IST-5-034116
SOCRADES

INTEGRATED PROJECT
of the
SIXTH FRAMEWORK PROGRAMM

PRIORITY 2.5.3

INFORMATION SOCIETY TECHNOLOGIES – EMBEDDED SYSTEMS

Final Management Report

Final Version V1

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Project coordinator:	Prof. Dr.-Ing. Armando Walter Colombo
Organisation Name:	Schneider Electric Automation GmbH

1. Justification of major cost items and resources

1.1. Brief Description of the Work Performed by Each Contractor

1.1.1 SEA

Schneider Electric Automation lead the SOCRADES project as a whole, acting as its Co-ordinator. Hence, Schneider Electric Automation designated the Project Co-ordinator (Prof. Dr.-Ing. Armando Walter Colombo) and the Business Manager (Mr. Ralf Neubert) and chaired the Project Co-ordination Committee as well as the General Assembly.

In **WP1**, Schneider Electric Automation co-operated with the other SOCRADES partners to come to an agreement on a common working ground through the elaboration of the global requirements for the primary application domains targeted by the project, bringing in its long-standing experience in the field of manufacturing automation.

In **WP2**, Schneider Electric Automation played a significant role in defining the framework for service-oriented device networking. Together with expertise in adjacent areas like the application of industrial agents, this early SOA know-how forms the foundation for the various frameworks defined in WP2. Schneider Electric Automation reached that blending its knowledge with the expertise brought in by the other WP2 partners – such as that in the areas of process automation, service orchestration, Semantic Web Services and enterprise applications – sparked the development of highly promising, novel architectural structures for industrial automation. Schneider Electric Automation participated in all the tasks of WP2. In task 2.6, this included co-operation with ARM to start exploring new ARM-based hardware architectures for intelligent devices.

In **WP3**, Schneider Electric Automation co-operated with Siemens and associated partners to work on the service-enablement of sensor/actuator networks. The results of this work were also exploitable in WP4, even if Schneider Electric was no direct participating in this WP.

Schneider Electric Automation lead and concentrate most of its technical efforts in **WP5**, which was implementing all the service-oriented frameworks for networked embedded devices specified in WP2. The extensions and enhancements of the device-level SOA infrastructure based on DPWS were expanding its applicability, which was further enlarged by the hardware design effort undertaken by ARM. The embedded orchestration and the service management infrastructures facilitated the co-ordination of device-level services. Together with the implementation of the industrial agent communications framework, complemented by that of the Semantic Web Services framework, they facilitated the integration of orchestrated device-level services with higher-level enterprise applications. Thus, the results of the work carried out in WP5 was linked to Schneider Electric's participation in **WP6**. Similarly, the work on service orchestration, management and configuration performed in WP5 were linked to Schneider Electric's participation in **WP7**, which concentrated on creating application engineering and management tools on the basis of the service-centric infrastructure developed in WP5.

In **WP9**, Schneider Electric Automation participated in the dissemination of the SOCRADES results, both through technical conferences and publications and through its participation in major industrial automation events, as well as via European networks of excellence (such as IPROMS and CONET) and international working groups (such as the IEEE technical committee on industrial agents). Furthermore, Schneider Electric used as dissemination channel its own Initi@tive fairs and conferences, at which early developments are brought to the attention of major customers and partners.

Schneider Electric lead the standardisation, roadmapping and exploitation preparation activities in **WP 10**, in particular as regards the effort for defining standards for a set of industrial device categories, in the context of the UPnP Forum or alternative standardisation body like the OASIS.

Contribution to the SOCRADES plan

Schneider Electric Automation GmbH strongly contributed to the SOCRADES vision, since it has substantial experience in the application of Formal Methodologies, Service-oriented Architecture, and Collaborative Automation in industrial automation. This expertise was playing a key role in the development of a service orchestration engine, as well as in the blending of Collaborative Automation with Web Services (WP2 and WP5).

1.1.2 ABB AB

The focus of ABB's efforts in Socrades was concentrated on developing theories, methodologies and tools for control over wireless connections.

- Part of the global task was to follow periodically the state of the art situation in the mentioned area, and this is marked as the contribution into **WP1**. Contribution: 2MMs, 3%.
- Theoretical advances, but also practical have been developed, at device levels within **WP3**. The main target here was the study and the development of WirelessHART networks. Even more, the core of the activities consisted in the analysis of available (or planned) WirelessHART network management devices. Contribution: 4MMs, 6%.
- The largest effort load can be observed in **WP4**. ABB has contributed to the specification of the wireless control plant architecture and to the development of scenarios and solutions for control under uncertain communication situations. Tool development and methodologies have been topics of crucial importance that were approached here. The analysis contains, for example, solutions for packet loss or synchronization problems. These results have been considered and applied (partially) in the practical approaches required in T4.4 and T4.5. Here, inter-device communication and further design tool development have been approached and implemented. Again, support for WirelessHART solutions has been the focus, but, unfortunately, not with an actual realisation, due to lack of field devices, eventually. However, provisions in terms of time and devices have been allocated in the project. Contribution: 4MMs, 72%.
- In **WP5**, the efforts have been oriented mostly to the study and analysis of the OPC UA and the DPWS approaches. Contribution: 2,5MMs, 3%.
- In **WP6**, the efforts have been spent on the integration of the demonstrator with enterprise level applications. Contribution: 1MMs, 2%.
- While ABB had no specification for participation in **WP8**, the situation evolved during the project and certain efforts have been placed here, as contributions to D8.1. and D8.2. Contribution: 3,6MMs, 6%.
- Several scientific publications have emerged during Socrades with the full / partial contribution of ABB, motivating the numbers in **WP9**. Contribution: 2MMs, 3%.
- Part of the activities towards the standardization of WirelessHART have been supported by Socrades – correlated with the activities in **WP10**. Contribution: 2,1MMs, 3%.
- The planned and reported management activities and related costs (**WP11**) were not enough to cover the whole necessities of implementing the project tasks. Contribution: 1MMs / 2%.

Remarks: The high volatility of the Swedish currency (SEK) against the EURO, especially in the end of the activities period lead to certain deviations from the planned amount. The locally planned budget (in SEK) was overloaded, while the budgeted amount with the project (EURO) ended as “underspent”.

1.1.3 APS GmbH – Europäisches Zentrum für Mechatronik

The Work performed by APS was focussed on the development and implementation of technologies to enable heterogeneous mechatronic devices like robots, sensors, gripper tools, and controllers of different types to interact and collaborate towards common goals across wired as well as wireless networks by means of appropriate middleware solutions and use of a SoA based IT infrastructure. To meet this goal and to open new perspectives in advanced automation and process control, research and technological development have been performed in cooperation with the partners and in line with the technical goals specified by the different WPs of the SOCRADES project.

In this context APS has developed a service-based, event driven control concept in WP 4 to be able to meet the real-time constraints coming up in process automation and control with embedded mechatronic devices on one hand, but also to allow direct access to each component of the mechatronic device cluster via WebService on the other hand. This has been achieved through the implementation of a DPWS mediator for the cluster.

For the integration of service-enabled mechatronic devices a special device profile stack (DPS) has been implemented within WP 5 and introduced to support publishing and subscription of services as well as for dynamic service invocation. Service composition was performed by the implementation of a Choreography Engine (also in WP 5). It enables configuration, deployment and management of services and is responsible for action and reaction of the devices inside the control concept, triggered by events.

As result from WP 6 the integration of the service–enabled mechatronic devices with business processes has been achieved by use of the SAP-SIA approach in combination with exchange of WebServices across the DPWS mediator. The approach is also able to receive Work Order services from business processes as trigger to start a new production sequence.

Finally, for engineering purposes and to enable user-oriented composition and reconfiguration of services, an event-driven 3D graphical monitoring and online simulation tool, developed in WP 7, was introduced as integral part of the trial site.

The results from the project work performed in the WP 4-7 have been integrated in WP 8 by setting up a test –and demonstration platform in the APS lab to run trials and to study the applicability of the SOCRADES technology for advanced automation and collaborative control in terms of inter-device communication, interaction and collaboration at device level but also across this layer.

1.1.4 Boliden Mineral AB

Boliden’s work in Socrades was in **WP4**. We have contributed to the specification of the wireless control plant architecture (T4.1) and to the development of scenarios for control under uncertain communication situations.

The control scenario for the demonstrator (T4.5) was described and some additions to the plant control system were designed to adopt to the scenario.

The installation in the plant of wireless sensors and actuators using ZigBee network was performed together with personnel from LTU. One of the additions to the plant system was to facilitate quick switching to/from wireless control.

A scenario was developed to allow for selection of control strategy from a management level system.

Boliden supported the teams from ABB and LTU during the demo in the plant.

For the exploatation of the results of Socrades Boliden will continue to cooperate with ABB and LTU in the area of wireless control and make possible the use of our plants for testing new equipments.

1.1.5 Prodatec Oy

The work of Prodatec Oy can be found in the number of the project deliverables. For instance, for the deliverable 6.6 (Business Evaluation of SOCRADES), Prodatec Oy provided details on business cases analysis in the domain of electromechanical assembly. In WP8, Prodatec Oy helped in requirements definition and implementation of electromechanical assembly demonstrator. Prodatec Oy identified the requirements for the Small Terminal Blocks (STBs) to make integration with the demonstration equipment.

The company contributed to the use case definition for the demonstrator (deliverable 8.1). In deliverable 8.2, the assessment of the demonstrator was made. In deliverable 6.5 (enterprise integration), Prodatec Oy contributed in interface specification for *Orchestrator* service (WP5) that can be used for the order input, e.g. from the remote locations (WP6).

1.1.6 ifak – Institut für Automation und Kommunikation e.V. Magdeburg

Within **WP1** ifak was playing the role of the WP leader, driving analysis of technical achievements within the dedicated subjects targeted by the project, deriving and clustering the end user, manufacturer and technological requirements as a contribution to risk analysis done throughout the overall project and a comprehensive self-assessment of the SOCRADES results at the end of the project. Technical achievements, identified EFTAs and practical results from demonstrations and trials were evaluated against the requirements established.

Within **Task 2.6** ifak contributed to the specification of the gateway framework allowing integrating non-service-enabled devices.

This work continued within **WP6**, where ifak added major contributions regarding the integration of legacy systems into service enabled architectures. ifak supported the technical specification of concepts for integrating single devices and representing them through a gateway or, in case of pre-processing device data, through a Mediator. The Mediator concept is also applicable for representing production/plant units. The Mediator allows defining added-value services for devices, systems or systems of systems – depending on the application or plant operation strategy. From the practical achievements point of view - a production cell, controlled in a classical way, has been represented through a Mediator and services to manage the production process integrated into an SAP MII system.

ifak work done in **WP7** supported the legacy system integration approach through works targeting the configuration management of the Gateway and Mediator concept to integrate legacy devices and systems. Work was done introducing up-to-date technologies like Electronic Device Description to configure Gateway/Server components connecting legacy networks and OPC UA or DPWS based communication philosophies.

In **WP3** ifak contributed to the investigation of integrating WSAN to Service based communication infrastructures and gateways at all. Based on the investigations and specification work, ifak created a concept and implemented a prototypical solution of a WSAN gateway integrating SmartMesh from Dust Networks. Further on the Mediator solution from WP6 has been improved to act as an OPC UA – to – DPWS Gateway.

All these activities, carried out by ifak, were well-focussed to support up-coming technologies (DPWS, OPC UA, WirelessHART, service description, …) and to bridge the gap to well proven technologies (like IEC 61158, Device Profiles, EDDL, IEC 61131, …). Consequently, the work was concentrated around a common Gateway/Mediator component (based on the results of former projects dedicated to integration and engineering aspects) that was extended to act as an OPC UA – to – DPWS Gateway in SOCRADES. Practical results are used in the final trial in Aachen, the demonstrator in Loughborough and the demonstrator at ifak in Magdeburg. Detailed descriptions can be found in the deliverables dedicated to WP3, WP6, WP7 and WP8.

In addition to these research activities, ifak participated in preparing several publications (including the SOA book), presentations at conferences and exhibitions (SPS/Drives 2008) as well as of training activities and participated in external technical working groups. ifak also participated in project management activities.

1.1.7 KTH – Kungliga Tekniska högskolan

KTH has mainly contributed to work packages WP1, WP4, WP9 and WP10. The focus of the efforts was on control under uncertain sensor and actuator communications. Our contributions have been published in relevant conferences and journals, and also documented in several deliverables, particularly D 4.2.

To WP1 we have contributed to the state-of-the-art technology assessment and the requirement assessment. In WP4 we have planned and executed experiments and demonstrations. These have established the feasibility of control over wireless as well as the SoA integration for a prototype laboratory process. Further, we have studied the design of control systems under uncertain aensor and actuator communication. We have studied the effects of imperfections in the communication between the devices of the control system, both between controller and actuator as well as between process and controller. To overcome these imperfections we have designed the *Predictive Outage Compensator*, which is a device able to handle losses in the control system communication links. We have also examined the multi-user aspects of control over wireless. Through simulations, theoretical studies and experiments, we have designed methods for dealing with the problems presented by the wireless channel. Our studies using the cross-layer approach provide answers to questions of scalability and optimal use of limited communication rates. We have also designed novel techniques of controlling systems when communication rates are limited. Our design methods use the strategy of Event-triggered sampling which allows for a substantial reduction in the communication requirements of control loops.

In WP9 and WP10 we have worked on scientific, technological and general dissemination as well as well as derived an exploitation plan.

1.1.8 Loughborough University

Loughborough University (Lboro) led the SOCRADES systems engineering and management workpackage. This work resulted in prototype engineering tools and environments to support selected aspects of the system lifecycles for the application domains studied. Deliverables 7.1 to 7.7 document user engineering requirements, assessment of emerging technologies and early prototype solutions, and the implementation of engineering tools and methods. A comprehensive study was carried out by Lboro on the validation and demonstration of the system engineering methods used across the project collaborators (D7.7). Lboro developed a prototype applications engineering environment and applied this to selected phases of the machine lifecycle within engine assembly automation.

Lboro made major contributions to the prototype implementation of the SOCRADES framework within the automotive domain, as part of WP8 activities. In close collaboration with Jaguar and Ford Motor Company, Lboro developed a laboratory demonstrator rig to investigate the applicability of the SOCRADES concepts and also the engineering application tools. The prototype rig and associated video have been demonstrated at six international exhibitions across Europe, successfully promoting the project results to industrial and academic audiences. Following successful laboratory tests, Lboro is now leading an industrial trial process in collaboration with Ford Motor Company to assess the SOCRADES results in a real industrial environment.

Lboro focused on the adoption of a SOA-based approach to applications engineering in automotive engine assembly with Jaguar and Ford. Lboro contributed to the project by capturing the industrial automation requirements within this domain at Ford and Jaguar, considering both current requirements and emerging trends. This activity included contributions to the deliverables 1.1 to 1.5 related to user requirements and trend screening.

Across the project, Lboro has made major contributions to key research and development themes, including distributed control system architectures and related service infrastructures and high-level systems integration. These activities are documented as part of the deliverables in workpackages 2, 5 and 6. Lboro also contributed in depth to low-level device integration and also to the support of legacy systems as part of workpackages 6 and 7.

Lboro has produced and contributed to more than 15 industrial and academic papers and articles, disseminating the concept of the SOCRADES project across multiple manufacturing engineering domains.

1.1.9 LTU – Luleå Tekniska Universitet

LTU has mainly contributed to WP1, WP4 and WP9. In WP1 LTU has contributed with expertise on tools and technologies for HW and SW for small wireless embedded devices. The majority of work was in WP4 on tools and technology for wireless communication intended for use in closed loop control. Here the real time tool Timber has been made use of and further developed to support formal verification of real time SW for embedded devices. Further the basic radio environment in industrial locations has been characterised. Future heavy wireless usage has been simulated both in lab and at industrial sites this to stress wireless links used for hard real time closed loop control. In WP9 a number of dissemination activities has been made. The most important one is writing one chapter in the "Socrades book".

1.1.10 Politecnico di Milano

Politecnico di Milano (POLIMI) leaded WP9 "Dissemination"; hence POLIMI managed and coordinated all the dissemination activities related to SOCRADES Project and the promotion of the project results. POLIMI took care of preparing and managing the overall dissemination plan with tight synchronization with all SOCRADES partners. Moreover, POLIMI took care of creating dissemination material (flyers, brochures, etc.), organization of international conference special sessions/workshops, plan and management of SOCRADES participation to industrial and research fairs, publications within scientific journals and special purpose magazines, update of the SOCRADES website (www.socrades.eu).

POLIMI gave significant contribution to WP10 “Exploitation, standards and roadmapping” with a particular focus on Roadmapping. The main final outputs of the roadmapping activity is the (Technology) Roadmap of the SOCRADES paradigm (D10.4c) and a booklet called “SOCRADES Roadmap”, a stand-alone pamphlet that will be used both for dissemination and exploitation purposes.

Within WP6, POLIMI contributed to the business evaluation of SOCRADES approach (D6.6). POLIMI assessed impacts of SOCRADES technologies in terms of manufacturing performances.

Finally, POLIMI contributed to other WP1 “Trend screening, requirements, state-of-the art, technology assessment”, for the state of art development, to WP2 “Framework specification for ad-hoc networking service platform” supporting the definition of the framework, and to WP7 “System engineering & management” where the attention was mainly related to the end-user requirement analysis.

1.1.11 SAP AG

SAP has been one of the driving forces on SOCRADES, focusing on the enterprise aspects of it. More specifically SAP within SOCRADES has analysed, designed and implemented the SOCRADES Integration Architecture (SIA) which enables the easy coupling of devices with enterprise systems. For the design a best paper award from IEEE has been awarded in 1997, while the specifics of the architecture and its implementation has been published in top international conferences, journals (under final review) and books. In multiple demonstrators with consortium partners we have proven the feasibility of the concepts in automation domain, in engineering, but also to other domains not envisioned at the begin of the project such as the Insurance and energy / smartgrid domain. As such the work carried out by SAP in all workpackages of the project has been an overall success leading to tangible scientific and industrial results.

1.1.12 Siemens AG

Siemens was mainly active in WPs 1, 3, 4, 8, 9, 10, and 11. As Siemens was leader of **WP 3**, the main efforts were dedicated to this WP. Here the following work was accomplished:

- Definition and specification of a novel WSN node architecture, the sensor integration and the interface between sensors and the network;
- Research in the area of wireless network topology, self-configuration, self-management, routing, scalability;
- Evaluation of communication technologies for Wireless Sensor Networks in industrial environment, e.g. IEEE 802.15.4, 802.15.4a and ZigBee;
- Pre-development work for power supply for the network infrastructure as well as the sensor itself;
- Definition of new services with Wireless Sensor Networks;
- Proof of concept implementations and demonstrator set-up.

In **WP 1**, which overall dealt with the existing state of the art, Siemens mainly contributed the sections on wireless technology and sensor networks – as prerequisites for the work in WPs 3 and 4 - and furthermore defined requirements for the work regarding Wireless Sensor Networks in the SOCRADES project.

The work in **WP 4**, dealing overall with wireless closed loop architectures, was relatively near to what was done in WP 3. Against this background, WP3 and 4 experimented with a common middleware – OPC UA – and erected a common demonstrator which was shown at the Lulea review in summer 2008.

In **WP8** Siemens took part in the definition of the envisaged common trials and contributed by means of its WSN gateway and several wireless sensors (all proof of concepts) which were developed in WP3 and which were also used in the WP4 demo in Lulea. The scenarios in Aachen embraced positioning tasks by means of wireless proximity switches, measurements of the acceleration of a robot gripper, as well as a tool changing task.

In **WPs 9 and 10** Siemens contributed with several Siemens internal presentations to the upper management and one conference paper at INCOM'09. A common standardization effort with Schneider Electric and ABB regarding DPUA was not as successful as originally planned as the technical prerequisites were not as favourable as estimated beforehand.

In **WP 11** Siemens contributed according to the coordinator's requests.

1.1.13 TUT – Tampere University of Technology

Tampere University of Technology (TUT) has been involved in defining SOCRADES architecture (work package 2) that has been implemented and demonstrated with the work done in work packages 5 and 8. TUT was also providing the assessment and contributions to the deliverable in other work packages.

In WP5, TUT has developed a set of software tools and services. The *Service Explorer* tool has been developed to allow automated and dynamic discovery of the web services. The tool allows connection to the UDDI registry. It was also used for early prototyping of service orchestration. The BPEL-based *Orchestration Engine* service has been developed by TUT. The service allows orchestration of the systems abstracted as web services. *Orchestrator* service was created to deploy Orchestration Engine services in an event of new product arrival. The agent-based *Decision Support System* was developed. *Ontology Service* was defined and developed by TUT to provide a service to access the knowledge models and perform run-time reasoning on the knowledge models. *Ontology Manager* application was developed as a engineer support tool and as an intelligent interface processing low level events and translating these to the changes in knowledge models.

For the WP8, the electromechanical assembly demonstrator equipment located at TUT[1] has been integrated and programmed. TUT has defined the control logic and service interfaces for the line. TUT did the assessment of the demonstrator. TUT has defined the ontology models for the line.

TUT has organized the training on the ontologies and semantic web services.

1.1.14 Jaguar Cars Limited

Jaguar Cars' contributions to the SOCRADES project were principally in requirements capture, pilot application studies, demonstrator systems, and evaluation and exploitation of the results in the automotive domain. As the former parent company of Jaguar and continuing supplier of all Jaguar engines, Ford Motor Company have been heavily involved in supporting the SOCRADES project at all stages. Jaguar and Ford supported i) the capture of user requirements for powertrain assembly

[1] http://www.youtube.com/user/TampereUniTechFAST

in WP1 and also a survey of the current state of the art in this workpackage, ii) the detailed evaluation of the pilot system in WP8, iii) the definition and later use and evaluation of the SOCRADES prototype engineering tools in representative engineering scenarios in WP7. Jaguar worked very closely with Loughborough University in WP1 (D1.1 and D1.2 in particular) with emphasis on i) determining suitable enabling technologies and methods for engineering tools to support the lifecycle needs of service-oriented systems and ii) gathering requirements within the manufacturing automation sector.

Ford's role in the later stages of the project has been heavily focused on assisting in the creation and evaluation of the application demonstrator in WP8 related to assembly automation with particular emphasis on system reconfigurability to meet frequent product changes. Jaguar and Ford have been closely involved in the evaluation of the pilot test rig against appropriate application scenarios in practice-oriented tests, training, and evaluation of project results. See deliverables D8.1 and D8.2 for the pilot system implementation and evaluation against application requirements. In WP7 Ford have also provided substantial support for the application engineering tool requirements and their evaluation as detailed in the relevant deliverables. This system has been demonstrated to senior Ford production engineers and managers.

1.1.15 ARM

The task is currently finished for deliverables D5.6.1, D5.6.2, D5.6.3 and D5.6.4. The results of D5.6.1 – D5.6.4 are reported in June 2009 for review. Due to this review, two deliverables D5.6.2 – D5.6.3 have been revised according to 5th EU-review session in Brussels/Belgium with notification of project management and according to EU-reviewers feedback. The revised document D5.6.2 – D5.6.3 (revision 2) have been reviewed again in July/August 2009 timeframe and got finally been accepted by EU-reviewers and project management on the 6th review session in Tampere/Finland on August/26a27/2009.

Achieved results on deliverables D5.6.1, D5.6.2, D5.6.3 and D5.6.4 have significant influence on a new MCU core design, which will be available for commercial licensing business beginning of year 2010. Currently further exploitation plans & projects for achieved SORCADES results are evaluated with several project partners and external companies to generate a market momentum.

1.1.16 Schneider Electric Industries

SEI was coordinating all the technical activities of the SOCRADES project, Francois Jammes being the project Technical Manager. Under this responsibility, he was working in all technical work packages in order to keep the consistency of the technical vision of the project.

In WP1 and WP2, SEI was one of the major contributors providing requirements, proposing the framework architecture able to answer to these requirements and checking at the end of the project how these requirements have been fulfilled by the project.

Main SEI contributions were in WP5, where SEI developed and provided the DPWS communication stack, with all associated options and some development and test tools. SEI set up the Open Source forge site, and released on it the successive versions of the stack. Full support was given to all project partners in order to use the solution. Moreover, SEI was looking with ARM to future hardware solution improvements

Some examples of SEI contributions in WP5 are:

- Dedicated developments for dynamic deployment of Web Services, which behavior is described using IEC 61131 or HLPN languages (requiring support of relevant language interpreters)
- Integration of the DPWS stack in hardware communication processors used in devices (e.g. in FTB and STB devices demonstrated in the car manufacturing and electronic assembly demonstrators as well as in the APS trials)
- Studying with ARM the integration of dedicated instructions. into the ARM core processor, in order to have an optimized XML frame process

The deep knowledge acquired in WP5 about the DPWS specifications and implementations was used in WP10 to push the DPWS specification as an OASIS standard, which was achieved mid of 2009 and is one of the major project success. Large academic and industrial dissemination was also performed by SEI, thanks to the DPWS work, and opened the way towards a large exploitation of the project results, e.g. through the Schneider Electric “EcoStruxure” company program launch, integrating all Schneider businesses solutions through one SOA solution based on DPWS.

The DPWS devices, implemented in WP5, were interconnected with SAP servers in WP6, and the device / business application interoperability was demonstrated in WP8.

1.2. Explanatory Note on any Major Cost Items

Participant 1 (Co-ordinator): Schneider Electric Automation GmbH (Germany)
RTD: Change of HW Platform (Consumables); Management: 6 EU Contract Amendments.

Participant 2: ABB AB (Sweden)
RTD: Development of the prototypes for the continuous process Pilot Applications at the Boliden premises (Travels and Consumables).

Participant 3: APS GmbH (Germany)

RTD: Building of the Mechatronics Trials (Consumables).

Participant 8: Loughborough University (UK)

RTD: Development of the prototypes for the manufacturing Pilot Applications and Engineering tools; Presentation of the applications in many public fairs (Consumables and Travels).

Participant 9: Luleå University of Technology – LTU (Sweden)
RTD: Development of the prototypes for the continuous process Pilot Applications at the Boliden premises (Consumables and Travels).

Participant 10: Politecnico di Milano (Italy)
RTD: SOCRADES Road mapping integrating external experts in public workshops (Travels).

Participant 13: Tampere University of Technology – TUT (Finland)
RTD: Implementation of the Electromechanical Assembly Pilot application together with Prodatec, SEA and SAP (Consumables). Participation in Conferences (Travels).

Participant 15: ARM Ltd (UK)
RTD: Change of HW Platform (Durable Equipment). Major costs explained during the 5th and 6th EU Review Meeting.

Overview of Budgeted Costs and Actual Costs

	Personnel costs	**1849431**	750170	765736	265998		**1781904**	96%	**67527**
	Major cost item 'x' / Travel	**0**	10512	22119	3163		**35794**	#DIV/0!	**-35794**
	Major cost item 'y' / Consum.	**0**	0	0	0		**0**	0%	**0**
	Other costs ('the rest')	**5691**	2431	21258	11037		**34726**	610%	**-29035**
	Total Costs	**1855122**	**763113**	**809113**	**280198**	**0**	**1852424**	**100%**	**2698**
Part. 13 TUT	**Total Person-month**	**84,1**	**18,05**	**38,4**	**80,9**		**137,35**	163%	**-53,25**
	Personnel costs	**820585**	102503	271176	299535		**673214**	82%	**147371**
	Major cost item 'x' / Travel	**0**	23460	30532	32219		**86211**	#DIV/0!	**-86211**
	Major cost item 'y' / Consum.	**0**	767	35238	7998		**44003**	#DIV/0!	**-44003**
	Other costs ('the rest')	**4000**	3153	9188	18466		**30807**	770%	**-26807**
	Total Costs	**824585**	**129883**	**346134**	**358218**	**0**	**834235**	**101%**	**-9650**
Part. 14 Jaguar	**Total Person-month**	**4,2**	**4**	**0**	**0**		**4**	95%	**0,2**
	Personnel costs	**38760**	40800	0	0		**40800**	105%	**-2040**
	Major cost item 'x' / Travel	**0**	0	0	0		**0**	0%	**0**
	Major cost item 'y' / Consum.	**0**	0	0	0		**0**	0%	**0**
	Other costs ('the rest')	**4080**	0	0	0		**0**	0%	**4080**
	Total Costs	**42840**	**40800**	**0**	**0**	**0**	**40800**	**95%**	**2040**
Part. 15 ARM	**Total Person-month**	**52,4**	**1,25**	**19,3**	**38,3**		**58,85**	112%	**-6,45**
	Personnel costs	**823160**	19789	280772	488540		**789101**	96%	**34059**
	Major cost item 'x' / Travel	**0**			0		**0**	0%	**0**
	Major cost item 'y' / Consum.	**0**			0		**0**	0%	**0**
	Other costs ('the rest')	**5541**		64140	4955		**69095**	1247%	**-63554**
	Total Costs	**828701**	**19789**	**344912**	**493495**	**0**	**858196**	**104%**	**-29495**
Part. SEI	**Total Person-month**	**96,25**	**36,08**	**38,4**	**38,2**		**112,68**	117%	**-16,43**
	Personnel costs	**1443750**	496867	570456	427065		**1494388**	104%	**-50638**
	Major cost item 'x' / Travel	**0**	0	0	0		**0**	0%	**0**
	Major cost item 'y' / Consum.	**0**	0	0	0		**0**	0%	**0**
	Other costs ('the rest')	**0**	0	0	0		**0**	0%	**0**
	Total Costs	**1443750**	**496867**	**570456**	**427065**	**0**	**1494388**	**104%**	**-50638**
TOTAL	**Total Person-month**	**1100,4**	**324,86**	**476,48**	**559,87**	**0**	**1361,21**	124%	**-260,81**
	Personnel costs	**13612803**	**3610864**	**4942461**	**4217537**	**0**	**12770862**	94%	**841941**
	Major cost item 'x' / Travel	**0**	**110054**	**219850**	**164834**	**0**	**494738**	#DIV/0!	**-494738**
	Major cost item 'y' / Consum.	**0**	**38827**	**85078**	**86900**	**0**	**210805**	#DIV/0!	**-210805**
	Other costs ('the rest')	**67918**	**17216**	**153356**	**91229**	**0**	**261801**	385%	**-193883**

Table 1: Budget vs. Actual Costs

Remark: See D11.3c (*IST-5-034116-D11.3c_2.Cost Budget Report*)

1.3. Overview of Budgeted Person-months and Actual Person-months

See D11.3c (*IST-5-034116-D11.3c_1.Efforts Report*), pages 1-2.

1.4. Summary Explanation of the Impact of Major Deviations from Cost Budget and from Person-month Budget

See D11.3c (*IST-5-034116-D11.3c-Final_Overview*)

Participant 1 (Co-ordinator): Schneider Electric Automation GmbH (Germany)
They expended more efforts than planned (considering the shift of efforts to TUT performed after the 1st 18 Months) (15.3 PM). Due to this increased number of expended efforts, they have more costs: 68.953 €.

IMPACT concerning Reported Work:

Management: 6 Amendments of the EU Contract / Demonstrations: Change of HW Platform for the Smart Embedded Devices developed and used in the Pilot Applications in Tampere, Loughborough, Seligenstadt and APS premises.

Participant 2: ABB AB (Sweden)
Although they expended more efforts as planned (8,4 PM), they claimed for less cost budget (23.588 €).

Participant 3: APS GmbH (Germany)

Although they expended more efforts as planned (4,8 PM), they claimed for less cost budget (207.096 €).

Participant 4: Boliden AB (Sweden)

They expended less efforts (0,7 PM). They claimed for less cost budget (13.179 €).

Participant 5: FlexLink AB / Prodatec Oy (Finland)
Although they expended more efforts as planned (1,6 PM), they claimed for less cost budget (7.084 €).

Participant 6: Institut f. Automation und Kommunikation e.V. Magdeburg – ifak (Germany)

They expended more efforts than planned (32,4 PM). Due to this increased number of expended efforts, they have more costs: 11.098 €.

IMPACT concerning Reported Work:
RTD: Development of the OPC-UA – DPWS Translator for being implemented in the Trials of WP8 and also a complementary Pilot Application with SAP.

Participant 7: Kungliga Tekniska Högskolan – KTH (Sweden)

They expended more efforts than planned (20,3 PM). Due to this increased number of expended efforts, they have more costs: 12.182 €.

Participant 8: Loughborough University (UK)
They expended more efforts than planned (considering the shift of efforts from Jaguar performed after the 1st 18 Months) (71,8 PM). Due to this increased number of expended efforts, they have more costs: 41.256 €.

IMPACT concerning Reported Work:

RTD: Development of the prototypes for the manufacturing Pilot Applications and Engineering tools; Presentation of the applications in many public fairs, representing the whole SOCRADES consortium (costs shared with the rest of the consortium).

Participant 9: Luleå University of Technology – LTU (Sweden)

They expended more efforts than planned (4,5 PM). Due to this increased number of expended efforts, they have more costs: 23.162 €.

IMPACT concerning Reported Work:
RTD: Development of the prototypes for the continuous process Pilot Applications.

Participant 10: Politecnico di Milano (Italy)

They expended more efforts than planned (32,8 PM). Due to this increased number of expended efforts, they have more costs: 33.819 €.

IMPACT concerning Reported Work:
RTD: SOCRADES Road mapping integrating external experts in public workshops: Initiation of the publication of the SoA-Book, publication of the Summary of the SOCRADES Roadmap.

Participant 11: SAP AG (Germany)

Although they expended slightly more efforts as planned (3,1 PM), they claimed for less cost budget (13.039 €).

Participant 12: Siemens AG (Germany)

They expended less efforts than planned (9,3 PM). Due to this decreased number of expended efforts, they have less costs: 2.698 €.

Participant 13: Tampere University of Technology – TUT (Finland)

They expended more efforts than planned (considering the shift of efforts from SEA performed after the 1st 18 Months) (53,3 PM). Due to this increased number of expended efforts, they have slightly more costs: 9.650 €.

IMPACT concerning Reported Work:

RTD: Implementation of the Electromechanical Assembly Pilot application together with Prodatec, SEA and SAP. Acquisition of leadership for Task 5.4 (SoA and Agents).

Participant 14: Jaguar Cars Ltd (UK)
They expended less efforts than planned (0,2 PM). Due to this decreased number of expended efforts, they have less costs: 2.040 €.

IMPACT concerning Reported Work:

Jaguar transferred all the planned efforts for the second 18 Months period to LOU, but they continued supporting the SOCRADES consortium with the specification, development and implementation of the Manufacturing Pilot Application.

Participant 15: ARM Ltd (UK)
They expended more efforts than planned (6,5 PM). Due to this increased number of expended efforts, they have more costs: 29.496 €.

IMPACT concerning Reported Work:

RTD: Change of HW Platform. Major costs explained during the 5th and 6th EU Review Meeting.

Participant 16: Schneider Electric Industries SAS (France)
They expended more efforts than planned (16,4 PM). Due to this increased number of expended efforts, they have more costs: 50.638 €.

IMPACT concerning Reported Work:

RTD: Standardization activities (OASIS); Integration and Stabilization of the DPWS-Stack in the Schneider HW-Platform (Smart I/O STBs and FTBs).

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Summary_1:

All partners, with exception of LTU), which have more calculated funding as originally planned, have claimed this exceeding funding as "Requested Contribution" in their Form C.

Summary_2:

All partners together have expended 260,8 PM more than originally planned. Due to this increased number of expended efforts, the consortium has reported **57.485 € more costs**. These exceeded final costs were distributed in the following manner:
RTD: + 261.685 €
Demonstration: - 98.029 €
Training: - 139.814 €
Management: + 33.643 €

Note: The consortium concentrated mainly in RTD activities (due to the innovative characteristics of the work). This is proved by the big number of successfully developed Prototypes and implemented Pilot Applications. Some other activities, like some training course on DPWS, were successfully performed and reported as RTD but not directly addressed in the Training-financial-reports.

Summary_3:

Related to the -in Summary_2- mentioned exceeded costs the calculative EC Contribution would amount to 8.638.607 €. But according to budget limit (considering the shift of efforts performed after the 1st 18 Months) the maximum amount of the EC Contribution is 8.451.564 €. This amount is **147.710 €** less than the originally calculated and applied EC Contribution of 8.599.274 €.

2. Form C - Financial statement per activity for the entire duration of the project, to be completed by each contractor

See D11.3c (*IST-5-034116-D11.3c_3.FORM C*), pages 4-67

3. Summary financial report

See D11.3c (*IST-5-034116-D11.3c_3.FORM C*), pages 1-3