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Internet of Things and Services

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D2.9.3 Updated requirements report 3

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1. Executive summary

This is the third update of the D2.9.x report series on requirements engineering and is intended to show the changes made to the requirements in the third project year. It complements the deliverable *D2.8.3 Change request and re-engineering report 3*.

In the third year of the ebbits project, the user requirements on the system functionality have been regularly updated. Of those updated requirements within the third year we currently have 15 requirements that are in status 'Open', 28 are in status 'QC passed', 19 are 'Part of specification", 23 are 'In Progress', 37 have been 'resolved', 50 have been 'Closed'.

Overall we have 15 requirements that are in status 'Open', 41 are in status 'QC passed', 25 are 'Part of specification", 23 are 'In Progress', 51 have been 'resolved', 91 have been 'Closed'.

After the third year we have closed 33 requirements, which have been implemented in the ebbits platform. We did also some cleanup work for the remaining 17 requirements which we identified as 'Duplicate', 'Nonsense' and 'Out of scope'.

The focus of the requirements engineering efforts in the last year was given on a connection between requirements and innovations in order to get a better overview of innovative aspects of the developing solution. We plan to proceed with this approach of integrated innovations and requirements in the last year of the project as well.

We currently have 48 requirements which are scheduled for implementation (Status "In Progress" and "Part of specification"). The requirements in status "Open" and "Quality check passed" will be evaluated if they would be taken into account for inclusion in the final demonstrator.

One major aspect of the last year in the project will be the evaluation of the ebbits system which will take place within WP9.

2. Introduction

2.1 Purpose, context and scope of this deliverable

This is the third update of the D2.9.x deliverables on requirements engineering and is intended to show the changes made to the requirements in the third year of the ebbits project; i.e., from September 2012 till August 2013. In addition to that this deliverable complements the deliverable *D2.8.3 Change request and re-engineering report 3*.

In this deliverable we highlight the already implemented requirements, those that have been closed due to different reasons, as well as the updated requirements.

2.2 Background

For first time readers we strongly recommend the reading of the first Lessons Learned (LL) deliverables *D2.7.1 Lessons Learned and Results of Usability Evaluation 1* and the first change request and reengineering reports (D2.8.1). Lessons Learned of the second and third year can be found in deliverable *D2.8.2 Change Request and Reengineering Report 2* and *D2.8.3 Change Request and Reengineering Report 3*.

As a kind of background knowledge about the methodology used the initial requirements report (D2.4) and validation framework (D2.6) deliverables are also recommended. A short overview of the requirements process steps and their associated requirements status is given in chapter 3.1.

2.3 Structure of this document

In chapter 3, a general overview of changes to the requirements is given in terms of a description of updated / implemented / closed requirements. In chapter 4, conclusions of the requirements engineering work are reported. The following chapters 5 and 6 highlight the list of requirements that have been implemented (refer to chapter 5) and closed (refer to chapter 6).

Chapter 7 includes a list of all the requirements updated since the last deliverable D2.9.2, which was published in December 2012.

3. Status of requirements

3.1 Overview

Within our iterative requirements engineering process we have defined and refined a workflow (extensively covered in D2.4, D2.8.1 and D2.8.2) that each requirement runs through (shown in Figure 1).

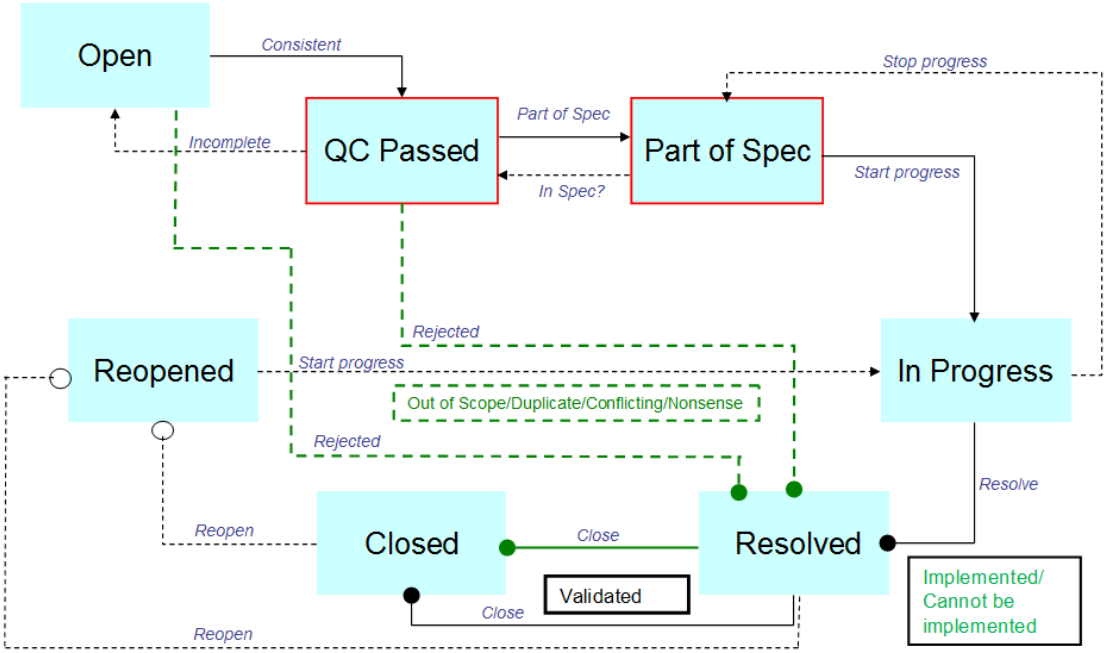

Figure 1: ebbits requirements workflow

After the third year of the project, we have 246 requirements in total, as it is presented in Table 1. Namely, there are 15 requirements in status 'Open', 41 are in status 'QC passed', 25 are 'Part of specification", 23 are 'In Progress', 51 have been 'resolved', 91 have been 'Closed'.

Requirements sta	#s
Closed	91
In Progress	23
Open	15
Part of specification	25
Quality Check passe	41
Resolved	51
Number of Reqs	**246**

Table 1: Overview of all requirements status

For the status 'Resolved' and 'Closed' the following table gives a more detailed overview:

Resolution	Closed	Resolved	Sum
Cannot be implemented		2	2
Conflicting	1		1
Duplicate	47	7	54
Implemented	33	22	55
Nonsense	4	1	5
Out of scope	6	19	25
Sum	**91**	**51**	**142**

Table 2: All requirements overview of status 'Resolved' and 'Closed'

3.2 Updated requirements

After the third year of all the updated requirements we currently have 15 requirements that are in status 'Open', 28 are in status 'QC passed', 19 are 'Part of specification", 23 are 'In Progress', 37 have been 'resolved', 50 have been 'Closed'.

Overview Status	#s
Closed	50
In Progress	23
Open	15
Part of specification	19
Quality Check passed	28
Resolved	37
Number of updated Reqs	**172**

Table 3: Overview of updated requirements status

For the status 'Resolved' and 'Closed' the following Table 4 gives a more detailed overview:

Status / Resolution Resolution	Closed	Resolved	Sum
Cannot be implemented		1	1
Conflicting	1		1
Duplicate	10	2	12
Implemented	33	21	54
Nonsense	2	1	3
Out of scope	4	12	16
Sum	**50**	**37**	**87**

Table 4: Updated requirements overview of status 'Resolved' and 'Closed'

3.3 Implemented requirements

The list of implemented requirements includes those requirements that have been completed and have been implemented in the demonstrators. Numbers of the implemented requirements are presented in Table 5.

Implemented Reqs	
Resolution	**Implemented**
Closed	33
Resolved	21
Sum	**54**

Table 5: Requirements overview of resolution 'Implemented'

The 21 requirements that are in status 'Resolved" are not yet externally validated and therefore could not be closed.

3.4 Closed requirements

In year 3 we have closed 33 requirements which have been implemented. In addition, we did also some cleanup work which you can see from the status 'Duplicate', 'Nonsense' and 'Out of scope' (see in Table 6).

Closed Reqs					
Status	**Conflicting**	**Duplicate**	**Implemented**	**Nonsense**	**Out of scope**
Closed	1	10	33	2	4

Table 6: Requirements overview of status 'Closed'

4. Conclusion

The work on requirements engineering, accomplished during the third year of the project, was focused on a connection between requirements and innovations. The reason for this approach was to foster innovative aspects of the ebbits platform, which is driven by the specified requirements. Since the integration of innovations and requirements was proven as advantageous and effective in terms of evaluating the priority of requirements on their innovativeness, we plan to continue with this approach in the last year of the project as well.

We currently have 48 requirements which are scheduled for implementation (Status "In Progress" and "Part of specification" - see above in Table 1). The requirements in status "Open" and "Quality check passed" will be evaluated if they would be taken into account for inclusion in the final demonstrator.

One major aspect of the fourth year of the project will be the evaluation of the overall ebbits system which will take place within WP9.

5. Implemented Requirements

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation
EBBITS-400	the ebbits PWAL support the LLRP compliant RFID reader	In order to provide the EPC compliancy, ebbits is providing, at PWAL level, a general purpose LLRP proxy: this means that the addition of a new RFID reader (natively providing LLRP interface), doesn't require any further effort for the application developer.	the PWAL includes a PWAL-LLRP driver;	Functional	high	high	Major	Physical devices common virtualization (CIC 12), General purpose RFID reader interface (CIC 10)
EBBITS-394	Traceability application is functioning on Android devices	There is a great abundance of Android devices. It will help to make the application widely available	The application is functioning on a wide range of Android devices	Functional	high	high	Critical	
EBBITS-379	Navigable entity IDs	The Event Processing Agent needs to be able to find related entities instances from a given entity id.	Given en entity instance (and id), it is possible to follow at least one edge in the corresponding entity structure model.	Functional	neutral	neutral	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Entity Manager
EBBITS-378	Entity structure accessible from event rules	The Event Processing Agent needs the entity structure for writing rules over complex entities.	Relations expressing entity compositions (part-of, consists-of) can be used in rules expressed over ebbits entities.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People

								Manager (CIC 15)
EBBITS-374	Support for multiple identification schemes	Application uses different identification schemes. In this way ebbits should support both the existing own identification scheme and other possible future identity management schemes. It is necessary to support an association between identifiers (while storing and querying them), which should be managed by the Entity Manager.	The Entity Manager supports multiple application-dependant identification schemes	Functional			Minor	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)
EBBITS-369	Query the main data in web services and the ontologies in a convenient, combined way	It should be possible to pose combined queries to the background knowledge in form of ontologies and data coming from web services.	SPARQL can be used as query language to ask information from ontologies and get the important data from web services.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18)
EBBITS-368	Service descriptions include operational and business aspects	Bring together business, operational and technical aspects of services into one single coherent language.	At least one service from one use case has been described including operational and business aspects.	Functional	very high	high	Major	Product Service Orchestration Manager (CIC18)
EBBITS-367	ebbits Access Control Policy will be respected by Ontology Manager	WP4 components need to respect WP8's access control policies	ebbits Access Control Policy will be respected by Ontology Manager	Non-Functional - Security	None	very high	Major	Trust and Semantic Access Restrictions (CIC 14)
EBBITS-365	The ebbits platform offers performant ad-hoc reasoning	Applications request information that needs to be inferred from the ontology and other knowledge sources through reasoning/information	The platform is able to provide a response to queries that require reasoning with an acceptable delay (< 1 sec)	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18)

		processing.						
EBBITS-363	Semantic model for the traceability domain is created	A detailed annotation of feedstuff is required to the reasoning processes devised. Proper identification of animals and logging the most relevant information about their lives is vital for the traceability and quality control proposed in ebbits. Meat traceability is one of the main added values of the ebbits platform in the agricultural domain. Different reasoning applications devised in ebbits for tracking the soil efficiency require a detailed annotation and logging of farms' soil. The ebbits platform would provide also some functionalities for the management of resources needed for harvesting, thus they need to be included in the knowledge model. Traceability of meat requires proper tracking of pigs since birth to stores, thus the information after its slaughter is very relevant. The traceability relays on the successful exchange of information about the monitored processes linked to the tracked product.	The semantic model fully enables the traceability scenarios	Non-Functional - Operational	high	very high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Trust and Semantic Access Restrictions (CIC 14)

EBBITS-362	Semantic model for the manufacturing domain is created	It is important to know when and where data were sensed/monitored. Generated messages and alerts need to be traceable and provide rich information about the event detected. Another added value that ebbits could introduce in enterprise domains is efficiency tracking, which requires a monitoring and log of several metrics in devices/tools/machinery and resources in general. Real-time traceability of produced goods/services is achieved by properly annotating their status and metrics during the manufacturing process. The ebbits platform could provide also a system for efficient management of consumables and logistic aspects needed in (not only) manufacturing domains.	The semantic model fully enables the manufacturing scenarios	Non-Functional - Operational	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), Event Processing Network, Entity Manager, IoT-A Compliance

EBBITS-341	Only relevant parts in the ebbits ontologies	The development of the semantic models must be driven by the real use-cases instead of the theoretical assumptions to avoid the unnecessary complexity in the knowledge.	Ontologies are relevant for ebbits use cases. The ratio of used/non-used terms contained in the ebbits ontologies is >90%.	Functional	None	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14)
EBBITS-340	Query the ontologies conveniently	Easy query possibility	SPARQL is used as query language, or an abstraction is used if this turns out to be more usable.	Non-Functional - Usability	None	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)

EBBITS-338	Appropriate ontology language used: follow standard, provide enough expressivity	Tradeoff between expressiveness vs. expensive processing of knowledge representation formalism.	The knowledge representation formalisms must be as small and easy as possible, but as expressive as necessary for our scenarios. As it looks currently, using OWL-Lite will solve this requirement.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), IoT-A Compliance
EBBITS-337	Semantic event processing	It must be possible to interpret events in the context of the different layers in the architecture (from PWAL to a business rules layer).	The system provides at minimum two layers of event processing where events can be captured and possibly filtered/fused	Functional	high	high	Major	Event Processing Network
EBBITS-335	Dependencies on past events possible	An action executed by the system may be dependent on more than one event, and some of them could have occurred in the past.	Actions executed by the system can be processed dependent on current events as well as events having occurred in the past.	Functional	high	high	Major	Event Processing Network
EBBITS-334	Mobile access to farm data in the ERP system	Mobility and access to mobile devices are required to manage aspects of the farm remotely if you are outside your office.	Mobile access (at least a read one) to the data of the ERP system is granted and solution should be browser-based.	Non-Functional - Operational	very high	low	Major	

EBBITS-332	Context management should be able to process a large number of sensor events	A Manufacturing site has at least 500 sensors, where each one raises about 1 event per second. All these events have to be processed by context management.	Context management is able to process at least 500 events / second.	Non-Functional - Performance	neutral	neutral	Major	Process related energy measurement (CIC 17)
EBBITS-330	Applications can monitor the state of devices and context entities	Continuous monitoring of context entities (e.g., pigs, welding guns) can be used to detect anomalies (e.g.: ill Pigs, overheated welding gun)	Applications receives current state of context entity/device and notifications about state changes in 100% of state changes.	Functional	low	very high	Blocker	Distributed Context Management (CIC 16)
EBBITS-329	The system must be able to assign fused data as a context attribute of an entity	Entities cannot provide their own context values, therefore sensors are needed to provide their context values. e.g.:a thermometer is needed to provide the temperature of a room.	The system allows relationship among context of entities and sensors to be modelled.	Functional	neutral	very high	Blocker	Distributed Context Management (CIC 16)
EBBITS-328	Sensor fusion algorithms must be realized as a decoupled component.	Sensor fusion algorithms can be re-used by several other components.	Sensor fusion algorithms are available as services or libraries to the entire platform.	Non-Functional - Maintainability	neutral	neutral	Major	Visual context modelling tool (CIC 17)
EBBITS-326	The system should compensate deviations of incoming data.	The incoming data could contain outliers e.g.: spikes which should not influence the measurement.	System provides configureable filter to exclude outliers e.g.: define upper & lower threshold	Functional	neutral	high	Major	Distributed Context Management (CIC 16)

EBBITS-309	ebbits platform should have a publish-subscribe system	The different monitored processes in ebbits should generate alerts and send them to the interested subsystems or stakeholders.	Directory of alerts/events. The ebbits system includes one or more directories of alerts or events, including for each item the list of subscribers.	Non-Functional - Operational	neutral	high	Major	Visual context modelling tool (CIC 17)
EBBITS-286	Events mapped to (business) rules	Events and services are basic mechanisms for the implementation of the (business) rules logic in the ebbits architecture.	Events of a at least two different event types can be detected in a (business) rule, as expressed in the ebbits business rules framework.	Functional	high	high	Major	Event Processing Network
EBBITS-285	Event model based on common vocabulary	The ebbits platform must be able to handle a potentially large number of events on different levels of abstraction in the system architecture and with different semantics. The processing of events should also be related to the processing and management of data in ebbits, and this should be based on the use of common vocabularies.	The system can distinguish between several (minimum 2) event types based on a common ebbits vocabulary, represented in the event model.	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Remotely control a robot within a manufactory environment (CIC 14), General purpose RFID reader interface (CIC 10)
EBBITS-284	Event history size and/or time span should be configurable	Different applications have different needs for the event history.	The event history can be configured wrt to timespan and size.	Functional	high	very high	Critical	Product Service Orchestration Manager (CIC18)

EBBITS-283	An event history should be maintained	Rule definitions can refer to past events, and behaviour can be defined based on that event history.	A rule that refers to previous events can be expressed.	Functional	neutral	very high	Critical	Event Processing Network
EBBITS-282	It must be possible to order events in the actual event sequence	The delivery of events received from different sources might not follow in the original sequence at transmission. There might be communication delays etc that make them arrive in the wrong order. Nevertheless rules should be able to express temporal/sequence dependencies on events that reflect the actual temporal event sequence at the sources.	It will be possible to express rules that contain temporal/sequence dependencies	Functional	neutral	very high	Critical	Event Processing Network
EBBITS-281	Explicit model of context	It must be possible to trace events and data items across processes and workflows, context management is one of the mechanisms to support this.	The system supports an explicit model of context, which can be applied in at least two application domains.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16)
EBBITS-274	The traceability chain should be computed on demand	The traceability chain should be computed on demand and not stored and recalled, due to storage. Thus, the combination of data is the challenge and a handover of identities might be required. A combination of searches should be realized by semantics.	The traceability chain is computed and not stored.	Functional	neutral	high	Major	Product Service Orchestration Manager (CIC18)

EBBITS-273	Access-control of data in enterprise systems	Access to data needs to be controlled, because some authorities require having access to this data, other stakeholders might have restricted access, other information could be made publicly available.	Access rights can be defined for several stakeholders.	Functional	high	very high	Blocker	Trust and Semantic Access Restrictions (CIC 14)
EBBITS-269	Alarms are send when specific situations occur	Issue alarms when an animal or production machine behaves differently or abnormal.	Application (domain) specific alarms can be modelled and executed by specific event types and by employing the event management functionality of the ebbits archiecture. Rules can be expressed (by an application developer) that may trigger alarm events based on lower level device or system events as well as system states (including time).	Functional	high	very low	Major	Event Processing Network
EBBITS-266	Synchronisation of Acquired Data is necessary	Data synchronization might be necessary, because data will be acquired automatically, manually, semi-manually with different timestamps.	A data synchronization component performs a time stamp based synchronization of a data set.	Functional	high	neutral	Major	Distributed Context Management (CIC 16)
EBBITS-264	Store meta-information with package labels	Meta-data should possibly be stored with packages, this may include: Temperature, location, dimension and weight	A minimal set of 5 attribute-value pairs can be associated with any package/label.	Functional	high	neutral	Major	Thing Manager (CIC16)
EBBITS-258	Waste of energy act definitions	Some users are waisting energy without realizing/being conscious that there are better alternatives.	Energy wasting behaviors are modeled	Functional	very high	very high	Major	

EBBITS-253	Download and harmonisation of third party device ontologies	Re-use of existing device ontologies.	Ontologies from different manufacturers can be used if they are in RDF, OWL or OWL-S.	Functional	very high	very high	Blocker	
EBBITS-252	Report errors in devices	Devices should be able to report errors.	Devices proxies provide report and log errors.	Functional	high	neutral	Critical	Physical devices common virtualization (CIC 12)
EBBITS-250	Support runtime reconfiguration	To supporting monitoring leading to adaptation, the architecture should be dynamic in the sense that components/services should be connectable at runtime.	Services and devices can be connected during runtime.	Functional	high	high	Major	
EBBITS-247	Handling of different device versions in device ontology	The device ontology should be able to handle different versions of a device.	The device ontology can maintain at minimum 2 versions of any single device	Functional	neutral	neutral	Major	
EBBITS-245	The context model needs to be extensible during runtime.	A knowledge model enables the middleware to contain a representation of itself and manipulate its state during its execution. This feature should serve as the basis for self-adaptation of the middleware (e.g. reconfiguration of resource usage, triggering the component-based services).	Middleware is able to adapt its configuration in 60% of identified cases requiring reconfiguration.	Functional	neutral	low	Critical	
EBBITS-244	Different views on the device ontology	It should be possible to present a developer user with different perspectives on the device ontology, depending on that user functional need (e.g., a services perspective, device category	At least two different views are available in the ontology browser.	Functional	high	neutral	Critical	Trust and Semantic Access Restrictions (CIC 14)

		perspective. etc.)						
EBBITS-243	Device and service exception handling	Exception handling	Exception handling constructs that the developer can use to specify exception responses with a success rate of 9/10.	Functional	high	neutral	Major	
EBBITS-233	Items need to be traced within an enterprise	Goods and items need to be traced within one farm or enterprise.	Any item that has an ebbits identifier can be reliably located within a determined area.	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16)
EBBITS-223	The system provides access to aggregated/selected information through filters or fusion	Different processes or process steps require different access to information, e.g. they only need parts of the information or they need aggregated information.	Processes can specify that information should be fused or filtered, and they only get the requested information	Functional	high	high	Major	

EBBITS-216	ebbits platform should integrate Programmable Logic Controllers (PLCs) and make them interoperable with the system	Production automation is controlled through a network of Programmable Logic Controller, the so called PLC, a digital device commonly used in the automation environment. The management of a PLC is usually vertically designed and the PLC monitoring is done at production chain level. Integrating a PLCs' line into ebbits means move the PLC handle and monitoring at higher level, e.g. on order to implement high value added services like the single stage energy consuption monitoring.	The PWAL includes a proper driver and able to integrate PLCs into the ebbits platform and the DDM defines proper models in the Device Catalog ontology.	Functional	very high	very high	Major	Remotely control a robot within a manufactory environment (CIC 14)
EBBITS-197	Historical data should be recorded persistently.	Quality is very important inside an assembly line as it is the essential parameter used for force tests or lack tests.Furthermore, if failures are detected lately when a car is already in the market, but shows some lack, the production history can be traced to find the devil in the detail.	Quality related information is logged inside a proper carrier medium.	Functional	low	high	Blocker	

EBBITS-189	Reduce paper based communication in the Traceability Scenario	Paper based communication between companies/enterprises takes time and efforts for inputing/aggregating sensor data into the backend enterprise systems	With the use of the Ebbits middleware, 50% reduction of current paper based communication.	Functional	neutral	very high	Critical	Thing Manager (CIC16), Entity Manager
EBBITS-186	Interoperability needs to be created between various subsystems in the manufacturing area	The subsystems in manufacturing environments are currently not interconnected and not able to exchange information.	Three independent subsystems from the manufacturing area can exchange information (show a use case)	Functional	neutral	high	Critical	
EBBITS-182	Resilience and adaptable to environment condition changes	Environmental changes such as lighting, temperature affect the results of manufacturing process. so far machines are tuned manually by technicians. adapting to environmental condition can lead to reducing energy consumption e.g.: reduce heater temperature when it's warm outside.	Machines can adapt its parameters adapting to environmental changes.	Non-Functional - Operational	low	high	Critical	
EBBITS-178	Aggregating collected sensor data at a central point	The aggregation of collected data is important for analyzing the data.	A framework is provided that aggregates collected sensor data at a central point of an application.	Functional	very high	low	Blocker	Distributed Context Management (CIC 16)
EBBITS-177	semantic relationships between data	Currently, any data is stored in a simple database. Hence, data is availabe, but cannot be interrelated intelligently.	Data can be queried and inferred in order.	Functional	very low	very high	Blocker	

EBBITS-174	Retrieve manufacturing data history of any relevant event during production	If production defects are recognized, it is helpful to look at the production process history in order to find out what caused the defects.	Any manufacturing relevant (pressure, energy consumption, temperature, humidity, time etc) data is retrievable.	Functional	very low	very high	Major	Event Processing Network
EBBITS-171	Controlling of machines/stations in manufacturing plant remotely	To optimize production process.	Relevant stations that operate automatically can be started/stopped via remote calls.	Functional	low	high	Major	Distributed Context Management (CIC 16), Remotely control a robot within a manufactory environment (CIC 14)
EBBITS-164	A product's lifecycle history can be traced within less than 24 hours.	EU Regulation in the future will obligate enterprises to be able to produce a request of information within 24 hours.	A product lifecycle cross Enterprises can be traced within less than 24 hours.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18)

6. Closed Requirements

6.1 Duplicate Requirements

Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation
The dynamic loading of libraries must be restricted through policies.	Non-Functional - Security	very high	low	Minor	Trust and Semantic Access Restrictions (CIC 14)
The ebbits system grants generation and reading of reports to allowed systems/applications/stakeholders.	Non-Functional - Operational	high	very high	Major	Trust and Semantic Access Restrictions (CIC 14)
The ebbits system provides a device catalog with the semantic models for all supported devices.	Non-Functional - Operational	high	low	Major	
The ebbits system allows the generation/consumption and historical trace of alerts.	Non-Functional - Operational	low	high	Major	
ebbits data acquisition devices/proxies annotates sensed data according to metadata models locally available or requested to semantic stores.	Non-Functional - Operational	low	high	Major	Product Service Orchestration Manager (CIC18), Event Processing Network
Minimum hardware requirements (which must be supported by all target hardware) are defined and all hardware that meets the specifications is guaranteed to work with hydra.	Constraint	neutral	neutral	Blocker	
The system supports at least two different soft-logic algorithms. e.g.: Fuzzy logic & probabilistic approach	Functional	high	neutral	Minor	
Management can do benchmarking in different operational level	Functional	very high	very high	Blocker	

6.2 Other closed requirements

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation
EBBITS-379	Navigable entity IDs	The Event Processing Agent needs to be able to find related entities instances from a given entity id.	Given en entity instance (and id), it is possible to follow at least one edge in the corresponding entity structure model.	Functional	neutral	neutral	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Entity Manager
EBBITS-378	Entity structure accessible from event rules	The Event Processing Agent needs the entity structure for writing rules over complex entities.	Relations expressing entity compositions (part-of, consists-of) can be used in rules expressed over ebbits entities.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)
EBBITS-369	Query the main data in web services and the ontologies in a convenient, combined way	It should be possible to pose combined queries to the background knowledge in form of ontologies and data coming from web services.	SPARQL can be used as query language to ask information from ontologies and get the important data from web services.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18)
EBBITS-368	Service descriptions include operational and business aspects	Bring together business, operational and technical aspects of services into one single coherent language.	At least one service from one use case has been described including operational and business aspects.	Functional	very high	high	Major	Product Service Orchestration Manager (CIC18)

EBBITS-366	The ebbits platform offers ad-hoc aggregation of knowledge	Knowledge is distributed in the ebbits network, and must be aggregated when a query requires so, transparently for the application	The platform is able to provide a response to queries that require aggregation of knowledge with an acceptable delay (< 1 sec)	Functional	high	high	Critical	Distributed Context Management (CIC 16)

EBBITS-363	Semantic model for the traceability domain is created	A detailed annotation of feedstuff is required to the reasoning processes devised. Proper identification of animals and logging the most relevant information about their lives is vital for the traceability and quality control proposed in ebbits. Meat traceability is one of the main added values of the ebbits platform in the agricultural domain. Different reasoning applications devised in ebbits for tracking the soil efficiency require a detailed annotation and logging of farms' soil. The ebbits platform would provide also some functionalities for the management of resources needed for harvesting, thus they need to be included in the knowledge model. Traceability of meat requires proper tracking of pigs since birth to stores, thus the information after its slaughter is very relevant. The traceability relays on the successful exchange of information about the monitored processes linked to the tracked product.	The semantic model fully enables the traceability scenarios	Non-Functional - Operational	high	very high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Trust and Semantic Access Restrictions (CIC 14)

EBBITS-362	Semantic model for the manufacturing domain is created	It is important to know when and where data were sensed/monitored. Generated messages and alerts need to be traceable and provide rich information about the event detected. Another added value that ebbits could introduce in enterprise domains is efficiency tracking, which requires a monitoring and log of several metrics in devices/tools/machinery and resources in general. Real-time traceability of produced goods/services is achieved by properly annotating their status and metrics during the manufacturing process. The ebbits platform could provide also a system for efficient management of consumables and logistic aspects needed in (not only) manufacturing domains.	The semantic model fully enables the manufacturing scenarios	Non-Functional - Operational	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), Event Processing Network, Entity Manager, IoT-A Compliance
EBBITS-337	Semantic event processing	It must be possible to interpret events in the context of the different layers in the architecture (from PWAL to a business rules layer).	The system provides at minimum two layers of event processing where events can be captured and possibly filtered/fused	Functional	high	high	Major	Event Processing Network
EBBITS-335	Dependencies on past events possible	An action executed by the system may be dependent on more than one event, and some of them could have occurred in the past.	Actions executed by the system can be processed dependent on current events as well as events having occurred in the past.	Functional	high	high	Major	Event Processing Network

EBBITS-334	Mobile access to farm data in the ERP system	Mobility and access to mobile devices are required to manage aspects of the farm remotely if you are outside your office.	Mobile access (at least a read one) to the data of the ERP system is granted and solution should be browser-based.	Non-Functional - Operational	very high	low	Major	
EBBITS-332	Context management should be able to process a large number of sensor events	A Manufacturing site has at least 500 sensors, where each one raises about 1 event per second. All these events have to be processed by context management.	Context management is able to process at least 500 events / second.	Non-Functional - Performance	neutral	neutral	Major	Process related energy measurement (CIC 17)
EBBITS-330	Applications can monitor the state of devices and context entities	Continuous monitoring of context entities (e.g., pigs, welding guns) can be used to detect anomalies (e.g.: ill Pigs, overheated welding gun)	Applications receives current state of context entity/device and notifications about state changes in 100% of state changes.	Functional	low	very high	Blocker	Distributed Context Management (CIC 16)
EBBITS-329	The system must be able to assign fused data as a context attribute of an entity	Entities cannot provide their own context values, therefore sensors are needed to provide their context values. e.g.:a thermometer is needed to provide the temperature of a room.	The system allows relationship among context of entities and sensors to be modelled.	Functional	neutral	very high	Blocker	Distributed Context Management (CIC 16)
EBBITS-328	Sensor fusion algorithms must be realized as a decoupled component.	Sensor fusion algorithms can be re-used by several other components.	Sensor fusion algorithms are available as services or libraries to the entire platform.	Non-Functional - Maintainability	neutral	neutral	Major	Visual context modelling tool (CIC 17)
EBBITS-327	Sensor fusion algorithm must be added during run-time in a modular and extensible way.	Sensor fusion algorithms vary greatly and can't be generalized only in one module.	New sensor fusion algorithms can be added in a pluggable way	Functional	high	neutral	Critical	Distributed Context Management (CIC 16)
EBBITS-326	The system should compensate deviations of incoming data.	The incoming data could contain outliers e.g.: spikes which should not influence the	System provides configureable filter to exclude outliers e.g.: define upper & lower	Functional	neutral	high	Major	Distributed Context Management (CIC 16)

		measurement.	threshold					
EBBITS-309	ebbits platform should have a publish-subscribe system	The different monitored processes in ebbits should generate alerts and send them to the interested subsystems or stakeholders.	Directory of alerts/events. The ebbits system includes one or more directories of alerts or events, including for each item the list of subscribers.	Non-Functional - Operational	neutral	high	Major	Visual context modelling tool (CIC 17)
EBBITS-285	Event model based on common vocabulary	The ebbits platform must be able to handle a potentially large number of events on different levels of abstraction in the system architecture and with different semantics. The processing of events should also be related to the processing and management of data in ebbits, and this should be based on the use of common vocabularies.	The system can distinguish between several (minimum 2) event types based on a common ebbits vocabulary, represented in the event model.	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Remotely control a robot within a manufactory environment (CIC 14), General purpose RFID reader interface (CIC 10)
EBBITS-284	Event history size and/or time span should be configurable	Different applications have different needs for the event history.	The event history can be configured wrt to timespan and size.	Functional	high	very high	Critical	Product Service Orchestration Manager (CIC18)
EBBITS-283	An event history should be maintained	Rule definitions can refer to past events, and behaviour can be defined based on that event history.	A rule that refers to previous events can be expressed.	Functional	neutral	very high	Critical	Event Processing Network

EBBITS-281	Explicit model of context	It must be possible to trace events and data items across processes and workflows, context management is one of the mechanisms to support this.	The system supports an explicit model of context, which can be applied in at least two application domains.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16)
EBBITS-271	The system should be self-ware	User statement: "Let me make my system self-aware"	User gets informed of any event she is interested in.	Functional	high	neutral	Major	
EBBITS-268	Different Views on the Data is necessary	We need services that provide different views on the data cloud by combining data from different sources.	Data can be filtered and sorted based on an arbitrary set of parameters.	Functional	very high	very low	Major	
EBBITS-266	Synchronisation of Acquired Data is necessary	Data synchronization might be necessary, because data will be acquired automatically, manually, semi-manually with different timestamps.	A data synchronization component performs a time stamp based synchronization of a data set.	Functional	high	neutral	Major	Distributed Context Management (CIC 16)
EBBITS-264	Store meta-information with package labels	Meta-data should possibly be stored with packages, this may include: Temperature, location, dimension and weight	A minimal set of 5 attribute-value pairs can be associated with any package/label.	Functional	high	neutral	Major	Thing Manager (CIC16)
EBBITS-252	Report errors in devices	Devices should be able to report errors.	Devices proxies provide report and log errors.	Functional	high	neutral	Critical	Physical devices common virtualization (CIC 12)
EBBITS-250	Support runtime reconfiguration	To supporting monitoring leading to adaptation, the architecture should be dynamic in the sense that components/services should be connectable at runtime.	Services and devices can be connected during runtime.	Functional	high	high	Major	

EBBITS-246	Dynamically loaded libraries must undergo a security check before their usage	Dynamically loaded libraries (e.g. DLL, JAR, OSGI bundle) could contain malicious code.	Dynamically loaded libraries must contain a valid signature in order to prevent security breaches in the system.	Functional	neutral	neutral	Major	
EBBITS-245	The context model needs to be extensible during runtime.	A knowledge model enables the middleware to contain a representation of itself and manipulate its state during its execution. This feature should serve as the basis for self-adaptation of the middleware (e.g. reconfiguration of resource usage, triggering the component-based services).	Middleware is able to adapt its configuration in 60% of identified cases requiring reconfiguration.	Functional	neutral	low	Critical	
EBBITS-244	Different views on the device ontology	It should be possible to present a developer user with different perspectives on the device ontology, depending on that user functional need (e.g., a services perspective, device category perspective. etc.)	At least two different views are available in the ontology browser.	Functional	high	neutral	Critical	Trust and Semantic Access Restrictions (CIC 14)
EBBITS-223	The system provides access to aggregated/selected information through filters or fusion	Different processes or process steps require different access to information, e.g. they only need parts of the information or they need aggregated information.	Processes can specify that information should be fused or filtered, and they only get the requested information	Functional	high	high	Major	

EBBITS-216	ebbits platform should integrate Programmable Logic Controllers (PLCs) and make them interoperable with the system	Production automation is controlled through a network of Programmable Logic Controller, the so called PLC, a digital device commonly used in the automation environment. The management of a PLC is usually vertically designed and the PLC monitoring is done at production chain level. Integrating a PLCs' line into ebbits means move the PLC handle and monitoring at higher level, e.g. on order to implement high value added services like the single stage energy consuption monitoring.	The PWAL includes a proper driver and able to integrate PLCs into the ebbits platform and the DDM defines proper models in the Device Catalog ontology.	Functional	very high	very high	Major	Remotely control a robot within a manufactory environment (CIC 14)
EBBITS-197	Historical data should be recorded persistently.	Quality is very important inside an assembly line as it is the essential parameter used for force tests or lack tests.Furthermore, if failures are detected lately when a car is already in the market, but shows some lack, the production history can be traced to find the devil in the detail.	Quality related information is logged inside a proper carrier medium.	Functional	low	high	Blocker	
EBBITS-186	Interoperability needs to be created between various subsystems in the manufacturing area	The subsystems in manufacturing environments are currently not interconnected and not able to exchange information.	Three independent subsystems from the manufacturing area can exchange information (show a use case)	Functional	neutral	high	Critical	

EBBITS-182	Resilience and adaptable to environment condition changes	Environmental changes such as lighting, temperature affect the results of manufacturing process. so far machines are tuned manually by technicians. adapting to environmental condition can lead to reducing energy consumption e.g.: reduce heater temperature when it's warm outside.	Machines can adapt its parameters adapting to environmental changes.	Non-Functional - Operational	low	high	Critical	
EBBITS-179	Farmers are able to retrieve optimized models from research	Farmers are willing to share data if they could get something in return such as models to optimize feeding process.	Farmers can get optimized models electronically.	Functional	high	low	Minor	
EBBITS-178	Aggregating collected sensor data at a central point	The aggregation of collected data is important for analyzing the data.	A framework is provided that aggregates collected sensor data at a central point of an application.	Functional	very high	low	Blocker	Distributed Context Management (CIC 16)
EBBITS-177	semantic relationships between data	Currently, any data is stored in a simple database. Hence, data is availabe, but cannot be interrelated intelligently.	Data can be queried and inferred in order.	Functional	very low	very high	Blocker	

EBBITS-171	Controlling of machines/stations in manufacturing plant remotely	To optimize production process.	Relevant stations that operate automatically can be started/stopped via remote calls.	Functional	low	high	Major	Distributed Context Management (CIC 16), Remotely control a robot within a manufactory environment (CIC 14)
EBBITS-167	Heterogeneous enterprise systems need to be able to exchange information.	Enterprises use various information systems that need to exchange information. Information needs to be propagated throughout the chain.	At least three different enterprise systems can exchange information.	Functional	low	very high	Minor	

7. Updated requirements for ebbits

7.1 WP3

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-377	Deconstruction and reconstruction of created or existing value models should be viable to reflect and understand the variation in value created.	Using deconstruction we are able to split a value model into smaller parts and reconstruction composes these parts in different ways. That enables us to reflect the possible variations in value created.	The requirement is met if the value model and value operational scenarios have been created.	Non-Functional			Major		Resolved	Out of scope
EBBITS-233	Items need to be traced within an enterprise	Goods and items need to be traced within one farm or enterprise.	Any item that has an ebbits identifier can be reliably located within a determined area.	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16)	Resolved	Implemented
EBBITS-228	reduce water consumption in PWT	water consumption for cooling and lubricating purposes in PWT is really high (300-500 lt./minute)	10% of water consumption can be reduced	Non-Functional - Operational	high	high	Minor		Resolved	Out of scope

EBBITS-217	3 Measurement Points for every station in body welding	energy cost that can be calculated includes: lightings, processes, energy for welding	3 measurement points are covered	Functional	very high	very high	Major		Open	*Unresolved*
EBBITS-193	Improve air compression energy usage	Air compression is one main energy guzzler. Only 40% of air can be transferred effectively.	More than 40% of air can be transferred effectively (@Roberto is this realistic?)	Non-Functional - Operational	very high	very low	Major		Resolved	Out of scope
EBBITS-164	A product's lifecycle history can be traced within less than 24 hours.	EU Regulation in the future will obligate enterprises to be able to produce a request of information within 24 hours.	A product lifecycle cross Enterprises can be traced within less than 24 hours.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18)	Resolved	Implemented

7.2 WP4

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-386	Toolset support allows administrators of a local ebbits instance to map the available devices to the domain model defined by the application	Application developers cannot define the mapping of devices to domain entities	Tool is available and tested	Non-Functional - Maintainability			Major	Visual context modelling tool (CIC 17)	Quality Check passed	*Unresolved*

EBBITS-367	ebbits Access Control Policy will be respected by Ontology Manager	WP4 components need to respect WP8's access control policies	ebbits Access Control Policy will be respected by Ontology Manager	Non-Functional - Security	None	very high	Major	Trust and Semantic Access Restrictions (CIC 14)	Resolved	Implemented
EBBITS-366	The ebbits platform offers ad-hoc aggregation of knowledge	Knowledge is distributed in the ebbits network, and must be aggregated when a query requires so, transparently for the application	The platform is able to provide a response to queries that require aggregation of knowledge with an acceptable delay (< 1 sec)	Functional	high	high	Critical	Distributed Context Management (CIC 16)	Closed	Conflicting
EBBITS-365	The ebbits platform offers performant ad-hoc reasoning	Applications request information that needs to be inferred from the ontology and other knowledge sources through reasoning/information processing.	The platform is able to provide a response to queries that require reasoning with an acceptable delay (< 1 sec)	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18)	Resolved	Implemented

EBBITS-364	Semantic model for the business process domain is created	ebbits platform can be exploited also for generic enterprise processes. Information exchanged between stakeholders could be exploited for some reasoning, thus it is convenient to model such exchange semantically and to forward or keep linked its metadata through the different stakeholders.	The semantic model fully enables business processes specified in scenarios	Non-Functional - Operational	neutral	neutral	Minor	Process related energy measurement (CIC 17)	Resolved	Out of scope
EBBITS-363	Semantic model for the traceability domain is created	A detailed annotation of feedstuff is required to the reasoning processes devised. Proper identification of animals and logging the most relevant information about their lives is vital for the traceability and quality control proposed in ebbits. Meat traceability is one of the main added values of the ebbits platform in the agricultural domain. Different	The semantic model fully enables the traceability scenarios	Non-Functional - Operational	high	very high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Trust and Semantic Access Restrictions (CIC 14)	Closed	Implemented

		reasoning applications devised in ebbits for tracking the soil efficiency require a detailed annotation and logging of farms' soil. The ebbits platform would provide also some functionalities for the management of resources needed for harvesting, thus they need to be included in the knowledge model. Traceability of meat requires proper tracking of pigs since birth to stores, thus the information after its slaughter is very relevant. The traceability relays on the successful exchange of information about the monitored processes linked to the tracked product.								

EBBITS-362	Semantic model for the manufacturing domain is created	It is important to know when and where data were sensed/monitored. Generated messages and alerts need to be traceable and provide rich information about the event detected. Another added value that ebbits could introduce in enterprise domains is efficiency tracking, which requires a monitoring and log of several metrics in devices/tools/machinery and resources in general. Real-time traceability of produced goods/services is achieved by properly annotating their status and metrics during the manufacturing process. The ebbits platform could provide also a system for efficient management of consumables and logistic aspects needed in (not only) manufacturing domains.	The semantic model fully enables the manufacturing scenarios	Non-Functional - Operational	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), Event Processing Network, Entity Manager, IoT-A Compliance	Closed	Implemented

EBBITS-360	Measured data and the context model (as defined by WP5) are consistent.	Consistency between abstract context model and concrete measured data.	We measure consistency by a standard reasoner. Consistency checking is one basic reasoning service.	Functional	None	high	Major	Distributed Context Management (CIC 16)	Part of specification	*Unresolved*
EBBITS-341	Only relevant parts in the ebbits ontologies	The development of the semantic models must be driven by the real use-cases instead of the theoretical assumptions to avoid the unnecessary complexity in the knowledge.	Ontologies are relevant for ebbits use cases. The ratio of used/non-used terms contained in the ebbits ontologies is >90%.	Functional	None	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14)	Resolved	Implemented
EBBITS-340	Query the ontologies conveniently	Easy query possibility	SPARQL is used as query language, or an abstraction is used if this turns out to be more usable.	Non-Functional - Usability	None	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)	Resolved	Implemented

EBBITS-339	Ontology namespace	Common ontology namespace is important.	ebbits ontologies will share namespace http://www.ebbits-project.eu/ontologies	Functional	None	high	Major	Product Service Orchestration Manager (CIC18), Visual context modelling tool (CIC 17), Thing Manager (CIC16), People Manager (CIC 15), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), Event Processing Network, Entity Manager, IoT-A Compliance	In Progress	*Unresolved*

EBBITS-338	Appropriate ontology language used: follow standard, provide enough expressivity	Tradeoff between expressiveness vs. expensive processing of knowledge representation formalism.	The knowledge representation formalisms must be as small and easy as possible, but as expressive as necessary for our scenarios. As it looks currently, using OWL-Lite will solve this requirement.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Distributed Context Management (CIC 16), Trust and Semantic Access Restrictions (CIC 14), IoT-A Compliance	Resolved	Implemented
EBBITS-308	Reports should have a list of allowed readers/subscribers.	Aggregated data, reports, alerts, etc, should be available only to stakeholders interested in them.	The ebbits system grants generation and reading of reports to allowed systems/applications/stakeholders.	Non-Functional - Operational	high	very high	Major	Trust and Semantic Access Restrictions (CIC 14)	Closed	Duplicate
EBBITS-289	Monitored/sensed data should be (semantically) annotated in local server/repo/store.	Information relationships should be available as soon as data enters the ebbits system.	ebbits data acquisition devices/proxies annotates sensed data according to metadata models locally available or requested to semantic stores.	Non-Functional - Operational	low	high	Major	Product Service Orchestration Manager (CIC18), Event Processing Network	Closed	Duplicate

EBBITS-287	All stakeholders should be annotated with unique Id, type, name and relevant info.	Model the users accessing the ebbits system.	The ebbits system includes one or more directories of stakeholders or identity managers, including for each stakeholder annotations about id, type, name and relevant info.	Non-Functional - Security	neutral	very high	Critical	People Manager (CIC 15)	Quality Check passed	*Unresolved*
EBBITS-274	The traceability chain should be computed on demand	The traceability chain should be computed on demand and not stored and recalled, due to storage. Thus, the combination of data is the challenge and a handover of identities might be required. A combination of searches should be realized by semantics.	The traceability chain is computed and not stored.	Functional	neutral	high	Major	Product Service Orchestration Manager (CIC18)	Resolved	Implemented
EBBITS-267	Meta-information associated with entities needs to be trustworthy	ebbits needs to guarantee that the information associated with a specific product is the right and correct one that has not been manipulated.	Acquired information cannot be manipulated by unauthorized people.	Non-Functional - Security	high	very high	Major	Trust and Semantic Access Restrictions (CIC 14)	Part of specification	*Unresolved*
EBBITS-263	The system should allow the correlation of information emerging from several sources	In order to easily analyse information, the system should allow for the correlation of information from different sources on a farm or enterprise	Information is correlated so that information from different sources on a farm has >0 explicit links. One criterion for the correlation can be timestamps.	Functional	high	low	Major		Resolved	Out of scope

EBBITS-262	Common structure of information is needed	Describe situations of pigs in a computable way.	Common data structure to describe situations of arbitrary entities is available	Functional	high	high	Major		Quality Check passed	*Unresolved*
EBBITS-258	Waste of energy act definitions	Some users are waisting energy without realizing/being conscious that there are better alternatives.	Energy wasting behaviors are modeled	Functional	very high	very high	Major		Resolved	Implemented
EBBITS-253	Download and harmonisation of third party device ontologies	Re-use of existing device ontologies.	Ontologies from different manufacturers can be used if they are in RDF, OWL or OWL-S.	Functional	very high	very high	Blocker		Resolved	Implemented
EBBITS-247	Handling of different device versions in device ontology	The device ontology should be able to handle different versions of a device.	The device ontology can maintain at minimum 2 versions of any single device	Functional	neutral	neutral	Major		Resolved	Implemented
EBBITS-245	The context model needs to be extensible during runtime.	A knowledge model enables the middleware to contain a representation of itself and manipulate its state during its execution. This feature should serve as the basis for self-adaptation of the middleware (e.g. reconfiguration of resource usage, triggering the component-based services).	Middleware is able to adapt its configuration in 60% of identified cases requiring reconfiguration.	Functional	neutral	low	Critical		Closed	Implemented

EBBITS-244	Different views on the device ontology	It should be possible to present a developer user with different perspectives on the device ontology, depending on that user functional need (e.g., a services perspective, device category perspective. etc.)	At least two different views are available in the ontology browser.	Functional	high	neutral	Critical	Trust and Semantic Access Restrictions (CIC 14)	Closed	Implemented
EBBITS-243	Device and service exception handling	Exception handling	Exception handling constructs that the developer can use to specify exception responses with a success rate of 9/10.	Functional	high	neutral	Major		Resolved	Implemented
EBBITS-235	Information needs to be described in a standardised way	Heterogeneous data sources and exchange formats.	A standard for exchanging information between system components is provided.	Functional	high	neutral	Major		Quality Check passed	*Unresolved*
EBBITS-204	Definition of smallest unit can be traced or uniquely identified	Small parts of products / cheap parts of products cannot be identified anymore because of physical limitation of tags. Price of tags is too expensive to tag cheap parts.	Clear definition in both domains of what can be tagged.	Functional	neutral	very high	Critical		Quality Check passed	*Unresolved*

EBBITS-197	Historical data should be recorded persistently.	Quality is very important inside an assembly line as it is the essential parameter used for force tests or lack tests.Furthermore, if failures are detected lately when a car is already in the market, but shows some lack, the production history can be traced to find the devil in the detail.	Quality related information is logged inside a proper carrier medium.	Functional	low	high	Blocker		Closed	Implemented
EBBITS-186	Interoperability needs to be created between various subsystems in the manufacturing area	The subsystems in manufacturing environments are currently not interconnected and not able to exchange information.	Three independent subsystems from the manufacturing area can exchange information (show a use case)	Functional	neutral	high	Critical		Closed	Implemented
EBBITS-177	semantic relationships between data	Currently, any data is stored in a simple database. Hence, data is availabe, but cannot be interrelated intelligently.	Data can be queried and inferred in order.	Functional	very low	very high	Blocker		Closed	Implemented

7.3 WP5

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-404	Generate java code from a visual model	Developers want to have the repetitive codes automatically generated and have the opportunities to extend the codes	Developers could have java code web service, rest, linksmart events automatically generated	Functional	high	neutral	Critical	Visual context modelling tool (CIC 17)	Open	*Unresolved*
EBBITS-399	Reference context model for Internet of things, people and services	a basic framework of context model will give developers directions how to extend ebbits	developers could extend or modify the reference context model if he's building his application.	Functional	low	high	Major	Visual context modelling tool (CIC 17), Thing Manager (CIC16), People Manager (CIC 15)	Quality Check passed	*Unresolved*
EBBITS-398	Java based object oriented context modeling	developers would like to have a unified platform that use the language they are familiar with	developers can define context model in java	Functional	neutral	very high	Blocker	Visual context modelling tool (CIC 17)	Quality Check passed	*Unresolved*
EBBITS-397	Prototyping tools for context modeling	novice developers find modeling context with ontology is time consuming and require a deep understanding of ontology engineering	model driven tool for modeling context exists	Functional	high	neutral	Major	Visual context modelling tool (CIC 17)	In Progress	*Unresolved*
EBBITS-385	Device Proxies need a standardized interface that provides control management services for event publication	a way to configure the event publication (topic, frequency, data fusion etc.) is needed to support adjusting data traffic according to the network	Device proxy interface defined	Functional			Major	Distributed Context Management (CIC 16)	In Progress	*Unresolved*

EBBITS-384	Device proxies reset devices upon problems when no other fix is defined by the developer	Sensors causing a lot of problems could effect the stability of the proxy; Reset is an easy way to recover the device states.	Shut-off functionality available, logic to detect problems implemented.	Functional			Major	Physical devices common virtualization (CIC 12)	Part of specification	*Unresolved*
EBBITS-383	Device proxies adjust event publishing frequency according to the network bandwidth	Static frequency of sensor reading is not optimal when the network bandwidth fluctuates because it causes congestion when the bandwidth is currently slow.	Control management services available.	Non-Functional - Performance			Major	Distributed Context Management (CIC 16)	Quality Check passed	*Unresolved*
EBBITS-382	Device proxies can shut off a physical device from the network if it causes a lot of problem	Sensors causing a lot of problems could affect the stability of the proxy.	Shut-off functionality available, logic to detect problems implemented.	Functional			Major	Physical devices common virtualization (CIC 12)	Quality Check passed	*Unresolved*
EBBITS-381	Self-* manager needs to monitor the connection to the physical devices	Proxy connection to the physical devices could be unstable.	Self-* manager implementation is available that can handle unstable device connection.	Functional			Major	Distributed Context Management (CIC 16)	Quality Check passed	*Unresolved*
EBBITS-333	Libraries must only be accessible only for permitted applications.	Libraries could contain functionality that should not be available to all kinds of applications (e.g. calculation of quality rating of meat should only be allowed for slaughterhouse application but not for consumer application.)	The dynamic loading of libraries must be restricted through policies.	Non-Functional - Security	very high	low	Minor	Trust and Semantic Access Restrictions (CIC 14)	Closed	Duplicate

EBBITS-332	Context management should be able to process a large number of sensor events	A Manufacturing site has at least 500 sensors, where each one raises about 1 event per second. All these events have to be processed by context management.	Context management is able to process at least 500 events / second.	Non-Functional - Performance	neutral	neutral	Major	Process related energy measurement (CIC 17)	Closed	Implemented
EBBITS-330	Applications can monitor the state of devices and context entities	Continuous monitoring of context entities (e.g., pigs, welding guns) can be used to detect anomalies (e.g.: ill Pigs, overheated welding gun)	Applications receives current state of context entity/device and notifications about state changes in 100% of state changes.	Functional	low	very high	Blocker	Distributed Context Management (CIC 16)	Closed	Implemented
EBBITS-329	The system must be able to assign fused data as a context attribute of an entity	Entities cannot provide their own context values, therefore sensors are needed to provide their context values. e.g.:a thermometer is needed to provide the temperature of a room.	The system allows relationship among context of entities and sensors to be modelled.	Functional	neutral	very high	Blocker	Distributed Context Management (CIC 16)	Closed	Implemented
EBBITS-328	Sensor fusion algorithms must be realized as a decoupled component.	Sensor fusion algorithms can be re-used by several other components.	Sensor fusion algorithms are available as services or libraries to the entire platform.	Non-Functional - Maintainability	neutral	neutral	Major	Visual context modelling tool (CIC 17)	Closed	Implemented
EBBITS-327	Sensor fusion algorithm must be added during run-time in a modular and extensible way.	Sensor fusion algorithms vary greatly and can't be generalized only in one module.	New sensor fusion algorithms can be added in a pluggable way	Functional	high	neutral	Critical	Distributed Context Management (CIC 16)	Closed	Out of scope
EBBITS-326	The system should compensate deviations of incoming data.	The incoming data could contain outliers e.g.: spikes which should not influence	System provides configureable filter to exclude outliers e.g.: define upper	Functional	neutral	high	Major	Distributed Context Management (CIC 16)	Closed	Implemented

		the measurement.	& lower threshold							
EBBITS-309	ebbits platform should have a publish-subscribe system	The different monitored processes in ebbits should generate alerts and send them to the interested subsystems or stakeholders.	Directory of alerts/events. The ebbits system includes one or more directories of alerts or events, including for each item the list of subscribers.	Non-Functional - Operational	neutral	high	Major	Visual context modelling tool (CIC 17)	Closed	Implemented
EBBITS-291	Devices should be annotated with id, type, name, location, and current/historical data (status, work in progress, consumables levels, quality record, energy consumption, energy profile, planned/unplanned intervention/maintenance, fault info, etc).	Another added value that ebbits could introduce in enterprise domains is efficiency tracking, which requires a monitoring and log of several metrics in devices/tools/machinery and resources in general.	The ebbits system provides a device catalog with the semantic models for all supported devices.	Non-Functional - Operational	high	low	Major		Closed	Duplicate
EBBITS-290	Alerts should be contextualized (timestamp, geotag, type, message, warning level, etc).	Generated messages and alerts need to be traceable and provide rich information about the event detected.	The ebbits system allows the generation/consumption and historical trace of alerts.	Non-Functional - Operational	low	high	Major		Closed	Duplicate
EBBITS-271	The system should be self-ware	User statement: "Let me make my system self-aware"	User gets informed of any event she is interested in.	Functional	high	neutral	Major		Closed	Nonsense
EBBITS-268	Different Views on the Data is necessary	We need services that provide different views on the data cloud by combining data from different sources.	Data can be filtered and sorted based on an arbitrary set of parameters.	Functional	very high	very low	Major		Closed	Out of scope

EBBITS-266	Synchronisation of Acquired Data is necessary	Data synchronization might be necessary, because data will be acquired automatically, manually, semi-manually with different timestamps.	A data synchronization component performs a time stamp based synchronization of a data set.	Functional	high	neutral	Major	Distributed Context Management (CIC 16)	Closed	Implemented
EBBITS-252	Report errors in devices	Devices should be able to report errors.	Devices proxies provide report and log errors.	Functional	high	neutral	Critical	Physical devices common virtualization (CIC 12)	Closed	Implemented
EBBITS-250	Support runtime reconfiguration	To supporting monitoring leading to adaptation, the architecture should be dynamic in the sense that components/services should be connectable at runtime.	Services and devices can be connected during runtime.	Functional	high	high	Major		Closed	Implemented
EBBITS-249	The system should support distributed intelligence on embedded system.	We have a need for "intelligence" (Semantics, reflection etc.). We have a need for supporting embedded systems. This should not conflict	Minimum hardware requirements (which must be supported by all target hardware) are defined and all hardware that meets the specifications is guaranteed to work with hydra.	Constraint	neutral	neutral	Blocker		Closed	Duplicate
EBBITS-246	Dynamically loaded libraries must undergo a security check before their usage	Dynamically loaded libraries (e.g. DLL, JAR, OSGI bundle) could contain malicious code.	Dynamically loaded libraries must contain a valid signature in order to prevent security breaches in the system.	Functional	neutral	neutral	Major		Closed	Out of scope

EBBITS-242	The system should be able to take decision based on uncertain facts	uncertain fact could happen due to noisy sensor data, interference from the environment, unreliable sensors, etc.	The system supports at least two different soft-logic algorithms. e.g.: Fuzzy logic & probabilistic approach	Functional	high	neutral	Minor		Closed	Duplicate
EBBITS-223	The system provides access to aggregated/selected information through filters or fusion	Different processes or process steps require different access to information, e.g. they only need parts of the information or they need aggregated information.	Processes can specify that information should be fused or filtered, and they only get the requested information	Functional	high	high	Major		Closed	Implemented
EBBITS-213	System should show Energy Cost for different granularity of production processes	Energy cost at different levels is needed to do benchmarking of operational processes.	Each automated process, machine is able to show energy cost	Functional	very high	very high	Blocker		In Progress	*Unresolved*
EBBITS-210	System should provide location tracking of context entities	Location is one of the basic context attributes. Due to its importance, as well as the explicit request from end-user workshops and the different options of location tracking, this is considered a requirement on its own.	Location is available as a generic context attribute (EBBITS-330), and applications can specify which sensors to use for location tracking (and choose among different standard tracking methods)	Functional	neutral	very high	Blocker		Quality Check passed	*Unresolved*

EBBITS-200	Distributed data can be referenced in data fusion and context management	Data is spread across several instances of ebbits, even several enterprises. In context management, data fusion, and also semantic querying, distributed data needs to be referenced.	References to remote data can be defined and the queries can be executed.	Functional	high	high	Major	Distributed Context Management (CIC 16)	In Progress	*Unresolved*
EBBITS-196	Diagnostic component to detect and correct malfunctions	If a malfunction has slipped in the plant it should be corrected ASAP. In fact, if possible any fault behaviour should be prevented at all.	Malfunctions or strange behaviour of machinery are recognized early enough.	Functional	high	neutral	Major		Resolved	Duplicate
EBBITS-184	Filtering to Obtain relevant Information	Too much information overwhelms farmers while making decisions.	Farmers are able to view the relevant information out of the whole.	Non-Functional - Usability	low	high	Major		Closed	Duplicate
EBBITS-182	Resilience and adaptable to environment condition changes	Environmental changes such as lighting, temperature affect the results of manufacturing process. so far machines are tuned manually by technicians. adapting to environmental condition can lead to reducing energy consumption e.g.: reduce heater	Machines can adapt its parameters adapting to environmental changes.	Non-Functional - Operational	low	high	Critical		Closed	Implemented

		temperature when it's warm outside.								
EBBITS-179	Farmers are able to retrieve optimized models from research	Farmers are willing to share data if they could get something in return such as models to optimize feeding process.	Farmers can get optimized models electronically.	Functional	high	low	Minor		Closed	Out of scope
EBBITS-178	Aggregating collected sensor data at a central point	The aggregation of collected data is important for analyzing the data.	A framework is provided that aggregates collected sensor data at a central point of an application.	Functional	very high	low	Blocker	Distributed Context Management (CIC 16)	Closed	Implemented
EBBITS-171	Controlling of machines/stations in manufacturing plant remotely	To optimize production process.	Relevant stations that operate automatically can be started/stopped via remote calls.	Functional	low	high	Major	Distributed Context Management (CIC 16), Remotely control a robot within a manufactory environment (CIC 14)	Closed	Implemented

7.4 WP6

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-402	Data exchange with Enterprise Systems in standard formats like Atom or OData	For the frequent changes and additions of the data model which are necessary for the different ebbits use cases, implementing services without a connectivity framework was not flexible enough. For each change this requires to write too much own code for standard functions. A connectivity framework with standard data formats is needed where changes in the data model are nearly automatically reflected in the provided service.	A connectivity framework is used that allows for data exchange using standards like Atom and OData	Non-Functional	high	high	Major	Entity Manager	Open	*Unresolved*
EBBITS-401	Enable self-service approach to BI information	Managers or users without the technical knowledge of Business Analysts want to get insights quickly without the need for help from an IT department	A "point and click" solution to manipulate, organize and consolidate data and answer business intelligence questions in a visual way should be available	Functional	high	high	Major	Process related energy measurement (CIC 17)	Open	*Unresolved*

EBBITS-369	Query the main data in web services and the ontologies in a convenient, combined way	It should be possible to pose combined queries to the background knowledge in form of ontologies and data coming from web services.	SPARQL can be used as query language to ask information from ontologies and get the important data from web services.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18)	Closed	Implemented
EBBITS-368	Service descriptions include operational and business aspects	Bring together business, operational and technical aspects of services into one single coherent language.	At least one service from one use case has been described including operational and business aspects.	Functional	very high	high	Major	Product Service Orchestration Manager (CIC18)	Closed	Implemented
EBBITS-334	Mobile access to farm data in the ERP system	Mobility and access to mobile devices are required to manage aspects of the farm remotely if you are outside your office.	Mobile access (at least a read one) to the data of the ERP system is granted and solution should be browser-based.	Non-Functional - Operational	very high	low	Major		Closed	Implemented
EBBITS-273	Access-control of data in enterprise systems	Access to data needs to be controlled, because some authorities require having access to this data, other stakeholders might have restricted access, other information could be made publicly available.	Access rights can be defined for several stakeholders.	Functional	high	very high	Blocker	Trust and Semantic Access Restrictions (CIC 14)	Resolved	Implemented

EBBITS-264	Store meta-information with package labels	Meta-data should possibly be stored with packages, this may include: Temperature, location, dimension and weight	A minimal set of 5 attribute-value pairs can be associated with any package/label.	Functional	high	neutral	Major	Thing Manager (CIC16)	Closed	Implemented
EBBITS-231	Summary of energy related information at management level for supporting management level optimizing energy use	Management needs a summary of energy related information that help them making decision to optimize the energy usage. The detailed information to be summed up has to be provided be the ebbits middleware.	Management can access summary.	Functional	high	very high	Major	Process related energy measurement (CIC 17)	Part of specification	*Unresolved*
EBBITS-230	Possibility for comparing different energy consumption among plants and corresponding processes	Management would like to learn from other plants if they use energy more efficiently.	Management can compare energy data of plants.	Functional	very high	high	Critical	Process related energy measurement (CIC 17)	Part of specification	*Unresolved*
EBBITS-229	Energy benchmarking of different granularity such as machines, processes, plants	Management would like to know how effective the energy is used in different operational levels.	Management can do benchmarking in different operational level	Functional	very high	very high	Blocker		Closed	Duplicate
EBBITS-189	Reduce paper based communication in the Traceability Scenario	Paper based communication between companies/enterprises takes time and efforts for inputing/aggregating sensor data into the	With the use of the Ebbits middleware, 50% reduction of current paper based communication.	Functional	neutral	very high	Critical	Thing Manager (CIC16), Entity Manager	Resolved	Implemented

		backend enterprise systems								
EBBITS-188	Slaughter house needs to know how many pigs they will get from farmers	slaughter house needs to know the flow of the pigs coming to them so that they can plan and balance supply from farmers and demands from retail store.	slaughter house can forecast how many pigs are going to be supplied by farmers.	Functional	high	high	Minor		Part of specification	*Unresolved*

7.5 WP7

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-406	The ebbits architecture should be IoT-A compliant	Relating the ebbits architecture to an external reference architecture falilitates further architectural development and communication to stakeholders.	The concepts in the ebbits domain ontology and the layered architecture can be explained by reference to the IoT-A models	Non-Functional	neutral	neutral	Minor	IoT-A Compliance	Open	*Unresolved*
EBBITS-380	Using Process IDs in Events	The Event model processID needs to be mapped to the corresponding process model.	If there is a process model available in the system, it can be referenced by any event processed by the event processing newtwork.	Functional	neutral	neutral	Major	Product Service Orchestration Manager (CIC18), Process related energy measurement (CIC 17)	In Progress	*Unresolved*

EBBITS-379	Navigable entity IDs	The Event Processing Agent needs to be able to find related entities instances from a given entity id.	Given en entity instance (and id), it is possible to follow at least one edge in the corresponding entity structure model.	Functional	neutral	neutral	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Entity Manager	Closed	Implemented
EBBITS-378	Entity structure accessible from event rules	The Event Processing Agent needs the entity structure for writing rules over complex entities.	Relations expressing entity compositions (part-of, consists-of) can be used in rules expressed over ebbits entities.	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)	Closed	Implemented
EBBITS-337	Semantic event processing	It must be possible to interpret events in the context of the different layers in the architecture (from PWAL to a business rules layer).	The system provides at minimum two layers of event processing where events can be captured and possibly filtered/fused	Functional	high	high	Major	Event Processing Network	Closed	Implemented
EBBITS-336	Scalable event processing	The platform must be able to handle a large number/high frequency of parallel event streams.	The platform can be configured to handle a span from low frequency processing (10 e/s) to high frequency processing (500 e/s).	Non-Functional - Performance	high	neutral	Critical	Process related energy measurement (CIC 17)	In Progress	*Unresolved*

EBBITS-335	Dependencies on past events possible	An action executed by the system may be dependent on more than one event, and some of them could have occurred in the past.	Actions executed by the system can be processed dependent on current events as well as events having occurred in the past.	Functional	high	high	Major	Event Processing Network	Closed	Implemented
EBBITS-286	Events mapped to (business) rules	Events and services are basic mechanisms for the implementation of the (business) rules logic in the ebbits architecture.	Events of a at least two different event types can be detected in a (business) rule, as expressed in the ebbits business rules framework.	Functional	high	high	Major	Event Processing Network	Resolved	Implemented
EBBITS-285	Event model based on common vocabulary	The ebbits platform must be able to handle a potentially large number of events on different levels of abstraction in the system architecture and with different semantics. The processing of events should also be related to the processing and management of data in ebbits, and this should be based on the use of common vocabularies.	The system can distinguish between several (minimum 2) event types based on a common ebbits vocabulary, represented in the event model.	Functional	high	high	Critical	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), Remotely control a robot within a manufactory environment (CIC 14), General purpose RFID reader interface (CIC 10)	Closed	Implemented

EBBITS-284	Event history size and/or time span should be configurable	Different applications have different needs for the event history.	The event history can be configured wrt to timespan and size.	Functional	high	very high	Critical	Product Service Orchestration Manager (CIC18)	Closed	Implemented
EBBITS-283	An event history should be maintained	Rule definitions can refer to past events, and behaviour can be defined based on that event history.	A rule that refers to previous events can be expressed.	Functional	neutral	very high	Critical	Event Processing Network	Closed	Implemented
EBBITS-282	It must be possible to order events in the actual event sequence	The delivery of events received from different sources might not follow in the original sequence at transmission. There might be communication delays etc that make them arrive in the wrong order. Nevertheless rules should be able to express temporal/sequence dependencies on events that reflect the actual temporal event sequence at the sources.	It will be possible to express rules that contain temporal/sequence dependencies	Functional	neutral	very high	Critical	Event Processing Network	Resolved	Implemented
EBBITS-281	Explicit model of context	It must be possible to trace events and data items across processes and workflows, context management is	The system supports an explicit model of context, which can be applied in at least two application	Functional	high	high	Major	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16)	Closed	Implemented

		one of the mechanisms to support this.	domains.							
EBBITS-280	Automatic Recovery from communication failures	We need to able to still guarantee delivery of data/events also in case of minor/temporary communication disruption.	The system should be able to recover from a 10 minute communication failure	Functional	high	very high	Major	Product Service Orchestration Manager (CIC18)	In Progress	*Unresolved*
EBBITS-279	Graceful degradation	The system should be functional even if some parts are unreachable or non functioning	System should be working even if 50 percent of sub systems are unreachable	Functional	high	very high	Major	Product Service Orchestration Manager (CIC18), Trust and Semantic Access Restrictions (CIC 14), Opportunistic communication (CIC 11), Event Processing Network, IoT-A Compliance	In Progress	*Unresolved*
EBBITS-269	Alarms are send when specific situations occur	Issue alarms when an animal or production machine behaves differently or abnormal.	Application (domain) specific alarms can be modelled and executed by specific event types and by employing the event management functionality of the ebbits archiecture. Rules can be expressed (by an	Functional	high	very low	Major	Event Processing Network	Resolved	Implemented

			application developer) that may trigger alarm events based on lower level device or system events as well as system states (including time).							
EBBITS-201	Notification throughout the chain	A reduction of time for recalling a product from end consumers is needed.	At least 2 levels of the link in the chain can be notified automatically. For instance, a farmer found a mutating pig problem, it can notify slaughterhouse and sausage factories who bought meat from the slaughterhouse automatically.	Functional	neutral	very high	Minor	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)	In Progress	*Unresolved*
EBBITS-174	Retrieve manufacturing data history of any relevant event during production	If production defects are recognized, it is helpful to look at the production process history in order to find out what caused the defects.	Any manufacturing relevant (pressure, energy consumption, temperature, humidity, time etc) data is retrievable.	Functional	very low	very high	Major	Event Processing Network	Resolved	Implemented
EBBITS-167	Heterogeneous enterprise systems need to be able to exchange information.	Enterprises use various information systems that need to exchange information. Information needs	At least three different enterprise systems can exchange information.	Functional	low	very high	Minor		Closed	Nonsense

		to be propagated throughout the chain.								

7.6 WP8

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-405	security has to be well documented	Generally it is desired that security enforces that messages arrive in the same order as they have been sent in. However, when many messages are sent in close time, switches in order over IP are a general phenomenon. To avoid frustration such behavior of the running security has to be well documented and developers should be well informed.	Security, which enforces order, has to be clearly marked and documented. Security related user interfaces should have an e-learning aspect, teaching users proper use.	Non-Functional - Operational	neutral		Minor		Open	*Unresolved*

EBBITS-400	the ebbits PWAL support the LLRP compliant RFID reader	In order to provide the EPC compliancy, ebbits is providing, at PWAL level, a general purpose LLRP proxy: this means that the addition of a new RFID reader (natively providing LLRP interface), doesn't require any further effort for the application developer.	the PWAL includes a PWAL-LLRP driver;	Functional	high	high	Major	Physical devices common virtualization (CIC 12), General purpose RFID reader interface (CIC 10)	Resolved	Implemented
EBBITS-393	meta-data about missing or corrupted information should be managed	Sometimes field information is missing or corrupted e.g. because the user has not entered it correctly or because of malicious behavior. ebbits should be aware and able to report that some information is missing or corrupted.	meta-data about missing or corrupted information is kept within the ebbits framework	Functional	neutral	high	Critical	Trust and Semantic Access Restrictions (CIC 14)	Quality Check passed	*Unresolved*

EBBITS-392	Robot Controller PWAL driver must support the automatic parIDs mapping into variables.	The Robot Controller itself does not support an automatic map of parIDs to variables and so a mechanism to receive and retrieve a list with the semantic information regarding the available parIDs is needed within the PWAL Robot controller driver.	Spport of the automatic parIDs mapping into variables is implemented into Robot Controller driver	Functional			Minor	Remotely control a robot within a manufactory environment (CIC 14), Physical devices common virtualization (CIC 12)	In Progress	*Unresolved*
EBBITS-391	PWAL Robot Controller driver should support automatic discovery of available axes.	Information about available axis is needed from the Robot controller to be added to capabilities which are automatically discovered.	Axis information by the robot controller can be accessed.	Functional			Minor	Remotely control a robot within a manufactory environment (CIC 14)	In Progress	*Unresolved*
EBBITS-390	PLC driver supports symbols recursive discovery.	PLC developers often rely on nested structures to organize variables and signals; the PLC PWAL driver should be updated to support recursive symbols discovery.	Supports to recursive symbols discovery is implemented.	Non-Functional			Minor	Remotely control a robot within a manufactory environment (CIC 14)	In Progress	*Unresolved*

EBBITS-389	Support to proxy authentication through NTML	LinkSmart should support strict security policies in enterprise networks.	NTML proxy authentication supported	Non-Functional			Minor	Trust and Semantic Access Restrictions (CIC 14)	Quality Check passed	*Unresolved*
EBBITS-388	Provide support to logging of information from physical-world devices and sub-systems	Logging mechanisms are used by companies to check correct functioning of devices and subsystems. Since logging at device level generates a great amount of information which is not needed continuosly, configurable and flexible methods should be provided to control logging features. Among the logged information, additional meta-data about the lack or corruption of information from the field should also be included.	Logging mechanisms within the PWAL can be controlled and configured at runtime	Functional			Major	Physical devices common virtualization (CIC 12)	Part of specificatio n	*Unresolved*

EBBITS-387	Support to describe company security policies and rules must be provided	Sometimes companies have restricted policies for information sharing and network traffic management. ebbits should provide means to describe such policies and rules programmatically, so that they can be enforced or at least understood automatically by ebbits security framework.	Comapanies policy and rule based procedures are modeled in a format which is compatible with ebbits security framework	Functional			Minor	IoT hierarchical networking (CIC 13)	Quality Check passed	*Unresolved*
EBBITS-376	Robot Controller must not freeze when clients interrupts communication	Robot Controller must not freeze when clients interrupts communication; more specifically, it may happen that the Robot Controller PWAL driver is interrupted or restarted for maintenance.	Robot Controller doens't freeze when client interrupts communication	Functional			Critical	Remotely control a robot within a manufactory environment (CIC 14)	Part of specificatio n	*Unresolved*
EBBITS-375	Robot Controller PWAL driver must support multiple clients	The Robot Controller server does not support multiple clients. As a consequence, the Robot Controller PWAL driver should provide mechanisms to	the Robot Controller PWAL driver receives requests from multiple clients; such requests are fed into the Robot Controller and answered.	Functional			Minor	Remotely control a robot within a manufactory environment (CIC 14)	Part of specificatio n	*Unresolved*

		manage requests from multiple clients e.g. by supporting queuing.								
EBBITS-374	Support for multiple identification schemes	Application uses different identification schemes. In this way ebbits should support both the existing own identification scheme and other possible future identity management schemes. It is necessary to support an association between identifiers (while storing and querying them), which should be managed by the Entity Manager.	The Entity Manager supports multiple application-dependant identification schemes	Functional			Minor	Product Service Orchestration Manager (CIC18), Thing Manager (CIC16), People Manager (CIC 15)	Resolved	Implemented
EBBITS-373	Out of channel event management is needed	Due to poor IT reliability, it is not always possible to programmatically react to channel problems or errors. It is supposed to just trigger channel events. Out of channel reporting	It is possible to detect network related problems at PWAL level	Functional			Trivial	Event Processing Network	In Progress	*Unresolved*

		of network events is preferred to automatic reaction to problems. Out of channel alarm mechanisms are needed.								
EBBITS-372	PWAL framework must scale efficiently when multiple drivers are executed at runtime	Multiple PWAL drivers might be running inside the same PWAL instances; the coexistence of multiple driver should not affect performance. The core framework currently should provide methods to divide PWAL workload if needed.	PWAL runs multiple PWAL drivers withouth performance issues (beyond the ones caused by the underlying hardware).	Functional			Minor	Physical devices common virtualization (CIC 12)	In Progress	*Unresolved*
EBBITS-361	Fine grained access control policies have to be definable in the ebbits system.	Merged from Requirements #398-#417, except #401+#405	Registering access control policies results in blocked requests from unauthorized entities.	Functional	neutral	very high	Major	Trust and Semantic Access Restrictions (CIC 14), IoT hierarchical networking (CIC 13)	Quality Check passed	*Unresolved*

EBBITS-359	6LoWPAN networks should include frequency agility features in order to enhance the overall system reliability	The ability to jump to a different channel automatically according to the channel occupancy or interference seems a promising solution in order to cope with the high electromagnetic pollution present in manufacturing scenarios, thus a frequency agility service should be included in 6LoWPAN networks	The ebbits platform includes frequency agility features in order to increase overall system reliability	Functional	None	low	Major	6LoWPAN sensor nodes compliances (CIC 12)	Part of specification	*Unresolved*
EBBITS-358	Multiradio devices should select the most proper network interface according to the application requirements	Depending on the properties of the information (e.g., importance, quality of service, timeout, etc), multiradio devices should select the network interface most suitable to the requirements of the application accessing it, which could be a energy or cost saving policy for instance, or an	Multiradio devices are able to select most proper network interface consistently with the application implemented	Functional	None	neutral	Major	Opportunistic communication (CIC 11)	In Progress	*Unresolved*

		urgent event that should be transmitted at all costs								
EBBITS-357	Multiradio devices should be able to gather information about their network interfaces needed for the selection policies.	Multiradio devices must be able to collect and expose some information about their interfaces, like throughput, energy consumption, cost of traffic, quality of service, between others. Such information will be useful for defining interface selection policies.	Multiradio devices can expose information about network interfaces	Functional	None	neutral	Major	Physical devices common virtualization (CIC 12), Opportunistic communicatio n (CIC 11)	In Progress	*Unresolved*
EBBITS-356	Multiradio devices with local data caching should implement suitable application specific data-expiration policies in order to prevent cache overflows	Devices with local data caching for delay tolerance networking, may exhibit cache overflows if they generate big amounts of information and/or experience large offline periods, thus data-expiration policies need to be applied in order to prevent this.	The platform prevents the data loss of devices with multiple radio interfaces (e.g. in case of loss of network intervals)	Functional	None	neutral	Major	Opportunistic communicatio n (CIC 11)	Part of specificatio n	*Unresolved*

EBBITS-355	Multiradio devices should be use local data caching and delay tolerance networking	Devices with multiple radio interfaces and in general devices with delay tolerance networking capabilities may experience periods with no networking, where some events may have happen, thus a local caching of its data may prevent any loss of data.	ebbits allow multiradio devices to use local data caching and delay tolerance networking.	Functional	None	neutral	Major	Opportunistic communication (CIC 11)	In Progress	*Unresolved*
EBBITS-354	Multiradio devices should avoid re-generation of HIDs when migrating to a different LinkSmart Network Manager	Devices with multiradio capabilities should be able to migrate to different networks without affecting the functionalities at the LinkSmart layer, including identificability, thus when registering to a new Network Manager, the device should try to register itself with the previous HID, triggering an unregistration request to the previous Network	Devices with multiradio capabilities don't affect the LinkSmart layer while switching radio interface, thanks to a proper HIDs assignments' mechanism.	Functional	None	neutral	Major	Opportunistic communication (CIC 11)	In Progress	*Unresolved*

		Manager								
EBBITS-353	Multiradio devices should be able to detect which LinkSmart Network Manager to connect/migrate to, according to the current network interface active	Devices with multi-radio capabilities should be able to switch interface, and therefore network, without compromising the connectivity to the LinkSmart layer. The multi-radio features should be handled at network manager level. Furthermore, when migrating to a new interface, the device should register itself to the proper Network Manager available in that network.	At network manager level is possible to automatically manage multi-radio features if any. Devices accessing ebbits by using non-corporate or external networks (e.g. 3GPP) knows which border network manager they must connect to.	Functional	None	neutral	Major	Opportunistic communication (CIC 11)	Part of specification	*Unresolved*

EBBITS-352	PWAL should expose basic feature extraction and sensor fusion functionalities (e.g., moving average, decimation, filtering, etc) in order to minimize scalability issues	Some variables gathered through the PWAL could require high sampling frequencies and maybe just some feature of the acquired signal is of interest, so in order to save some bandwidth and avoid scalability issues, the PWAL could offer some basic feature extraction and sensor fusion capabilities.	The PWAL offers methods to extract features and to exploit the sensor fusion	Functional	None	neutral	Major	Opportunistic communication (CIC 11)	Quality Check passed	*Unresolved*
EBBITS-351	PWAL should implement a heterogeneous multi-data aggregation in single events.	Event-driven data acquisition can easily generate scalability issues if single events are generated per sample. Thus aggregation of several samples in a single or few events has to be devised.	It is possible to aggregate events coming from the same source at PWAL level	Functional	None	neutral	Major	Physical devices common virtualization (CIC 12)	Resolved	Out of scope

EBBITS-350	PWAL should implement an error control strategy to assert correct data type and values written to the PLC	Errors in writing variables to the PLC must be avoided at all cost, since they can lead to a halt in the running program. The PWAL has to adopt a suitable error control strategy in order to assert data has been introduced correctly (this eventually would require a control logic in the PLC program as well).	The PWAL always writes on the PLC memory the appropriate data types, consistently with variables and respecting the appropriate value ranges.	Functional	None	very high	Major	Remotely control a robot within a manufactory environment (CIC 14)	Part of specification	*Unresolved*
EBBITS-349	PWAL should adopt a lock and semaphore-based policy to the access of PLC memory	Since different applications could eventually be interested in a common variable, the PWAL must assure its access is controlled in order to avoid collisions in concurrent requests, as well as possible locks or restrictions to specific applications	When the PWAL tries to read or write some critical variable onboard the PLCs, all variables exposed are safe	Functional	None	very high	Major	Physical devices common virtualization (CIC 12)	Part of specification	*Unresolved*

EBBITS-348	PWAL should be able to match PLC symbols with ebbits ontologies	The definition of symbols on an OPC server (i.e., variables of interest inside the PLC) could be made in accordance with the PLC programmer according to an agreed convention that could be exploited for an automatic matching with a predefined model in the Device Catalogue Ontology	PWAL provides an interface to expose PLC symbols as events, services or variables according to the models described within the ebbits ontologies.	Functional	None	neutral	Minor	Physical devices common virtualization (CIC 12)	Resolved	Out of scope
EBBITS-347	PWAL should expose suitable methods in order to enrich raw data	Data acquainted through the PWAL needs to be enriched with meta-data (like source, geotag, timestamp, units, etc), which will be then used by upper layers and applications. Being the PWAL the lowest link between ebbits platform and the physical world, part of this meta-information could be already attached at this	Meta-information could be attached to data or events at PWAL level	Functional	None	neutral	Major	Physical devices common virtualization (CIC 12)	Quality Check passed	*Unresolved*

		level, easing the processing of it by the multi-sensor fusion and context awareness services.								
EBBITS-346	PWAL should support accurate timestamping of data acquainted	The PWAL should be able to properly handle time information of the data and events it access/generate. This handling must include the synchronization to the ebbits time dissemination service and compensation of hardware and communication delays if possible.	The PWAL, while managing data or events, handles time-related information through the interaction with the time synchronization services.	Functional	None	neutral	Major	Remotely control a robot within a manufactory environment (CIC 14), Physical devices common virtualization (CIC 12), General purpose RFID reader interface (CIC 10)	In Progress	*Unresolved*
EBBITS-345	ebbits should implement a distributed time dissemination and synchronization service	Several application in ebbits relay directly or indirectly on accurate timestamping of data and events, thus given the distributed nature of ebbits, a time dissemination and synchronization service is	ebbits provides a time dissemination and time synchronization service	Functional	None	high	Major	Event Processing Network	Quality Check passed	*Unresolved*

		required within the platform.								
EBBITS-344	PWAL should support reconfigurable dynamic polling policies	Applications could have different polling needs, which eventually could change in runtime, so the PWAL must offer an easy reconfiguration of the polling policies per parameter and per application	The PWAL provides a control interface supporting the definition of polling policies (i.e., sampling and/or reporting frequency, intervals, time-outs, etc.) for the available devices.	Functional	None	neutral	Major	Physical devices common virtualization (CIC 12)	Part of specification	*Unresolved*
EBBITS-343	ebbits should properly handle network and environment instability	ebbits should be more robust to different network issues, like temporary offline periods or restarting of remote instances.	The critical event of ebbits environment reboot while developing is handled by a specific exception.	Functional	neutral	high	Major	IoT hierarchical networking (CIC 13)	Quality Check passed	*Unresolved*
EBBITS-278	Save historical information in farms	Feeding history	It must be possible to access information about animals history at farms through ebbits. At a minimum birth data must be available. Information about feed (organic/non-organic) should also be available	Functional	very high	high	Major	Thing Manager (CIC16)	In Progress	*Unresolved*

EBBITS-254	Comply with industrial standards	The middleware should embrace existing industrial device integration and communication standards, e.g. EIB/KNX	Claimed support for any specific standard in ebbits can be verified using the conformance rules / procedures available from the issuing standards body.	Non-Functional - Legal	very high	high	Critical	Entity Manager, IoT-A Compliance	Open	*Unresolved*
EBBITS-251	Device proxies should provide a common monitoring interface	The middleware should contain services that allow monitoring on what devices are doing. This includes monitoring response time, device load (e.g., CPU), and message interchanges per second.	Device proxies are instantiated with a monitoring interface linked to the network- and context-management features at device level.	Functional	neutral	high	Major	Remotely control a robot within a manufactory environment (CIC 14), Physical devices common virtualization (CIC 12), General purpose RFID reader interface (CIC 10)	Part of specification	*Unresolved*
EBBITS-240	Energy consumption should be optimized automatically	Farmers want to optimize the energy consumption in their production and they adapt this manually, and they would like to have this done automatically (e.g. putting some production steps towards a cheaper time of the day).	The farmer doesn't act manually any energy consumption tuning. The farmer only defines some "Rules" in order to do that automatically.	Functional	very high	high	Major		Open	*Unresolved*

EBBITS-238	Batches need to be identified on a farm level	The average feed production batch size is 20 tons; however farmers want their own specific production which is way smaller. A unique identification of the batch to the farm is necessary.	Every batch has one unique identifier.	Functional	high	neutral	Critical		Resolved	Out of scope
EBBITS-225	Bring data from fieldbus network to ethernet network	Analytics is done by ERP program on a computer that work on TCP/IP.	Analytics software can analyze data from manufacturing robots	Functional	high	high	Major	Remotely control a robot within a manufactory environment (CIC 14)	Closed	Duplicate
EBBITS-218	Reliable wireless solution for new sensors	cable costs are high and due to harsh condition, cable might break	sensors are using wireless connection.	Functional	high	high	Major		Resolved	Out of scope

EBBITS-216	ebbits platform should integrate Programmable Logic Controllers (PLCs) and make them interoperable with the system	Production automation is controlled through a network of Programmable Logic Controller, the so called PLC, a digital device commonly used in the automation environment. The management of a PLC is usually vertically designed and the PLC monitoring is done at production chain level. Integrating a PLCs' line into ebbits means move the PLC handle and monitoring at higher level, e.g. on order to implement high value added services like the single stage energy consuption monitoring.	The PWAL includes a proper driver and able to integrate PLCs into the ebbits platform and the DDM defines proper models in the Device Catalog ontology.	Functional	very high	very high	Major	Remotely control a robot within a manufactory environment (CIC 14)	Closed	Implemented
EBBITS-209	ebbits should support legacy network interfaces	Many legacy systems still use old network interfaces	At least 3 types of common old interfaces of each domain (manufacturing and farm) are supported	Functional	very high	very high	Blocker	Opportunistic communication (CIC 11)	Part of specification	*Unresolved*

EBBITS-195	The ebbits system should integrate 6LoWPAN sensor nodes for seamless data collection	Data collection is the required input for simple and complex analysis in both manufacturing and traceability scenario. Both mobile or static sensors are affixed to any medium (animal, robot etc) in order to sense the environment.	The PWAL (developing a proper driver) and the DDM (defining proper models in the Device Catalog ontology) are able to integrate 6LoWPAN sensor nodes into the ebbits platform.	Functional	very low	very high	Major	Physical devices common virtualization (CIC 12), 6LoWPAN sensor nodes compliances (CIC 12)	In Progress	*Unresolved*
EBBITS-176	Integration of mobile sensing devices on running infrastructure manufacturing plant without interrupting running processes	In brown field it is too risky or too expensive to stop production in order to install missing sensors (e.g. smart meter).	It is possible to enhance a station/machine/robot with mobile sensing devices to gather data.	Functional	very high	very low	Critical	Process related energy measurement (CIC 17), Remotely control a robot within a manufactory environment (CIC 14)	Resolved	Cannot be implemented
EBBITS-169	Each sow carry an electronic unique ID	If battery cage is not used anymore and sows are let loose, farmers need to identify and track sows uniquely because each sow produces piglets with different quality and productivity.	Farmers can identify sows uniquely and track them if they are on the loose.	Functional	low	high	Major		Resolved	Out of scope

EBBITS-163	The ebbits platform should facilitate the integration of physical devices	Enterprises that already have a running ebbits system may need to add new devices. Adding a new device in the enterprise scenarios is always complicated because of the complexity of the legacy systems. The use of a platform like ebbits should facilitate this operation from the developer point of view.	ebbits provides a common approach for the integration of devices from the physical world, abstracting their technological-specific interfaces (via Physical World Adaptation Layer) and exposing to the platform their capabilities and information in a common way (the so called PWAL DRIVER). At least 3 common possibility to access devices are available (depending on device): polling variables, sending events or exposing services.	Functional	high	very high	Blocker	Remotely control a robot within a manufactory environment (CIC 14), Physical devices common virtualization (CIC 12), 6LoWPAN sensor nodes compliances (CIC 12), General purpose RFID reader interface (CIC 10)	In Progress	*Unresolved*
EBBITS-162	ebbits should be able to handle massive number of devices	The future use cases of ebbits need to handle massive number of devices and applications within and cross enterprises, i.e. ci. 300-1000 in a manufacturing plant and 500 in a farm.	ebbits is able to handle 500 devices simultaneously.	Non-Functional - Operational	low	high	Critical	Physical devices common virtualization (CIC 12), 6LoWPAN sensor nodes compliances (CIC 12)	Resolved	Duplicate

7.7 WP9

Key	Summary	Rationale	Fit Criterion	Requirement Type	Cust. Satisf.	Cust. Dissatisf.	Priority	Innovation	Status	Resolution
EBBITS-342	ebbits platform should support automatic builds	To make the ebbits platform easier to use for future developers it has to be easy to build and start. Else developers will not take it serious and will not try it.	All demos and prototypes have to provide a uniform method for building and starting. The build process has to be decided in advance else it will take extra effort to realize it.	Functional	neutral	high	Major	Visual context modelling tool (CIC 17)	Quality Check passed	*Unresolved*
EBBITS-277	Integration of legacy systems into ebbits platform	ebbits platform is deployed for solving interoperability of the existing systems (software and devices)	3 different existing systems used in each domain is supported i.e.: Danish national cattle database, Farm managemnt system, ERP system in manufacturing	Functional	very high	very high	Major	Product Service Orchestration Manager (CIC18), Entity Manager	Quality Check passed	*Unresolved*