Enabling the business-based
Internet of Things and Services

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1. Executive summary

The Internet of Things (IoT) will be an important part of the Internet of the future and already receives considerable support within the European Commission. Together with radio frequency identification (RFID) the IoT is seen as one basis for the future networked society (CASAGRAS, 2009). Other reports from analysts, like (Harbor Research, 2010) and (Michael Chui, 2010) see also a big potential in this approach. It will lead to a convergence of the physical and virtual worlds and allow for great improvements in decision making capabilities for societies that more and more rely on real-time information and interactions. This phenomenon could even drive the largest growth opportunity in the history of business (Harbor Research, 2010). This deliverable will elaborate further on these analyses.

This deliverable describes activities executed in the context of Work Package 2. This work package has among other things in its objectives the continuous study of the technological, regulatory-standards and market developments. Besides compulsory regulations, the ebbits project wants to support as much standards as possible and the support of standards then translates into requirements, this deliverable also contributes to Task 2.2 "Initial Requirements Specification" which should provide initial functional requirements, trust, privacy and security requirements and societal and business requirements. As there is separate deliverable "Technology Watch Report 1", which is also due end of month 6, all the more core research and technological developments will be described in the parallel deliverable.

This deliverable will give an initial analysis of market developments and regulatory standards and it is therefore divided into two parts. The first part starts with a general overview of current trends in the market. This also includes some figures about possible future market potential and a sketch about potential application areas. The first part ends with a more detailed look into the markets for RFID and Smart Sensor Networks as they play important roles in ebbits.

The second part of this deliverable is devoted to regulatory standards. In this deliverable, regulatory standards regarding the ebbits project are only indentified for the topic of food safety. Otherwise, there are some international standards but they are not regulatory or at least not European-wide. Very often it is the case, that every country can set its own rules. For RFID technology, there are some ISO and ASTM standards which are mentioned in this deliverable. Additionally, for Smart Sensor Networks, some IEEE standards are shortly described. Furthermore, important W3C standards are listed in this deliverable. As they are important topics in the ebbits project, a more detailed view is given on standards for persistent data fusion ANSI/ISA-95 and OAGIS as well as on standards to describe information about sensors, although these standards are not regulatory.

2. Introduction

2.1 Overview of the ebbits project

The ebbits project aims to develop architecture, technologies and processes, which allow businesses to semantically integrate the Internet of Things into mainstream enterprise systems and support interoperable real-world, online end-to-end business applications. It will provide semantic resolution to the Internet of Things and hence present a new bridge between backend enterprise applications, people, services and the physical world, using information generated by tags, sensors, and other devices and performing actions on the real world.

The ebbits platform will support interoperable business applications with context-aware processing of data separated in time and space, information and real-world events (addressing tags, sensor and actuators as services), people and workflows (operator and maintenance crews), optimisation using high-level business rules (energy and cost performance criteria), end-to-end business processes (traceability, lifecycle management), or comprehensive consumer demands (product authentication, trustworthy information, and knowledge sharing).

The ebbits platform will feature a Service-oriented Architecture (SoA) based on open protocols and middleware, effectively transforming every subsystem or device into a web service with semantic resolution. The ebbits platform thus enables the convergence of the Internet of People (IoP), the Internet of Things (IoT) and the Internet of Services (IoS) into the "Internet of People, Things and Services (IoPTS)" for business purposes.

The ebbits platform will be demonstrated in end-to-end business applications featuring connectivity to and online monitoring of a product during its entire lifecycle, i.e. from the early manufacturing stage to its end-of-life. The project will develop, implement and demonstrate two ebbits IoPTS applications. The first application demonstrates real-time optimisation metrics, including energy savings, in manufacturing processes. The other demonstrates online traceability with enhanced information on food.

2.2 Purpose, context and scope of this deliverable

This deliverable belongs to Work Package 2 of the ebbits project. This work package has among other things in its objectives the continuous study of the technological, regulatory-standards and market developments. Besides compulsory regulations, the ebbits project wants to support as many standards as possible and the support of standards then translates into requirements. Therefore, this deliverable also contributes to Task 2.2 "Initial Requirements Specification" which should provide initial functional requirements, trust, privacy and security requirements and societal and business requirements. As there is a separate deliverable "Technology Watch Report 1", which is also due end of month 6, the more core research and technological developments will be described in this parallel deliverable.

This deliverable will give an initial analysis of market developments and regulatory standards and it is therefore divided into two parts. The first part starts with a general overview of current trends in the market. This also includes some figures about possible future market potential and a sketch about potential application areas. The first part ends with a more detailed look into the markets for RFID and Smart Sensor Networks as they play important roles in ebbits.

The second part of this deliverable is devoted to regulatory standards. In this deliverable, regulatory standards regarding the ebbits project are only indentified for the topic of food safety. Moreover, there are some international standards but they are not regulatory or at least not European-wide. Very often it is the case, that every country can set its own rules. For RFID technology, there are some ISO and ASTM standards which are mentioned in this deliverable. Additionally, for Smart Sensor Networks, some IEEE standards are shortly described. Furthermore, important W3C standards are listed in this deliverable. As they are important topics in the ebbits project, a more detailed view is given on standards for persistent data fusion ANSI/ISA-95 and OAGIS as well as on standards to describe information about sensors, although these standards are not regulatory.

Since there will be a continuous monitoring of technological, regulatory-standards and market developments and there are further reports in form of deliverables foreseen during the complete project time of 4 years, and this deliverable is due after the first 6 months, it can only be considered as a starting point. Later deliverables will incorporate the advancements in technology, standards and markets during the project lifetime and will also be better able to be more specific about the actual techniques and methods that will actually be employed in ebbits. The present deliverable can only be rather general, mostly in terms of standards, as the project has just started to evolve.

2.3 Background

This Deliverable contributes to the Task 2.2 of the ebbits project. The goal of Task 2.2 in the Work Package 2 is the following (citation from the ebbits Description of Work):
Initial requirements specification: Derive initial functional requirements, trust, privacy and security requirements and societal and business requirements.

3. Market Overview

In this part of the deliverable, a market overview is given. We start with some general trends and give some figures about market potential and application areas. The RFID technology and Smart Sensor Networks will especially be focused upon.

3.1 Current trends in the market

According to (Michael Chui, 2010), predictable pathways of information in organisations are changing as the physical world itself becomes a type of information system. This has implication for companies: Business models based on largely static information architectures must change as new ways of creating value arise. If customer's preferences and behaviours can be sensed in real time, prices can be determined by current demand or sales can even be replaced by models of lending and usage fees. Manufacturing processes can be controlled much more efficiently and fine-grained if there are sensors at every place in the shop-floor. Additionally, continuously supervised operations can avoid hazards and lead to shorter down-times due to predictive maintenance. Companies that take advantage of these phenomena will have a lead over competitors that don't.

This new emergent convergence between the physical world and the virtual world can be divided in two broad categories: first, information and analysis and second, automation and control (Michael Chui, 2010).

The information and analysis category will lead to greatly enhanced decision making and according to (Michael Chui, 2010), there are three distinct emerging applications in this group:

1. **Tracking Behaviour:** This application includes monitoring the behaviour of persons, things, or data trough space and time. Products equipped with sensors can be tracked and interactions can be logged. For example, insurance companies now provide some cars with location sensors and only charge for the distance driven. In the B2B world, one other possibility is to use RFID tags to track products moving through supply chains.
2. **Enhanced Situational Awareness:** The aim is to achieve real-time awareness of the physical environment. Large numbers of sensors are deployed, for example, on roads to get a real-time overview on traffic congestion.
3. **Sensor-driven Decision Analysis:** The goal is to use deep analysis and visualization to assist in longer-range, more complex human decision making. In health care, for example, patients with chronic diseases can be provided with sensors to continuously monitor their health status and transmit small early warning signs.

In the automation and control category the collected data is converted into instructions that are feed back to actuators in the IoT. The corresponding processes can be modified automatically without the need for human intervention and adjust to complex changes in the environment. After (Michael Chui, 2010), we can again distinguish between three types:

1. **Process Optimization:** This includes automated control of closed/self-contained systems. One example is the exact positioning of an item running down in an assembly line for optimal machine processing. This is achieved using sensors and actuators and leads to reduction in waste, energy cost and human supervision.
2. **Optimized Resource Consumption:** The remit includes the optimization of resources across networks. Data centres, for example, which have a fast growing energy demand, adopting power-management techniques tied to information from the IoT. Each server is now equipped with a sensor to monitor its power usage; data, which is otherwise difficult to estimate as energy usage patterns depend heavily on time and workloads. With the collected data from sensors better load balancing can be achieved which evades underused servers and storage devices.
3. **Complex Autonomous Systems:** The ultimate goal is to have automated control in dynamic, open environments with great uncertainty. It would be necessary to do rapid, real-time sensing and processing to react autonomously to unexpected failures and deviations. Automatic braking systems and collision avoidance systems in cars would be an example. Even autonomous driving in a city

without human intervention is an area of active research. For the systems alone which try to avoid accidents the potential savings could surpass $100 billion annually.

For the ebbits project the focus should clearly be on Tracking Behaviour, Process Optimization and Optimized Resource Consumption as the use case in the agricultural domain is tied to the first and the use case in the manufacturing domain relates to the latter two (Consortium, 2011).

3.2 General future market potential and potential application areas

There is huge potential for the IoT as can be seen in Figure 1, especially for the development of new services and applications which are not possible without the information and control trough sensors and actuators in IoT.

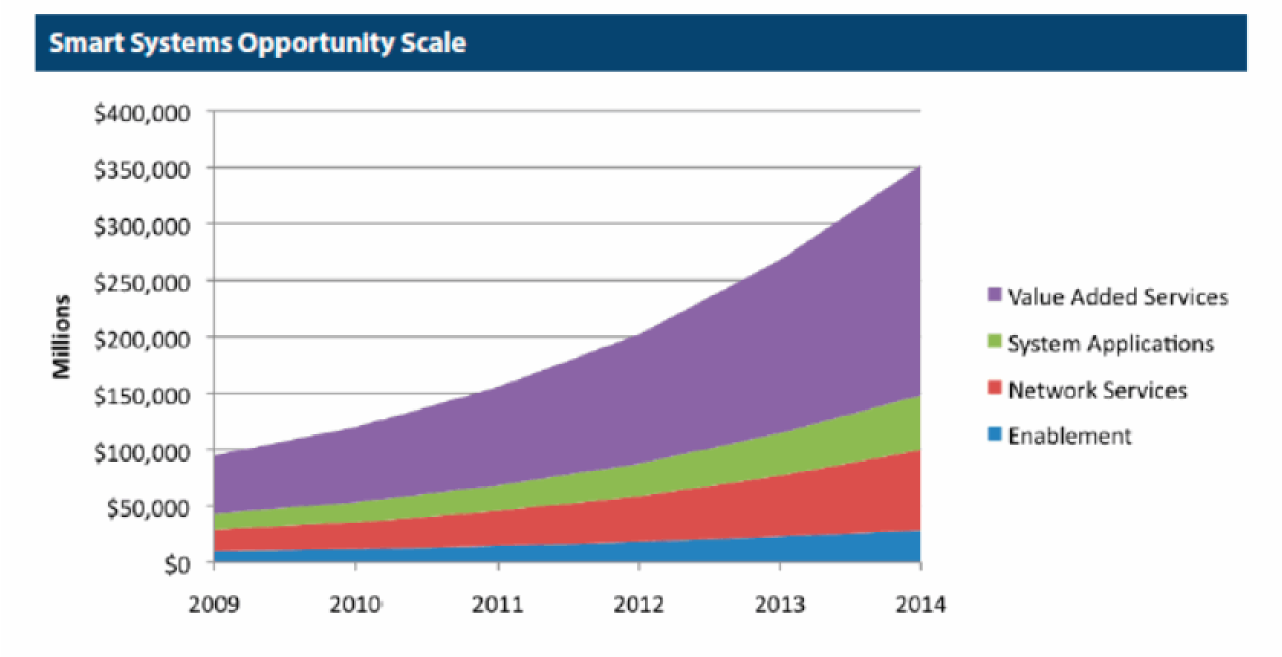

Figure 1: Opportunities for the IoT, Source: Harbor Research, Inc.

Although there is great prospective for future business opportunities, some challenges have also been identified in (Harbor Research, 2010):

- Making the business case to get management buy-in for investments.
- Complex eco-systems require new ways for business to network.
- The anticipation and research of new product and service ideas.
- Fragmented vendor landscape for RFIDs, Smart Sensor Networks etc. that is not yet well aligned with larger IT infrastructure and players.

Despite the challenges, the analysts see the market for IoT reaching a new level of maturity with a much greater recognition of technological capabilities and opportunities than two years ago. There should be a significant wave of growth in the IoT and the connection between physical and virtual world. This optimism is supported by observations of the following market forces (Harbor Research, 2010):

- The cost of devices continues to fall.
- In the meantime, at least in the developed countries, a ubiquitous broadband infrastructure has been developed.
- The monthly prices for cellular device links are being drastically reduced.
- The storage capacity and the processing power of computers continue to expand exponentially, which allows for new challenges in data management and data processing to be tackled.
- The continued miniaturization and the integration of a broad range of sensors into the edge nodes of the IoT.

- The continued evolvement of the Internet and of the next generation telecommunication network architecture that will allow the movement of very large amount of information.
- Simplified system interactions and better user interfaces, which have been reached trough technology advances, are propelling adoption of new business models.

One additional predication in (Harbor Research, 2010) is that end user participation in the design, development and management of the new technologies will increase during the next period of market development:

- End customers will put more emphasis on vertical solutions that integrate with enterprise systems.
- The demand for new features, innovations and adaptability will rise. If these needs are fulfilled, customers will fully integrate the new technology in their work and personal lives.
- The user experience will be an important topic. End users want to have systems tailored to their needs.

Over 300 specific services and machine types central to the future networked society have been identified. An overview is given in Figure 2: Overview over potential applications, Source: Harbor Research, Inc. where all these items are arranged into the ten main areas of buildings, energy, industrial, healthcare, retail, security, transportation, IT & networks, resources and consumer/professional (Harbor Research, 2010). The ebbits automotive use case can be classified in this picture under discrete assembly with the devices motors, fabrication and assembly. The other use case in the ebbits project can be sorted into the topic agriculture with the connected devices agricultural equipment and tags. During the run time of the project, it will be worthwhile to also keep an eye on the technology developments in the topics which are connected to the ebbits categories.

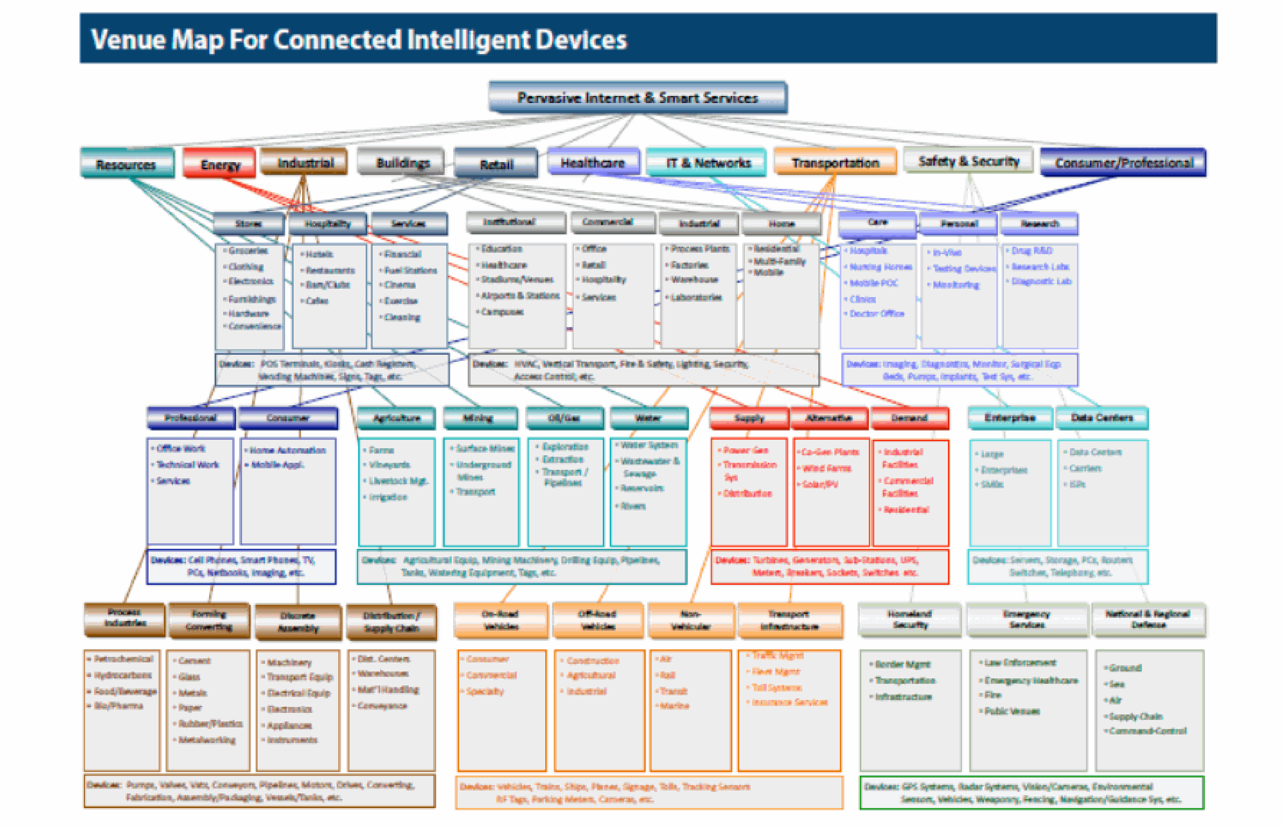

Figure 2: Overview over potential applications, Source: Harbor Research, Inc.

The ebbits project is also very well positioned in respect to the challenges mentioned above. As a research project, one of our main focuses is the development of new business ideas and applications. We have use cases from completely different domains and can therefore explore new ways to connect businesses. As we are 9 partners in the consortium, we also have a lot of experience with different technologies, e.g. in areas of RFIDs and Smart Sensor Networks. Finally, we have a dedicated work package to address the need for working out business cases.

3.3 Market trends for RFID technology

Companies are now realizing the fact that the value of RFID is in the enablement of new business processes and not only the technology (Eschinger, 2008). Therefore, instead of only driving down the cost or compliance with a retailer mandate, innovation is becoming a key topic in the RFID market. Additionally, it becomes important for vendors to build complete solutions to targeted problems. At the moment, the applications needed to manage these new technologies are still missing. In the future, these newly developed applications will also be offered by business application suite vendors, such Oracle, Microsoft and SAP, as part of the life cycle of innovation. Other key trends according to (Eschinger, 2008):

- Asset management projects increase their importance as companies want to manage nonmaintained or disposable assets.
- In the retail domain, in-store inventory management instead of supply chain inventory management is the focus of many projects.
- In general, the second wave of RFID adoption has begun which can be classified as exploration phase and is beyond initial pilot projects. Data is now collected through the pilots but now enterprises are thinking about intelligent ways to harness this large amount of new facts. Companies are using RFID to enhance their business competitiveness.

Factors which are contributing to these trends are globalization with the need to reduce the time-to-market and the combination of technologies for new applications, for example, RFID merged with GPS.

The analysts in (Eschinger, 2008) see the following key industries nearly in the phase, where a majority of the players have adopted the technology: healthcare, aerospace/defence and automotive. Furthermore, traceability and recall are focus topics in pharmaceutical, retail and asset-intensive industries.

The market for RFID technologies has a healthy growth trajectory as can be seen in Figure 3.

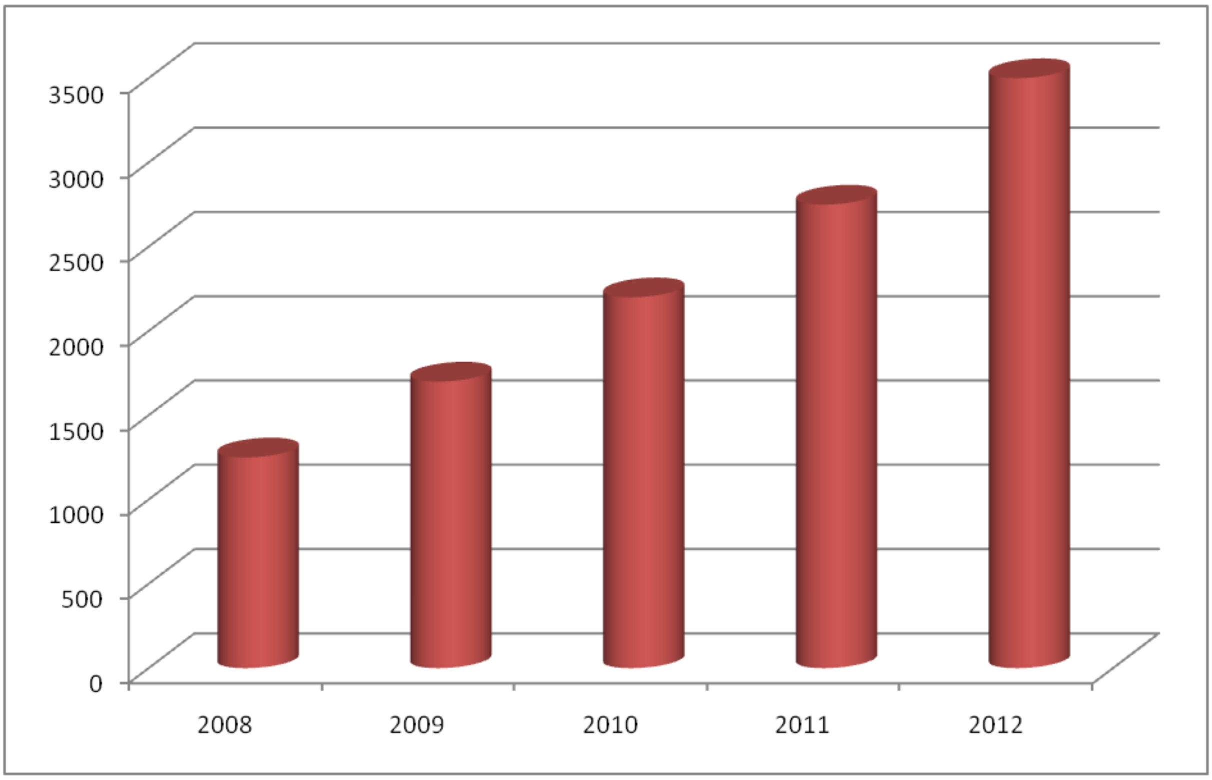

Figure 3: Total RFID Revenue in Millions of Dollars (Software and Hardware), 2008-2012, Source: Based on Gartner, 2008

RFID in Europe is still below the size and growth expectations of many within the industry. It is expected that high-volume RFID deployments increase only slowly in the region. However, Europe is heading for a significant upturn in RFID activity taking advantage of the latest tag and reader technology (Eschinger, 2008).

The ebbits project will also rely on RFID technology. It is very well positioned with regard to current trends in the market, especially regarding the new approach of not only collecting data but building innovations on top of it and doing complex processing. Due to the research in semantic technologies within the project it should be possible to combine RFID from various sources and develop new applications. The combination of such data with Enterprise Resource Planning Systems will also allow for new, value-added services.

3.4 Green market trends for Smart Sensor Networks with respect to the ebbits use cases

According to (OECD, 2009), sensors and sensor networks can significantly contribute to more efficient use of resources, which in turn would lead to less CO_2 emissions. Especially in the fields of smart grids, smart buildings, industrial applications and agriculture, there are only positive effects. Intelligent transportation systems, which provide for a reduced cost of transport, also affect the demand side and lead to a greater resource consumption. For the latter field, governmental regulations and demand-side management seem necessary.

Industrial applications

The industry sector was responsible for 23% of total greenhouse gas emissions in 2002 and consumed nearly half of the world-wide electricity. Sensors and in particular sensor networks are employed in industrial application in many ways as the following three examples illustrate (OECD, 2009):

- **Process control:** Sensor networks are used to continuously get real-time data on the production process and to detect unwanted deviations already during the processing. In consequence, deficit products can be recognized very early and reprocessing can be minimized. Additionally, the efficient use of energy can be better ensured.
- **Control of physical properties:** The sensors assess various properties like for example, gases used during the production process and the corresponding amount of free resources. In this way, the deployed resources can be precisely controlled and excess of potentially pollutant material avoided.
- **Equipment management and control:** Parameters of the machines in the shop floor are constantly measured by sensors and this data is exchanged and communicated over sensor networks. This increases error diagnosis accuracy and allows for the replacement of machine parts based on degradation assessment rather than on replacement rules. It also improves planning and forecasting capabilities of technicians' dispatches and makes predictive maintenance possible. Some of the issues could then even be solved remotely while at the moment there are still 29% of these unnecessary dispatches resolved by technicians on premise (Dutta, 2009). Besides monitoring the status, sensors also control motors during the production process. Motor systems are responsible for 65% of total energy use in industrial application (OECD, 2009). A motor running at full speed regardless of load unnecessarily consumes too much energy. It is much better to have variable speed optimized to current situation in the production process. This approach employed worldwide could have a huge energy abatement potential which is also depicted in Figure 4.

Lever	Assumptions for the calculations
Optimisation of variable speed of motor systems	30% increase in efficiency of industrial motor systems through optimisation 60% penetration of motor system optimisation technology
ICT-driven automation in key industrial processes	15% decrease in total electricity consumption 33% penetration of process optimisation technology

Figure 4: Assumptions for calculating positive impact of smart motors, Source: OECD, 2009

The ebbits project will also perform research in the area of equipment management and control to reduce energy consumption and CO_2 emission, particularly in this field there is a high level of interest among the industrial partners and thus, this research may have great potential.

Precision agriculture and animal tracking

Sensors and sensor networks can play a role in agriculture to maximize productivity and minimize the impact on the environment (OECD, 2009). They can be used for example to monitor the status of the soil and the water quality and therefore to help combat land over-exploitation. In animal tracking, sensor networks can identify the paths that animals in the herd take by using GPS and peer-to-peer networks. The combination with RFID technology and animal tags is also a topic of current research. With the collected data about the interaction with the surrounding environment general models of animal and herd behaviour are created and this contributes to a better management of grazing areas. Doing so helps to evade overgrazing of pasture and land erosion. Pasture can also be supervised with high-resolution remote sensing technology. Especially by observing the changes over time it is possible to detect problematic areas and manage limited pasture resources optimally. Exact observation of soil, micro-climate and crops and optimized application can also cutback the use of fertilisers and pesticides and therefore reduce environment pollutants.

In the field of animal tracking, sensor networks also collect data about the health of animals (OECD, 2009).

Overall, the analysts in (OECD, 2009) see the potential for more environment-friendly techniques and procedures trough the use of sensors and sensor networks. However, the market is still at an early stage with only trials and field experiments. Additionally, the application of sensor technology is sometimes relatively expensive in farmers' economic terms. The government can assist here through conservation programmes and by highlighting the benefits of improved soil, water and pasture quality.

The ebbits project will also have a look at precision agriculture. Furthermore, it will expand the research frontier in animal tracking with new applications in the retail chain and for pig breeding.

4. Regulatory Standards

In this section, regulatory standards regarding the ebbits project are only determined for the topic of food safety. For RFID technology, there are some ISO and ASTM standards which are mentioned in Subsection 4.2. Additionally, for Smart Sensor Networks, some IEEE standards are shortly described in Subsection 4.3. Furthermore, important W3C standards are listed in Subsection 4.4. As they are important topics in the ebbits project, a more detailed view is given in Subsection 4.5 on standards for persistent data fusion ANSI/ISA-95 and OAGIS as well as on standards to describe information about sensors, although these standards are not regulatory. Some content from this section is also going to be published in the ebbits Deliverable D7.1.1 "Concepts and technologies for a unified lifecycle persistent data fusion architecture 1".

4.1 Regulatory standards for food safety

The regulation **(EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety** is binding for all member states of the EU (Council, 2002). It is applied to all production, handling and retail processes for food or animal feed. It is divided into 5 chapters, where the last chapter defines a standing commission:

- In the first chapter the application range is defined and definitions are given.
- The second chapter defines the general food law. Article 18 is especially interesting for the ebbits project as it describes a traceability requirement of food, feed and food-producing animals at all stages of production, processing and distribution. The article requires that "Food and feed business operators shall be able to identify any person from whom they have been supplied with a food, a feed, a food-producing animal, or any substance intended to be, or expected to be, incorporated into a food or feed. To this end, such operators shall have in place systems and procedures which allow for this information to be made available to the competent authorities on demand". Of course, this also applies to the ebbits agricultural use case.
- The establishment of the European Food Safety Authority is described in the third chapter and Chapter 4 details a rapid alert system to fight dangers from food or feed.

4.2 International standards for RFID technology

For RFID technology, there are many international standards describing radio frequencies and protocols but in principle the rules are not globally valid but determined in every country (Radio-frequency identification, 2011):

- ISO 14223 – Radiofrequency identification of animals – Advanced transponders
- ISO/IEC 14443: This standard is a popular HF (13.56 MHz) standard for HighFIDs which is being used as the basis of RFID-enabled passports under ICAO 9303. The Near Field Communication standard that lets mobile devices act as RFID readers/transponders is also based on ISO/IEC 14443.
- ISO/IEC 15693: This is also a popular HF (13.56 MHz) standard for HighFIDs widely used for non-contact smart payment and credit cards.
- ISO/IEC 18000: Information technology — Radio frequency identification for item management
- ISO/IEC 18092 Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1)
- ISO 18185: This is the industry standard for electronic seals or "e-seals" for tracking cargo containers using the 433 MHz and 2.4 GHz frequencies.
- ISO/IEC 21481 Information technology — Telecommunications and information exchange between systems — Near Field Communication Interface and Protocol -2 (NFCIP-2)
- ASTM D7434, Standard Test Method for Determining the Performance of Passive Radio Frequency Identification (RFID) Transponders on Palletized or Unitized Loads
- ASTM D7435, Standard Test Method for Determining the Performance of Passive Radio Frequency Identification (RFID) Transponders on Loaded Containers

4.3 IEEE standards for smart sensor networks

Nodes in sensors networks often communicate wireless. An overview over the most important wireless IEEE standards is given in Figure 5.

IEEE standard	Applications	Strengths	Weaknesses
Wi-Fi (IEEE 802.11)	• connecting equipment at customer' site • access between WAN networks and customers' site	• easy deployment • falling costs	• only useful within the customer site • additional security layers required
ZigBee (IEEE 802.15.4)	• drive-by meter reading • user interface at customers' site • connection of sensors and other equipment in a customer LAN	• low power requirements • low implementation cost • good scalability (many devices can be connected) • particularly designed for use in industrial and home automation or security applications	• limited range • relatively low data rates (but probably sufficient) • possibly more secure than other standards
Bluetooth (IEEE 802.15.1)	• drive-by meter reading • user interface at customers' site • connection of sensors and other equipment in a customer LAN	• more mature than ZigBee • many products already available • permits higher data rates than ZigBee	• so far, most equipment does not have Bluetooth implementation • limited maximum number of devices in a network • security vulnerabilities

Figure 5: IEEE standards, Source: OECD, 2009

4.4 W3C standards

In the area of web services and service-oriented architecture there are a lot of international standards, the most important are the following (CASAGRAS, 2009):

W3C, Extensible Markup Language (XML) 1.0 (Third Edition) (04 February 2004)
W3C, Namespaces in XML (14-January-1999)
W3C, XML Schema Part 1: Data types (02 May 2001)
W3C, XML Schema Part 2: Data types (02 May 2001)
W3C, Note, web services Description Language (WSDL) 1.1 (15 March 2001)
W3C, Web Services Description Language (WSDL)
W3C, Simple Object Access Protocol (SOAP) 1.1 W3C Note (08 May 2000)
W3C, SOAP Version 1.2 Part 1: Messaging Framework (Second Edition) (24 June 2003)
W3C, SOAP Version 1.2 Part 2: Adjuncts (Second Edition) (24 June 2003)
W3C, Web Services Policy 1.5 – Framework (04 September 2007)
W3C, Web Services Policy – Attachment (04 September 2007)
W3C, XML Path Language (XPath) Version 1.0 (16 November 1999)
W3C, XPointer Framework (25 March 2003)
W3C, Web Services Addressing 1.0 –Core (09 September 2006)
W3C, Web Services Addressing 1.0 – SOAP Binding (09 June 2006)
W3C, Web Services Addressing 1.0 – Metadata (04 September 2007)
W3C, MTOM Serialization Policy Assertion 1.1 (18 September 2007)
OASIS, WS-Security Policy 1.2 (1 July 2007)
OASIS, Web Services Reliable Messaging Policy Assertion (WS-RM Policy) Version 1.1, 07 January 2008
OASIS, UDDI Version 3.0.2, UDDI Spec Technical Committee Draft, Dated 20041019

4.5 Additional standards for data fusion and sensors

4.5.1 ANSI/ISA-95 Objectives

Objectives

Starting in 1995, the ANSI/ISA-95[1] standard has been developed in an international working group of the American National Standards Institute (ANSI) and the Instrumentation, Systems and Automation Society (ISA). The key objective is to describe standard interfaces between control systems on the manufacturing side and enterprise systems on the supplier side. In that sense, it specifies models, operations and processes which foster the integration of different manufacturing execution systems (MES), responsible for production, maintenance and quality management, and arbitrary enterprise resource planning systems (ERP), covering sales, finance and logistics, across all industries. The set of models described reaches from models of the physical structure of enterprises and production procedures to models of information flows and object models. Furthermore, the standard supports various sorts of processes, be it batch, continuous or repetitive processing. All in all, ISA-95 provides a shared conceptualization for describing data exchange as well as workflows and processes in plant systems and therefore facilitates inter and intra-company system integration.

Structure

The ANSI/ISA-95 standard consists of five parts which are introduced in the following. Every part covers one particular aspect of the system integration. The information is mainly structured in UML models, which are the basis for the development of standard interfaces between ERP and MES systems. For a more in-depth description of the various parts the reader is referred to the respective documents distributed by the ISA (ANSI/ISA-95, 2011).

ANSI/ISA-95.01: Models and Terminology

The primary objective of this part of the standard is to describe the manufacturing domain and to specify what information should be exposed to and exchanged with ERP systems and what terminology is used to describe those two domains. Therefore, it provides various models to represent the organization of the company as well as of physical assets involved in manufacturing. Furthermore, it offers models to define the function associated with the interfaces between control functions and enterprise functions.

A basic building block of this part is the functional hierarchy model describing the whole integration domain. It consists of 4 layers with corresponding scopes and time frames. The model is depicted in Figure 6.

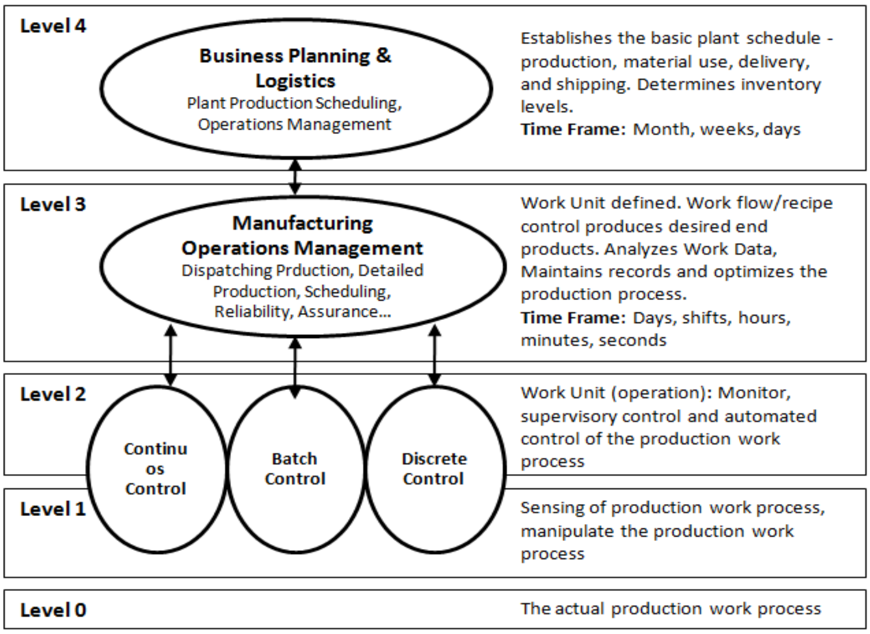

Figure 6: Hierarchical model of the control and enterprise system integration domain (Gifford, Boyd, Childress, delaHostria, & Noller, 2006)

[1] www.isa-95.com

ANSI/ISA-95.01 and ANSI/ISA-95.02 mainly address the interfaces between level 3 and level 4. The models defined in the context of this layer are: 1) hierarchy models to describe levels of functions and domains. The taxonomies specified here include terms like *enterprise*, *site*, *area*, *unit*, *work cell* and so on, 2) data flow models to specify functional as well as data flows and 3) object models used to model information types that need to be exchanged. The main scope of those models is related to the questions about how to create a product, about the capability to produce a product and about actual production of the product.

ANSI/ISA-95.02: Object Model Attributes

Whereas part 1 of the standard describes the data that needs to be exchanged between MES and ERP systems with the help of the predefined object models on entity level, part 2 extends the latter by attributes for each object. In addition, a comprehensive description and examples for all the attributes are given. The *production capability* object contains e.g. the attributes *ID*, *description*, *type* and others.

ANSI/ISA-95.03: Activity Models of Manufacturing Operations Management

Part 3 of the standard focuses on reference-models for activities and functions operating between business planning and logistics (level 4) as well as process control functions (level 2). It provides guidelines for describing and comparing the production levels of different sites in a standardized way and indentifies data exchanged between level 3 activities.

ANSI/ISA-95.04: Object models and attributes for Manufacturing Operations Management

Part 4 further defines object models and attributes involved in data exchange between the activities identified and specified in part 3. Both parts together aim at optimizing supply chains and reducing life-cycle engineering efforts.

ANSI/ISA-95.05: Business to manufacturing transactions

Part 5 of the standard describes the exchange of information of applications performing business and manufacturing activities with regard to information collection, retrieval, transfer and storage in support of enterprise-control system integration. It, therefore, specifies transactions on the basis of the object models and attributes defined in part 1 and part 2. Models covered in this standard are: personnel model, equipment model, maintenance model and others.

Implementation: B2MML

The object models and their attributes, defined in part 1 and 2 of the standard, are solely described on a conceptual rather than on an implementation level. In order to fill this gap, the Business-To-Manufacturing Mark-up Language (B2MML) (World Batch Forum, 2011) has been introduced. It is a full implementation of the ISA-95 as a set of XML schemas, one for every object model. Based on that, data between ERP and ME systems can be exchanged by means of XML messages. An example message is illustrated in Figure 7.


```xml
<?xml version="1.0" encoding="UTF-8"?>
<p:Person xmlns:p="http://www.wbf.org/xml/b2mml-v0400"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="http://www.wbf.org/xml/b2mml-v0400 B2MML-V0400-Personnel.xsd ">
    <p:ID>P1234</p:ID>
    <p:Description>Manager</p:Description>
    <p:PersonName>John Doe</p:PersonName>
    <p:Location>
        <p:EquipmentID>E0128</p:EquipmentID>
        <p:EquipmentElementLevel>Site</p:EquipmentElementLevel>
    </p:Location>
</p:Person>
```


Figure 7: Example B2MML message

The example uses the schema defined for the personnel model defined in the ISA-95 and therefore reuses the vocabulary resp. schema defined there.

Application in ebbits

Especially the implementation of the ISA-95 by means of B2MML could be a potential adoption point of the standard in the context of the ebbits project. It would introduce existing and well established taxonomies and terminologies into the project. This would foster intra-project communication as well as inter-project dissemination of results. Moreover, the predefined message and data formats could be used. Apart from that, it can be used as a methodology to capture the integration requirements of the ebbits use cases. Furthermore, extending the standard by means of semantic annotations might be of interest and will be investigated during the project runtime.

4.5.2 OAGIS

In contrast to ISA-95, which solely focuses on MES to ERP integration, the OAGIS (Open Applications Group Integration Specification (OAGIS)) standard is much broader. The Open Application Group Integration Specification is designed to cover every class of business to business transaction. Nevertheless, as a result of the broader scope, the coverage of pure P2B integration scenarios is less detailed. In order to facilitate integration between various business systems, OAGIS proposes a reference-architecture for exchanging messages. Every message is represented as a so called Business Object Documents (BODs). They can be seen as message templates and are provided in form of XML Schema definitions. Additionally, XPath can be used to define constraints. The overall structure of a BOD is illustrated in Figure 8.

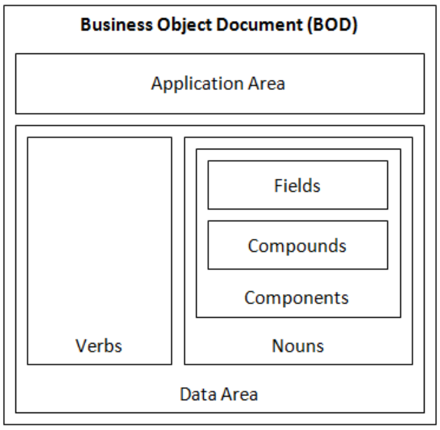

Figure 8: Structure of a BOD (Open Applications Group Integration Specification (OAGIS), 2011)

The application area contains general information about the BOD, as e.g. a timestamp or a unique identifier. The data area, in turn, contains business related data, which is divided into *Verbs* and *Nouns*. The 20 verbs defined in the latest version of the standard (OAGIS 9.4.1) describe business actions, such as *get*, *confirm*, *notify* and *update*. The 79 nouns are often, but not always, a combination of a verb and business object. Examples are *Personnel* or *PaymentStatus*. Every noun can contain other object types (components) as well as various attributes (fields). The name of the BOD is a combination of a verb and a noun, such as *NotifyPersonnel*. Following this naming guidelines, a huge number of BOD can be composed and used for describing the integration layer. In addition to BODs, OAGIS provides 61 integration scenarios which describe the integration of various business applications based on BOD messages by example.

Application in ebbits

The strength of OAGIS results from the modular way to describe business messages. The flexibility gained here, could also be of value for the ebbits project. In that sense, OAGIS could easily be expanded or adopted by introducing new verbs and nouns. Nevertheless is has to be noted, that the predefined nouns and verbs provided for MES and ERP integration are not as detailed and complete as in ISA-95.

In the following, we give a brief overview of available sensor languages regarding their suitability for describing sensors and sensor readings within ebbits. We will now look at the languages EEML, PML and SensorML in detail. The languages are rated according to their maturity, expressive power, adoption by the industry and activity of the development.

4.5.3 EEML

The Extended Environments Markup Language (EEML)[2] is an XML-based language that describes the data output of sensors and allows for the addition of metadata about the origin of the data, which enables searching for data streams without having to know the exact details of the source. The developers claim that it also allows for making "spontaneous connections between streams from different sources", however this would require a commonly accepted semantics of the metadata. A design goal of EEML is sharing of sensor data between remote environments in real time. The most important application of EEML is Pachube[3], a data brokerage platform for the Internet of Things, whose goal it is to store, share and discover real-time sensor data. The system provides measurements of electricity, weather, building management systems, air quality, and radioactivity, while metadata comprise timestamps, geolocation, units, and tags. According to its organizers, it manages millions of data points per day from thousands of organizations and individuals. With recently posted forum messages and news, the web page gives the impression of being more vivid than that of EEML.

4.5.4 PML

The Physical Markup Language (PML)[4] is an XML-based language developed at the MIT whose main purpose is the description of physical objects and environments. Its applications include inventory tracking, SCM, machine control and object-to-object communication. The language itself is intended to be general; therefore it is kept rather simple. With detailed descriptions of XML entities like "date", "location", or "physical properties", it appears to be more sophisticated than EEML. However, XML schemata are not available for download. Moreover, the latest updates on the PML homepage are from 2002, and many important pages like "API", "Applications", or "Contact" are empty, thus it appears that PML is not used in applications, and the development of the language has been halted.

4.5.5 SensorML

The Sensor Model Language (SensorML)[5] is an XML-based language that was developed by the Open Geospatial Consortium (OGC). It allows for describing geometric, dynamic, and observational characteristics of sensors. For example, it is possible to capture that a sensor is moving or is measuring a remote phenomenon, which unit of measure is used, and how accurate the readings are. Thus, SensorML is a very powerful and complex language, covering a large range of sensors "from simple visual thermometers to earth-orbiting satellites". Consequently, only a limited subset of its features will be required for the intended use cases within ebbits, e.g. moving or remote sensors are not needed, but the capability of capturing the (geo-)location of a sensor is required.

Unlike EEML or PML, SensorML is described by a detailed standard document (Botts, 2007), containing over 60 pages of XML schema definitions for the components of the language. The standard also mentions that the semantics of the phenomena to be observed is supposed to be defined by the respective communities and to be referenced by URIs.

In the following, we briefly introduce the most important SensorML data types:

- **Data Component:** A data component represents, for example, measured values. The most important subtypes are count, i.e. integer values, and quantity, i.e. real-number values. Besides the value itself, a data component can be assigned a quality value, a unit of measure (only for quantity), a textual description, and a definition as a URI. Data components also can be time values, quantity and count ranges, and more general types like text, numericals, and Booleans.
- **Position**: A position is given via a reference frame that is denoted by a URI, a time and a location vector. For moving sensors, additional vectors like velocity, acceleration and orientation are possible.
- **Process:** Slightly counter intuitively, sensors are represented as processes. This is because processes comprise both physical processes, which involve interaction with the environment, and

[2] www.eeml.org

[3] www.pachube.com

[4] http://web.mit.edu/mecheng/pml

[5] http://www.opengeospatial.org/standards/sensorml

pure processes, which merely consist of mathematical-logical operations. A process can be an atomic process or, if several steps of data processing are involved, a process chain. All processes can have inputs, outputs, a name and a textual description. Physical processes, i.e. sensors, are also called components. They additionally can have a position and a spatial as well as a temporal reference frame.

- **Phenomenon:** The semantics of a measured value can be defined via reference to a phenomenon, like temperature, pressure, or count.

On the OGC web page, about 20 products implementing SensorML are mentioned[6], mostly from 2008 and 2009, it therefore appears to be adopted by the relevant industry and under active development. However, the most recent version 1.01 of the standard document dates from 2007.

SensorML has been adopted by a large number of applications and provides extensive documentation and XML schema definitions. Moreover, interaction with ontologies or other web-based knowledge representation mechanisms has been anticipated by the SensorML developers and integrated into the language. It therefore is a promising starting point for the intended ebbits use cases and much better than EEML or PML.

[6] http://www.opengeospatial.org/resource/products

5. Conclusions

This deliverable was the first report on market trends and regulatory standards. It provides useful information to the ebbits project team related to market trend, forecasts and regulations.

Concerning current market trends and potential forecasts, this document provides information based on several reports from the EU and private analysts. It starts with a general overview of current trends in the market. This also includes some figures about possible future market potential and a sketch about potential application areas. Afterwards, a more detailed outlook into the markets for RFID and Smart Sensor Networks are given. For the later one, the focus is on ecological aspects of this new technology. In general, it can be said that most of analysts see great potential in the technologies that the ebbits project is going to research. Furthermore, the ebbits project is looking in the right trends and addresses the challenges that are identified in those reports.

Moreover, this deliverable reports on (regulatory) standards. In particular, regulatory standards regarding food safety have been identified. These regulations apply to the agricultural use case in ebbits and are in line with the proposed research on animal tracking. Some other international, but non-regulatory standards for different subjects of ebbits are given in this section. Furthermore, standards on data-fusion and sensors are described.

Since there should be a continuous monitoring of technological, regulatory-standards and market developments and there are further reports in form of deliverables foreseen during the complete project time of 4 years, this deliverable can only be considered as a starting point. The ebbits project is committed to continuously observe the current trends in the market and the evolutions of the standards and regulations actually used in the industrial and agricultural fields.

6. Bibliography

ANSI/ISA-95. (2011). Retrieved 2011, from http://www.isa.org

Botts, M. (2007). *OpenGIS sensor model language (SensorML) implementation.*

CASAGRAS. (2009). *RFID and the Inclusive Model for the Internet of Things (Final Report).* CASAGRAS Partnership.

Consortium, E. (2011). *D3.1 Enterprises Use Cases.*

Council, E. P. (2002). *Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food saf*. Retrieved 2011, from http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R0178:EN:HTML

Dutta, S. (2009). *The Evolution of Remote Product Service and the Emergence of Smart Services.* Aberdeen Group.

Eschinger, C. (2008). *Market Trends: Radio Frequency Identification, Worldwide, 2007-2012.* Gartner.

Gifford, C., Boyd, A., Childress, L., delaHostria, E., & Noller, D. (2006). *Standards for Manufacturing Systems Integration ISA-95 and OAGIS.*

Harbor Research, I. (2010). *2010 - 2014 M2M & Smart Systems Forecast Report - The Emergence of Smart Business.* Forecast Report Overview.

Michael Chui, M. L. (2010). *The Internet of Things.* McKinsey Quartely.

OECD. (2009). *Smart Sensor Networks: Technologies and Applications for Green Growth.*

Open Applications Group Integration Specification (OAGIS). (n.d.). Retrieved from Open Applications Group: http://www.openapplications.org

Open Applications Group Integration Specification (OAGIS). (2011). Retrieved 2011, from Open Applications Group: http://www.openapplications.org

Radio-frequency identification. (2011). Retrieved 2011, from http://en.wikipedia.org/wiki/Radio-frequency_identification

World Batch Forum. (2011). Retrieved 2011, from Business To Manufacturing Markup Language (B2MML): http://www.wbf.org