

# ebbits

Results from the project ebbits – *Enabling the Business-Based Internet of Things and Services*

**A platform for creating new business applications by integrating the Internet of People, Things and Services into existing enterprise systems**





The ebbits project is co-funded by the European Commission within the 7th Framework Programme in the area of Internet of Things and Enterprise environments under Grant Agreement no. 257852.

Project partners: Fraunhofer Institute for Applied Technology (Coordinator, Germany), CNet Svenska AB (Sweden), SAP (Germany), Comau (Italy), Technical University of Kosice (Slovakia), Istituto Superiore Mario Boella (Italy), TNM A/S (Denmark), In-JeT ApS (Denmark), Intersoft a.s. (Slovakia).



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## WELCOME TO THE EBBITS PROJECT

In the next pages you can read about the main results and specific outcomes of the ebbits project which ran from September 2010 to February 2015.

The main goal of ebbits was to develop a widely deployable platform that allows enterprises to develop and deploy a new range of business applications by integrating the Internet of People, Things and Services into their systems. The ebbits platform integrates information from heterogeneous real-world sensors and devices and contains event management, context aware features and semantic enrichment of data, allowing developers to create value-added IoT apps with less effort.

A particularly valuable outcome of ebbits is the aspect of traceability and life cycle management. ebbits has developed and tested the platform and its functionalities in two domain applications: One for food traceability in a Danish setting and one for automotive manufacturing with the Italian automation company Comau. The tests have added a new and important level of quality and sustainability to business processes in the Internet of Things.

In the food traceability scenario, the ebbits platform has demonstrated traceability at every step of the food chain with focus on beef, continuously collecting data about the product from farm to fork. The main aim has been to increase consumer confidence in food products and make the concept of traceability more transparent but also to give the farmer, the slaughterhouse and shop some new value added tools for data management and consumer interaction.

In automotive manufacturing, the ebbits platform has enabled the optimisation of processes in the production of cars for the purpose of reducing energy consumption.

To demonstrate life cycle management, the energy footprint of a car has been traced in a selected phase of the production chain by creating a new OEEE (Overall Equipment and Energy Efficiency) index which can be used to measure energy efficiency of the production system and compare performance across the factory, highlighting poor line performance in terms of energy consumption.

In the last part of the project, ebbits has further developed the business applications to support a many-to-many relationship, accommodating both the one-to-many relation existing in food traceability, where one cow ends up as many pieces, and the many-to-one relation in car manufacturing, where many parts are assembled into one car. The result of the ebbits project is a platform which supports complex interactions and processes by managing a wide range of objects, actors and systems through their digital representations.

We hope you enjoy the next few pages which highlight the architectural innovations in ebbits and present 10 specific outcomes of the project.



Markus Eisenhauer  
Project Coordinator

# ARCHITECTURAL INNOVATIONS

The development of the ebbits platform has been driven by the identification and integration of several innovations in the ebbits platform which has helped developers meet the requirements for user applications.

## Innovation area 1: The architecture for life cycle data collection

### Entity Management

Identification of entities and resources that need to be monitored throughout the entire life cycle. This information is stored together with a basic set of resource attributes supporting the lookup operations.

### Product Service Orchestration

Arrangement, coordination, and management of product objects which act as digital shadows of the corresponding physical objects. The object has complete knowledge of its own life cycle and the services it needs to connect to in order to obtain data.

### People Manager

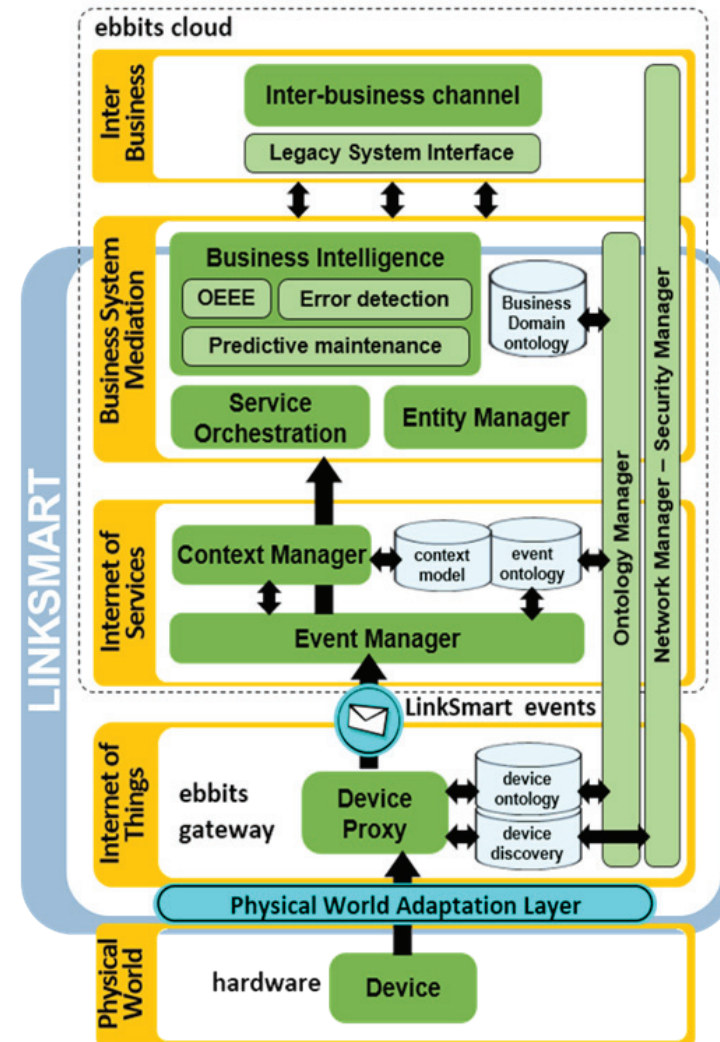
Inclusion of the human user in Internet of Things applications. Since not all processes are automated, people must be included in the IoT processes to enable manual intervention and to interact with Product Service Orchestration.

### Event Processing Network

Establishment of a framework for receiving and processing events. The network consists of several subsets and is used by several ebbits managers such as the Thing manager and the Product Service Orchestration Manager.

### IoT-A Compliance

Adaption of the IoT-A reference architecture model for the interoperability of Internet of Things systems, with principles and guidelines for the technical designs of protocols, interfaces and algorithms: [www.iot-a.eu](http://www.iot-a.eu).



The innovation areas covered are:

Architecture for life cycle data collection; physical world integration; reliability and security and developer support.

## Innovation area 2: Physical world integration

### Thing Manager

Integration of real world “things” as software objects. Physical objects are IoT-enabled and made addressable through the ebbits middleware. A standard web service interface is generated based on type of object and the services of the object are invoked via QR codes and/or RFID tags.

### Physical Device Virtualisation

Integration of many heterogeneous devices into the same platform by device virtualisation which enables a seamless integration of these devices with other components such as web applications or enterprise resource planning systems.

### 6LoWPAN Compliance

Achievement of interoperability and full IoT integration via compliance with IPv6 and 6LoWPAN nodes. Developers who add 6LoWPAN nodes in an existing network will benefit from auto-configuration features and already developed instruments.

### General Purpose Interface to RFID Reader

Provision of a standard interface which can interact with and control many different RFID technologies available in product traceability, in particular the food chain.

## Innovation area 3: Reliability and security

### Opportunistic communication features

Provision of robust features which can manage network issues and provide reliability such as multi-radio support, frequency agility and delay tolerance network.

### Semantic Access Restrictions

Implementation of a framework to manage trust and semantic access restrictions.

## Innovation area 4: Developer support

### Visual IoT Modelling Tool, ioTLink

Development of a simplified, rapid prototyping tool to author the relation between 1) sensors, service and software components, and 2) domain objects such as things or people.

### Model-based IoT-enabled business process measuring

Provision of a more detailed measurement of processes for the next generation of energy optimisation. Process and context models are available as well as semantically enriched events and logging of event data for analysis and optimisation.

# PRODUCTS FOR DEVELOPERS

## ebbitts Service Platform

The ebbitts platform is a product life cycle management system featuring a Service oriented Architecture based on open protocols and middleware, effectively transforming every subsystem or device into a web service with semantic resolution. It presents a new bridge between backend enterprise applications, people, services and the physical world.

The platform is a conceptual infrastructure where different IoT components, applications and services can be developed and executed to adapt them to special needs and requirements of a given domain.

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## Semantic Models

Semantic models are used within the ebbitts platform for several functionalities and include: Device taxonomy containing information of known device types and their features; events model; services model; domain and context model and semantic discovery model.

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## The Virtual Private Ontology Server

The Virtual Private Ontology Server (VPOS) is an ebbitts component that provides an access control framework for ontologies. Based on explicit restrictions annotated on specific axioms of an ontology, it is able to compute implied restrictions for all axioms of the same ontology. In practice, it can be applied, e.g. to ensure that only the direct manager has access to an employee's human resource information.

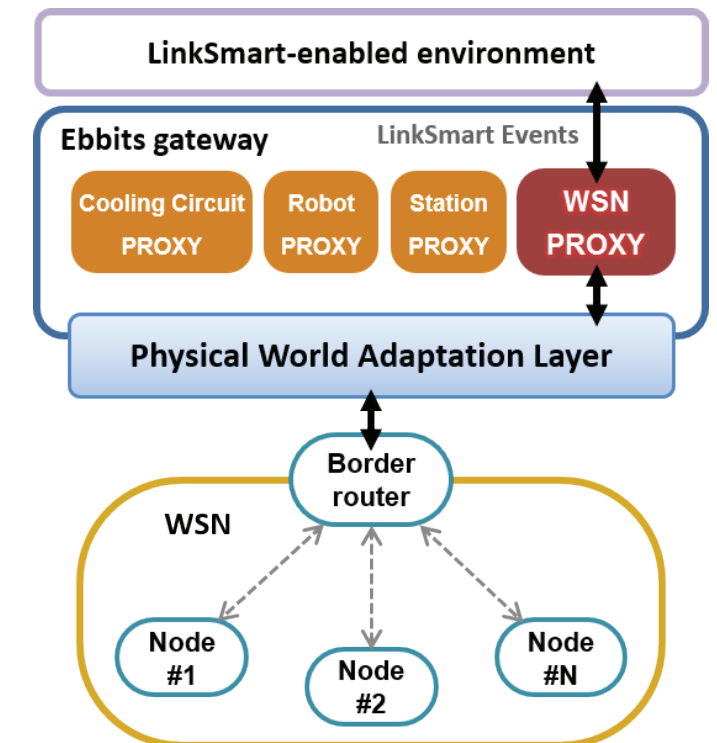
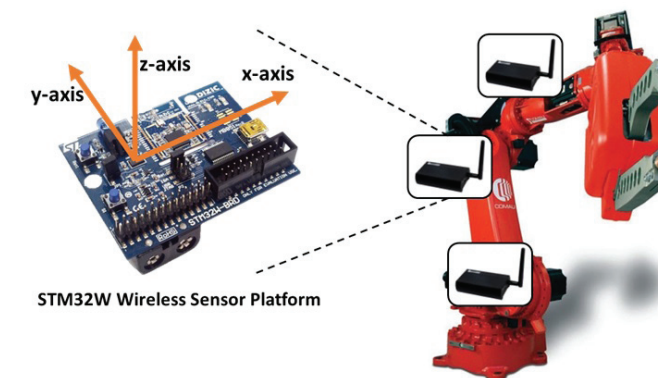
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## Applications for Wireless Sensor and Actuator Networks - IPV6 based 6LoWPAN WSN

A WSN is a network of power-constrained devices, used to interface physical quantities with virtual systems. WSNs can achieve this by acquiring information related to environment and equipment states and wirelessly performing actuation functions.

WSAN prototypes have been developed both in the manufacturing and traceability scenarios, implementing applications for monitoring the movement of a welding robot arm and the vibrations of a conveyor belt in the manufacturing scenario as well as actuating when abnormal vibrations are detected by means of blinking warning lights. In the traceability chain, an application for monitoring the temperature inside a mobile refrigerator-truck has been developed.

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# PRODUCTS FOR DEVELOPERS *continued...*

## Denial of Service Protection Mechanisms in 6LoWPAN

Denial-of-Service (DoS) attacks are among the security threats targeting IP networks. The DoS Protection Mechanisms consists of a Manager component which secures the 6LoWPAN based WSNs and helps mitigate potential DoS attacks as well as an Intrusion Detection System (IDS) which monitors the 6LoWPAN traffic and identifies potential threats.

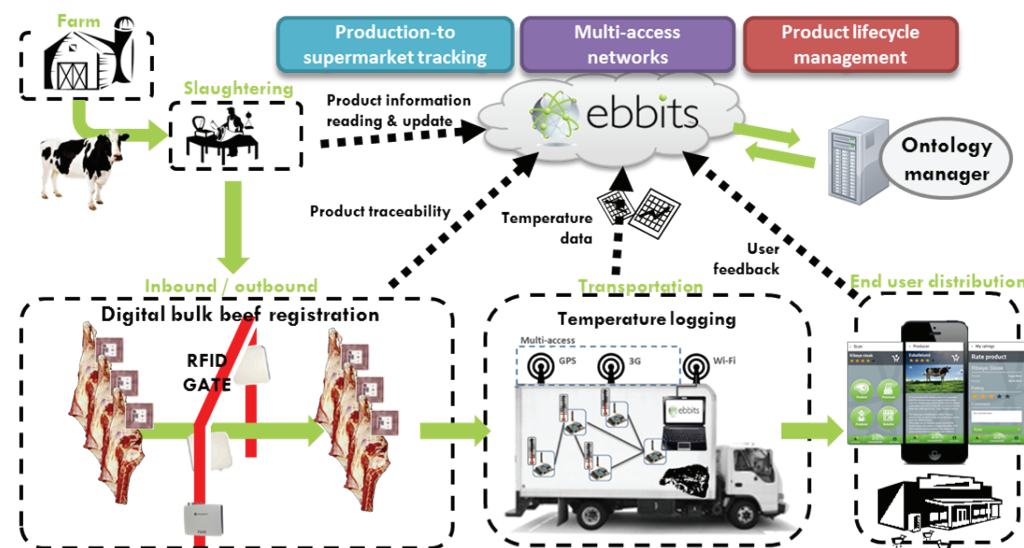
The IDS implements signature-based as well as anomaly-based detection mechanisms. In addition, the IDS is connected to an Opportunistic Manager to trigger an appropriate defensive action, represented here by channel switching. The developed IDS is network based so that it does not introduce any additional traffic to the 6LoWPAN and does not exhaust the resource-constrained nodes with heavy computations.

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## LLRP RFID Reader Proxy and Applications

This is a PWAL subcomponent proposed to manage an LLRP (Low Level Reader Protocol) compliant RFID reader. The LLRP Standard, released by EPC Global Inc., specifies interfaces operation between RFID Readers and the Client application. The LLRP PWAL driver exposes its resources and data available via the LinkSmart middleware, fully abstracting the actual RFID reader device.

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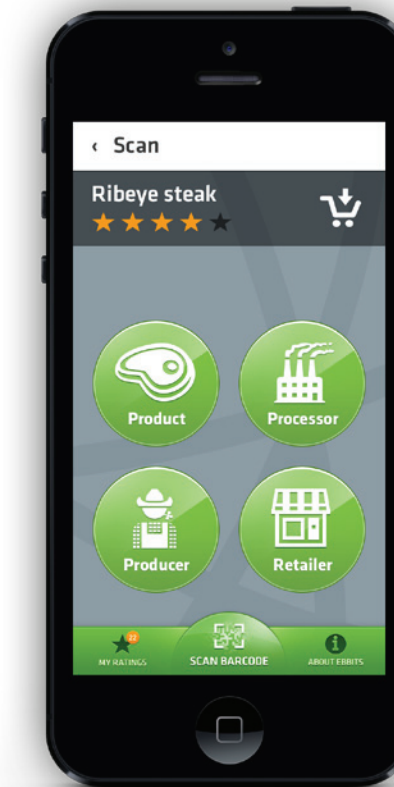


# PRODUCTS FOR END USERS

## Consumer App for Traceability

The Consumer App serves as the consumer oriented frontend of the traceability application. The software has been developed for both iOS and Android platforms. It presents traceability information for a given product and allows the user to rate the product as well. Communication is done through a web service interface to the LinkSmart Middleware.

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### With the ebbits app you can

- Scan the meat and get information about the origin and history of the animal: How the animal has been fed, how long it has been on grass as well as transport time to the slaughterhouse
- Get information about the processing of the meat at the slaughterhouse and the quality of the meat
- See which cows the butcher's cut come from
- See which cut are the most popular
- Get advice on type of cut and how you prepare it
- Register your purchases, rate the meat and ask for certain cuttings
- Earn points that can be used in the shop
- Receive notifications when the meat reaches its best-before date and if your purchased meat is being recalled due to health issues

## PRODUCTS FOR END USERS *continued...*

### Butcher's App

The Butchers App is a tool for butchers when cutting and packaging bulk meat into smaller packages. By use of a scanner (QR and Bar codes), it links the identity of the bulk with the cut. It allows input of meat type and weight. The software is developed to be executed on a PDA running MS Windows Mobile. Communication is done through a web service interface to the LinkSmart Middleware.

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### Mobile Context Aware GUI

The Mobile Context Aware GUI makes it possible to monitor and control the processes within a factory. It shows monitoring and analysis data and is based on the LinkSmart platform. Based on the business process model, the user is able to get detailed information of every sensor connected to the process model and accessible by LinkSmart. The analysis part shows detailed information about historical data in days, weeks or months. This can also be done for every station of the production line or the complete production line. There are also graphs visualising the resource consumption on line, station and robot level for the aggregated analysis data.

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### OEEE Optimisation Method and Business Models

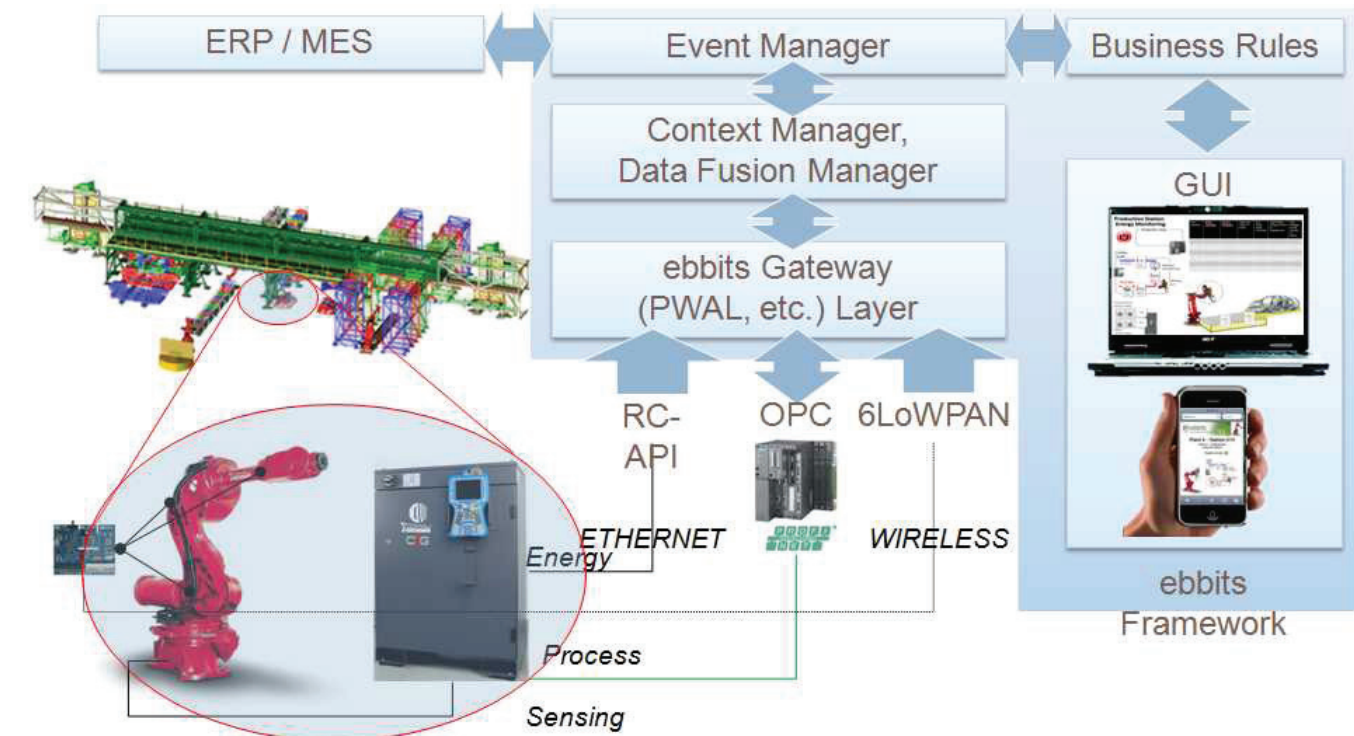
The OEEE; Overall Equipment and Energy Efficiency index will add the energy component to the well-known OEE index and thus allow industry to optimise both in economic, resource, and energy terms. An associated business model framework will include metrics and taxonomies for the OEEE as well as use cases for how and when OEEE metrics may be used for real-time decision support and changes in manufacturing execution.

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## THE EBBITS PLATFORM

With the ebbits platform you can optimise the energy usage in car manufacturing:

- See the data flow from a framing station within the production line
- Monitor the production process based on real-time data
- Analyse and compare energy consumption for stand-by usage and for consumption during line, station and subsystem production
- Calculate the energy efficiency for each production phase based on energy profiles and analysis
- Interact with the robot on a tablet and get all the necessary input for life cycle costs as well as energy efficiency calculations



# RESULTS FROM THE EBBITS PROJECT

## Enabling the **Business-Based Internet of Things and Services**

The purpose of the ebbits project was to integrate the Internet of People, Things and Services into mainstream enterprise systems and support business applications with a variety of possibilities, ranging from optimisation of manufacturing processes to enhanced consumer information about the life cycle of food products. The result is a platform providing innovative results within three main areas:

### **Efficient creation of innovative product services**

The ebbits platform integrates information from heterogeneous real-world sensors and devices into business systems. It includes a platform for event management, context aware features and semantic enrichment of data, allowing developers to create value-added IoT apps with less effort.

### **Food product traceability through the entire life cycle**

Food products are traced to enable an ecosystem for developers of intelligent apps. To increase consumer confidence in food products, data about the product are continuously collected through its complete life cycle without interfering with existing stakeholder processes.

### **Creation of a new performance indicator in car manufacturing**

Starting from the set of measurements that tracks availability, performance and quality output of the plant equipment, it is possible to create a new overall key performance indicator taking into account the energy consumption of the manufacturing process, named OEEE - Overall Equipment and Energy Efficiency.

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For more information, please visit [www.ebbits-project.eu](http://www.ebbits-project.eu) or contact the Project Coordinator, Markus Eisenhauer: [markus.eisenhauer@fit.fraunhofer.de](mailto:markus.eisenhauer@fit.fraunhofer.de)