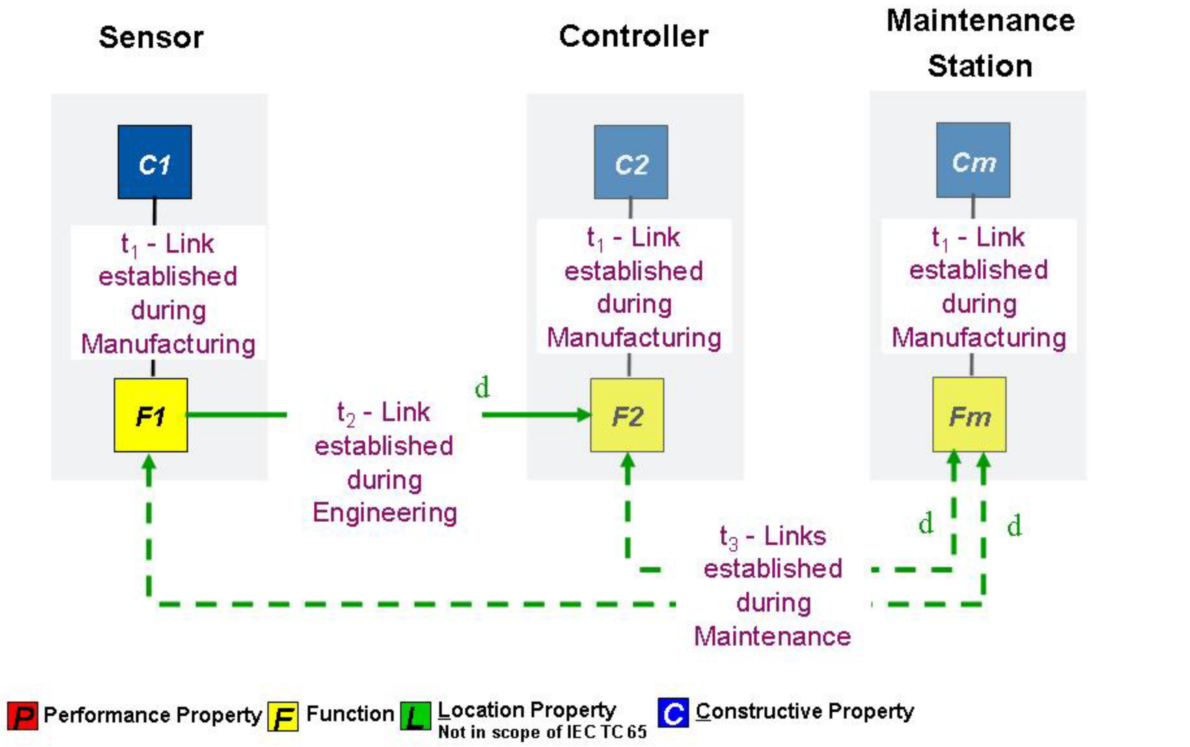
Table 4 – Summary of valid combinations of relationship attributes

Relationship type	**Duration**	**Timing**	**Operation**	**Graphical representation (informative)**
Structural	Permanent	None	not relevant	———————
		At an absolute time		——— t_a=ttt ———
		At a relative time		——— t_r=ttt ———
		At a period		——— t_n ———
Structural	Temporary	None	not relevant	– – – – – – – – –
		At an absolute time		– – – – t_a=ttt – – –
		At a relative time		– – – – t_r=ttt – – – –
		At a period		– – – – t_n – – – –
Operational	Permanent	None	Unidirectional action	st ————→
			Unidirectional data transfer	d ————→
			Bidirectional data transfer	←—— d ——→
		At an absolute time	Unidirectional action	st —— t_a=ttt ——→
			Unidirectional data transfer	d —— t_a=ttt ——→
			Bidirectional data transfer	←— d — t_a=ttt ——→
		At a relative time	Unidirectional action	st —— t_r=ttt ——→
			Unidirectional data transfer	d —— t_r=ttt ——→
			Bidirectional data transfer	←— d — t_r=ttt ——→
		At a period	Unidirectional action	st —— t_n ——→
			Unidirectional data transfer	d —— t_n ——→
			Bidirectional data transfer	←— d — t_n ——→

Relationship type	Duration	Timing	Operation	Graphical representation (informative)
Operational	Temporary	None	Unidirectional action	– – – – st – – – – ▶
			Unidirectional data transfer	– – – – d – – – – ▶
			Bidirectional data transfer	◀ – – – d – – – – ▶
		At an absolute time	Unidirectional action	– – – st – ta=ttt – – ▶
			Unidirectional data transfer	– – – d – ta=ttt – – ▶
			Bidirectional data transfer	◀ – – d ta=ttt – – ▶
		At a relative time	Unidirectional action	– – – st – tr=ttt – – – ▶
			Unidirectional data transfer	– – – d – tr=ttt – – – ▶
			Bidirectional data transfer	◀ – – d tr=ttt – – ▶
		At a period	Unidirectional action	– – – st – tn – – – ▶
			Unidirectional data transfer	– – – d – tn – – – ▶
			Bidirectional data transfer	◀ – – d – tn – – – ▶

5.3.6.2 Examples of relationships

Figure 13 shows examples of combinations of the various relationship types and attributes.



IEC 2039/12

Figure 13 – Examples of relationships

NOTE The basic elements are viewpoints of the particular automation asset, such as sensor, controller, and maintenance station; i.e. the collection of properties related to the particular viewpoint, since the information for each automation asset will adhere to the component specification per the relevant standard for each automation asset.

Three devices are involved in this example, PLC1, PLC2 and a “maintenance station”.

In PLC1 the construction element *C1* (computing board) is associated with the function element *F1* through a permanent structural relationship, which is established during the manufacturing time *t1*. This is identical for the relationships in PLC2 between *C2* and *F2* and in the “maintenance station” between *Cm* and *Fm*.

The relationship between *F1* and *F2* is of type “operational” and “permanent” and is established at engineering time *t2*. Over this relationship data *d* will be transferred from *F1* to *F2*.

The relationships between *Fm* and *F1* as well as *Fm* and *F2* are established in this example only at maintenance time. These relationships are of type operational and temporary. Data *d* will be transferred only at the maintenance phase.

6 Activities of the reference model

6.1 Relationship between the digital factory repository and activities

The DF repository concepts provide a common semantic interface for all phases of the plant lifecycle, thus simplifying data exchanges between these phases.

NOTE ISO 15704 defines “life cycle” as phases and steps within the phases.

During the plant lifecycle phases, different activities operate on selected information from the DF repository, then save the enriched information (by addition, extension or connection of basic elements) in the DF repository for further use by other activities.

EXAMPLE Figure 14 shows how an engineering activity (part) selects two devices out of a catalogue PLC1 and PLC2. The basic element function *F1* of PLC1 needs to be related to function *F2* of PLC2. This new or enriched information will be stored in the DF repository for further use by other activities.

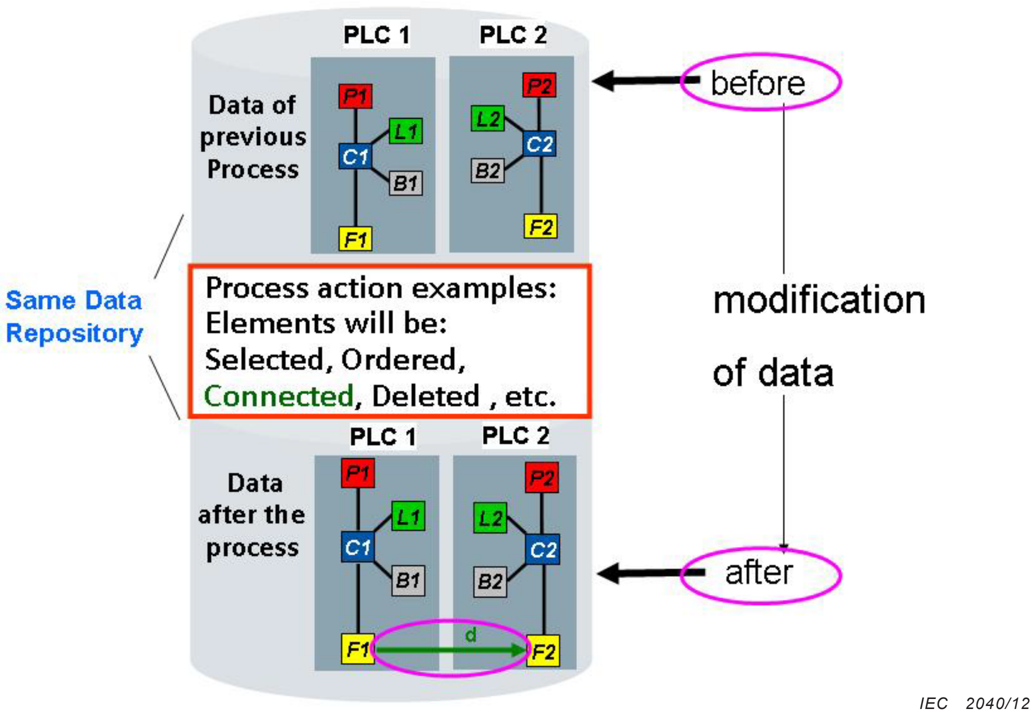


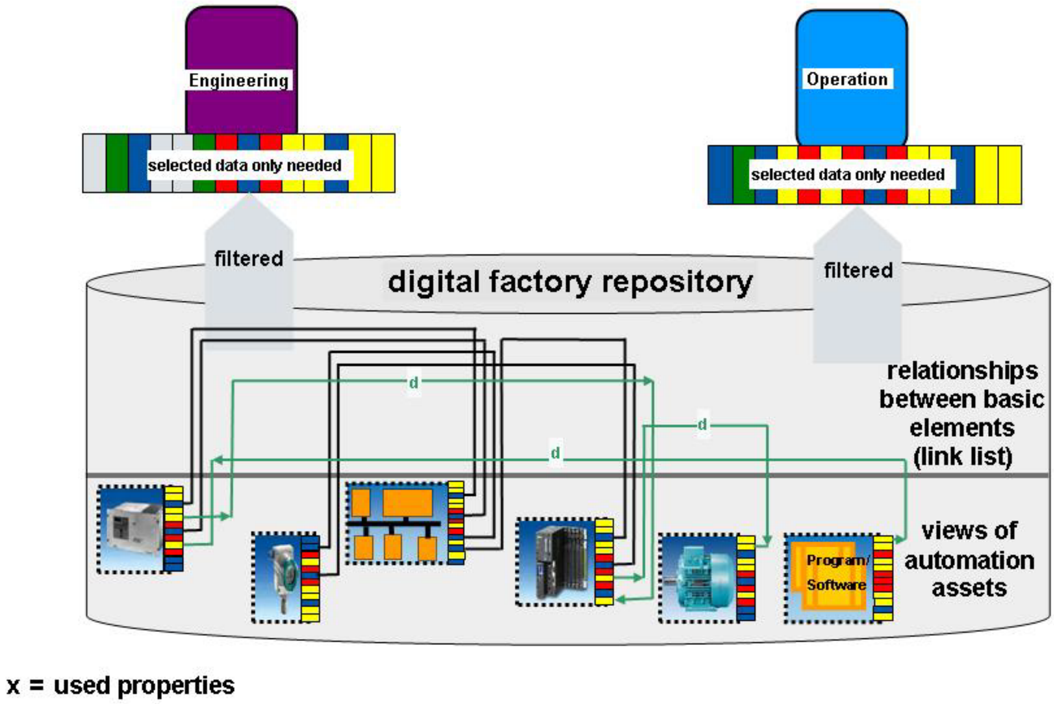
Figure 14 – Part of an engineering activity

6.2 Filtering of data for lifecycle viewpoints

Different subsets or views of the integrated information about the automation assets reduces the complexity that is presented to the user. These viewpoints enable operational activities to access, manage, update the information in the DF repository. A given operational activity typically does not use all of the automation asset information in the DF repository. Selection of the appropriate properties is the responsibility of the particular lifecycle activity.

NOTE Viewpoints contain subset of the automation asset model to concentrate on relevant concerns to a particular aspect of interoperability (ISO 15704, B.3.1.5.2). Viewpoints can be expressed by different techniques, such as “filtering” of the information in the DF repository, or by using “profiling” concepts (ISO 15745-1). Filtering is more concrete and implementation oriented, while profiling is conceptual and standards-based.

Figure 15 shows how data from the DF repository can be filtered for different lifecycle activities like the engineering activity or the maintenance activity.



IEC 2041/12

Figure 15 – Filtering of data for lifecycle activities

6.3 Activities for lifecycle workflow

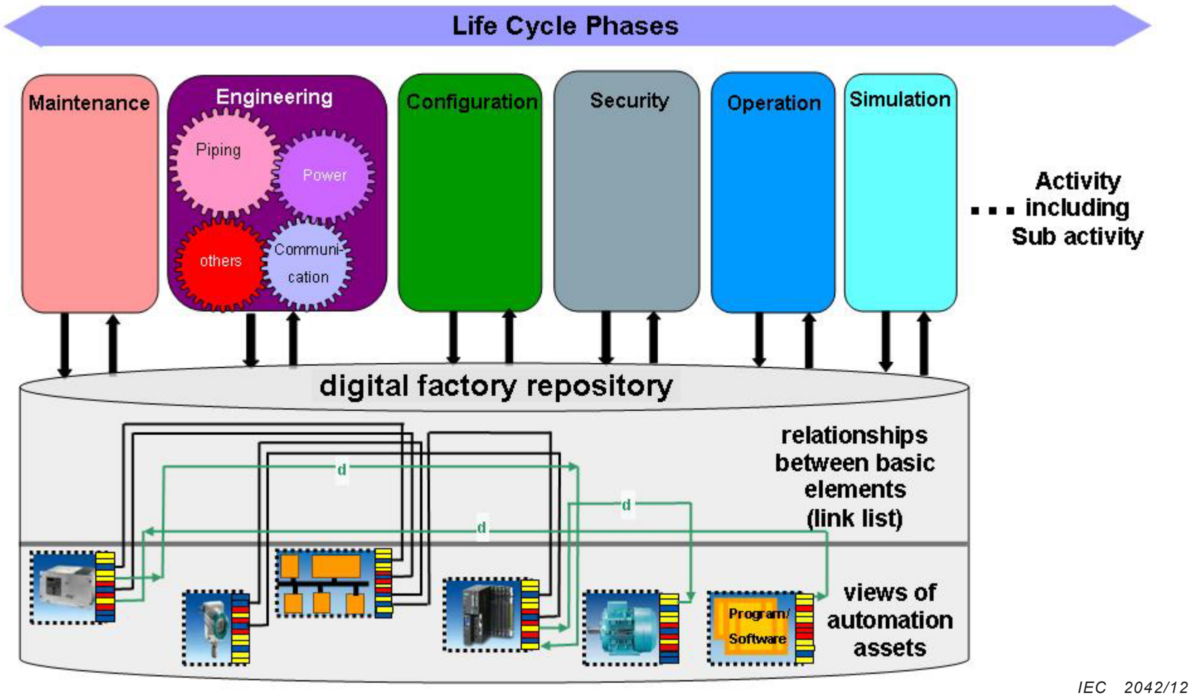
6.3.1 General concepts for automation activities

Driving the activities through the DF repository method allows for any activity to run at any time of the plant lifecycle, and not necessary in a predefined sequence.

Potential conflicts with simultaneous data usage should be prevented. In some cases, it may be necessary for an activity to wait for a complete and consistent data set to become available before the work can proceed.

A specific activity may be split into several tasks. In this case there is a direct dependency between the tasks.

These concepts are shown in Figure 16.



NOTE 1 In a late activity of the lifecycle the "maintenance activity" replaces an automation device which is no longer available on the market. The DF repository allows to go back for this specific device to the stored "requirement activity" and a partial "engineering activity" is started again up to the "operation activity" to bring the plant into operation. The actual DF repository will be updated with these changes.

NOTE 2 In the "engineering activity", four tasks work together to produce a consistent data set for use by other activities.

Figure 16 – Lifecycle workflow

6.3.2 Example of lifecycle activities – simulation activity

A simulation activity example is shown in Figure 17. In this case the application process defines the production requirements that need to be checked against the capabilities of the automation assets that are needed to execute the production process.

This example only addresses the automation parts of the plant described in the DF repository.

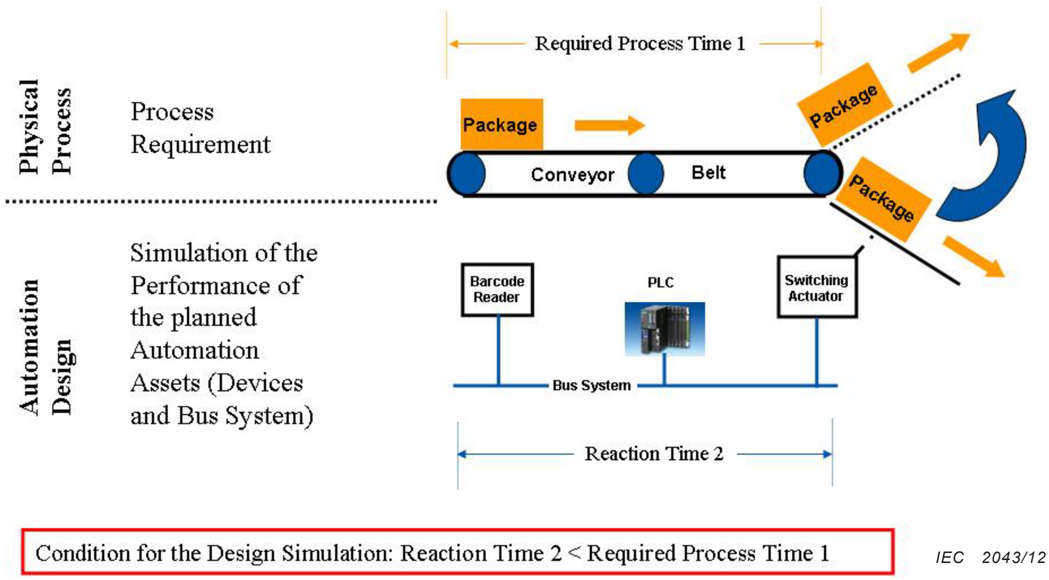
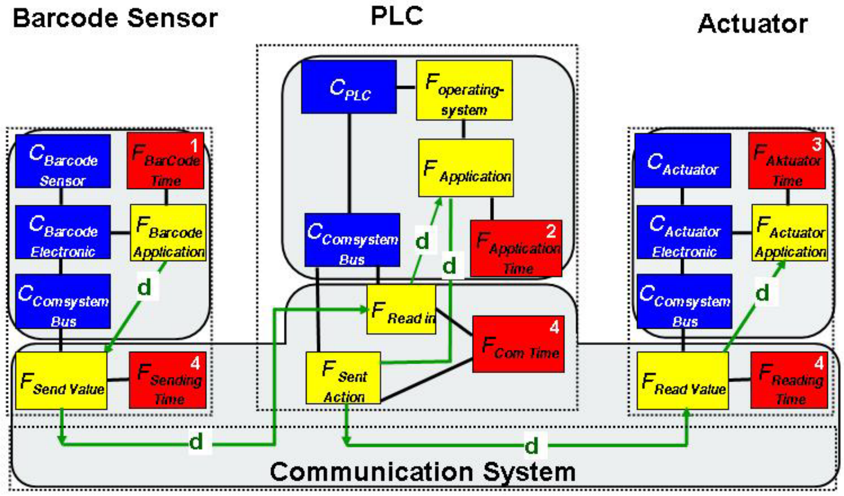


Figure 17 – Production process vs. application performance requirements

The most important basic element here is the performance property, which should be available from the device manufacturer. Some of this performance information is static like the reaction time of a barcode reader. Other performance information requires a simulation calculation or depends on other factors.

EXAMPLE The transmission time of a message from a barcode reader to a PLC depends at least on the baud rate of the communication system chosen, but also on the bus access method.

See Figure 18 for a complete decomposition of the planned devices (structural and operational) and their performance properties (whether available or to be calculated).



1,3 : values known by Device Producer
2 : values from Simulation of Application Software on PLC Hardware
4 : values from Simulation of Communication System Software and Hardware
Reaction Time 2: 1+2+3+n(4)

IEC 2044/12

Figure 18 – Performance simulation of a digital factory

Annex A
(informative)

Relationships between terms

The relationships between the terms defined in 3.1 are shown in Figure A.1 and Figure A.2.

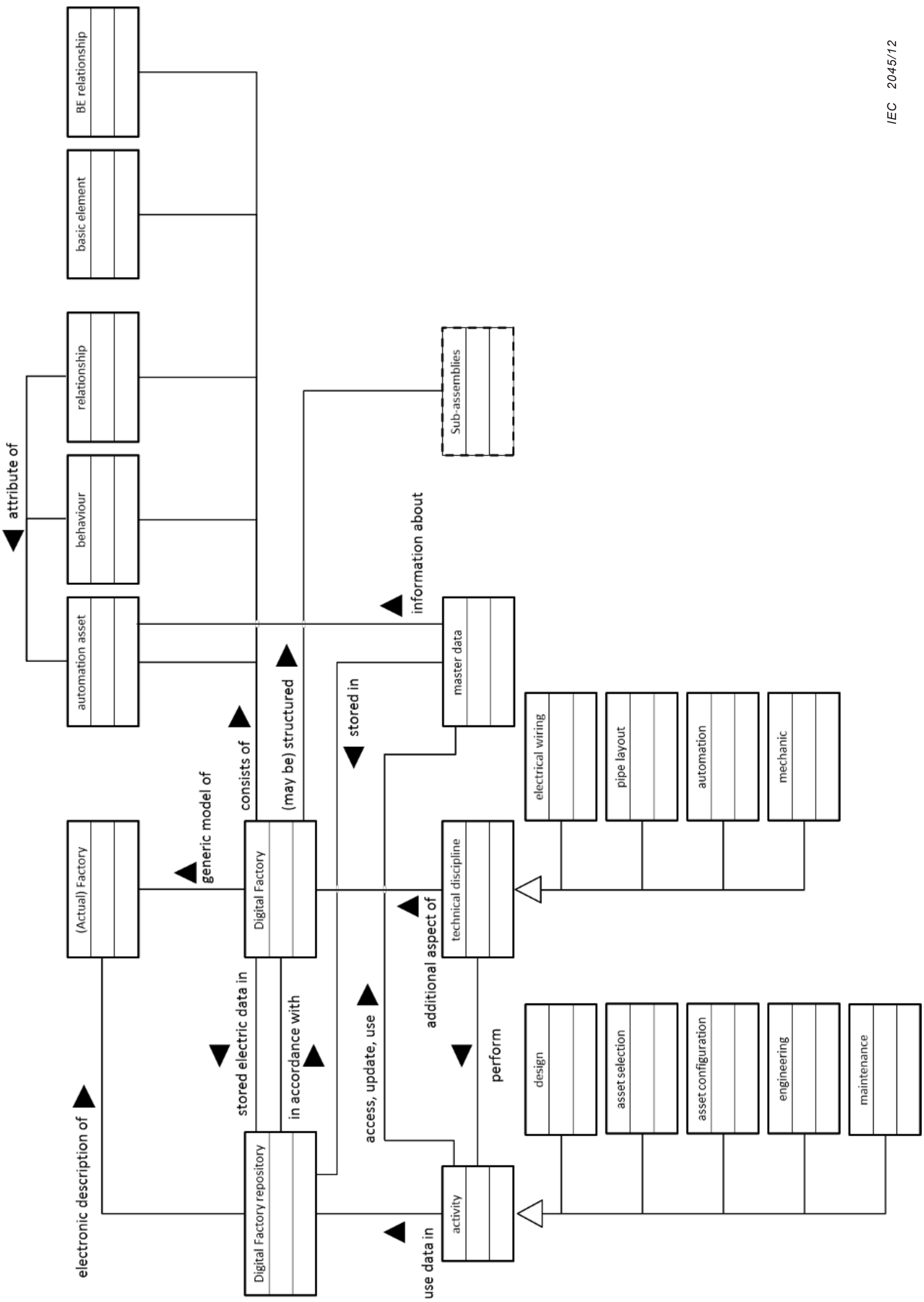


Figure A.1 – Relationships between terms (1)

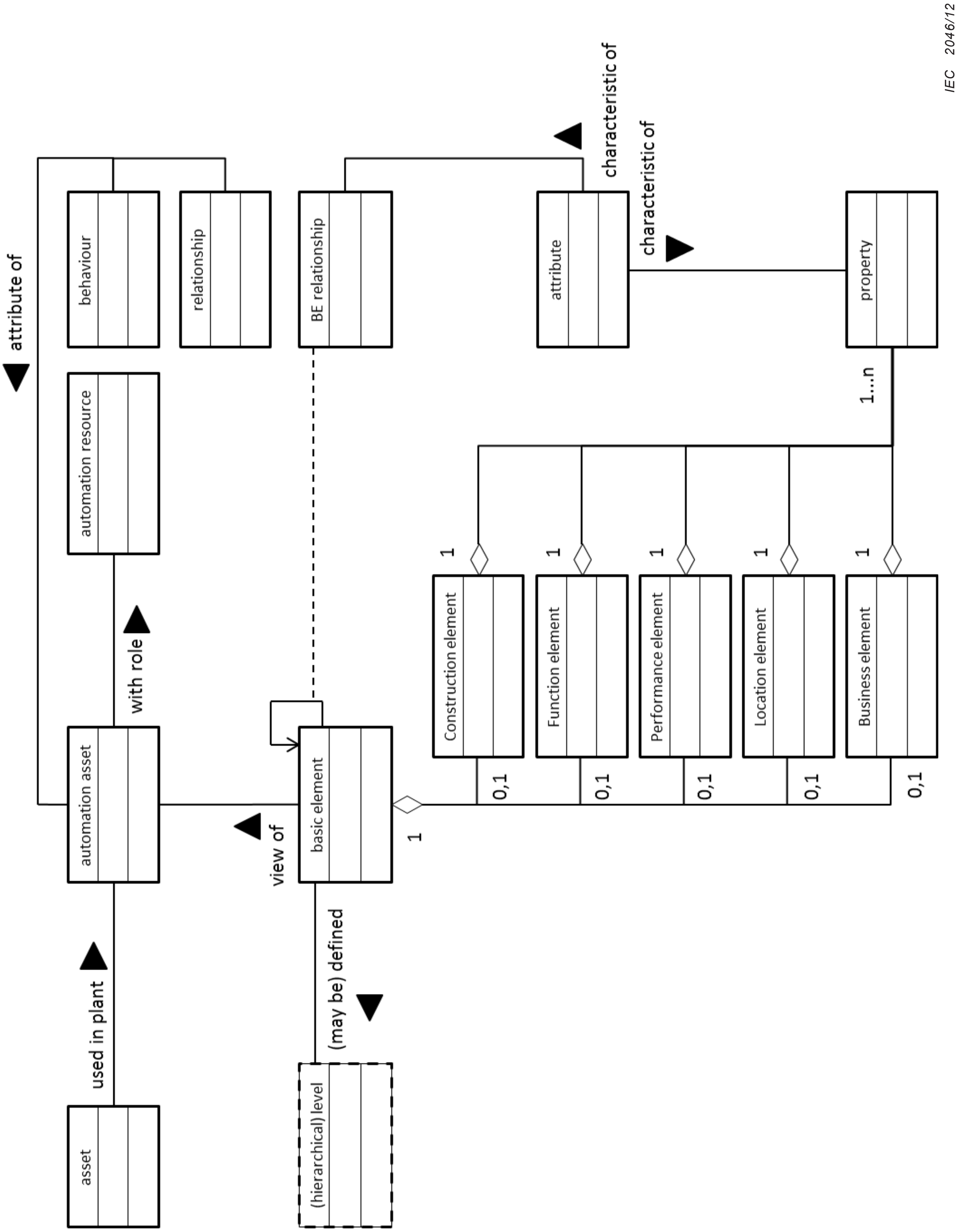


Figure A.2 – Relationships between terms (2)

Annex B
(informative)

Reference to property database standards

Some properties for electrical automation assets are available in the IEC 61360 database (IEC Component Data Dictionary)[2]. These properties are based on the data model of IEC 61360-1 and IEC 61360-2, which is identical to the data model of ISO 13584-42.

Various IEC Technical Committees (TCs) and Subcommittees (SCs) are currently working on the definition of properties for electrical automation assets. IEC SC 65E (Devices and integration in enterprise systems) has developed general description concepts, as well as properties for some sensors. IEC SC 65B (Measurement and control devices) is developing properties for other sensors and actuators. IEC SC 17B (Low-voltage switchgear and controlgear) is developing properties for contactors, starters, control switches, circuit-breakers, switches, disconnectors and terminal blocks.

NOTE The corresponding standards are the IEC 61987 series and IEC 62683.

Figure B.1 and Figure B.2 provide an overview of the corresponding standards projects.

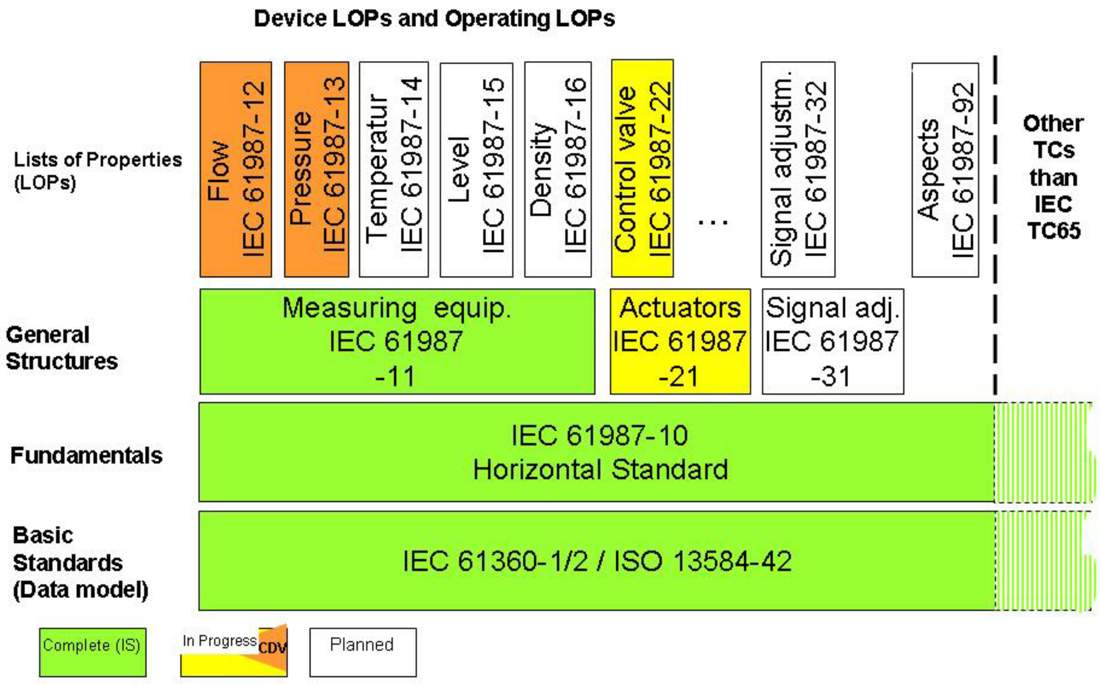


Figure B.1 – Overview of the IEC 61987 series

2 The IEC Component Data Dictionary can be accessed on the IEC web site, in the area for “standards in database formats”, available at: <http://std.iec.ch/iec61360>.

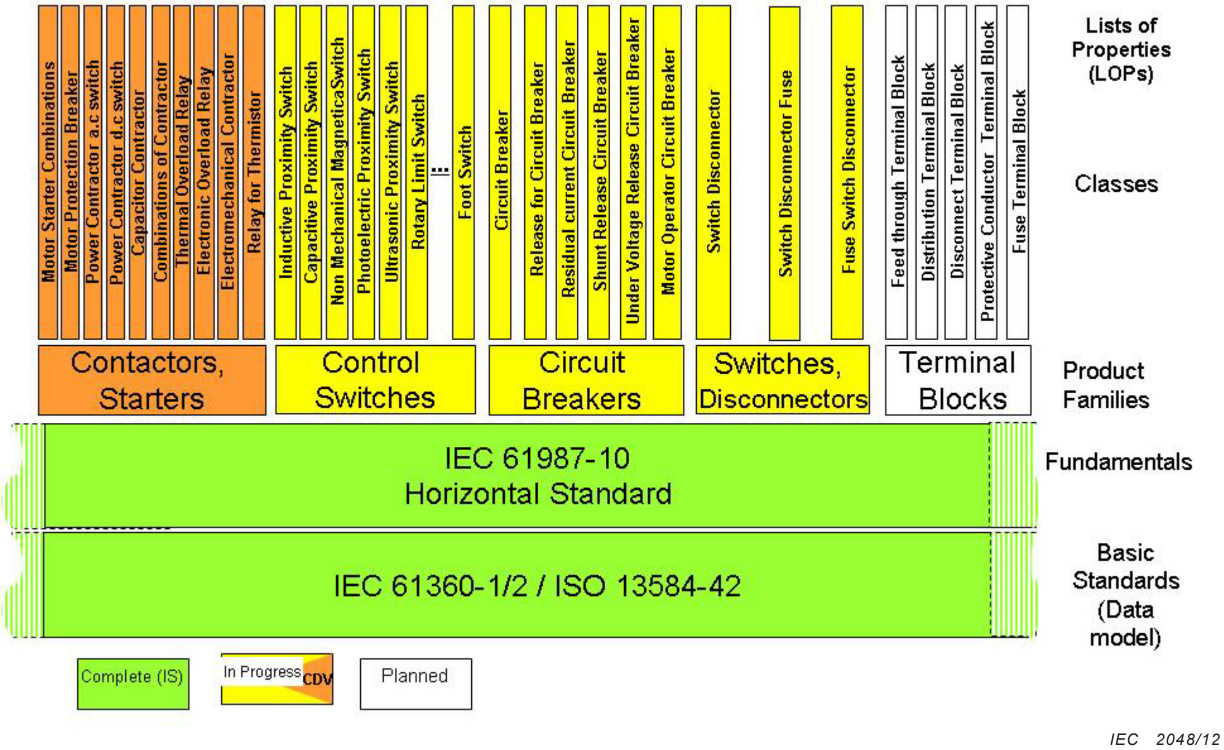


Figure B.2 – Overview of the IEC 62683 standard

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3 In preparation.

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[4] In preparation.

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