ISO/TC 184/SC 4/WG 15
Digital manufacturing

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MB/ NC[1]	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table/ (e.g. Table 1)	Type of comment[2]	Comments	Proposed change	Observations of the secretariat
FR 01-001				ge	The documents of the ISO 23247 series circulated as CD do not reflect the outline of the proposed project NWIP (ISO/TC 184/SC 4/WG 15 N 17). The intended scope of the project as stated in the NWIP was "The Digital Twin is a virtual representation of manufacturing elements such as personnel,products, assets and process definitions."	Align the project on the NWIP.	**Accepted in principle** Assets are not specifically mentioned; however, equipment and facility are included as types of assets.
FR 02-002				ge	The documents of the ISO 23247 series circulated as CD do not reflect the outline of the proposed project NWIP (ISO/TC 184/SC 4/WG 15 N 17). The NWIP standards gap analysis listed and summarized: - IEC 62264 Enterprise-control system integration, - IEC 62832 Digital factory framework - ISO 16400 Equipment behaviour catalogues for virtual production system. These standards are not considered in documents of the ISO 23247 series circulated as CD.	Consider the current normative landscape.	**Noted** IEC 62264 is informatively referenced and listed in bibliography of this part. IEC 62832 and ISO 16400 have been determined not to be referenced in ISO 23247, however they can be listed in bibliography during DIS development if necessary.
FR 03-003				ge	The concept of Digital Twin manufacturing framework seems based on JTC 1's ISO/IEC 30141. The added value of this document to ISO/IEC 30141 is questionnable;	1- Add ISO/IEC 30141 in the normative references. 2- Provide valuable provisions focusing on industrial data, which is the scope of ISO/TC 184/SC 4.	**Accepted** 1. ISO/IEC 30141 has been added in the normative references. **Discussion:** How to deal with 2-?
DE 05-004	GENERAL				Not clear: does the framework describe how to build a single twin. Or does it describe an infrastructure that can handle a large number of	Clarify system boundaries of the reference architecture	**Accepted** Following text will be added

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					twins? What is the scope of the reference architecture? The Entity CSE seems to show that it is the handling of a large number of twins. However the term “entity” suggerates a single twin…		into 6.2.1. “Digital Twin reference architecture for manufacturing provides an infrastructure to support a large number of Digital Twins” Digital Twins are managed by DTRE (Digital Twin Representation entity), not by CSE (Cross-system entity).
JP 01 (AO) -005		A comment common to four proposed documernts		ge	To say “Digital Twin”, consistency management between physical objects and their digital representations shall be a core concern. In other words, how to relate a physical object with its digital representation and how to keep consistency between the two in the circumstances where the physical object is constantly changing shall be a keen concern. Imagine the case of removal machining for creating a die. There are many physical objects including work piece, machining tool, etc. During machining, the shape and material characteristics of the work piece will constantly change. It is the same for the machining tool caused by fatigue. How to capture those changes and how to reflect the changes into their digital counterparts shall be a core concern for digital twin manufacturing. But, no specification is defined in the proposed four documents concerning how to relate a physical object and its digital representation, and how to keep consistency between the two. The phrases “ detailed modelling” and “dynamic modelling” appear with no clear definitions、	Regenerate the document from scratch.	The Digital Twin framework for manufacturing describes framework how to relate physical object to digital representation. Specific technologies that are to be used to perform the synchronization are not prescribed by this standard and left by users’ to select. Use cases are to be developed in future reports and they will recommend technologies to achieve the qualities described by the framework in the context of specific processes.

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					which is extremely inappropriate.. There will be changes which can be captured and those which are difficult to capture. Therefore, it is understood that clear statements of in scope issues and out of scope issues should be possible. But, current scope statement says almost nothing. In order to get support from industries, clear answers to the issues raised above is critically important.		
JP 02 (AO) -006		A comment common to four proposed documernts		ge	The title of the series of standards is digital twin manufacturing framework but no manufacturing specific terms appear. There are many types of manufacturing including removal machining for creating automotive dies. What types of manufacturing is in scope and what types are not shall be clearly described.	Clear statements required.	**Accepted in principal** Following has been added to introduction for clarification: All types of manufacturing should be supported including discrete and continuous manufacturing for individual parts, assemblies or continuous processes. However, the actual types of manufacturing that can be supported by an instance of the framework will depend on the technologies selected to implement its functional elements.
JP 03 (AO) -007		A comment common to four proposed documernts		ge	It is very hard to imagine how to effectively use proposed standards, which is a key requirement to stimulate manufacturing industry.	It is recommended to include real-life examples on how to effectively use proposed standards/	**Accepted in principal** Following has been added to introduction for clarification: All types of manufacturing should be supported including discrete and continuous manufacturing for individual parts, assemblies

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							or continuous processes. However, the actual types of manufacturing that can be supported by an instance of the framework will depend on the technologies selected to implement its functional elements.
JP 04 (AO) -008		Throughout of the document		ge	Meaningless number appears at the left of each line.	Remove them.	**Acknowledged** The number in left side of document is for easy pointing to give comments for the ballot. In IS publication stage, this number will be totally removed.
US 01-009	0	TITLE		ge	The title is not clear nor grammatically correct.	Change title to, "Automation systems and integration – Digital twin framework for manufacturing – Part 2: Reference architecture"	**Accepted in principle** Changed to “Automation systems and integration – Digital Twin framework for manufacturing – Part 2: Reference architecture"
US 02-010	0	WHOLE DOCUMENT		ge	See CD 23247-1 Comment US-08 to remove "Digital Twin Representation"	Change "digital twin representation" to "digital twin" throughout entire document	**Accepted** The term “Digital Twin Representation” is architectural point of view and implies a set of systems and functionalities to manage and maintain Digital Twins.
US 03-011	0	WHOLE DOCUMENT		ge	"Digital twin manufacturing" is not a defined term.	Change to, "Digital twin" throughout entire document	**Accepted in principle** Changed to “Digital Twin for manufacturing”.

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							See US01-009.
US 04-012	0	WHOLE DOCUMENT		ge	See US-01.	Change "digital twin manufacturing framework" to "digital twin framework for manufacturing" throughout entire document.	**Accepted in principle** **Changed to "Digital Twin framework for manufacturing"**
JP 05 (AO) -013		Introduction		ge	What are written are not appropriate as explanations in "Introduction". Many phrases appear without definition or detailed specification, such as "Deatiledmodelling", "Dynamic modelling", etc.		**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
US 05-014	80	Introduction		ge	Duplicated text from CD 23247-1 is not consistent.	Ensure consistency between CD 23247-1 and -2 Introductions.	**Accepted** Introduction of Part 1 will be used.
DE 01-015	81			ge	See other comment w.r.t. definition of a twin, should then be aligned	Aligned usage of definition of twin in all parts	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
DE 02-016	83			ge	Why detailed modelling: it has to be as detailed as needed. Detailing is not a quality in itself	Remove detailed from sentence	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
DE 03-017	83			ge	The term "Digital Twin Manufacturing" is very difficult to understand and to use. Compare to findings for part 1. What exactly is it? And what is its relationship to the twins? Is it the infrastructure for the twins? Is it the name for the complete system that also	Improve definition of DT Manufacturing and use consistently in all part of DT Framework e.g. Explain DT manufacturing by using the term digital twin. Same for the other terms.	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.

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					contains twins. Or is it: A twin consists of a) a DT manufacturing b) a DTRE c) … Not very clear… If a twin either represents a product how can it then also represent the process and describe all relevant manufacturing aspects. Or is it a composite twin that uses other twins? How many manufacturing elements are represented by a single twin? It seems a twin can represent a large number of manufacturing elements at once. Why not only one element and the compose more complex twin out of the atomic twins? In part 1 hierarchical twin are mentioned.	Explain what a twin exactly is representing Introduce term of composite or hierarchical twin (or similar)	
KR 01-018	85-87	Introduction		ed	Editorial enhancement	Change to read: Digital Twin manufacturing maintains a digital model that continuously updates and changes as the physical counterpart changes to represent manufacturing status, manufacturing conditions, product geometries, resource state, and any other observable status and conditions in a synchronous manner.	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
KR 02-019	88-91	Introduction		ed	Editorial enhancement	Change to read: Digital Twin Representation provides functionalities to maintain and synchronize the representation of a Digital Twin with its corresponding observable manufacturing	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2.

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						elements by constantly exchanging operational and environmental data.	See US05-014.
KR 03-020	90	Introduction		ed	Use a consistent term with other parts.	Change “physical manufacturing elements” with “observable manufacturing elements”.	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
CN 01-021	96	Introduction		ge	To use the term “Digital Twin manufacturing” instead of “Digital Twin for manufacturing”.	The visibility into process and execution enabled by Digital Twin manufacturing enhances business cooperation and various efficiencies.	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
KR 04-022	99	Introduction		ed	Use a consistent term with other parts.	Change “physical manufacturing elements” with “observable manufacturing elements”.	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
CN 02-023	103	Introduction		ge	Keep “Introduction” consistent between part 1 and part 2.	provides requirements and guidance for developing a Digital Twin manufacturing framework;	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
CN 03-024	106	Introduction		ge	Keep consistent between part 2 description with other parts.	Provides a reference architecture goals and objectives, reference model, and reference architectural views for a Digital Twin manufacturing framework;	**Acknowledged** Revised Introduction of Part 1 will replace the Introduction of Part 2. See US05-014.
KR 05-025	123	1		ed	Use a consistent term with other parts.	Change “physical manufacturing elements” with “observable manufacturing elements”.	**Accepted**

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KR 06-026	123	1		ed	Consistency with other parts	Add “environment”	**Accepted**
FR 04-027	123	1		ed	A comma is missing.	Replace by: "personnel, equipment, material, processes, facilities, and products"	**Accepted**
JP 06 (KD) -028	125	1		ge	The scope is not consistent with the following scope text stated in ISO/TC 184/SC 4 N 3224 (NWIP). Part 2: Reference architecture Provides a reference architecture, set of terms and definitions, and requirements for Digital Twin manufacturing realization in terms of information modelling, in-loop simulation, information exchange, and identification of information objects; Requirements for Digital Twin manufacturing realization in terms of information modelling physical elements seem not specified in the document.	1) Make the scope text consistent with the scope text in the NWIP. 2) Provide requirements for Digital Twin manufacturing realization in terms of information modelling physical elements.	**Acknowledged** 1. Requirements of Digital Twin framework for manufacturing are defined in Part 1. The overall scopes of Part 1 – Part 4 do not differ from the scope of NWIP, but re-arranged between each part for enhancement. It will be asked to SC 4 Secretariat to be necessary of scope change ballot. 2. Technical Reports on use cases will cover requirements for Digital Twin for manufacturing in terms of information modelling physical elements
JP 07 (KD) -029	125	1		ge	ISO TC184/SC4 N1167 “SC4 Industrial Data Framework” states the following in 1.2 Out of Scope. Any architecture or definition of how STEP/SC4 standards support the industrial requirement is out of scope.	Provide the information view of Digital Twin, especially in terms of data structure, instead of providing the architecture view.	**Acknowledged** Information view of Digital Twin, especially in terms of data structure (information attribute) and information exchange are addressed in

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							Part 3 and Part 4.
CN 04-030	144	4		ge	"Digital Twin manufacture" is a new term without definition. It is suggested using "a Digital Twin manufacturing system" instead.	Digital Twin manufacturing reference architecture outlines what the overall structured approach for the construction of a Digital Twin manufacturing system should be.	**Accepted in principle** Digital Twin reference architecture for manufacturing outlines what the overall structured approach for the construction of a Digital Twin for manufacturing should be.
KR 07-031	144	4		ed	Editorial enhancement	Change "the construction of Digital Twin manufacture" with "the construction of Digital Twin manufacturing".	**Accepted in principle** See CN04-030.
KR 08-032	145	4		ed	Choose better word that suits manufacturing	Change to read: Digital Twin manufacturing reference architecture provides guidance for developing Digital Twin manufacturing.	**Accepted in principle** Digital Twin reference architecture for manufacturing provides guidance for developing Digital Twin for manufacturing and aims to give a better understanding of Digital Twin for manufacturing to the stakeholders of such systems, including device manufacturers, application developers, users, etc.
KR 09-033	147	4		ed	"Customers" and "Users" seem to be somewhat redundant and vague.	Change to read: including device manufacturers, application developers, users, etc.	**Accepted** See KR08-032.
KR 10-034	149-151	4		ed	Editorial enhancement	Change to read: - Digital Twin manufacturing reference models, describing structure of the domains and structure of the entities; - a set of relevant architectures in terms of	**Accepted in principle** - Digital Twin reference models for manufacturing, describing structure of

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						functional and networking views	the domains and structure of the entities; - a set of relevant architectures in terms of functional and networking views
KR 11-035	155-156	4		ed	Editorial enhancement	Change to read: Figure 1 shows outline of Digital Twin manufacturing reference architecture defining relevant reference models and architectural views derived from requirements specified in ISO 23247-1.	**Accepted in principle** Figure 1 shows outline of Digital Twin reference architecture for manufacturing to define relevant reference models and architectural views derived from requirements specified in ISO 23247-1.
CN 05-036	158	5		ge	The title of Clause 5 should use plural for the word “model”.	5 Digital Twin manufacturing reference models	**Accepted**
JP 08 (KD) -037	158	5	Entire Clause	ge	The Digital Twin manufacturing framework seems based on ISO/IEC 30141, however there is almost no valuable contents in addition to the original IoT-RA.	Provide valuable contents focusing on the information view.	**Acknowledged** Clause 5 gives reference models in terms of Digital Twin for manufacturing based on IoT reference architecture. Information view (that is Information attribute) and information exchange are given in Part 3 and Part 4.
KR 12-038	160-165	5.1		ed	Move clause 5.1 to more appropriate place and improve text.	Add the follows before line 148 and remove subclause 5.1: Digital Twin encompasses Internet of Things (IoT) as its data collecting and controlling technology as well as conceptual background. ISO/IEC 30141 defines IoT reference models	**Accepted**

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						including domain-based reference model and entity-based reference model, and also defines reference architecture by providing several reference architectural views including functional view, system deployment view, networking view, and usage view. By reference to ISO/IEC 30141, this document has the following descriptions:	
FR 05-039	166	5.2		ed	Complicated acronyms (OMSD, ASSD, RAISD, DCDCD, PMD) have bben added on top of ISO/IEC 30141 that does not help because too long and difficult to pronounce.	Remove or simplify the acronyms.	**Accepted** Acronyms will be removed.
KR 13-040	170	5.2.1		ed	Editorial enhancement	Change ". Mainly" with ", in other words"	**Accepted**
CN 06-041	172	5.2.1		ge	According to Fig 2, there are three not four kinds of domains inside the box of Digital Twin manufacturing framework.	In Digital Twin manufacturing framework, domains are classified into three categories ...	**Not accepted** Physical manufacturing domain is one of four categories.
KR 14-042	172-174	5.2.1		ed	Editorial enhancement	Change to read: In Digital Twin manufacturing framework, domains are classified into four categories as follows:	**Accepted in principle** In Digital Twin framework for manufacturing, domains are classified into four categories as follows:
KR 15-043	176-178	5.2.1		te	To avoid confusion of domain-based reference model and entity-based reference model, sub-domain is not required in DTRD.	Remove OMSD, ASSD and RAISD from DTRD. This shall be consistent in other parts.	**Accepted**
KR 16-044	180-182	5.2.1		ed	Editorial enhancement and use a consistent term with other parts.	Change to read: Observable manufacturing domain (OMD) is out of scope of Digital Twin manufacturing framework, however, this document describes OMD to enhance understanding of Digital Twin manufacturing.	**Accepted in principle** Observable manufacturing domain is out of scope of Digital Twin framework for manufacturing, however, this document describes

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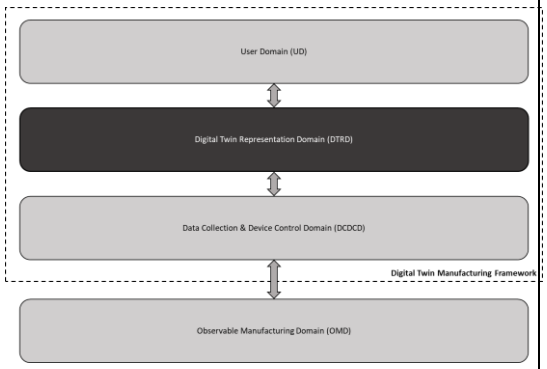
							observable manufacturing domain to enhance understanding of Digital Twin for manufacturing.
CN 07-045	181	5.2.1		ge	To use the term “Digital Twin manufacturing” instead of “Digital Twin for manufacturing”.	… however this document includes PMD to show the whole reference architecture of Digital Twin manufacturing.	**Not accepted** See US03-011 and KR16-044.
KR 17-046	184-185	5.2.1	Figure 2	te	If KR15 is accepted, remove OMSD, ASSD and RAISD from DTRD in Figure 2.	Modified Figure 2:  This shall be consistent in other parts.	**Accepted**
US 06-047	185	5.2.1	Figure 2	te	Need explaining the arrows between domains. OMSD interacting with RAISD passes through ASSD?	If not, draw an arrow between OMSD and RAISD. Please refer fig 1 in the part 4	**Acknowledged** See KR17-046
KR 18-048	187-189	5.2.1		ed	Follow a way of reference to clause and subclause in a document given in ISO/IEC Directive Part 2.	Change to read: This classification is a logical grouping of tasks and functions, which are performed by Digital Twin manufacturing framework entities explained in 5.3 and functional entities (FE) explained in 6.2 in detail. Entities in domain interact with other entities by means of a set of networks described in 6.3.	**Accepted in principle** This classification is a logical grouping of tasks and functions, which are performed by Digital Twin framework entities for manufacturing explained in 5.3 and functional entities (FE) explained in 6.2 in detail. Entities in domain

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							interact with other entities by means of a set of networks described in 6.3.
KR 19-049	190	5.2.2		ed	Use a consistent term with other parts.	Change the title of subclause 5.2.2 with "Observable manufacturing domain (OMD)"	**Accepted in principle** Observable manufacturing domain See FR 05-039.
KR 20-050	191-194	5.2.2		te	Use a consistent term with other parts and editorial enhancement.	Change to read: "OMD consists of the physical manufacturing resources such as personnel, equipment, material, process, facility, and environment. OMD shall be monitored and sensed for data collection and device control in Digital Twin manufacturing framework".	**Accepted in principle** Observable manufacturing domain consists of the physical manufacturing resources such as personnel, equipment, material, process, facility, and environment. Observable manufacturing domain shall be monitored and sensed for data collection and device control in Digital Twin framework for manufacturing Example: Spatial/logical/functional area of machine tool is an example of observable manufacturing domain See US03-011 and FR 05-039.
DE 04-051	196		DCDCD		It is not clear whether DCDCD is one program that is used by many twins. Or is one DCDCD for each twin? (See other comment: does DT consists of DTRE	Perhaps it helps to formulate a sentence with digital twin and DCDCD in one sentence to describe the relationship.	**Accepted** Domain is useful to describe various tasks that have to be performed in separate areas, by allowing a logical and

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					and DCDCD or does DT = DTRE or …)		sometimes physical subdivision, in other words, domains are used to sort functions into areas of responsibility. Therefore, domain is not a program, but entity can be programs and systems that is used by Digital Twin. Following text will be added in new clause under 5.x.x Data collection and device control entity “Digital Twin for manufacturing shall have one or more data collection and device control entity, because Digital Twin for manufacturing consists of one or more observable manufacturing elements that shall be controlled.”
KR 21-052	197-200	5.2.3		ed	Editorial enhancement	Change to read: DCDCD is a logical domain which monitors and collects data from sensory devices in OMD, and control and actuate devices in OMD. DCDCD links observable manufacturing elements and digital entities for synchronization.	**Accepted in principle** Data collection and device control domain is a logical domain which monitors and collects data from sensory devices in observable manufacturing domain, and control and actuate devices in observable manufacturing domain. Data collection and device control domain links observable manufacturing elements and digital entities for synchronization.

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							See FR 05-039.
KR 22-053	202	5.2.4		te	To avoid confusion of domain-based reference model and entity-based reference model, sub-domain is not required in DTRD. See KR15.	Change to read: **5.2.4 Digital Twin Representation domain (DTRD)** DTRD is responsible for overall operation and management of Digital Twin manufacturing including provisioning, managing, monitoring, and optimization. In detail, digital modeling, presentation, and synchronization of observable manufacturing element are done in DTRD. Digital Twin applications and services are hosted in DTRD such as simulation, analysis, etc. In addition, DTRD provides access to entities of Digital Twin manufacturing framework and interaction with external entities such as peer DTRD by guaranteeing interoperability. EXAMPLE Spatial/logical/functional area of Digital Twin server implementing Digital Twin management, simulation, and authentication and authorization is an are example of DTRD.	**Accepted in principle** **5.2.4 Digital Twin domain** Digital Twin domain is responsible for overall operation and management of Digital Twin for manufacturing including provisioning, managing, monitoring, and optimization. In detail, digital modeling, presentation, and synchronization of observable manufacturing element are done in Digital Twin domain. Digital Twin applications and services are hosted in Digital Twin domain such as simulation, analysis, etc. In addition, Digital Twin domain provides access to entities of Digital Twin framework for manufacturing and interaction with external entities such as peer Digital Twin domain by guaranteeing interoperability. EXAMPLE Spatial/logical/functional area of Digital Twin server implementing Digital Twin management, simulation, and authentication and authorization is an are example of Digital Twin

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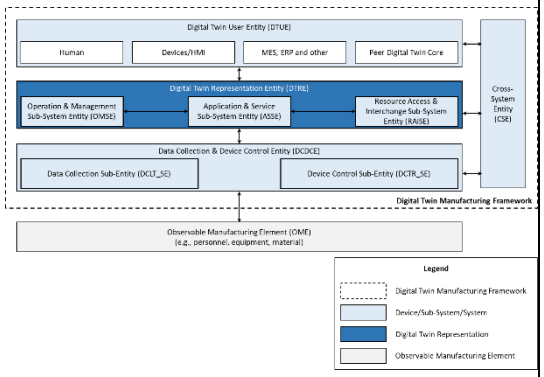
							domain. See US02-010, US03-011, US04-012 and FR05-039.
KR 23-054	203-218	5.2.4.1 5.2.4.2 5.2.4.3		te	To avoid confusion of domain-based reference model and entity-based reference model, sub-domain is not required in DTRD. See KR15.	Remove 5.2.4.1, 5.2.4.2, and 5.2.4.3	**Accepted**
KR 24-055	230-231	5.3.1	Figure 3	te	Data collection and device control are separate functions; therefore, they shall be separate entities. Use a consistent term with other parts.	Change Figure 3 as follows: 	**Accepted in principle** Remove acronyms and add arrow between OMSE and RAISE. See US07-056
US 07-056	231	5.3.1	Figure 3	te	Need explaining the arrows between domains. OMSE interacting with RAISE passes through ASSE?	If not, draw an arrows between OMSE and RAISE. Please refer fig 1 in the part 4	**Accepted**
KR 25-057	232-233	5.3.1		te	Use a consistent term with other parts and editorial enhancement	Change to read: Figure shows an entity-based Digital Twin manufacturing reference model. A set of OMSE, ASSE, and RAISE digitally represents observable manufacturing elements as Digital Twins, and maintains the Digital Twins, therefore it is called Digital Twin Representation entity.	**Accepted in principle** Figure 3 shows an entity-based Digital Twin reference model for manufacturing. A set of operation and management sub-system entity, application and service sub-system entity, and resource access and

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							interchange sub-system entity digitally represents observable manufacturing elements as Digital Twins, and maintains the Digital Twins, therefore it is called Digital Twin entity. See US02-010, US03-011, US04-012 and FR05-039.
KR 26-058	235	5.3.2		te	Use a consistent term with other parts.	Change the title of 5.3.2 as follows: 5.3.2 Observable manufacturing element (OME)	**Accepted in principle** 5.3.2 Observable manufacturing element See FR05-039.
KR 27-059	236-237	5.3.2		ed	Editorial correction for use of a consistent term.	Change to read: OME shall be monitored and sensed, and may be actuated and controlled by DCDCE. It includes personnel, equipment, material, process, etc.	**Accepted in principle** Observable manufacturing element shall be monitored and sensed, and may be actuated and controlled by data collection and device control entity. It includes personnel, equipment, material, process, etc. See FR05-039.
KR 28-060	239	5.3.3		ed	Editorial correction for use of a consistent term.	Change PME with OME.	**Accepted in principle** PME will be replaced by Observable manufacturing element. See FR05-039.
KR 29-061	238-244	5.3.3		te	According to KR24, 5.3.3 shall be restructured.	If KR24 is accepted, change 5.3.3 to read: **5.3.3 Data collection and device control entity (DCDCE)** **5.3.3.1 Data collection sub-entity (DCLT_SE)**	**Accepted in principle** **5.3.3 Data collection and device control entity** **5.3.3.1 Data collection sub-**

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						DCLT_SE interacts with the OME by monitoring and sensing for data collection, therefore may include sensors and other data collecting devices. DCLT_SE communicates with Digital Twin Representation entities (DTRE), i.e., OMSE, ASSE and RAISE, for support of generating, synchronizing, and managing Digital Twins, exactly speaking, digital entities of observable manufacturing elements. Therefore, DCLT_SE may include executables in the form of a program or agent such as Administration Shell in Industrie 4.0. **5.3.3.2 Device control sub-entity (DCTR_SE)** DCTR interacts with the OME by controlling and actuating for device control, therefore may include controller and other actuating devices. Like DCLT_SE, DCTR_SE may include executables in the form of a program or agent.	**entity** Data collection sub-entity interacts with the observable manufacturing element by monitoring and sensing for data collection, therefore may include sensors and other data collecting devices. Data collection sub-entity communicates with Digital Twin entities, i.e., operation and management sub-system entity, application and service sub-system entity and resource access and interchange sub-system entity, for support of generating, synchronizing, and managing Digital Twins, exactly speaking, digital entities of observable manufacturing elements. Therefore, data collection sub-entity may include executables in the form of a program or agent. Digital Twin shall have one or more data collection sub-entity, because Digital Twin consists of one or more observable manufacturing elements that shall be monitored. **5.3.3.2 Device control sub-entity** Device control sub-entity

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							interacts with the observable manufacturing element by controlling and actuating for device control, therefore may include controller and other actuating devices. Like data collection sub-entity, device control sub-entity may include executables in the form of a program or agent. Digital Twin shall have one or more device control entity, because Digital Twin consists of one or more observable manufacturing elements that shall be controlled.
DE 06-062	244				For our understanding the asset administration shell is a DTRE and not a DCDCE. Plattform I4.0 does not have an explicit term to refer how to collect and get the data needed from the sources (like DCDCE). It is all part of the asset administration shell. This framework explains how (in an architectural point of view) a twin should be built and which functional entities need to be considered. So this is very helpful and complementary.	e.g. [1] describes a specific reference model for a digital twin called asset administration shell but does not distinguish between DTRE and DCDCE. Line 310 With “asset administration shell in detail” Plattform Industrie 4.0 provides a specification how a digital modelling FE could be realized in a harmonized way. https://www.plattform-i40.de/PI40/Redaktion/DE/Downloads/Publikation/2018-verwaltungsschale-im-detail.html	**Acknowledged** AAS in Industrie 4.0 is a good example to explain Digital Twin Reference Architecture and it entities. However, there are a lot of reference models for smart manufacturing, therefore it might be not appropriate to pick up AAS only as an example. Remove “such as Administration Shell in Industrie 4.0”

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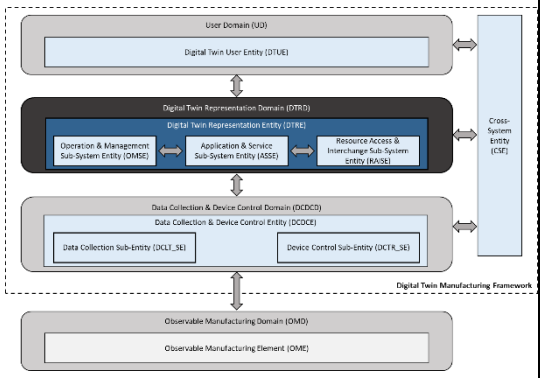
KR 30-063	261	5.3.5		ed	Editorial enhancement	Change to read: As shown in Figure 3, DTUE can be any entity that can utilize Digital Twin manufacturing such as human, a device, MES/ERP systems, or even peer DTRE.	**Accepted in principle** As shown in Figure 3, Digital Twin user entity can be any entity that can utilize Digital Twin for manufacturing such as human, a device, MES/ERP systems, or even peer Digital Twin entity. See US02-010 and FR05-039.
KR 31-064	270-271	5.4	Figure 4	te	According to KR24, Figure 4 shall be modified.	If KR24 is accepted, change Figure 4 as follows: 	**Accepted**
US 08-065	271	5.4.1	Figure 4	te	Need explaining the arrows between domains. OMSE interacting with RAISE passes through ASSE?	If not, draw an arrow between OMSE and RAISE. Please refer fig 1 in the part 4	**Accepted**
KR 32-066	275	6.1		ed	Editorial enhancement	Change to read: Clause 6 defines functional view and networking view of Digital Twin manufacturing based on IoT reference architecture defined in ISO/IEC 30141.	**Accepted in principle** This clause defines functional view and networking view of Digital Twin reference architecture for manufacturing based on

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							IoT reference architecture defined in ISO/IEC 30141.
CN 08-067	162, 276	5, 6		te	Seeing that IoT reference architecture of ISO/IEC 30141 is a key and unique reference of ISO 23247, the framework, reference models, reference architecture views of Digital Twin manufacturing proposed in ISO 23247 are supposed to be applicable for not only Digital Twin for manufacturing but any general Digital Twin.	1. As for part 1 and part 2 of ISO 23247, it is suggested that using general terms, “Digital Twin framework”, “Digital Twin reference architecture”, “Digital Twin reference models”, “Digital Twin reference architecture views” as main topics. 2. It is suggested that providing specific business/stakeholders/system requirement analysis for Digital Twin Manufacturing from the perspective of architecture, representation and information change in part 1 or part 2. 3. It is suggested that keeping the topics of part 3 and part 4 unchanged focusing the representation and information change of specific Digital Twin Manufacturing application scenarios.	**Partly accepted** Proposal 1 is not accepted because general Digital Twin in not the scope of this standard. Proposal 2 is accepted in principle, further Technical Reports on use cases will cover this proposal. Proposal 3 is accepted and further Technical Reports on use cases will cover specific Digital Twin for manufacturing application scenarios
KR 33-068	278-280	6.2.1		ed	Change subclause title and the corresponding text.	Change to read: **6.2.1 Functional reference architecture** Figure 5 show a functional reference architecture to support requirements defined in ISO 23247-1.	**Accepted**
KR 34-069	281-283	6.2.1	Figure 5	te	According to KR24, Figure 5 shall be modified.	If KR24 is accepted, change Figure 5 as follows:	**Accepted in principle** Figure 5 – Functional reference architecture of Digital Twin framework for manufacturing – decomposition of functional entities (FEs)

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						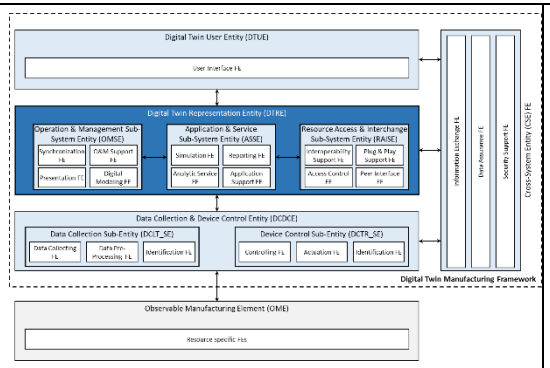 **Figure 5 – Functional reference architecture of Digital Twin manufacturing framework – decomposition of functional entities (FEs)**	
KR 35-070	284-287	6.2.2		ed	Classification of resource-specific FE is not clear. If it is some function that an entity in OME can perform, it shall be represented by Digital Twin representation entity so that entities in DCDCE can utilize that function. If not, what else can it be? This shall not be out of scope.	Change to read: Resource-specific FE is a functional entity of an observable manufacturing element. It shall be digitally modelled to be utilized by entities in Digital Twin manufacturing framework.	**Accepted**
KR 36-071	289	6.2.3.1		ed	According to KR24, it is beneficial to change the title of subclause 6.2.3.1.	Change to read: **6.2.3.1 Data collecting FE in DCLT_SE**	**Accepted in principle** 6.2.3.1 Data collecting FE in data collection sub-entity See FR05-039.
KR 37-072	291	6.2.3.2		ed	According to KR24, it is beneficial to change the title of subclause 6.2.3.2.	Change to read: **6.2.3.2 Data pre-processing FE in DCLT_SE**	**Accepted in principle** 6.2.3.2 Data pre-processing FE in data collection sub-entity

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							See FR05-039.
KR 38-073	294	6.2.3.3		ed	According to KR24, it is beneficial to change the title of subclause 6.2.3.3.	Change to read: **6.2.3.3 Controlling FE in DCTR_SE**	**Accepted in principle** 6.2.3.3 Controlling FE in device control sub-entity See FR05-039.
KR 39-074	296	6.2.3.4		ed	According to KR24, it is beneficial to change the title of subclause 6.2.3.4.	Change to read: **6.2.3.4 Actuation FE in DCTR_SE**	**Accepted in principle** 6.2.3.4 Actuation FE in device control sub-entity See FR05-039.
KR 40-075	299	6.2.3.5		ed	According to KR24, it is beneficial to change the title of subclause 6.2.3.5.	Change to read: **6.2.3.5 Identification FE in both DCLT_SE and DCTR_SE**	**Accepted in principle** 6.2.3.5 Identification FE in both data collection sub-entity and device control sub-entity See FR05-039.
CN 09-076	326	6.2.4.2.4		ge	The example “Node.js” is too specific and cannot play the exemplification role.	To delete it or change with another example.	**Accepted** “Node.js” will be removed.
KR 41-077	353-362	6.3.1		ed	Change subclause title and editorial enhancement.	Change to read: **6.2.1 Networking reference architecture** Networking reference architecture describes communication network which are involved in Digital Twin manufacturing framework. Figure 6 shows three principal communication networks in terms of domain-entity mixture	**Accepted in principle** **6.2.1 Networking reference architecture** Networking reference architecture describes communication network which are involved in Digital Twin framework for

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						reference model (see 5.4) in Digital Twin manufacturing framework. Main role of communication network provides means to exchange information between entities across the different domains. However, DCDCE is physically attached or integrated into OME, therefore communication network between these two entities is not considered in this document.	manufacturing. Figure 6 shows three principal communication networks in terms of domain-entity mixture reference model (see 5.4) in Digital Twin framework for manufacturing. Main role of communication network provides means to exchange information between entities across the different domains. However, data collection and device control entity is physically attached or integrated into observable manufacturing element, therefore communication network between these two entities is not considered in this document. See US02-010 and FR05-039.
KR 42-078	361-362	6.3.1	Figure 6	te	According to KR24, Figure 6 shall be modified.	If KR24 is accepted, change Figure 6 and caption as follows:	**Accepted in principle** Figure 6 – Networking reference architecture of Digital Twin framework for manufacturing See US02-010

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						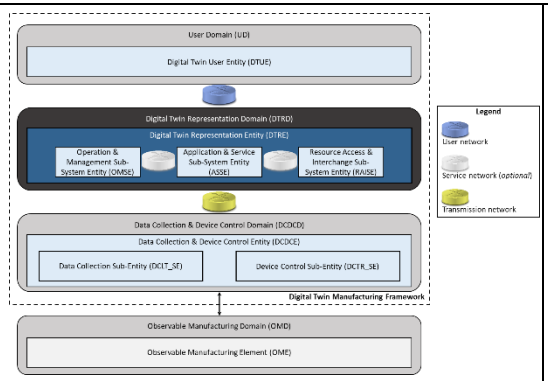 **Figure 6 – Networking reference architecture of Digital Twin manufacturing framework**	
KR 43-079	366	6.3.2		te	Use a consistent term with other parts.	Change “physical manufacturing resources” with “observable manufacturing elements”.	**Accepted**

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