

ISO/IEC TR 30166:2020-04 (E)

Internet of things (IoT) - Industrial IoT

Contents	Page
FOREWORD.....	6
INTRODUCTION.....	7
1 Scope.....	10
2 Normative references	10
3 Terms and definitions	10
4 Abbreviated terms	10
5 IloT systems and landscape, see [1].....	12
5.1 Overview.....	12
5.1.1 General	12
5.1.2 Architecture	15
5.1.3 Implementation of IloT systems	15
5.1.4 IloT use case implementations	16
5.1.5 Edge (fog) computing in IloT, see [2]	16
5.1.6 Interoperability and conformance	16
5.1.7 IloT characteristics trustworthiness.....	17
5.1.8 Wearables in IloT	18
5.1.9 Cross-cutting activities on IloT.....	18
5.2 Analysis consideration on IloT landscape of systems	19
5.2.1 General	19
5.2.2 IloT systems and architecture	19
5.2.3 IloT application (virtual/physical use case)	22
5.2.4 IloT connectivity	23
5.2.5 IloT interoperability focus	23
5.2.6 The IloT user, see [20]	23
5.2.7 IloT migration strategies, see [29].....	24
5.3 General definition of IloT and smart manufacturing (SM).....	25
5.3.1 Definition of IloT	25
5.3.2 Cyber physical systems differentiation in the IloT	26
5.3.3 Industrial Internet to CPPS and CPS definition	26
5.3.4 Smart Manufacturing differentiation vs. IloT	26
5.3.5 Verticals of IoT market.....	26
5.4 Smart Manufacturing and IloT	28
5.4.1 General	28
5.4.2 The IloT high-level view.....	28
5.4.3 Industrial products/services life cycle – in IloT/Smart Manufacturing.....	30
5.4.4 Industrial manufacturing/automation through (IT/OT) standardization – CPPS	30
5.5 Collaboration considerations on an IloT reference architecture for standardization (use case driven)	31
5.5.1 General	31
5.5.2 General comparison of RAs and models on IloT, see [37].....	31
5.5.3 IloT systems characteristics: connectivity and communication aspects	31

5.5.4	IloT semantic aspects: IloT characteristics	32
5.5.5	Data scale in IloT	37
5.5.6	Runtime integration of IloT	37
5.5.7	Edge computing in IloT	37
5.5.8	The endpoint – considerations on IloT	37
5.5.9	“Dependability” for IloT systems (IEC TC 56).....	38
6	Considerations for future standardization of IloT.....	38
6.1	Main findings by this document on IloT standardization	38
6.2	Risk for standards development on IloT	39
6.2.1	General	39
6.2.2	Avoiding work duplication on IloT standards development – across SDOs.....	39
6.2.3	Important to IloT: "semantics above syntax", see [55].....	39
6.2.4	Standards for handling the “ownership of data” in IloT, see [56]	39
6.2.5	Vocabulary definitions – issues to IloT.....	40
6.3	Perspective to development of standards for IloT.....	40
6.3.1	"Digital twins" – as a generic concept in IloT	40
6.3.2	(AI) Artificial Intelligence to be used by IloT (ISO/IEC JTC 1/SC 42).....	41
6.3.3	Federation of cloud in/between IloT systems (DIN SPEC 92222)	42
6.3.4	Future standardization on: “microservices and micro-applications in IloT” see [40]	42
6.3.5	“Blockchain technology” – future standardization in IloT	42
6.3.6	“Wearables” (in IloT).....	43
6.3.7	Compatibility requirements and model – for devices – within IloT systems	43
6.4	Roadmap perspective analysis for future standardization work for IloT	45
6.4.1	Future standardization work for IloT as a vertical domain of the IoT	45
6.4.2	ISO/IEC collaboration in relation to IloT	47
Annex A (informative)	Listing of all SDOs, non-SDOs, consortia, FOSS (free open source systems) in context of the IloT mentioned in this document.....	50
A.1	SDOs recognized/identified as of interest to IloT and also in relation to Clause 5 on standardization landscape in IloT	50
A.1.1	General	50
A.1.2	3GPP 3 rd Generation Partnership Project.....	50
A.1.3	ETSI (European Telecommunication Standards Institute)	51
A.1.4	IEEE (Institute of Electrical and Electronics Engineers)	51
A.1.5	ISO/IEC	52
A.2	IloT related initiatives/engagements by national standardization bodies.....	61
A.2.1	General	61
A.2.2	Sweden – LISA.....	61
A.2.3	France – “Usine du Futur”, see [67]	62
A.2.4	Germany – Industrie 4.0, see [68].....	63
A.2.5	Korea – “Korea – Manufacturing Industry Innovation 3.0 strategy”,	63
A.2.6	China – Industrial Initiatives (Standards Development)	64
A.2.7	Japan (RRI and IVI).....	65
A.2.8	USA – CPS/CPPS/IloT Standards Initiatives	67
A.2.9	IloT activities by EC EU.....	69
A.3	Industrial consortia recognized/identified as being of interest on working about the IloT	69
A.3.1	General	69
A.3.2	Alliance of Industrial Internet: “Chinese Model of Smart Manufacturing in context of program China Manufacturing 2025” [70]	70
A.3.3	5G-ACIA in IloT, and Smart Manufacturing	70
A.3.4	China Edge Computing Consortium ECC	71
A.3.5	DMG (Data Mining Group)	71

A.3.6	eCI@ss.....	71
A.3.7	IIC (Industrial Internet Consortium).....	73
A.3.8	International Data Spaces.....	73
A.3.9	Industrial Value Chain Initiative (IVI).....	73
A.3.10	ISA (International Society of Automation)	74
A.3.11	oneM2M – also linked to ETSI above	74
A.3.12	OPC Foundation	74
A.3.13	Automation ML	75
A.3.14	OMAC (Organization for Machine Automation and Control), see [71]	75
A.3.15	IIoT Semantic: WiSE-IoT (Worldwide interoperability for semantics IoT), see [72]	75
A.4	RFC-based standards development recognized as being of interest to IIoT.....	76
A.4.1	General	76
A.4.2	IETF/IRTF on IT Section related standards development also in IIoT	76
A.4.3	OASIS – Organization for the Advancement of Structured Information Standards	77
A.4.4	OCF (Open Connectivity Foundation)	77
A.4.5	ODVA – Open DeviceNet Vendors Association	78
A.4.6	OGC (Open Geospatial Consortium).....	78
A.4.7	OMG (Object Management Group).....	79
A.4.8	OpenFog Consortium – former, now part of IIC	80
A.4.9	The Open Group.....	80
A.4.10	Project Haystack – IIoT Semantic	81
A.4.11	W3C – World Wide Web Consortium.....	81
A.5	Consortial work on standardization by reference	82
A.5.1	General	82
A.5.2	IIRA (by IIC)	82
A.5.3	Bluetooth SIG	83
A.5.4	IO-Link – on Wireless Industrial RealTime Communication	83
	Bibliography.....	85
	Figure 1 – Six typical features of IIoT.....	8
	Figure 2 – IIoT mapping landscape description for SDO and non-SDO, consortia, FOSS.....	14
	Figure 3 – Trustworthiness functional components as identified in ISO/IEC 30141:2018	18
	Figure 4 – Migration approach towards IIoT systems	25
	Figure 5 – IoT SDOs and alliances landscape (vertical and horizontal domains)	27
	Figure 6 – Layout of the overall view on IIoT in the SC 41 context – the IoT bird’s eye view in ISO/IEC JTC 1/SC 41, see [34].	29
	Figure 7 – Diagram showing that the IIoT is part of the IoT applications domain (bird’s eye view), see [35].....	30
	Figure 8 – IIoT connectivity stack from IICF, see [38].....	32
	Figure 9 – The semiotic triangle	33
	Figure 10 – Semantics in IIoT meaning context, i.e. sensing	36
	Figure A.1 – Structure of IEC TC 65 and ISO/TC 184 JWG 21	58
	Figure A.2 – ISO/IEC Taskforce Standards Map Smart Manufacturing	59
	Figure A.3 – KOSF logo	64
	Figure A.4 – Link reference on Chinese GB/T standards vs. OPC/UA	65

Figure A.5 – Robot Revolution & Industrial IoT Initiative66

Figure A.6 – RRI and cooperative relationship66

Figure A.7 – Industrial Value Chain Initiative (IVI).....67

Figure A.8 – NIST logo68

Figure A.9 – eCI@ss in Context to other SDO’s and institutions72

Figure A.10 – Activities in the BIM domain:72

Figure A.11 – Overview of the W3C WoT Building Blocks82

Table A.1 – List of protocol for IIoT / SM use case by NC China64