

DIN SPEC 92222:2021-12 (E)

Reference architecture for Industrial Cloud Federation; Text in English

Contents		Page
Foreword		5
Introduction.....		7
1 Scope.....		8
2 Normative references		8
3 Terms and definitions.....		9
4 Abbreviated terms		11
5 Conceptual structure of the document.....		11
5.1 General.....		11
5.2 Elements and relations.....		12
5.2.1 Conceptual model for Industrial Cloud Federation.....		12
5.2.2 Reference Architecture Model for Industrial Cloud Federation		12
5.2.3 Reference Architecture for Industrial Cloud Federation		12
6 Conceptual Model for Industrial Cloud Federation.....		13
6.1 General.....		13
6.2 Elements and relations.....		13
6.2.1 General.....		13
6.3 Requirements		14
6.3.1 General.....		14
6.3.2 Interoperability		14
6.3.3 Scalability and flexibility		14
6.3.4 Shareability		14
6.3.5 Connectivity		14
6.3.6 Resilience.....		14
6.3.7 Configurability		14
6.3.8 Security and integrity.....		15
7 Reference Architecture Model for Industrial Cloud Federation		15
7.1 General.....		15
7.2 RAMI 4.0 derivation		15
7.3 Hierarchy Level perspective		16
7.4 Life cycle and value stream perspective		17
7.5 Layer perspective.....		17
7.6 Usage perspective		17
8 Reference Architecture for Industrial Cloud Federation		19
8.1 General.....		19
8.2 Architectural requirements.....		19
8.2.1 Interoperability related requirements		19
8.2.2 Connectivity related requirements		20
8.2.3 Configuration related requirements.....		20
8.2.4 Security and integrity.....		21
8.3 Communication patterns		21
8.3.1 General.....		21
8.3.2 Communication patterns		22
8.3.3 Application of communication patterns in ICF		23
8.4 Architectural patterns of ICF		24

8.4.1	General	24
8.4.2	Edge-to-one-to-many clouds communication	24
8.4.3	Edge-to-many_clouds communication brokering.....	25
8.4.4	Combining architectural patterns	26
9	Outlook.....	29
Annex A (informative) Icon set.....		31
Annex B (informative) Use cases		33
B.1	Data as a service — order data access [Expleo].....	33
B.1.1	Activity “Order data access at machine-building company”	33
B.2	Reconfiguration of production processes in a micro-flow cell [Fraunhofer IPA].....	35
B.2.1	Activity “operating the cell to plan and execute production orders”	35
B.3	Monitoring of humidity in a production hall (Fraunhofer IPA)	36
B.3.1	Activity “setup and operate monitoring”	36
B.4	Robot systems in a pay per use / predictive maintenance scenario [Fujitsu]	38
B.4.1	Activity „installation and setup of robots“	38
B.5	Seamless approach for condition monitoring systems [SCHAEFFLER].....	39
B.5.1	Activity „installation and setup of condition monitoring system“	39
B.6	Robotic edge/cloud-2-cloud [SCHAEFFLER]	41
B.6.1	Activity “installation and setup of AGV”	41
B.7	Verification as a service [TÜV SÜD].....	42
B.7.1	Activity „verify safety certificates“	42
B.8	Condition monitoring for smart products [Wittenstein].....	44
B.8.1	Threshold monitoring and alerting.....	44
B.8.2	Update condition monitoring threshold values	45
B.9	Monitoring of component quality (Fraunhofer IGCV)	47
B.9.1	Activity „monitoring during production“	47
Bibliography		49

Figures

Figure 1	— Overview of stakeholders and major building blocks of this document	8
Figure 2	— Overall conceptual structure for Industrial Cloud Federation	12
Figure 3	— Elements of Conceptual Model for Industrial Cloud Federation	13
Figure 4	— Derivation of RAM4ICF from RAMI 4.0	16
Figure 5	— RAMI 4.0 life cycle & value stream axis	17
Figure 6	— System under consideration “Industrial Cloud Federation” and its stakeholders.....	18
Figure 7	— Industrial Cloud Federation implementation with multicast communication pattern.....	23
Figure 8	— Industrial Cloud Federation implementation with unicast and request response communication pattern.....	24
Figure 9	— Edge-to-one-to-many_clouds communication.....	25
Figure 10	— Edge-to-many clouds exemplified by two edge computing entities and two supplier’s service platforms.....	26
Figure 11	— Example for a combination of the edge-to-one-to-many clouds und edge-to-one cloud	27

Figure 12 — Transparent communication through ICF.....	28
Figure 13 — Standardization of end-to-end communication in ICF	29
Figure B.1 — Usage viewpoint of the use case “data as a service”	34
Figure B.2 — Usage Viewpoint of the use case “reconfiguration of production processes in a micro-flow cell”	36
Figure B.3 — Usage Viewpoint of the use case “Monitoring of humidity in a production hall”	38
Figure B.4 — Usage Viewpoint of the use case “seamless approach for condition monitoring systems”	40
Figure B.5 — Usage Viewpoint of the use case “robotic edge/cloud-2-cloud”	42
Figure B.6 — Usage Viewpoint of the use case "verification as a service" (direct connection variant)	43
Figure B.7 — Usage Viewpoint of the use case “condition monitoring for smart products — threshold monitoring and alerting”	45
Figure B.8 — Usage Viewpoint of the use case “condition monitoring for smart products — update condition monitoring threshold values”	46
Figure B.9 — Usage Viewpoint of the use case “monitoring of component quality”	48

Tables

Table 1 — Main roles involved in using an ICF in production state.....	19
Table 2 — Overview of basic communication patterns in ICF	22
Table A.1 — Overview and description of the used icon set	31