Revolution in Industrial Environment:
Ambient Intelligence Technology for
Systemic Innovation in Manufacturing SMEs

Deliverable D1.4

Business Cases & AmI-4-SME Solution Concept

WP100

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Project Partners

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5	PRO DV Software AG	PRO DV	Germany
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10	Brüggen Oberflächen- und Systemlieferant GmbH	Brüggen	Germany
11	OAS AG	OAS	Germany
12	TNS Sp.z.o.o.	TNS	Poland

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0.1	Creation of the Document	12.05.2006
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0.60	Adding analysis approach, first versions of the business case analysis results and first approach for the identification of AmI BBs and derivation of BB requirements	24.07.2006

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Table of Contents

Abbreviations

AmI	Ambient Intelligence
BB	Building Blocks
BC	Business Case
e.g.	exempli gratia (engl. for example)
GUI	Graphical User Interface
ICT	Information Communication Technology
ISO	International Standard Organisation
LAN	Local Area Network
PDA	Personal Digital Assistant
RFID	Radio Frequency Identification
SME	Small and Medium Enterprise
SRS	Speech Recognition System
WAP	Wireless Application Protocol
WLAN	Wireless LAN
WP	Work package
w.r.t.	with respect to
XML	Extensible Markup Language

1 Purpose of the Document

The objective of this document is to present the results of WP100 of the AMI-4-SME project, covering the SMEs innovation needs based on the analysis of the five AMI-4-SME business cases. Also a brief description of the methodology and the AmI building block technology concepts are presented in this report. More specifically this report will detail the AMI-4-SME findings of the following areas:

- Present an overview of the Ambient Intelligence definition and its meaning within the AMI-4-SME project.
- Outline of the AMI-4-SME methodology concept supporting SMEs to introduce AmI technologies based business process improvements.
- First results of the business cases analysis, carried out in strong collaboration of the SME, RTD and vendor partners of the AMI-4-SME project, indicating the SME innovation needs.
- The AmI building block technology approach and basic concepts are also presented in this report.

The results of WP100 will be used as input for the realisation of WP 200 Specification & Design.

2 What is AmI-4-SME

Modern SMEs (Small and Medium sized Enterprise) have to meet the challenges of the increasing product variants and service content of products by radically innovating their business processes. To achieve this objective, the usage of Ambient Intelligence (AmI) technologies is promising to enable the realisation of new paradigms, focusing upon the main actor in industry: the human actor. This will allow a key improvement of collaborative working environments, also in the manufacturing industry[1].

Currently, AmI technologies (e.g. wireless multi-media, wearable IT, wireless sensor networks, agent technologies etc.) are attracting a high interest in the research domain, where their applications in manufacturing industry are still in an initial phase. Particular in manufacturing SMEs, constraints like limited investment potentials and investment risks, limited staff quantity and qualification to drive business process innovations often create a strong reluctance to innovations. Therefore, SMEs need specific approaches how to address the successful utilisation of these new technologies to create measurable business benefits on short to medium term, enabling SMEs to keep pace with the innovation speed at large companies.

The strategic objective of the presented research results of the AMI-4-SME project is to enable SMEs to actively take part in this revolution, by proposing a new scheme for systemic innovation of industrial working environments in SMEs by applying AmI technology. The basic approach, presented below, targets to enable SMEs to make decisions on the following key topics:

- To what extent AmI technologies can create innovation potentials – innovation by technology.
- In which of their business processes technology need to be introduced and organisation of work to be changed – innovation by a human centric process reorganisation.

2.1 Reference Model for AmI in Industry

Ambient Intelligence represents a new wave of technology that refers to “an exciting new paradigm in information technology, in which people are empowered through a digital environment that is aware of their presence and context and is sensitive, adaptive and responsive to their needs, habits, gestures and emotions” (Ambience project). This definition does not employ a new complete wave of technologies, however the focus of ICT technologies is shifting in the domain of ambient intelligence to one that is human centered. The definition also aims to realize new potentials such as reactive and responsive and relies on the human implicit responses that are not explicitly initiated by the human. Other definitions for ambient intelligence incorporate ambient intelligence as “the effective and transparent support to the activity of the subject/s through the use of information and communication technologies.”

However, in spite of intensive research activities on specific AmI technologies, besides such generic formulation on AmI, there are no wide spread accepted definitions of AmI systems in manufacturing industry. Objective of the AMI-4-SME project was to provide a definition of AmI systems relevant for manufacturing industry which will serve to understand how AmI systems ‘upgrade’ classical intelligent systems.

[1] Maurtua, Unceta, de Vallejo: Ambient Intelligence in Manufacturing: Organisational Implications, 1st International Workshop on Social Implications of Ubiquitous Computing, April 2005, Portland.

Based on the definition of AmI systems relevant for manufacturing industry[2], a reference model was developed, based on the main assumption that the AmI systems in industry can be considered as control systems of Automation & Robotics and processes, which include human operators in the control loop. The elaborated reference model indicates, where AmI technologies offer potentials to optimise the interaction of human operators within their working environment.

The reference model indicates the different areas of required AmI based solutions to enable a human centred interaction of the worker with his ambience. Thereby, the ambience is split up in a manufacturing related ambience, covering process, plant, machines etc. and an ambience representing a wider human operator environment, not directly (however indirectly) related to the manufacturing process. The intelligence of interaction of the human operator with the environment is managed by the AmI system (see Figure 1).

As presented in Figure 1 the reference model covers the input and output areas of the human operator with the AmI system comprising implicit (1.1) and explicit (1.2) inputs from human operator to the AmI system and the explicit outputs of the AmI system to the human operator (1.3). Additionally input/output areas address the interaction of the different ambiences (environment (2) and process (3)) with the AmI system.

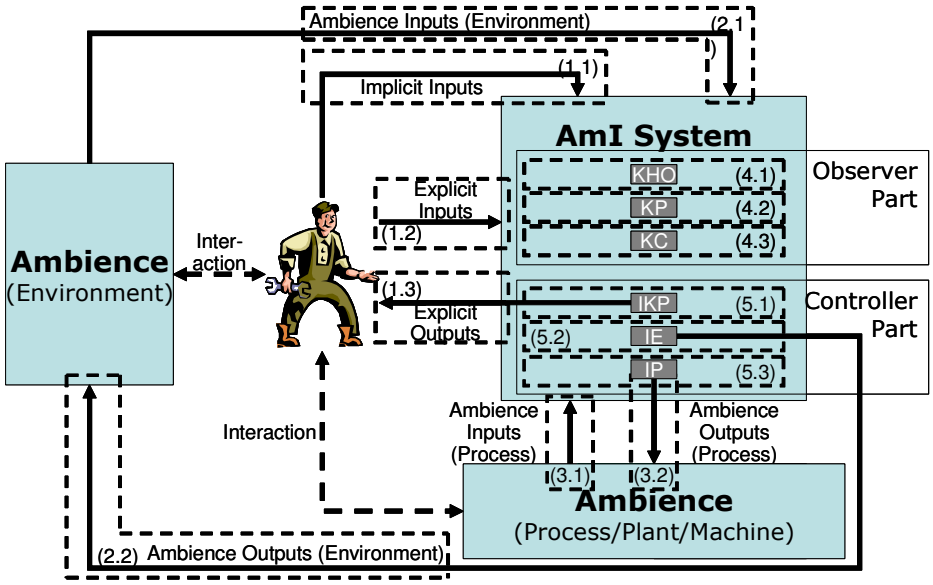

Figure 1: Reference model for AmI in manufacturing industry.

Based on the control engineering approach the AmI system is separated in an observer and a controller part. The observer part is creating, based on input information and other existing knowledge and information, the knowledge about human operator (4.1), the knowledge about ambiences (4.2), covering process, environment and interactions, as well as the knowledge on context (4.3), based on knowledge and information provided by the mentioned two observer modules and other systems.

Based on knowledge and information provided by the observer part, the controller part of the AmI systems covers the information/knowledge provision to human operator (5.1 - IKP), the

[2] Stokic et. al : Ambient Intelligence in Manufacturing Industry: Control System Point of View, IACTED, Conference on Control and Applications, Montreal, 2006

intelligent interaction with ambience (environment) (5.2 - IE) and the intelligent interaction with ambience (process) (5.3 - IP).

2.2 The AmI Features Concept

The objective must be to enable SME end-user, representing "non-experts in AmI technology", to identify most appropriate AmI technologies for a human centred business improvement, not requiring any expertise on AmI technologies. The key approach to bridge the gap between identification of the required AmI potentials and the AmI technology, required to create an AmI based solution realising the intended improvements, represent the introduction of the AmI Feature concept. AmI features represent a solution independent formulation of AmI technology potentials offered to the human operator when interacting with the ambience, where a feature defines WHAT an AmI system may offer, but not HOW it may achieve.

For each of the five areas of the AmI reference model one or more AmI features are defined, formulating specific AmI characteristics in this area.

Table 1: Example for the relation between AmI features and technologies.

AmI Features	**Related Technologies & Functions of Supporting Applications**
(1) Human Operator I/O	
(1.2) Explicit inputs from HO to the AmI system • Natural HO inputs: i.e. spoken language, handwriting, touch screen, gesture, gaze to forward unstructured information and observation to the AmI system • Simultaneous exchange of information over multiple channels at different levels of abstraction, e.g. speech, gesture, animation, non-speech audio. • Provision of observations and experiences of the HO on the status and problems in process and environment to the AmI system • Request for data without knowing specific file names, location or format. • Automated user identification and authentication and authorisation. • Forwarding unstructured communication needs with collaborating partners • Mobile or nomadic access • ...	• Digital pen, touch screen, handwriting recognition, speech recognition technologies. • Wireless handheld devices like PDAs, tablet PC or mobile phones. • Wearable input devices like e.g. key boards sewed in cloth, data glove etc. • Biometric authentication and authorisation technologies • Video conference technologies • Mobile communication and interoperability technologies (Bluetooth, WLAN, GPRS, UMTS etc.) • Collaborative working environment – core services • Network interoperability and ubiquitous communication • ….

3 Methodological Approach

To bring AmI technologies to the industrial sector of manufacturing SMEs, an SME tailored methodology is essential. As the technology innovation in the past exemplifies, such methodologies are indispensable for SMEs to keep pace with the innovation speed of the utilisation of new technologies at large companies. The methodology to be developed has to support SMEs to identify to what extent AmI technologies can create innovation potentials in their business processes. However, SME constraints like limited investment potential, limited staff quantity and qualification often create a strong reluctance to innovation. Therefore, SMEs will not go for a general experimentation of new technologies. They are looking for innovative solutions which can be put into daily operation on a short-term, creating measurable business benefits.

The analysis of the SME specific constraints clearly indicated, that the AMI-4-SME methodology can not focus straight forward on the introduction of AmI technologies, but has also to cover the redesign of the existing business process execution and the introduction of a basic integrated ICT infrastructure as prerequisite for the introduction of AmI solutions. Hence the approach follows two key dimensions as seen in Figure 2:

The **"process dimension",** targeting the QCS-optimisation (Quality/Costs/Schedule) of the execution of the business processes, supported by an advanced and integrated company wide ICT system, open for its integration in an Extended Enterprise ICT environment.

The "**human centric dimension**", targeting the creation of a context sensitive intelligent ICT environment for the human operators involved in the different business processes of the company, based on the potentials of the application of AmI technologies.

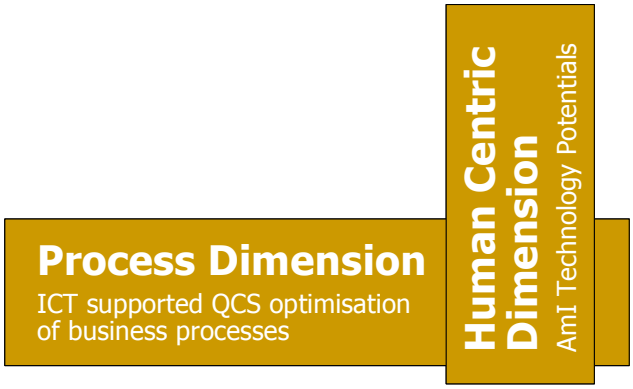

Figure 2: The two optimisation dimensions.

Against this background the AMI-4-SME methodology has to merge these two dimensions to manage this complex process of an AmI based business process improvement. Therefore, the key of the developed concept of the AMI-4-SME methodology is driven by a superposition of the two optimisation dimensions. Thereby, the resulting two step optimisation process has to start with the process optimisation dimension, as the essential prerequisite and basis for the human centric optimisation aspects.

For the process dimension well experienced and international recognised methodology solutions already exist[3]. One of these methodological approaches (BEP2-Method) covers the process dimension for an ICT supported business improvement. The methodology is extended to identify and implement "AmI based" ICTs required to cover the human centric optimisation dimension based on AmI potentials.

[3] **www.cost-worth.net,** descriptions of 5 business improvement methodologies and support material, accessible free of charge, results of the EU funded COST-WORTH project.

4 SME Business Cases

Usage of Ambient Intelligence (AmI) technologies is promising to enable the realisation of new paradigms, which will allow for a key improvement of collaborative working environments, also in the manufacturing industry. In the following the introduction of AmI solutions to five industrial business cases and identify the key problems is presented. The building blocks that will be employed as part of the solution are also described.

4.1 Business Case 1

4.1.1 General Situation, Problems and Business Strategy

Business Case 1 is based on the collaboration of the German company **Brüggen Oberflächen- und Systemlieferant GmbH** and the Polish company **TNS Sp.z.o.o.** which are cooperatively producing in relatively small batches special, customised, change over platforms for lorries. Brüggen Oberflächen- und Systemlieferant GmbH was founded in 1990 by Bernhard Brüggen, beginning with around thirty employees and over the last 16 years, the company had in average a yearly growth rate of around 13%. Presently, operating with around 220 employees, Brüggen is the market leader in its business field, having one of the biggest and most modern surface coating systems in Europe. The key customer of Brüggen, ordering around 50-65% of Brüggens' manufacturing output, is the German company Krone[4].

TNS Sp.z.o.o. was founded in Warsaw in December 1989 and started full operations in April 1990. The company is located in Warsaw (Poland), Krapkowice (Poland) and since 1992 having a technical office in Germany. The product portfolio includes manufacturing of metal construction, vehicle chassis, trailers & semi-trailers, construction parts for bucket depth & mechanical shovel excavators, metal containers, road bridge steel constructions. TNS is also active in installation of pipelines, ducts, tanks, cooling, heating ventilation systems, environmental control systems as well as provides welding and assembly services for metal structures both at TNS facilities or at the facilities of their customers. From mid 90's TNS is cooperating with Brüggen, especially overtaking welding tasks. In the beginning TNS was supplying their products from Poland, while the amount of supplied parts continuously increased. To improve a reliable just in time or just in sequence delivery Brüggen and TNS decided to further integrate their production in Germany. This also enabled a strategic change of the production structure, where Brüggen reduced their production depth especially in the early assembly phases by outsourcing all frame welding activities to TNS. Nowadays, around 120 qualified welders and fitters are working in close cooperation with Brüggen, enabling a fully integrated and synchronised production.

4.1.2 Key Objectives to be achieved by Process Improvement

Currently a majority of the customer orders have to be realised by keeping the delivery time of 5 days. The key business objectives are on one side to cut the delivery time to less than 4 days, and, on the other hand, to increase number of variants, i.e. to achieve higher customisation following the total Build-to-Order (BTO) philosophy. This requires to further increase

[4] Krone is Europe's second largest manufacturer of truck trailers and semi-trailers today. At the Werlte plant in the Emsland region (Northern Germany) with an area of 180,000 m², 650 Krone employees produce 19,000 vehicle units per year. The product line includes semi-trailers, linkage systems, trailers and motor vehicle bodies.

flexibility of their manufacturing and assembly lines, while due to high diversity in product variants a (re-) planning and control of batches is difficult.

Focusing on key objectives w.r.t. Quality, Costs and Schedule, the following were identified, representing the process related strategy:

- Decreasing lead time and delivery time
- Increased flexibility w.r.t. customer order changes
- Faster rescheduling of the production
- Increasing productivity and material availability, while decreasing waste.

4.1.3 Business Improvements & Solution Concept

As a key vision it is expected to realise an ad-hoc collaboration of relevant actors of both organisations (i.e. specifically production manager and foremen) to enable a harmonised 'situation dependent' rescheduling at Brüggen and line reconfiguration at both companies. Key business processes concerned with respect to the envisaged improvements of the collaboration between Brüggen and TNS are presented in the following Figure 3.

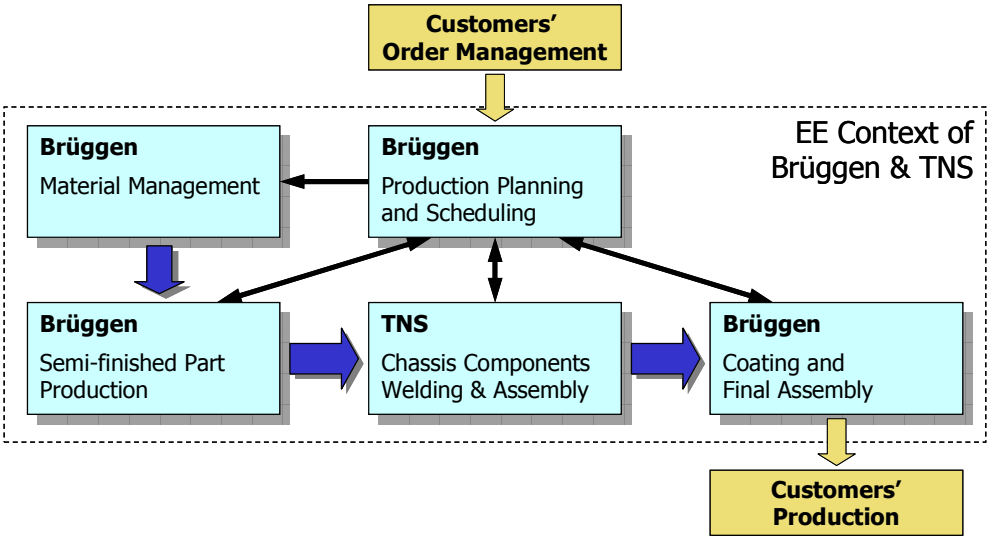

Figure 3: Basic collaboration structure between Brüggen and TNS.

The key improvement strategy targeted by Brüggen and TNS is to achieve an order related production process as early as possible (however, not giving up batch optimisation potentials in the production of semi-finished products) and to consistently trace the production progress per order over all production cells. From human centric point of view the strategic improvement is concerning the order tracking, not to impose additional efforts on the workers in the shop floor and to improve the communication between the respective staff members in both companies responsible for reliable rescheduling and reconfiguration activities.

Kernel sub-processes affected by the identified weak points are production operations management and materials management:

Sub-process Production Operations Management:

- Delayed update of the production progress information by foremen and missing actual status information along the entire assembly line.
- Production problems and delays sometimes detected too late, reducing the reaction time for problem elimination.
- Rescheduling of the production order sequence is too slow.

Sub-process Materials Management:

- Semi-finished products are not delivered order related to the frame welding areas, causing sometimes missing material or waste of material:

Further on it was analysed which key business benefits may be achieved (i.e. also resulting in subsequent benefits in the overall business process), when eliminating the identified weak points in the inter-organisational business processes:

- Reduction of delivery time and increasing productivity.
- Increased flexibility in case of customer order changes.
- Reduced reconfiguration effort for the foremen.
- Decreasing loss of material:

It is envisaged to realise additional benefits, but these potential benefits need to be further analysed in more detail.

Solution Features

The general objective of the business case is to improve the inter-organisational collaboration with respect to planning and control of the assembly and manufacturing lines in both companies aiming to easily reschedule the customer orders and reconfigure the lines according to the product variants (and volume) to be manufactured/ assembled. Therefore, from human centric point of view the following general aspects shall be taken into account:

- realising interconnections of the production planning and control systems in the companies,
- intensively supporting human operators to
  - avoid repetitive tasks, like searching for planning relevant information,
  - facilitate complex tasks like rescheduling of interconnected production lines and
  - make available distributed information.

The envisaged AmI system with its different AmI features shall enable to eliminate the identified weak points and specifically support the concerned human operators in the execution of their tasks in the business process.

4.2 Business Case 2

4.2.1 General Situation, Problems and Business Strategy

Business Case 2 is realised with the company **OAS AG**, an SME type company established in 1982 in the region of Bremen in Northern Germany. It operates with ca. 180 employees with offices at 6 locations in Germany. Key business activities are industrial plant construction and engineering with focus on process engineering in combination with weighing, measurement and control technology as well as computer applications for continuous and discontinuous processes. Based on these activities, competencies and strategic partnerships, OAS offers its products on the German as well as international market:

- plant constructions for process engineering domain
- road vehicle and rail wagon weighing systems with industry specific software and EU-admission,
- solutions for dispatch automation,
- dosing- and weighing technology,
- automation technology,
- switchgear construction,
- PLC- and computer based process control systems and

- process visualisation.

4.2.2 Key Objectives to be achieved by the Process Improvement

OAS currently provides sophisticated routine maintenance services to their customers (e.g. embedded diagnostics, remote diagnostics support and preventive maintenance etc.). The key improvement domain is to go beyond the state-of-the-art in industry within the next 2-5 years, addressing a new maintenance service quality in case of unexpected problems of installations at customer sites. From Quality, Costs and Schedule point of view, the OAS' key objectives can be summarised as follows:

- Decreasing reaction time in case of unexpected problems, failures and breakdowns at customer premises
- Decreasing fault recovery times
- Reduction of maintenance efforts and costs
- Increasing maintenance productivity
- Increase of maintenance quality

4.2.3 Business Improvements & Solution Concept

Based on the presented OAS business objectives, to better serve their customers as well as to reduce costs and efforts in case of unexpected problems at customer installations and in reference to the maintenance process reference model, OAS will require a new dimension of interaction and collaboration within OAS as well as with their customers by structuring the corporate knowledge, providing optimal electronic access to information, and supporting documentation. Moreover, to achieve a sustainable improvement, the interacting of maintenance processes with existing information systems (see also Figure 4).represents an essential improvement dimension.

From human centric point of view the strategic improvement addresses the objective to optimally support the human operators in the different business processes in a way that they can focus on decision processes and are disburdened from elementary information processing activities. Furthermore, the mobile information access represents a key issue.

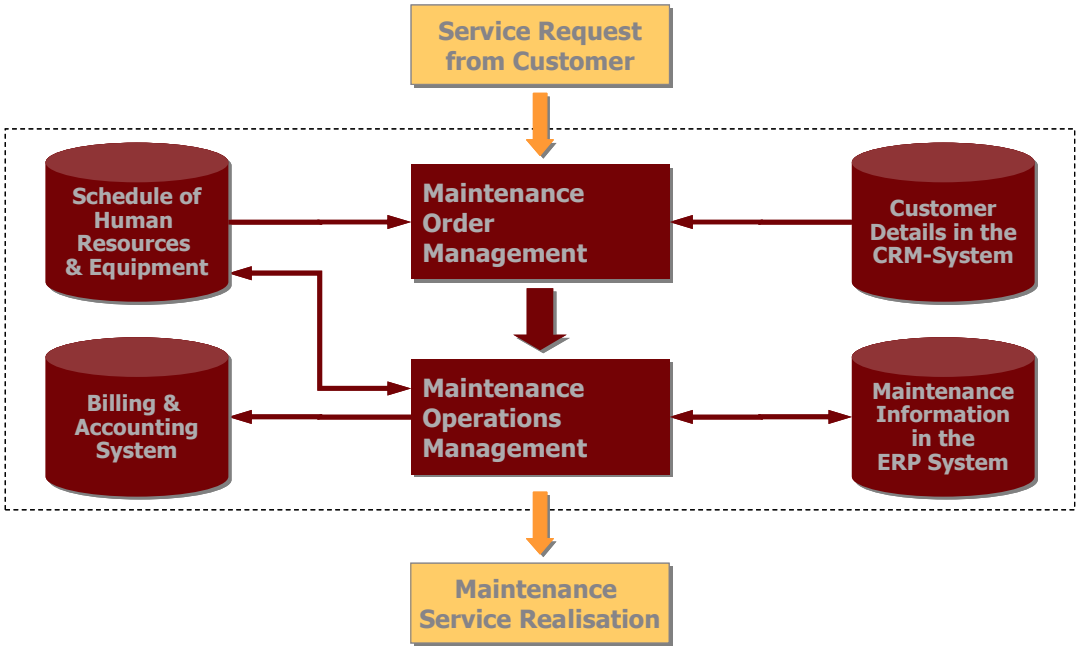

Figure 4: Business Processes of OAS to be improved.

In the scope of an interview with the responsible staff members at OAS the above stated business processes were analysed and several weak points in the actual process execution identified. The resulting ***weak points in the addressed processes***, to be eliminated by the envisaged process improvement activities in the scope of the AMI-4-SME business case, were summarised. The following weak points shall be eliminated with highest priority:

Sub-process Maintenance Order Management:

- Hotline reaction time to identify customer's reference information and the appropriate OAS expert for an unexpected customer problem is too long.

Sub-process Maintenance Operations Management:

- OAS service staff has insufficient access to information about the concerned installation required for an efficient identification of corrective measures.
- Service staff efforts for the recording of the provided services (e.g. time, materials, error reports etc.) are too high and documentation is sometimes incomplete.

The business case analysis also addressed the identification of business benefits which can be realised after weak points elimination. In the following, the most important benefits are presented, including first quantitative estimates:

- Reduced time and effort to react on problems of customers:
- Increase in "customers solving problems themselves".
- Increased productivity.
- It is envisaged to realise additional benefits, but these potential benefits need to be further analysed in more detail.

Solution Features

To improve the maintenance services of OAS in case of unexpected problems at customer site, explicit measures have to be taken to overcome the identified weak points in the maintenance order management and in the maintenance operation management domain. This will reduce the reaction time to customer problems, improve the identification of problems and measures. From human centric point of view the optimisation of the HO involvement in the execution of the required activities shall address the following general aspects:

- Focus of the task allocation of the human operator on decision processes.
- Provision of all decision relevant information to the HO to
  - make available context dependent distributed information and
  - avoid repetitive tasks, like searching for relevant information, elementary information I/O.

The envisaged AmI system with its different AmI features shall enable to eliminate the identfied weak points and specifically support the concerned human operators in the execution of their tasks in the business process.

4.3 Business Case 3

4.3.1 General Situation, Problems and Business Strategy

TRIMEK is a Spanish SME manufacturer and seller of 3D contact equipment. During the last years, TRIMEK has opened a gap in the Spanish dimensional measurement cluster. TRIMEK designs and assemblies four different types of Measurement Machines (Bridge Type Systems, Arm Type Systems, Gantry Systems, and Vulkan Systems) that can be adapted to specific requirements. Apart from CMMs, TRIMEK provides the following services to their custom-

ers: Measurement Services at TRIMEK facilities or customer's; Updating of CMMs; Calibration and Tuning Services; Transfer of Machinery; Technical Assistance; Consultancy. TRIMEK facilities are located in Altube (Vitoria, SPAIN), strategically situated in a very industrial area of the Basque Country. TRIMEK disposes of commercial offices all around the world. In Spain, apart from Altube's headquarters, TRIMEK has also facilities at Barcelona and Valladolid, for commercial purposes but also to perform measurement services.

4.3.2 Key Objectives to be achieved by the Process Improvement

From Quality, Costs, and Schedule point of view, TRIMEK's objectives consist mainly in the following:

- Decrease reaction time between customer request and maintenance execution
- Decrease time to identify breakdown problem
- Reduce number of misidentifications
- Reduce time to repair
- Reduce maintenance efforts (optimising resources management)
- Avoid non-added value services (tele-maintenance services)

Focusing on human operators, TRIMEK's key objectives can be summarised as follows:

- Ameliorate support to HO in the repairing tasks
- Favour knowledge/experience exchange among HO
- Avoid non-added value tasks.

4.3.3 Business Improvements & Solution Concepts

With these objectives in mind, to provide more efficient maintenance and metrological services to their customers as well as optimise resources and efforts, TRIMEK seeks to improve the maintenance operation management and more specifically the resource & equipment management. Historically, TRIMEK has lacked from a structured basis of exchanging existing knowledge, capitalised by some individuals in what has been named "knowledge islands". To optimally address the maintenance services to customers, TRIMEK has first to overcome this lack of "knowledge structure". This requires the existence of solid and structured information and documentation channels. Thus, the HO should have optimal access to *"relevant"* information and documentation, as well as real-time support from other technicians. The third leg of this "knowledge structure" should be the information channel established between the machine and HO, friendly and interactive, providing all relevant data required from the technicians.

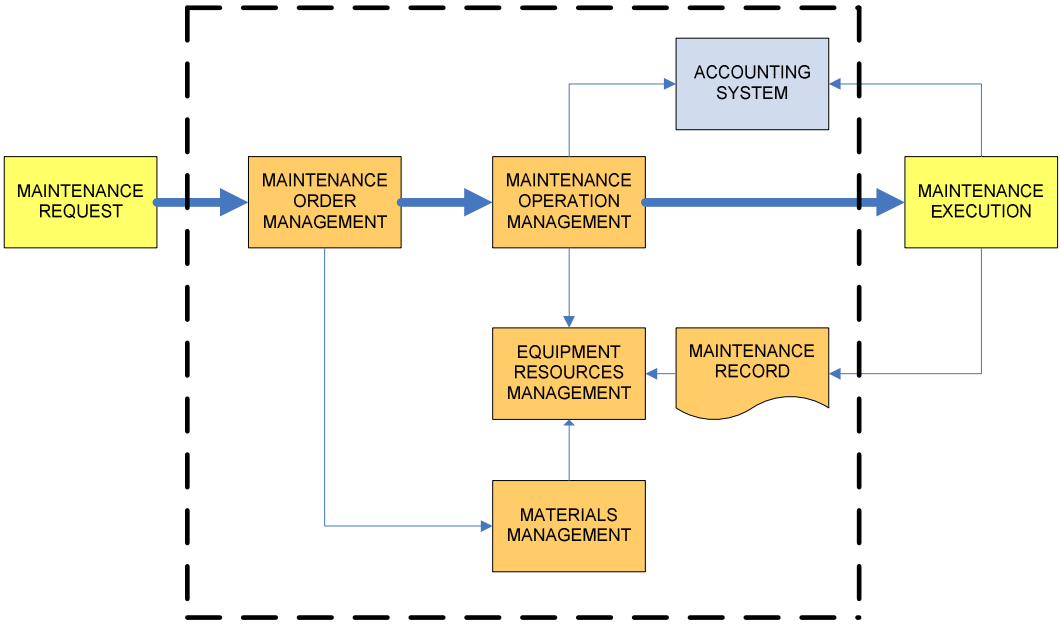

Figure 5: Maintenance Reference Model adapted for TRIMEK Maintenance process.

Figure 5 represents the maintenance process as seen by TRIMEK. Analysing the sub-processes that take part in the maintenance services, we have identified some weak points that can be potentially addressed by means of Ambient Technologies. The analysis has yielded the following conclusions:

Maintenance Order Management

- When customers encounters a problem in their CMMs they often appeal to commercials (sales department) rather than the help-desk, which is sometimes ignored in the maintenance process. This leads into a delay in the time to react face an intervention, because the commercial usually is not fully able to identify the problem. The communication efficiency between departments has been ameliorated in last times but is still not optimal.
- Also the access to an historical data of repairing/calibration services offered to the customer (calling) is not evident. This data exists but is not uniformly used by the staff.
- A real-time update of emergency calls received by both customer and help-desk in a unique database that contains all relevant information from customer (customer name, location, type of machine, symptoms, and historical services provided) lacks.

Maintenance Operation Management

- *Information Management:* As many times repeated in this report information access is the key question to be addressed in TRIMEK maintenance process. Technicians, working at customers do not always have all necessary documentation on the machine with them, and must access to TRIMEK databases. This access is not as easy as should be today. Moreover, data provided by the machine about its condition is not sufficient and not task/decision support oriented.
- *Equipment & Resources Management:* Effort in terms of time and human resources involved in repairing services is sometimes too high and even inappropriate when there has been a misidentification of the problem. This is a direct consequence of the previous point, and of the lack of a decision support oriented database.

- *Maintenance Record:* Currently, technicians must report in a document, the lists of services (and materials) provided to customer. This allows the accounting and billing of the services. However, these documents are not always electronically recorded and information is sometimes incomplete. This prevents a complete updated database of incidence and a measurement of customer satisfaction, efficiency, etc..

Solution Features

To improve the maintenance services of TRIMEK at customer site, explicit measures have to be taken to overcome the identified weak points in the maintenance order management and in the maintenance operation management domain. This will reduce the reaction time to customer request, improve the identification of problems and measures.

Basically, these AmI features should address the TRIMEK necessity of having real-time, relevant information anytime, anywhere, and this considering three channels of communication: HO-HO, HO-Machine, and Machine-Machine communication.

The envisaged AmI system with its different AmI features shall enable to eliminate the identified weak points and specifically support the concerned human operators in the execution of their tasks in the business process

4.4 Business Case 4

4.4.1 Company Background

Silcotec Europe is a medium size organisation in the west of Ireland that employees over 20 people and has over thirty years experience in the field of cable harness manufacturing and are the main suppliers for a number of blue chip companies. They have a plant in Ireland and in Slovakia. Siloctec provide services from the design right through to the final shipment of the product to the customers along with after sales services etc. Quality, cost, reliability are of high importance to the organisation. The key customers of Silcotec are in the Aerospace or defence manufacturing as well as the medical device sector where they manufacture connectors, power supply units, electrical switching systems, and custom wire harnesses. Silcotec have annual sales exceeding €9 million.

4.4.2 Key Objectives to be achieved by the Process Improvement

4.4.2.1 Overall weak points of the process

In order to successfully compete in the today's fast moving market of electronic manufacturing Silcotec Europe must compete on cost, time to market, reliability and quality. In order to do this they must adopt a systematic approach of improving their entire development life cycle. There are a number of requirements however in order to improve this level of systematic improvement. In order for Silcotec to fully implement an improvement or maintenance life cycle in place they will achieve the following objectives:

- Improve the reliability
- Improve the traceability of the products
- Reduce lead time

In order to achieve these company objective Silcotec's maintenance process was examined to identify what the key weak points in the maintenance process are. They include:

- **Weak point 1:** Poor traceability of the products: Currently Silcotec's manufacturing process begins with a batch production of all the Silcotec's components and wire parts. After these batches are made they enter into several different cells in the manufacturing process

where they are used for higher level assemblies. However currently there is no means of identifying what batch each component came from. This makes it difficult to trace the origins of the problem

- **Weak point 2:** When the product enters into the final assembly and on to packing there is no accurate record kept of the shipping. Instances occur where the customer's records of goods received do not math that of Silcotecs count for goods sent. In each case Silcotec must bare the brunt of the cost.
- **Weak point 3:** There is no functional testing that can be done in house therefore even supplier parts cannot be accurately traced to identify the causes of their weaknesses in the product.
- **Weak point 4:** There is no traceability of individual worker or equipment that was done on each part. Therefore no systematic improvement can be traced and updated.

4.4.2.2 Weak Points on the Role of the Human Actor

The human actor has a number of weak points from the overall weak points that were identified above:

- **Weak Point 1:** The maintenance personnel cannot track any of the products from the batch to the final assembly products. Where there is limited traceability the information is limited due to the lack of opportunities of the shop floor workers to input information to the system.
- **Weak Point 2:** The records for the shipping is dependant on the human operator to input the information on the shipping pallets to the database however this process is subject to human error and there can appear conflicts between the customer and Silcotec's records.
- **Weak Point 3:** Due to the fact that Human Operators do not record all the relevant data for the maintenance process there is little traceability from batch to final assembly. The maintenance manager thus cannot trace component faults to the supplier parts and allocate responsibility.
- **Weak Point 4:** The maintenance personnel does not have any customised reports or access to data that reflects any key improvement areas and hence their decision making is limited and problems are re-occurring.

4.4.3 Business Processes to be improved & investigated Business Benefits

The business process to be improved is focused on the maintenance processes. The key reason for focusing on this process is to enable Silcotec to systematically improve their production processes according to feedback from customers.

The envisaged solution will be primarily driven from the maintenance planning system where by the plan will consult the production records to examine for each product what batch the components came from and who or what machines worked on it. These records will help to identify the key problem areas. Re-work is executed once the problem area is identified and the records of what happened can be captured on the maintenance schedule. Testing and shipping are completed and the shipping process items can be traced via wireless technologies to ensure that all products are electronically recorded and traced to improve the records of what the customer received. The overall process can be seen in Figure 6.

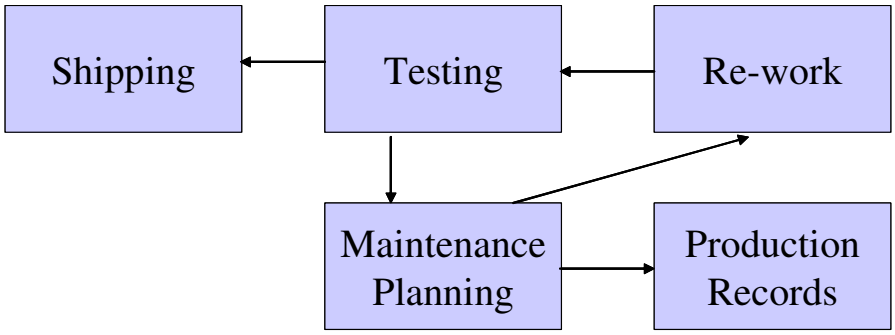

Figure 6 Silcotec Maintenance Process

Solution Features

- The solution will enable full traceability (via RFID) of their product parts throughout the system so as to easily assess where and what damage was caused from both their processes and their suppliers
- To more effectively prevent product failures by capturing and analysing causes of failures.
- More effectively isolate key problems and defects in higher assembly products

4.5 Business Case 5

4.5.1 General Situation, Problems and Business Strategy

Sidean Teo is a small to mediums size manufacturing enterprise that is located in the rural region in the West of Ireland and currently employ over 20 people and make an annual turn-over of €3.0 million. Sidean Teo was established in the year 2000 as an independent company to take over the fire engine business that had been operating out of there since 1984. They currently are in the business of manufacturing and fabricating fire engines for local authorities. The company also has a large upgrading and repair unit for second hand fire engines. The key processes in Sidean Teo include sheet metal facilities in terms of CNC punching, Folding, Cutting, MIG and TIG welding, Spot welding etc. and they also carry out sub-contract manufacturing and assembly work in these areas.

4.5.2 Key Objectives to be achieved by the Process Improvement

4.5.2.1 Overall weak points on the process

In an initial experiment that was conducted in Sidean Teo it was found that the optimum lead time to make a product could be completed in six weeks. However currently it takes due to the delays it takes on average nine weeks to complete. This is primarily due to stoppages in work due to the lack of availability of supervisor to instruct the shop floor staff on what tasks to do next and also due to the unavailability of material on the shop floor. This also has the added complexity of billing the labour costs accurately to the individual product costs as it becomes difficult to assess the level of activity to each product on the shop floor. Further more many saving could be made by reducing the holding cost of the stock if the lead time is reduced by improving the overall scheduling on the shop floor.

After reviewing the process itself a number of key performance indicators were identified that are considered to be of key critical importance for the entire organisation. These are namely

- To improve the information of the process schedule for the operators
- To increase the level of efficiency and effectiveness
- Reduce the overall lead time to manufacture the produce

- And to reduce the overall stock outs.

The process does not offer a high level of standardisation as each customer can customise the product and is highly involved throughout the entire product development process. Sidean Teo currently experience a number of inefficiency that can be found in the process. The causes of inefficiency are both social and technical. Within the process itself that are a number of weak points that are cause of excess time and cost to the process such as:

- **Weak point 1:**Material shortages are a main cause of time delay in the process. This problem results in the delaying of the product being made and extending the lead time. This also results in increased holding cost of the stock.
- **Weak point 2:** Increased lead time due to redundancy of information on the schedule. The schedule itself is subject to an extreme amount of variation on a daily basis due to changes in customer requests, material shortages, absenteeism etc.
- **Weak point 3:** Production progress is often unknown due to lack of information status on the shop floor. Information is dependant on end of shift or end of week work updates and delayed decisions result from this. Poor real time information to update schedule
- **Weak point 4:** There is poor traceability of the activity of the individual worker to the activity on the shop floor which makes the costing of the jobs inaccurate and complex.

4.5.2.2 Weak points in the role of the human actor

The overall contribution to the weak points identified above from these actors in the process and the weak points of their role in the process include:

- **Weak Point 1:** The increased lead time due to stoppages in the shop floor activity as a result of the material shortages are a direct cause of not checking the material out.
- **Weak Point 2:** When information on the schedule becomes redundant the operator must wait until the supervisor is free to receive instruction on what tasks are available to do next and where he is needed.
- **Weak Point 3:** Status regarding jobs is not communicated in real time and thus the information in the schedule becomes redundant. Improved decision making can be done with more real time information on the shop floor from all actors.
- **Weak Point 4:** Currently the system does not recognise the human actor and hence if the human actors spends more or less time on one job then another the system is not capable of capturing it.

4.5.3 Business Processes to be improved & investigated Business Benefits

The overall scheduling process and order handling process on the shop floor is driven by the initial schedule. The schedule should contain real time information regarding the materials and the human personnel roles and positions for the manufacturing and assembly of the work on the shop floor. This schedule drives the production execution on the shop floor and after the product is made at the different stages the schedule is updated according to work status etc. The product is then tested and after successful functional and parts testing the customer is involved in the process where changes may need to incur. Again after each of these stages the schedule should be updated and the shop floor activities should be modified as appropriate. Parts and products leave the shop floor after final testing to the customer and materials, labour availability etc. should be updated on the schedule. A summary of this process is shown in Figure 7.

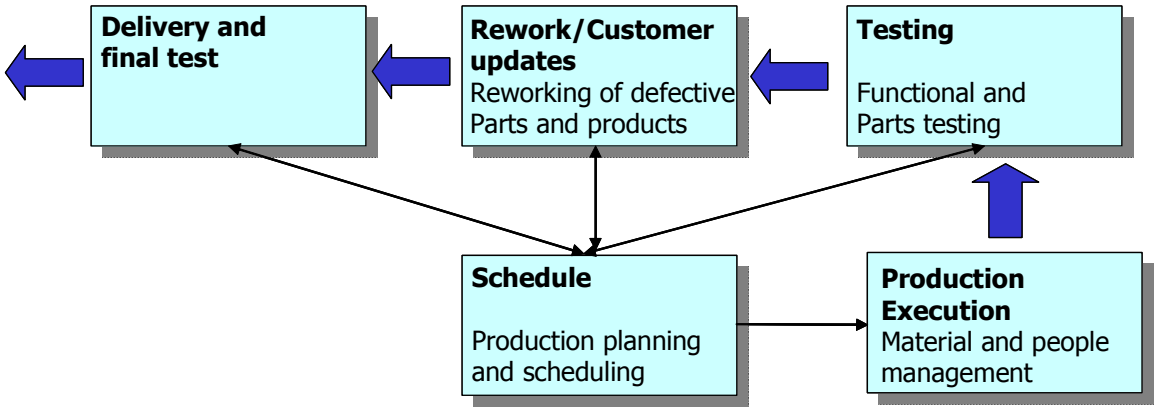

Figure 7: Proposed scheduling process for Sidean Teo.

Solution Features

- *RFID* - Radio Frequency tags will be needed to identify the people who are working on the shop floor as well as recording their skill sets etc. Also the different components and jobs will need to be identified and the various location of each part
- *SRS* - A speech recognition system can be placed in the stores to capture any instructions for the effective real time recording of stock taking and can be used to update the database and stock records. However this may not work with regard to the manufacturing noise.
- *Mulit-modal services* - This will allow the wireless connection to and from the information databases that exist on the shop floor to enable the effective decision making from various locations throughout the plant

5 Building Block Concept

The AMI-4-SME vendor companies focus on AmI-BBs addressing the explicit HO interaction with the AmI-system (more human oriented, to facilitate complex tasks, disburden HO from explicit inputs etc.), where mobile access represent an essential issue. In reference to this focus the AMI-4-SME project addresses the following AmI BB technologies:

- RFID – Radio frequency identification tags that enable the tracking and traceability of objects as well as the recording of information.
- SRS – Speech recognition system that enables the recording of voice enabling commands. This facilitates the easy recording of data on the job.
- Multi Modal services – this enables users to send and receive information from various locations and provides the user with mobile services such as texting services etc.

However for a successful Business Process Innovation will require an integrated optimisation approach, covering the optimisation of the Methods of Work and the ICT Services supporting the business process execution. In order to ensure that the AmI ICT solutions can be easily deployed into the business cases a systematic innovation that integrates the AmI technology into the application environment was required. The role of the person who is creating value is central, as the collaborative technologies will change the organization and interaction models and work processes, especially in knowledge work. Those enterprises and organizations that can capture this change of the centre of gravity of innovation are able to enjoy fully the enabling infrastructure development and hence improve their competitiveness.

As a systematic approach to describe this interdependencies of the AmI based business innovations in the different BCs and the AmI BB technologies required to realise these solutions, a Reference Structure for an AmI based Business Process Innovation has been elaborated, presenting this relation between business process innovation and the AmI Building Blocks (BB), as shown in Figure 8 and explained in the following.

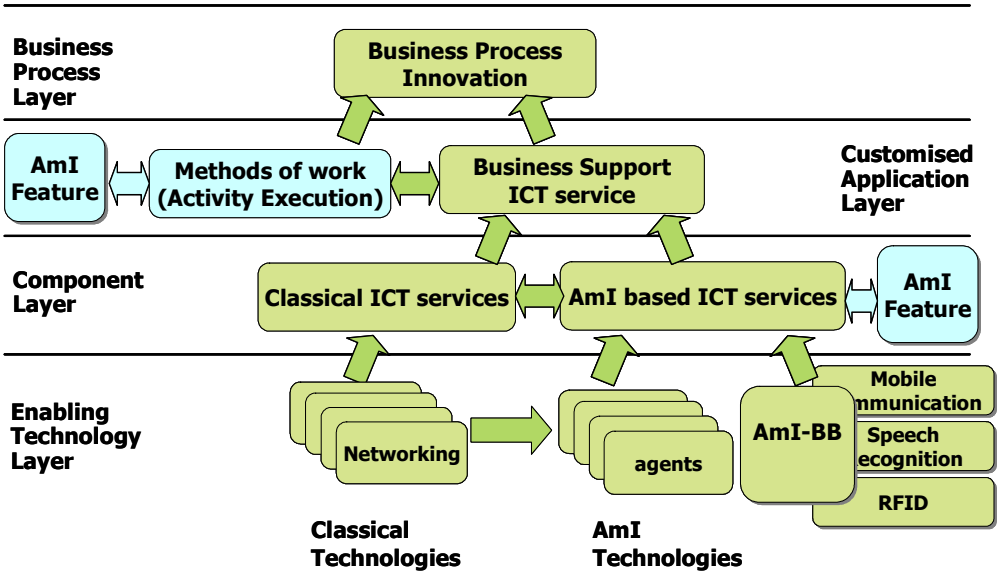

Figure 8 Reference Structure for an AmI based Business Process Innovation.

This approach is reflected in the reference structure by the represented relation between the Business Process Layer and the Customised Application Layer, where on the Customised Application Layer the integrated design approach of methods of work and related ICTs is real-

ised. In this context, the AmI features reference scheme is supporting the identification to what extent AmI technologies can create human centric innovation potentials in the design of the new methods of work. The Business Support ICT Services on the Customised Application Layer represent customised applications in respect to a company specific improvement scenario, created by the orchestration of classical and AmI based ICT services. The introduced separation between classical ICT services and AmI based ICT services reflects the typical ICT infrastructure situation in companies, where already existing ICT solutions have to be integrated with advanced AmI based ICT solution concepts.

The lowest layer of the reference structure represents the Enabling Technology Layer covering all basic Enabling Technologies required to create and operate services on the Component and Customised Application Layer. Also on the Enabling Technology Layer the separation between classical and AmI based solutions is introduced, because in general a combination of classical and AmI based enabling technologies will be required to create and operate services.

In reference to this structure, based the analysis of the SME business cases the following building block concepts for the three addressed AmI technologies were elaborated, that will be further developed in WP200 and deployed as an integral part of the innovation approach in each of the business case solutions.

5.1 Mobile Building Block

Mobile BBs representing the variety of mobile communication techniques of mobile devices with the system (e.g. a prototype middleware for UMTS, GPRS, Bluetooth, WLAN, WiMAX etc.) required for a mobile interaction of explicit I/O of the Human Operator (HO) with the AmI-system.

The components of the needed multi modal services, based on the mobile communication BBs, include the following components and services as part of its construction:

- A **BPEL Engine** which is in charge of web services orchestration. Business processes defined in WSBPEL can be modelled and re-engineered using numerous BPEL modelling tools to generate a BPEL file, which can then be deployed and executed in a runtime environment known as a native BPEL engine
- **Web Services** is a key component that enables services-based business process orchestration. WSDL has the most influence on WSBPEL, as its process model is layered on top of the service model defined by WSDL 1.1. At the core of the WSBPEL process model is the notion of peer-to-peer interaction between the services described in WSDL; both the process and its partners are modelled as WSDL services. A business process defines how to coordinate the interactions between a process instance and its partners. In this sense, a WSBPEL process definition provides and/or uses one or more WSDL services and also provides the description of the behaviour and interactions of a process instance relative to its partners and resources through Web services interfaces.
- **Ontology** could be generally defined as an explicit and formal specification of a shared conceptualization. All the elements and their features and functions which take part in SME processes will be defined in the underlying ontology
- **Location Manager** is the element in charge of managing the location of each element (e.g sensors, actuators…) which take part in SME processes and also knowing the OSGi framework which controls each element and where it is allocated
- **OSGi frameworks** are in charge of controlling several line elements which are deployed over each shop floor

- Each **line element** is a component of the assembly line or the control system and define a number of services which have to be in compliance with the defined ontology. These services will take part in the execution of a process according to the selection made by an operator, customer…

5.2 RFID Building Block

RFID BBs represent a specific type of sensor system for the assessment of process status information or HO location (HO location not addressed by the BCs) required by the AmI system to provide AmI-system observer or controller features.

The RFID building block provides the tags, antennas, readers as well as interrogation module that provides the functionality to extract the key pieces of information from the signals being sent and received. The RFID building block is essentially a selection of the technology that is required for the businesses cases as well as the interrogation module that will be developed to interact with the web services to make business sense of the signals being received. In summary the RFID building block is comprised of a number of units and characteristics. It is comprised of the tags, readers, antennas and finally the interrogation module (See Figure 9).

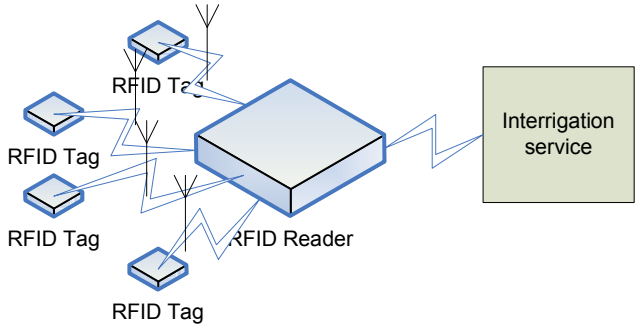

Figure 9 RFID Building block

5.3 SRS Building Block

In reference to the identified requirements in the scope of the BC analysis, in the following, the solution concept and elements to be developed concerning a building block of a speech recognition system in the context of the AMI-4-SME project are described.

SRS BBs represent a specific type of I/O technology of the HO with the AmI-system providing a natural human interaction via speech.

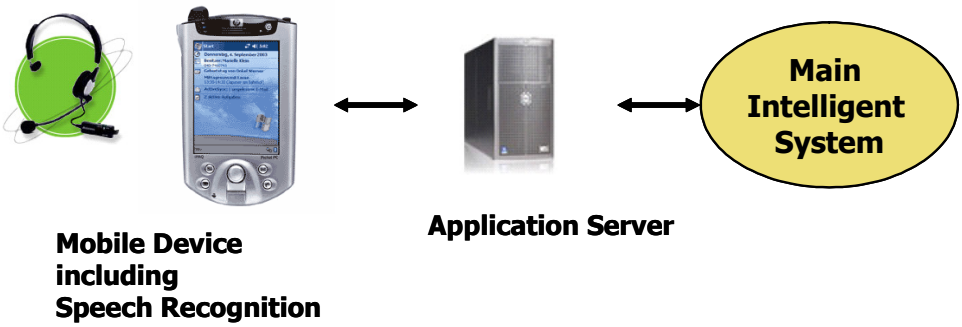

Figure 10 : Configuration of an enhanced AmI-System by a Voice User Interface

In reference to the requirements on the SRS, identified in the scope of the analysis of the different business cases, the key operational functionalities the SRS system has to provide represent:

- Menus can be selected by speech
- Forms can be selected by speech
- A set of commands can be selected by speech (like save data, stop, export etc.)
- Data input: Like string, number, date, boolean => grammar (BNF) etc.
- Text to speech – answers
- Only a limited vocabulary has to be supported (about 1000 words)
- High detection rate at noisy industrial environment
- SRS on a mobile device

Even though, the vocabulary to be handled is limited in all BCs, the application specific vocabulary for the different BCs can be totally different. Furthermore, the vocabulary might change during operation due to changes in the business processes or products and materials. Therefore, the key challenge of the SRS BB represents the implementation of an easy to build and reconfigurable speech recognition system, which can be tuned easily by the end-user himself. This approach results in the concept of a reconfigurable form generator to be developed.

6 Conclusions

The purpose of the report was to identify the key problems and the solution concepts within the AmI-4-SME business cases employing the AmI technologies used within the project. This report has presented an outline of Ambient Intelligence and its meaning in the AMI-4-SME project and a methodology concept supporting SME in the introduction of AmI based business process improvements.

The report detailed the findings of each of the business cases that are involved in the AmI-4-SME project. The business cases were divided into several sections detailing the introduction to the organisation, the key limitations of the processes and both their process and human cantered weak points. Further to this the concept for the new work practice was presented.

Based on these needs, an outline of the key building block technologies that will be employed as part of the solutions to these concepts were also presented. The findings of this report are a result of WP100 and will be employed as key inputs to WP200 in the Specification of the solutions for each of the business cases.

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