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TECHNICAL REPORT

colour inside

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

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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- withdrawn,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.

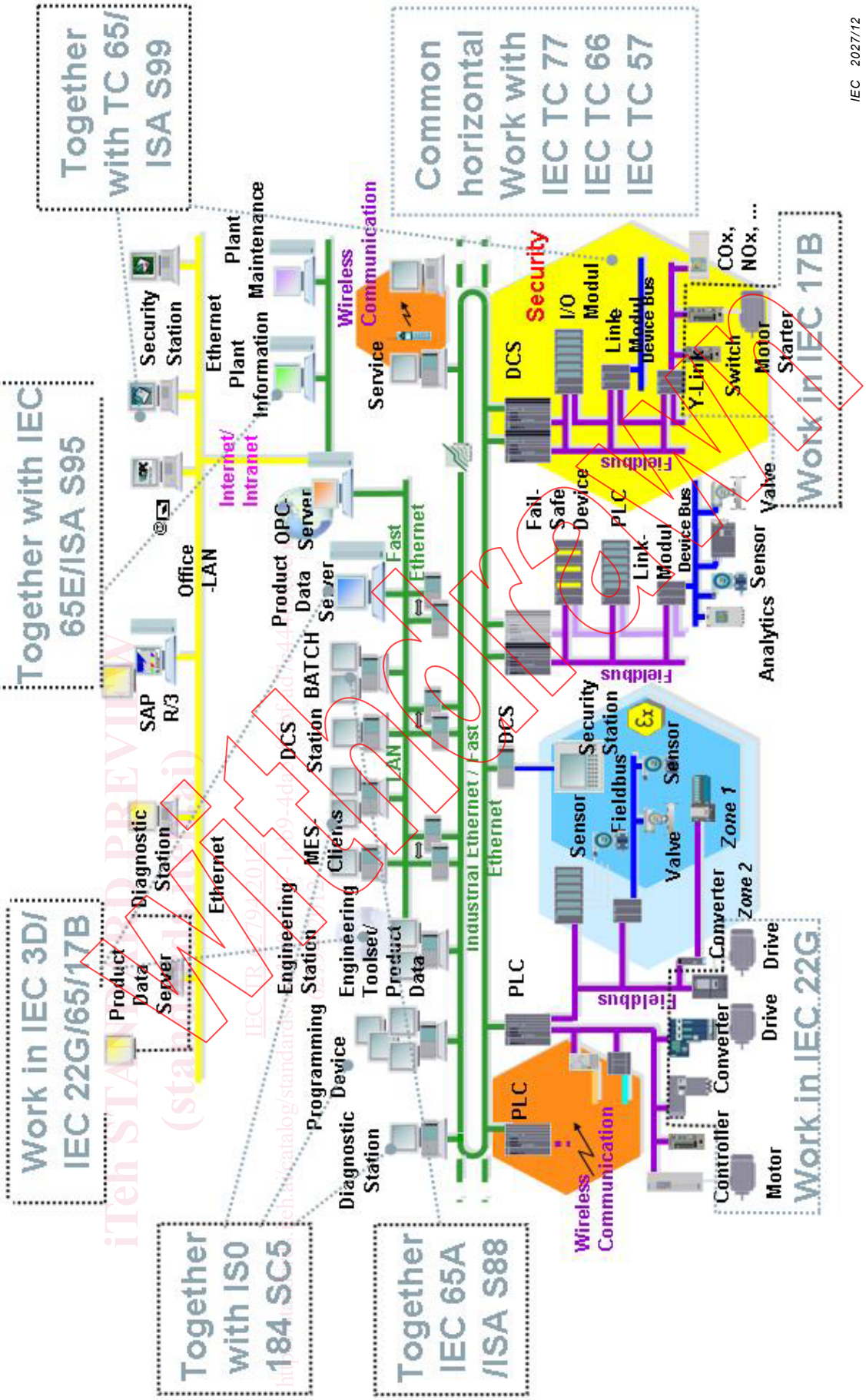

Figure 1 – The digital factory and related standard activities

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.

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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