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Collaborative Manufacturing Network for Competitive Advantage

Publishable Summary
1st Periodic Report

1   PUBLISHABLE SUMMARY

ComVantage addresses a *Collaborating Manufacturing Network for Competitive Advantage*. It is envisioned to be an interorganisational collaboration space turning today's organisation-centric manufacturing approach into a product-centric one. Manufacturers will benefit from a flexible, efficient platform that helps them to operate as one virtual factory and thus gain competitive advantages in their markets.

Based on best practises of Web 2.0 technologies the collaboration space will be an extension to existing business and engineering software. It will allow the involved stakeholders, according to their rights, to share, administrate and monitor focused information throughout a product's life cycle in a decentralised manner. The close collaboration on the business to business and business to consumer levels will foster existing trends such as Open Innovation or Crowdsourcing.

The framework of the virtual factory will encompass a secure access control that is founded on dynamic workflow models and flexible user roles accounting for large enterprises, SMEs and for end-customers. It will enable temporary and decentralised access management for ad-hoc collaboration between geographically distributed experts.

To adhere to changing working situations, to efficient communication, and to rich interaction technologies, *ComVantage* will focus on mobile devices. Intuitive and trustful mobile apps shall support users in fast decision making and problem solving. Information from different sources across the organisations will be provided and maintained via 'Linked Data'. The integration of sensor data allows for products to be members of the collaboration space.

A continuous evaluation of the ICT and business model considering use cases throughout the project will verify the added-value of *ComVantage* for the European industry. The utilisation of existing technologies, a close user approach, and an incremental project set-up will provide sound concepts ready for fast production. Thus implementing *ComVantage* will increase lean communication, agile and highly efficient production processes, cost control and a low carbon footprint.
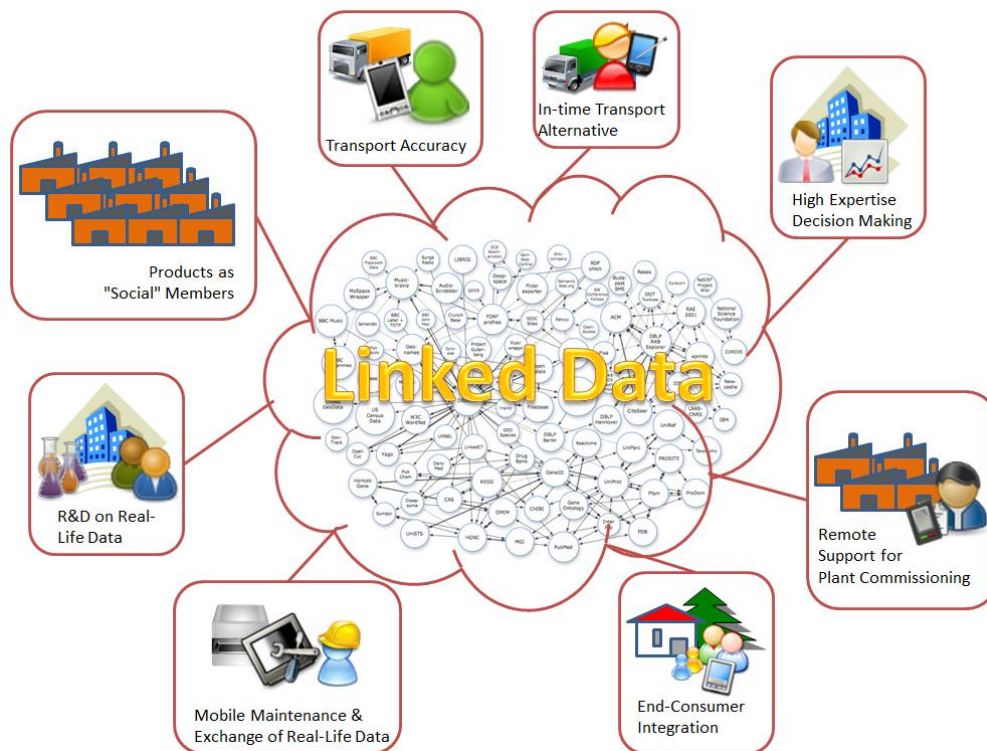

Figure 1: The collaboration space of *ComVantage*

Results Achieved in the First Year (M01-M12)

In the first year of the *ComVantage* project the focus was on defining initial requirements and basic concepts regarding research and technological development which will be incorporated in the mockup prototypes due in M14.

COMVANTAGE ARCHITECTURE

Based on a comprehensive requirements analysis among all project partners an initial architecture was drafted. This architecture represents an integrated state of all the various technology concepts such as business process model, a secure information model, data integration via Linked Data, and an orchestration concept for mobile apps. The architecture envisions an infrastructure of distributed domains that are hosted individually by each collaboration partner. Centralised functionality is reduced to a minimum and is used for configuration purposes of generic components only. The core concept of the architecture is about integrating data sources of arbitrary technology and data schema. This is realised by developing a data integration layer that works with RDF and Linked Data principles.

COMVANTAGE BUSINESS PROCESS MODELS

Based on a metamodelling framework developed in University of Vienna, the first version of the *ComVantage* modelling method has been specified. It aims to support the design and analysis of product-centric, process-driven supply chains, with processes mapped on IT support systems featuring the *ComVantage* specificities - mobile user interfaces and Linked Data informational resources. The modelling method covers a modelling language, a modelling procedure and a set of mechanism specifications to be implemented in a modelling tool, in later stages of the project. The specification of the method's first generic iteration covers multiple layers of detail, from high level business models, logistical scope and process map, to the operational level of business processes mapped on various resource types (human, apps, information), and down the technical level of mobile app user interaction flows.

COMVANTAGE SECURITY MODEL

As a result of an extensive research of the existing access control and trust models and of the different needs of each use case, a first draft of a suitable security method and architecture has been defined to enable secure and trusted collaboration for enterprises sharing their information by means of Linked Data. The approach extends well established multi domain access control practices to incorporate specific capabilities to deal with private-public web of data leveraged by Linked Data technology. The *ComVantage* access control model is designed based on a multi-tiered security approach dealing with web and data access control needs for effective enterprise collaboration. *ComVantage* access control model is aligned with the principles of dynamic and de-centralised collaboration and ensures that Linked Data information remains private to authorised members.

This security approach will be able to protect all data sets in the collaboration network. *ComVantage* provides sufficient granularity to present specific data sets to each of the collaboration networks and tasks set up by the enterprises in their trusted collaboration circle. Thereby, helping to ward off threats and eliminate vulnerabilities while proving compliance and maximising the efficiency of the operations.

LINKED DATA INTEGRATION

We have performed a thorough state-of-the-art analysis regarding existing ontologies and tools that can be employed in the *ComVantage* prototypes as well as regarding ontology development and publishing methods. Based on this, we have developed an ontology for the customer-oriented production application area and initialised the development process for the other areas. This ontology, which captures terms describing the goods offered as well as the customer-related information, was installed on a Linked Data server and published internally.

Moreover, we have semantically lifted the existing database for the application area Customer-oriented Production and integrated it with this ontology, thus completing the central part of the first mockup

prototype. This prototype was aligned with the *ComVantage* architecture as well as with the approach of intuitive and trustful mobile collaboration.

INTUITIVE AND TRUSTFUL MOBILE COLLABORATION

The area of mobile collaboration addressed four challenges within the first year: One challenge addressed the specification of a concise and pragmatic framework for a User Centered Design. This framework defines all relevant terms, conceptualisations and principles, and provides a sophisticated design and evaluation methodology. It specifies the expected results and their lifecycles across all phases of the project. An analysis of the use cases to design appropriate evaluation scenarios, and the basic choice of an evaluation methodology in coordination with the general progress of the project has been provided.

Moreover, an overview of initial concepts for flexible UI presentation frameworks, data structures and dynamic workflow models was created. These frameworks, data structures and workflow models relate to the UI framework and basic principles of User Centered Design process and are aligned with the requirements analyses and scenario specifications provided by the application partners. First mockup prototypes that incorporate these results were designed for exemplary use cases within each application domain covered by the *ComVantage* project.

Furthermore, the conceptual design of the user interface modelling and generation framework for *ComVantage* was developed. A comprehensive review of the current scientific literature on running and completed research projects in the field of model-driven software development was carried out. Through an Analytic Hierarchy Process and an assessment of the programming expertise of the *ComVantage* partners with implementation tasks it has been decided to use native iOS and native Android as development technologies for the mobile apps. The user interface modelling and generation framework will allow the development of mobile apps for the *ComVantage* project. This approach has been verified for a maintenance use case in an industrial facility. The use case proves the feasibility of the orchestration approach.

Also first generalised visualisation and workflow patterns were identified and conceptualised. The final patterns and guidelines will be available in the third year of *ComVantage*.

SCENARIOS AND USE CASE DEFINITION IN THE APPLICATION AREAS

- **PLANT ENGINEERING AND COMMISSIONING**

  Plant Engineering and Commissioning is the first out of three work packages that elaborates use cases and implements the concepts and methods developed in the technical work packages. The objective is to save money and time during commissioning activities with the implementation of tools that help designers in cycle time validation, data elaboration and sharing information.

  The main results achieved so far are:

  - Use cases definition and specifications refinement
  - Analysis of tools and technical approaches useful for commissioning efficiency improvement
  - Data workflow management
  - Development of an ontology, implemented by terms and vocabulary, and a set of concepts within a domain with the relationships among those concepts in order to organise a machine semantic
  - Evaluation of a secure information model
  - Elaboration of a mockup prototype for the user interface

- **CUSTOMER-ORIENTED PRODUCTION**

  Customer-oriented Production is the second out of three application oriented scenarios that implements the concepts and methods developed in the technical work packages. The objective of

this scenario is to refine the establishment of the *ComVantage* prototype for a mobile infrastructure to ease collaboration and communication between customers and production stakeholders in order to have a transparent supply chain that provides the possibility for late changes. A further objective of this application scenario is to enhance the competeveness of SMEs by allowing better communication in between the different suppliers involved within a design and production process.

The main results achieved so far from the beginning of the project cover:

- o Refinement of the Customer-oriented Production Use Case with respect to the business model

- o Elaborating in detail the personas, the scenarios and use cases as well as a set of initial requirements for the target system

- o First adaptions and refinements of the secure information model

- o First adaptions and refinements of the Linked Data concepts

- o First adaptions and refinements of the generic framework of user interfaces for mobile collaboration with respect to their relevance according to the domain specific mockup prototype

- ■ **MOBILE MAINTENANCE**

  Mobile Maintenance is the third out of three use case oriented work packages that adapt and evaluate the concepts and methods developed in the technical work packages. It aims to illustrate the improvement of asset management and mobile maintenance by combining mobile collaboration and sensor data integration.

  The main results achieved so far are:

  - o Refinements of the scenarios and use case specifications

  - o Alignment of the design for mobile maintenance with the overall *ComVantage* architecture

  - o Specification of an ontology for machine semantic

  - o Implementation of Live Data Access

  - o Implementation of the execution of test case scripts

EVALUATION OF ICT AND BUSINESS MODEL

In the context of evaluation of ICT and business model, the first year of the project has focused on the development of the theoretical and conceptual foundations upon which the contribution of the project would be evaluated. The first stage involved the construction of an evaluation roadmap to guide the evaluation process throughout the project. Then, a comprehensive review and analysis of the relevant literature was performed, resulting in the formulation of an evaluation framework that would serve as the conceptual foundation for all future evaluation activities. In general, the framework identifies three collaborative capabilities that are expected to be enhanced by the project (supplier-related, internal, and customer-related) and six organisational dimensions on which these collaborative capabilities are expected to make an impact (cost, efficiency, quality, flexibility, innovation, and sustainability). The third stage involved the development of a comprehensive set of metrics through which the specific impacts of the project could be evaluated. To achieve these objectives, we also performed in-depth analyses of the various project scenarios and used interviews and questionnaires to collect preliminary data from key stakeholders in each application area. The resulting evaluation framework and metric set will be used to evaluate the effects of *ComVantage* on the implementing organisation.

STANDARDISATION, EXPLOITATION, DISSEMINATION, AND CLUSTER ACTIVITIES

In the area of standardisation, dissemination, exploitation, and cluster activities the focus was on presenting and discussing the overall idea and first concepts which provided the basis for further collaborations.

- **STANDARDISATION**

  The consortium spent their efforts to introduce the preliminary results of the *ComVantage* project to the relevant standardisation bodies:

  o Task Force GMA FA 5.16 "Middleware in Automation"

  o DKE Standardisation Task Force UK 921.1 "Begriffe der Leittechnik" (mirror to the IEC/TC65 "Industrial-process measurement and control")

  o "IEC 60050 - International Electrotechnical Vocabulary, Part 352: Industrial IT"

  o of DKE/K 931 "Systemaspekte" (mirror to the IEC/SC 65E "Devices and integration in enterprise systems"

  o OMI workshop on "Modelling Methods in Motion"

- **EXPLOITATION**

  In the area of exploitation internal activities by the partners have been started which are yet in a too early stage to present official statements. The first specific output is the identification of the cooperation domain on modelling by UNIVIE and BOC-IB. Furthermore, a first *ComVantage* prototype was presented at the SAP internal Developer Kickoff Meeting (DKOM).

- **DISSEMINATION**

  In the area of dissemination several channels have been engaged for communicating the *ComVantage* idea and first results:

  o *ComVantage* project web site (www.comvantage.eu), including the availability of public deliverables

  o Set-up of social media channels including a communication strategy being aligned with FInES / ENSEMBLE

  o Dissemination material such as project leaflet and EFFRA brochure.

  o Participation at conferences

  o Publication of scientific and journal articles

  o Internal collaboration wiki

- **CLUSTER ACTIVITIES**

  The idea and first concepts of *ComVantage* have been discussed within the FInES Cluster as well as towards other national and international projects.

  o Participation in FInES Cluster meetings and workshops

  o Contributions to FInES Task Forces (Business Values, Scenarios, and Models; Interrelation between FInES Research and Standards & Standardisation; FInES Research Roadmap; Manufacture and Industry)

  o Lead of FInES Task Force SMEs in the Future Industry

  o Discussion of concepts and identification of synergies with other EU and national projects

  o Participation in the MEP 2020 Master Plan Survey

Potential Impact and Use

ComVantage will trigger a significant impact on improving interorganisational production processes by supporting emerging virtual factories and enterprises. The collaboration of various experts and end-customers regarding specific product-related issues will lead to major enhancements of product design and related services, and such to substantial competitive advantage for the European industry.

In the above spirit, European enterprises will benefit from enhanced know how on product development and product-related services, cost and time reduction by merging geographically distributed expertise, and thus by accelerated innovation processes.

- European citizens will benefit as *ComVantage* will have a positive impact on the European manufacturing competitiveness as well as by being active part of Open Innovation and Crowdsourcing.
- The European market will benefit by introducing advanced ICT technologies that support the networked enterprise concepts.

IMPACT AND USE OF THE FIRST YEAR

The results of the first project year provide a solid foundation for the upcoming research and technological development activities, thus their potential use and impact outside the consortium is limited.

Yet, the preliminary results on Intuitive and Trustful Mobile Collaboration enable the implementation partners to adapt the generic concepts and to design, implement and evaluate their initial prototypes in accordance with the expected level of functionality and refinement proposed in the *ComVantage* outline. The *ComVantage* User Centered Design framework is publicly available for other projects. The framework is in an applicable state and can be used for evaluation activities in these projects as well. The user interface modelling and generation framework for *ComVantage* already gained some attention from research partners outside the *ComVantage* consortium and thus may have impact on future research projects soon.

Moreover, the evaluation framework and metric set, generated as part of the Evaluation of ICT and Business Model activities, can be straightforwardly generalised to assist in the evaluation of the organisational effects of various technologies in various industrial settings.

FINAL RESULTS

The final results address the following goals:

- Higher management efficiency of networked and sustainable business operations
- ICT tools enabling the participation of SMEs in virtual factory environment
- New business models and innovation scenarios for a low carbon economy

ComVantage Web Site and Contact Information

For further information, please, refer to the project's web site www.comvantage.eu. Specific questions may also be directly addressed per email: dissemination@comvantage.eu.

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