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ReCaM

Rapid reconfiguration of flexible Production Systems

ReCaM — Rapid Reconfiguration of Flexible Production Systems through Capability-based Adaptation, Autoconfiguration and Integrated tools for Production Planning

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Authors:	Gernot Kollegger, Sejla Selimovic, Sven Dose, Sebastian Schröck
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List of Abbreviations

HMI: Human Machine Interface

HW: Hardware

SW: Software

WP: Work Package

Executive summary

Deliverable 7.2a is part of the standardisation task 7.3, which coordinates the standardisation activities and shares information about applicable standards between WPs. The first step is to collect all possible standards that might be able to be applied within the different demonstrators of ReCaM in order to fulfil the requirements given in Deliverable D1.2.

This deliverable report summarises the first investigation of state of the art industrial standards and protocols that can be utilised to define the Plug-and-Produce concepts of ReCaM.

Functional areas with missing standardisation will be identified as well as standards which need to be adapted / enhanced. The specifications made during the project aiming standardisation are started to be collected and organised.

1 Introduction

The purpose of this document is to give a first overview on standards that can be used in different functional areas of the ReCaM concept, including specifications in the fields of interfaces, concepts and methods relating to both HW and SW in terms of control, communication, safety and HMI.

The consortium has identified relevant standards in the different functional areas of the ReCaM model. These standards have been collected in one table which contains all the important information about these standards. Also, in this table all standards have been sorted in the subsequent categories:

- Communication
- Control
- Electrical
- Mechanical
- Methods
- Terms and Definitions

In this report the above mentioned categories will be used to classify and give a better overview of the collected standards. Applicable standards can be listed in multiple categories.

1.1 Document Maintenance

This document will be updated as needed. If the document is written in a format that got outdated (i.e. technically incompatible) during the reporting period, the document will be revised into the latest template format at the next review.

This document contains a revision history log. When changes occur, the document's revision history log will reflect an updated version number, the date of the new version, the owner making the change, and a detailed description of the changes.

1.2 Selection of applicable standards

To select and find applicable standards, technical specifications and good practices we followed the process of:

- Starting on an existing, reusable excel list of standards from TUT
- Share the excel list with the partners for
 - Review the list, mark standards that are applicable per partner
 - Add standards, technical specifications or good practices if applicable but not in the list
- If possible at this preliminary stage, rate a standard for applicability per partner from 0 (not useable) to 10 (must be used)
 - The rating of standards is reflected by coloured rows in the excel file
 - Light Green if a rating exists (0 ... 10)
 - Green if the rating is ≥ 8
 - Yellow if no rating exists, but has an Interest Priority of "1"
- Rows marked (independent of any rating) as applicable by the partners are added to this deliverable

The selection is done, based on the knowledge at this time of the project and can change during the project work.

2 Preliminary list of applicable standards

The following chapter contains the preliminary list of standards that might be applicable within the different demonstrators of ReCaM. The subsequent categories are not disjoint as specific standards might cover more than just one of these aspects.

The list of standards, technical specifications and good practices included in the xls-file reflects the large field the standardization covers. Based on the know-how of the partners and the defined scope of ReCaM, only a part of the listed information is detailed within this deliverable.

The base of the xls-file has been provided by Tampere University and contributions were added by the partners (Bosch, DGH, Tecnalía, NXT and Polimi). In the mentioned file a column exists that indicates the contributions, as well as those standards shared by the different partners. Within the xls-file, for example the abbreviation “WP7-3” means Task 3 within workpackage 7. This is used to define the tasks in which the standards are expected to be used.

2.1 Communication

The category “Communication” is used to group standards that cover e.g. the software platform, data modelling, the communication between the different modules and the self-description or different layers of the system.

Table 1: Communication standards

Code of standard	Name of standard
FDT-JIG-IF Spec	FDT (Field Device Tool) Interface Specification
IEC 61512-1	Batch Control Part 1: Models and Terminology
IEC 62264-1, 2, 3	Enterprise-Control System Integration <ul style="list-style-type: none"> - Part 1: Models and Terminology - Part 2: Object Model Attributes - Part 3: Activity models of manufacturing operations management
IEC 62407	Real-time Ethernet control automation technology (EtherCAT™)
IEEE 802.11 a/b/g	WLAN
IEEE 802.15.1	Bluetooth 1.2/2.0
IPC-2501	Definition for Web-Based Exchange of XML Data
IPC-2541	Generic Requirements for Electronics Manufacturing Shop-Floor Equipment Communication Messages (CAMX)
ISO 14443-{1-4}:2008 /IEC	Identification cards <ul style="list-style-type: none"> - Contactless integrated circuit(s) cards - Proximity cards - Part 1: Physical characteristics - Part 2: Radio frequency power and signal interface - Part 3: Initialization and anti-collision

Code of standard	Name of standard
	- Part 4: Transmission protocol
ISO 15693-{1-3}:2000 /IEC	Identification cards <ul style="list-style-type: none"> - Contactless integrated circuit(s) cards - Vicinity cards
ISO 16100-1:2002	Industrial automation systems and integration <ul style="list-style-type: none"> - Manufacturing software capability profiling for interoperability - Part 1: Framework
ISO 16100-2:2003	Industrial automation systems and integration <ul style="list-style-type: none"> - Manufacturing software capability profiling for interoperability - Part 2: Profiling methodology
ISO 18629-{1, 11-14, 41-44}:2004-2006	Industrial automation systems and integration <ul style="list-style-type: none"> - Process specification language - Part 1: Overview and basic principles - Part 11: PSL core
ISO/IEC 20922:2016	Message Queuing Telemetry Transport (MQTT)
ISO/PAS 17506:2012	COLLADA (COLLABorative Design Activity)- 3D Asset Exchange Schema
JSON	JavaScript Object Notation (JSON)
UPnP: Basic Device Definition	Universal Plug and Play (UPnP™) Forum, Basic Device Definition
XML	Extensible Markup Language (XML)
XMPP	XMPP Extensible Messaging and Presence Protocol
OMQ	Zero-M-Queue
AllJoyn	AllSeen Alliance
RDF	Resource Description Framework
OWL	Ontology Web Language
SPARQL	SPARQL Query Language for RDF
SWRL	Semantic Web Rule Language
WAMP	Web Application Messaging Protocol
WebSocket	WebSocket
IEEE 802.3	Ethernet
TCP/IP	Transmission Control Protocol / Internet Protocol (TCP/IP)
Fieldbus Systems	Profibus, Profinet, Sercos, EtherCat in general usage

Code of standard	Name of standard
IEC 62541	OPC Unified Architecture (and companions)

2.2 Control

The category “Control” contains standards that are directly or indirectly related to shop floor automation. This contains automation control, visualization (HMI/SCADA), sensor data acquisition and actor control.

Table 2: Control standards

Code of standard	Name of standard
EUPASS-0006	EUPASS Blue Print Specification
FDT-JIG-IF Spec	FDT (Field Device Tool) Interface Specification
IEC 60204-1	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
IEC 61131-3:2003	Programmable controllers - Part 3: Programming languages
IEC 61499-1:2000	Function blocks for industrial-process measurement and control system - Part 1: Architecture
IEC 61512-1	Batch Control - Part 1: Models and Terminology
IEC 62264-1, 2, 3	Enterprise-Control System Integration - Part 1: Models and Terminology - Part 2: Object Model Attributes - Part 3 Activity models of manufacturing operations management
IEC 62407	Real-time Ethernet control automation technology (EtherCAT)
IPC-2501	Definition for Web-Based Exchange of XML Data
IPC-2541	Generic Requirements for Electronics Manufacturing Shop-Floor Equipment Communication Messages (CAMX)
Fieldbus Systems	Profibus, Profinet, Sercos, EtherCat in general usage

2.3 Electrical

The category “Electrical” groups standards that are relevant for electrical parts within the ReCaM use cases.

Table 3: Electrical standards

Code of standard	Name of standard
IEC 60204-1	Safety of machinery <ul style="list-style-type: none"> - Electrical equipment of machines - Part 1: General requirements
IEC 60917-{1,2,2-1,2-2,2-3}	Modular order for the development of mechanical structures for electronic equipment practices <ul style="list-style-type: none"> - Part 1: Generic standard
ISO 14443-{1-4}:2008 /IEC	Identification cards <ul style="list-style-type: none"> - Contactless integrated circuit(s) cards - Proximity cards - Part 1: Physical characteristics - Part 2: Radio frequency power and signal interface - Part 3: Initialization and anti-collision - Part 4: Transmission protocol
ISO 15693-{1-3}:2000 /IEC	Identification cards <ul style="list-style-type: none"> - Contactless integrated circuit(s) cards - Vicinity cards
IEEE 802.3af	Power over Ethernet

2.4 Mechanical

The category “Mechanical” is used to group standards that cover all mechanical issues regarding both the modules as well as the federation built of different modules. These standards can describe the positioning of the modules or their mechanical connection.

Table 4: Mechanical standards

Code of standard	Name of standard
EN 60917-2	Modular order for the development of mechanical structures for electronic equipment practices <ul style="list-style-type: none"> - Part 2: Sectional specification - Interface co-ordination dimensions for the 25 mm equipment practice.
EUPASS-0001, 0002, 0003	0001 EUPASS Carrier 0002 EUPASS Bay Interface 0003 EUPASS Workstation framework
IEC 60917-{1,2,2-1,2-2,2-3}	Modular order for the development of mechanical structures for electronic equipment practices - Part 1: Generic standard

2.5 Methods

The category “Methods” is used to group all methods that might be applied in the project.

Table 5: Methods

Code of standard	Name of standard
DIN 8593-{0-8}	<p>Manufacturing processes joining</p> <ul style="list-style-type: none"> - Part 0: General; Classification subdivision, terms and definitions - Part 1: Assembling; Classification subdivision, terms and definitions - Part 2: Filling; Classification subdivision, terms and definitions - Part 3: Joining by mechanical means; Classification subdivision, terms and definitions - Part 4: Joining by processing of amorphous materials; Classification subdivision, terms and definitions - Part 5: Joining by forming processes; Classification subdivision, terms and definitions - Part 6: Joining by welding; Classification subdivision, terms and definitions - Part 7: Joining by soldering or brazing; Classification subdivision, terms and definitions - Part 8: Joining by means of adhesives; Classification subdivision, terms and definitions
EUPASS-{0004, 0005, 0006, 0007, 0008}	<p>0004 EUPASS Emplacement Guideline 0005 EUPASS Emplacement Template 0006 EUPASS Blue Print Specification 0007 Assembly Process Terminology and Ontology Specification 0008 Equipment Terminology and Ontology</p>
IEC 61131-3:2003	<p>Programmable controllers</p> <ul style="list-style-type: none"> - Part 3: Programming languages
IEC 61499-1:2000	<p>Function blocks for industrial-process measurement and control systems</p> <ul style="list-style-type: none"> - Part 1: Architecture
IEC 61512-1	<p>Batch Control</p> <ul style="list-style-type: none"> - Part 1: Models and Terminology
IEC 62264-1	<p>Enterprise-Control System Integration</p> <ul style="list-style-type: none"> - Part 1: Models and Terminology - Part 2: Object Model Attributes - Part 3 Activity models of manufacturing operations management

Code of standard	Name of standard
ISO 10303	Industrial automation systems and integration - Product data representation and exchange (STEP)
ISO 13584-1:2001	Industrial automation systems and integration - Parts library - Part 1: Overview and fundamental principles
ISO 18629-{1, 11-14, 41-44}:2004-2006	Industrial automation systems and integration - Process specification language - Part 1: Overview and basic principles - Part 11: PSL core
ISO/PAS 17506:2012	COLLADA (COLLABorative Design Activity) - 3D Asset Exchange Schema
VDI 2860	Assembly and handling; handling functions, handling units; terminology, definitions and symbols
XML	Extensible Markup Language (XML)
WAMP	Web Application Messaging Protocol
WebSocket	WebSocket
IEC 62714	Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language
Vorto	Vorto DSL
DIN SPEC 91345	RAMI 4.0 (Reference architecture model Industry 4.0) & Industry 4.0 Component
ISO/IEC 15418	Information technology - Automatic identification and data capture techniques
OSGi Release 6	OSGi Service Platform
VDI 3682	Formalised Process Description

2.6 Terms & Definitions

This category contains different terms and definitions that are applicable to the ReCaM approach.

Table 6: Terms and definitions

Code of standard	Name of standard
DIN 8593-{0-8}	Manufacturing processes joining <ul style="list-style-type: none"> - Part 0: General; Classification subdivision, terms and definitions - Part 1: Assembling; Classification subdivision, terms and definitions - Part 2: Filling; Classification subdivision, terms and definitions - Part 3: Joining by mechanical means; Classification subdivision, terms and definitions - Part 4: Joining by processing of amorphous materials; Classification subdivision, terms and definitions - Part 5: Joining by forming processes; Classification subdivision, terms and definitions - Part 6: Joining by welding; Classification subdivision, terms and definitions - Part 7: Joining by soldering or brazing; Classification subdivision, terms and definitions - Part 8: Joining by means of adhesives; Classification subdivision, terms and definitions
EUPASS-{0007, 0008}	0007 Assembly Process Terminology and Ontology Specification 0008 Equipment Terminology and Ontology
IEC 61499-1:2000	Function blocks for industrial-process measurement and control systems <ul style="list-style-type: none"> - Part 1: Architecture
IEC 61512-1	Batch Control <ul style="list-style-type: none"> - Part 1: Models and Terminology
IEC 62264-1	Enterprise-Control System Integration <ul style="list-style-type: none"> - Part 1: Models and Terminology - Part 2: Object Model Attributes - Part 3 Activity models of manufacturing operations management
IPC-2541	Generic Requirements for Electronics Manufacturing Shop-Floor Equipment Communication Messages (CAMX)
ISO 10303	Industrial automation systems and integration <ul style="list-style-type: none"> - Product data representation and exchange (STEP)

Code of standard	Name of standard
ISO 18629-{1, 11-14, 41-44}:2004-2006	Industrial automation systems and integration <ul style="list-style-type: none"> - Process specification language - Part 1: Overview and basic principles - Part 11: PSL core
VDI 2860	Assembly and handling; handling functions, handling units; terminology, definitions and symbols
XML	Extensible Markup Language (XML)
ISO/TS15066	ISO/TS15066 Robots and robotic devices <ul style="list-style-type: none"> - Collaborative robots
WAMP	Web Application Messaging Protocol
WebSocket	WebSocket
RFC 7159 / ECMA-404	JSON - JavaScript Object Notation
ISO/IEC 15445, W3C HTML 5, 4.01, 3.2	HTML – Hypertext markup language
IEC 62714	Engineering data exchange format for use in industrial automation systems engineering - Automation Markup Language
XML v1.1	Extensible Markup Language (XML)
Vorto	Vorto DSL
OpenAAS	Open Asset Administration Shell (OpenAAS)
DIN SPEC 91345	RAMI 4.0 (Reference architecture model Industry 4.0) & Industry 4.0 Component
FDI	Field Device Integration (FDI)
ISO/IEC 15418	Information technology <ul style="list-style-type: none"> - Automatic identification and data capture techniques
NE148	Automation Requirements relating to Modularisation of Process Plants
VDI 3682	Formalised Process Description

3 Conclusions and Consequences

In the first phase of the project applicable standards and definitions were identified and collected in an Excel table. The table is used by the partners as a working base to unify the applied standards, terms and definitions within the project.

As a first step, the partners identified most reasonable standards and definitions. These were categorized to have an overview about the huge number of standards. The results are summarized in this deliverable. Details about the standards, availability, their usage and rating for applicability within the consortium has been done and will be continued in the Excel document listed as Attachment 1. The ongoing results will be documented in the deliverable D7.4, which will be elaborated based on this document.

It is an ongoing work to evaluate, analyse and select standards that will be used by the partners within the project. This document will be updated or extended if additional or new results become available.

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Attachments

Attachment 1: ReCaM_WP7-3_Std_table_v3.xlsx

ReCAM Applicable standard information form including evaluation information ReCAM CONSORTIUM CONFIDENTIAL

Main table with columns: #, Year, Ref, Title, Category of Ref, Summary, Price, Legend, Comments, etc. It lists various standards and their evaluations.

ReCaM Applicable standard information form including evaluation information ReCaM CONSORTIUM CONFIDENTIAL

Main table with columns for Year, WPT, Code of standard, Title, Normative references, Abstract, Price, and various WPT 1-33 evaluation metrics. Includes rows for standards like EN 953 1997, EN 954-1, EN 952 1996, EN 953 1998, EN 959 1998, EN 60204-1, EN 60204-2, EN 60204-3, EN 60204-4, EN 60204-5, EN 60204-6, EN 60204-7, EN 60204-8, EN 60204-9, EN 60204-10, EN 60204-11, EN 60204-12, EN 60204-13, EN 60204-14, EN 60204-15, EN 60204-16, EN 60204-17, EN 60204-18, EN 60204-19, EN 60204-20, EN 60204-21, EN 60204-22, EN 60204-23, EN 60204-24, EN 60204-25, EN 60204-26, EN 60204-27, EN 60204-28, EN 60204-29, EN 60204-30, EN 60204-31, EN 60204-32, EN 60204-33, EN 60204-34, EN 60204-35, EN 60204-36, EN 60204-37, EN 60204-38, EN 60204-39, EN 60204-40, EN 60204-41, EN 60204-42, EN 60204-43, EN 60204-44, EN 60204-45, EN 60204-46, EN 60204-47, EN 60204-48, EN 60204-49, EN 60204-50, EN 60204-51, EN 60204-52, EN 60204-53, EN 60204-54, EN 60204-55, EN 60204-56, EN 60204-57, EN 60204-58, EN 60204-59, EN 60204-60, EN 60204-61, EN 60204-62, EN 60204-63, EN 60204-64, EN 60204-65, EN 60204-66, EN 60204-67, EN 60204-68, EN 60204-69, EN 60204-70, EN 60204-71, EN 60204-72, EN 60204-73, EN 60204-74, EN 60204-75, EN 60204-76, EN 60204-77, EN 60204-78, EN 60204-79, EN 60204-80, EN 60204-81, EN 60204-82, EN 60204-83, EN 60204-84, EN 60204-85, EN 60204-86, EN 60204-87, EN 60204-88, EN 60204-89, EN 60204-90, EN 60204-91, EN 60204-92, EN 60204-93, EN 60204-94, EN 60204-95, EN 60204-96, EN 60204-97, EN 60204-98, EN 60204-99, EN 60204-100.

ReCAM Applicable standard information form including evaluation information ReCAM CONSORTIUM CONFIDENTIAL

Table with columns: Year, WP, Code of std, Ed, Org, Name of standard, Normative references, Additional information URL, Date of publication, Committee, Abstract, Price, Japan, Long, Computer, White, Gantt, DTD, IFA, PLS, TS, IS, Control, Electric, Mechanical, Methods, Terms, WP 1-33, High, Mid, Low, no interest, not evaluated, total, Evaluation, comments, Evaluation, date, who, comments, Attachments, link, Classification, Source, Notice.