

The COIN Enterprise Collaboration SaaS Platform

Hong-Linh Truong¹, Patrick Sitek², Carmen Aguilera³, Michele Sesana⁴,
Florian Skopik¹, Novica Zarvić²

¹*Distributed Systems Group, Vienna University of Technology*
{truong, skopik}@infosys.tuwien.ac.at

²*Bremen Institute for Production und Logistics GmbH, University of Bremen*
{sit,zar}@biba.uni-bremen.de

³*Ingenieria y Soluciones Informaticas, caguilera@isoin.es*

⁴*TXT e-solutions S.p.A, michele.sesana@txt.it*

This paper describes the COIN SaaS (Software-as-a-Service) platform for cross-enterprise collaboration. We discuss the importance of having integrated SOA (Service-Oriented Architecture) platforms for networked enterprise collaborations and present our techniques to consolidate existing enterprise collaboration tools to provide a rich SaaS platform for enterprise collaboration. The COIN enterprise collaboration platform can support dynamic collaboration to the end-user and brings many benefits to the researcher and service integrator.

1. INTRODUCTION

Today's cross-enterprise collaboration is dynamic and complex, involving diverse types of activities among different enterprises, teams, and people, that requires much advanced, integrated collaboration services. In our work we focus on enterprise collaboration (EC) in collaborative networks. Conceptually, EC in collaborative networks has been considered to include four phases (the virtual organization life cycle is generally considered to consist of the four phases named *preparation, formation, operation* and *dissolution*) and carried out through a virtual breeding environment (VBE) established by a network of enterprises (Camarinha-Matos, Afsarmanesh, 2008; Romero, 2008). To support these concepts, many tools have been developed. However, when considering the complexity of enterprise collaboration, in particular the operational support for collaborative processes among different SMEs (Small and Medium Enterprises), there are many obstacles hindering us to use these tools effectively as well as these tools have not been integrated together to provide converged collaboration services for networked enterprises. Many tools are designed for isolated usage thus it is difficult to compose them to support complex collaborations which require different features. Making these tools work together is a required, but challenging, task. On the other hand, the SaaS model (Bennet, 2000) has been increasingly supported. The SaaS model creates a swift change in how enterprises use software. By utilizing the SaaS model,

diverse enterprise collaboration tools could be consolidated and new collaboration services could be integrated, thus providing different solutions for conducting complex collaboration. To date, the SaaS model has not been well exploited for cross-enterprise collaboration.

The above-mentioned issues have motivated our work on developing and providing an integrated SaaS platform for EC. Our result is the COIN¹ EC SaaS platform. By following the SaaS model and utilizing SOA techniques for service integration, we have unified and integrated various models of profiles, competencies, business opportunities, and human interaction contexts from disparate sources to provide an extensible platform including a rich set of services for EC. The goal of the COIN EC SaaS platform is to provide these services in a way that they can be composed and utilized in different ways for different collaboration purposes.

The rest of this paper is organized as follows: the related work is presented in Section 2. Section 3 describes our platform for enterprise collaboration. Section 4 presents key benefits of the platform. We present an illustrating example in Section 5. Section 7 concludes the paper and discusses our future work.

2. RELATED WORK

Many general purpose collaborative software have been developed and they can be used for cross-enterprise collaboration. However, most of them did not support virtual organization and virtual team collaboration and were not designed to be composable. Recently, many projects have developed various collaborative systems which could be classified into systems for virtual teams, such as the inContext system² or for virtual enterprises (Camarinha-Matos, Afsarmanesh, Ollus, et al., 2008). The first type is generic enough to be used in team collaboration of cross-enterprises but they are not integrated into real business of enterprises, e.g. product management, in collaborative networks. The latter typically includes separate tools for different purposes; these tools are not well integrated to support different needs. In parallel, while commodity collaborative services are increasingly used, a platform including well-integrated collaborative services which cover different aspects is missing, forcing the user to utilize different tools in separate ways. Moreover, the SaaS model has a strong impact on the design and implementation of collaboration tools which increasingly rely on Web services technology to support service interoperability. Industrial SaaS collaboration platforms, like Zoho³, Central Desktop⁴, and Injoos⁵, just focus on single enterprise or virtual team. EC SaaS platforms that can cover many aspects, such as communication, activity management, partner search, and product and customer support, are missing.

Before building our SaaS platform for EC, we have performed a detailed analysis of existing EC tools, in particular from the EU IST 6th Framework Program. Table 1 summarizes some major tools (a detailed survey can be found in (Sitek, 2008)). Most of the tools are specific for EC but some are generic, such as the Communication service set and the Activity Management service. As

¹ <http://www.coin-ip.eu>

² <http://www.in-context.eu>

³ <http://www.zoho.com/>

⁴ <http://www.centraldesktop.com>

⁵ <http://www.injoos.com>

shown in Table 1, many tools have been developed for EC. However, most of them did not follow the SOA paradigm but Web application, and they are designed to work in an isolated manner with a focus on the end user, not the service integrator. Thus, while useful for EC, they often focus on a specific perspective and it is difficult, if not impossible, to compose them for complex collaborations. While we utilize several existing tools for our platform, we have refactored them and provided Web services interface and other solutions to integrate them into our platform.

Table 1: Existing EC tools and systems

Category	Software	Number of Tools	Tool Name
Web application	Tomcat	10	Virtual Breeding Environment Management (VMBS), Professional Virtual Community (PVC) Management and Governance, PVC Rewarding Tool, Requirement Identification Service (refQuest), E4 (Extended Enterprise Management in Enlarged Europe) Platform, Supported Indicator Definition (SID), Collaboration Opportunity Characterization (COC) Plan, Virtual Organization (VO) Model Repository, Partner Selection (PS), VO Formation
	Apache Web server	2	Collaboration Opportunity (CO) Finder, Customer Support Service (DISCO)
	Microsoft IIS	4	PVC Management and Governance, Planned, Mediated, and Ad-hoc Collaborations
Web service	Axis	2	Communication Service Set, Activity Management
Database	MySQL	9	PVC Management and Governance, PVC Rewarding Tool, Planned, Mediated, and Ad-hoc Collaborations, Communication Service Set, Activity Management, refQuest, DISCO
	PostgreSQL	5	VBMS, E4 Platform, CO Finder, COC-Plan, VO Formation
Programming Language	Java	10	VBMS, PVC Rewarding Tool, Communication Service Set, Activity Management, refQuest, SID, COC-Plan, VO Model Repository, PS, VO Formation
	C#	5	PVC Management and Governance, Planned, Mediated, and Ad-hoc Collaborations, E4 Platform
	PHP	2	CO Finder, DISCO

Some tools from the ECOLEAD project⁶ are adopted and integrated into our platform. But the ECOLEAD tools are designed for isolated use, diverse types of data are not integrated and it is difficult to compose different tools and services for newly-emerging collaboration needs. Moreover, ECOLEAD focuses separately on Virtual Organizations and Professional Virtual Communities, while we concentrate on dynamic enterprise collaborations between organizations and individuals in business ecosystems.

3. The COIN SaaS Platform for Enterprise Collaboration

3.1. SOA-based Enterprise Collaboration Platform

⁶ <http://ecolead.vtt.fi/>

Many existing EC systems are based on Web applications. They do not provide Web services interfaces and are not well integrated with each other because they lack interoperability support and dynamic composition support at runtime. Considering the benefits of the SOA and SaaS models, we structure the COIN EC SaaS platform into three layers: data, services and tools. Figure 1 depicts the overall architecture of the COIN SaaS platform for enterprise collaboration. The layers are designed for SaaS models. The *data layer* includes common data models, data and data management services for many collaboration services. This layer provides necessary data for most activities performed by other services, such as partner registration, team formation, and customer support. The *services layer* includes services offering specific functionalities for EC. Services can be domain-independent, being used for different purposes, or domain-specific, being used for a particular business/domain. Collaboration services retrieve, utilize and manipulate common data provided by the data layer and specific data managed by themselves. The *tool layer* provides various tools which utilize different services to offer particular functionalities required by the end user. Tools can range from generic to specific. Data, services, and tools for EC are decoupled and integrated through SOA technologies, making the platform extensible and new services can be easily plugged and composed. The services layer, for example, can provide many different types of services which can be composed to create new services. Potential domain-specific and domain-independent tools can be built based on features offered by the set of services.

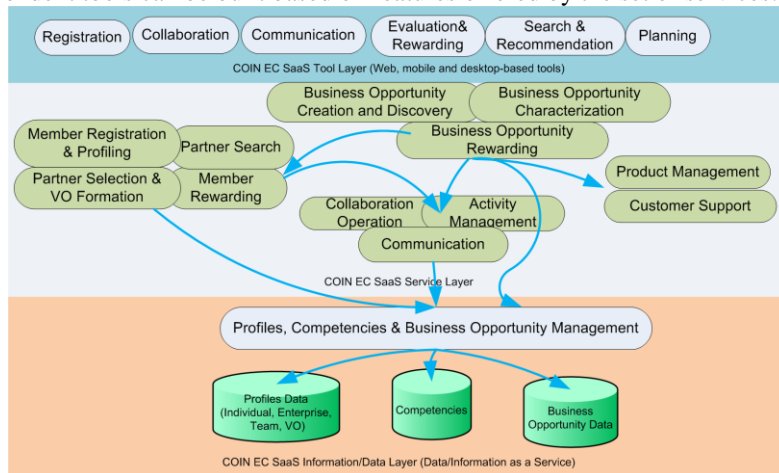


Figure 1: The architectural overview of the COIN SaaS platform for enterprise collaboration. Arrowed links indicate illustrative service invocations. A rounded corner rectangular represents a group of software services/tools.

Many existing EC tools need to be consolidated and harmonized in order to be a part of the COIN EC SaaS platform. This involves in refactoring systems, which are not based on SOA, and in harmonizing data structures used for EC. First of all, a main integration issue among tools/services is that they should access as much as possible common data which is needed for almost any collaboration and is independent from domain-specific collaboration. Examples of such common data are profiles (e.g., name, contact information, business areas, membership, and context information), competencies (e.g., skills, technical knowledge, involved

activities and processes, performance, products), and business opportunities. Common data is associated with organizations, individuals, and their virtual structures (e.g., virtual team and virtual organization), and services. For highly dynamic collaboration, such as in business ecosystems, these types of data should be easily linked together to support collaboration services. To this end, we have developed common competencies and profiles models for organizations and individuals based on existing work from the ECOLEAD and the inContext projects. Second, a great engineering effort has been spent in order to adapt Web application tools to Web services and to make these services work with the new common data service. Third, when tools and services offer similar functions (though their configuration and the usage context might vary), we have grouped them into a toolset or a service set in order to foster the composition of services/tools. For example, many different communication services, such as emails, instant messages, and voice chat, can be grouped into a communication services set. Through the integration we have achieved a core set of services and tools available for use. Our platform can be used by the end-user as well as serve as a foundation for future research on innovative collaboration services. Table 2 presents the current services and tools (depicted in Figure 1) in the COIN EC SaaS platform.

Table 2: Summary of services in the COIN EC SaaS platform

Features	Description
Centralized Profiles, Competencies & Business Opportunity Management	Manage business opportunity information, individual credits, profiling, human interaction information, etc., which are used by all tools and services, and allow tools/services to save/retrieve/exchange required data from different models.
Communication	Support human communication and notifications, such as emails, instant messages and voice chat. Communication services can be used by human as well as by tools and services to disseminate relevant information.
Collaboration Operation	Support the user to compile solution forms, taking into account the experts suggestions, deciding which contributions shall be included in the solution and, at closing time, choose which contributions should be published to which relevant people.
Activity Management	This service supports the creation and management of activities of people within a collaboration scenario in a Virtual Organization (VO).
Business Opportunity Creation and Discovery	Support an opportunity broker to discover business opportunities (BOs). In most cases, an opportunity broker has to search for collaboration opportunities through calls for tenders and select the most appropriate ones.
Business Opportunity Characterization	Support the management and access business opportunity models. Business opportunities can be characterized by the Work-Break-Down-Structure (WBS), the tasks to be performed, and the special competencies needed.
Business Opportunity Rewarding	Reward organizations for creating new business opportunities. A score, representing the reward, is defined and maintained for each member in the network of enterprises.
Member Registration and Profiling	Support the management of member information and member profiling. Member registration and profiling management can be applied for both individuals and organizations.
Partner Search	Support the search for relevant partners based on diverse criteria. The service suggests the most suitable members for a VO regarding the requirements of a given business opportunity.
Partner Selection & VO Formation	Manage information about VOs during the formation phase of the collaboration life-cycle. It provides mechanisms for storing information on created VOs in the data-structure as well as structuring, storing, and providing inheritance information to the VO formation process.
Member Rewarding	Support the rewarding of members, checking and comparing credits which

	are a performance indicator used to represent and monitor individuals activities in each collaboration.
Product Management	Enable networked product developers to share documentation of their products and assemblies, and structure their complex products in catalogs, categories and different configurations.
Customer Support	Enable customers to access the information of products and assets described in a structured classification in catalogs and categories.

3.2. Extensibility of the Platform

Because our entire platform is provided under the SaaS model in which services are based on SOA, the service integrator can integrate new services into the platform. A new service can provide a separate feature, which can be used by any other services, or it can be composed from existing services. Services can also come from third party providers to provide complement features. For example, currently our platform does not include an SMS (Short Message Service) Web service for communication but a similar one, such as StrikeIron SMS Web service⁷, could be straightforwardly integrated into our `Communication` service set to enable SMS communication.

4. KEY BENEFITS OF THE COIN EC SAAS PLATFORM

4.1. Supporting Dynamic Enterprise Collaboration

The end-user needs a platform that is able to support dynamic enterprise collaboration which involves many organizations, individuals, resources and software services. First, due to the dynamics of collaboration and rapid formation of collaborative networks, these networks require different services for different collaboration phases (Camarinha-Matos, Afsarmanesh, 2008). By providing a large set of services, our platform meets this requirement well.

Second, by combining the management of organizations and individuals and their virtual forms, we could support the formation of highly dynamic collaboration networks including business ecosystems because rich sources of common data, such as profiles, product/service, processes and performance data, is linked and available in a common data-as-a-service. Converged collaboration services are provided by composing different services, i.e., communication services with other services to support realtime information dissemination among collaborators. Furthermore, with our platform a business opportunity (product/service) can be created from inside (based on the network competencies) or discovered through third party services.

Third, business opportunities and collaborations are manageable through activities associated with individuals, teams, and their competencies and processes, and relevant product information and documents. For example, by using the `Business Opportunity Characterization` service the end user can define the tasks to be performed and the special competencies needed. Based on that, planned and mediated tasks can be defined for each network partner. Ad-hoc task force teams can be set up in critical collaboration situations. The execution of the defined tasks is supported by the `Activity Management` service, which links acting people with used resources, and tracks the state of each task. Exchange of product data and progress information related to the tasks are supported by communication services.

⁷ <http://www.strikeiron.com/productdetail.aspx?p=450>

Finally, through the platform, feedback can be collected and evaluated in a coherent way from individuals, organizations, customers and also from *many software services* to evaluate the success of collaborations. Such evaluations are valuable for determining trust and plans in future business opportunities.

4.2. Supporting Advanced Research on Enterprise Collaboration

The COIN EC SaaS platform brings many benefits for future research that is hard to conduct without such a platform. First, the platform enables the composition of commodity EC services: many existing EC services are common because we can use them for different purposes. With such a platform, new EC services can be created through the composition of common EC services. This will enhance the EC SaaS platform, reducing duplicated work and providing a better integration of EC services to other business of enterprises. Second, the platform enables the acquisition of rich data sources for understanding collaboration interactions and performance evaluation: complex interactions are inherent in EC that need to be analyzed in order to improve our understanding and to support adaptive collaboration. Without such a platform, it is very difficult, if not impossible, to obtain different kinds of data characterizing interactions for analysis. With our platform, profiles, activities, operations, contexts, etc., can be logged and retrieved through a Web services-based platform, supporting many research activities, such as trust analysis and collaboration adaptation, which rely on realistic data for experiments.

5. ILLUSTRATING EXAMPLES

Currently, the COIN EC SaaS platform offers a single portal⁸ supporting single sign-on mechanism and its services are deployed in several machines in Bremen, Milan, Sevilla, and Vienna. In this section, we demonstrate the usefulness of our platform by supporting scenarios from the Aeronautic Cluster of Andalusia (include EADS-CASA, AIRBUS, GAMESA, 125 subcontractors and supporting entities).

To illustrate how the COIN EC SaaS platform could foster the development of collaboration tools, we considered the case when collaboration on a final assembly of an aircraft is operated. During the operation of the collaboration, a team needs to manage its activities, discussing potential issues using different kinds of communication channels. To support this type of collaboration, which actually occurs in many cases in EC, we built a collaboration tool by utilizing the Centralized Profiles, Competencies, & Business Opportunity Management service, the Activity Management service for managing activities, and the Communication services for supporting situational communications. Figure 2 illustrates activities during a collaboration managed and conducted by using this tool.

6. CONCLUSION AND FUTURE WORK

This paper has presented the COIN EC SaaS platform whose ultimate goal is to consolidate earlier research results, especially from the EU IST 6th FP, and to move from those “island solutions” towards an integrated and unified collaboration support under the SaaS model. We have presented how the implementation of this goal, through the prototype of the COIN SaaS EC platform, represents a real added

⁸ <http://demos.txt.it:8055/web/guest/home>

value compared to the situation that we had before. Our platform is able to support the end-user to conduct dynamic enterprise collaboration and to allow the developer and service provider to carry out advanced research and service provisioning.

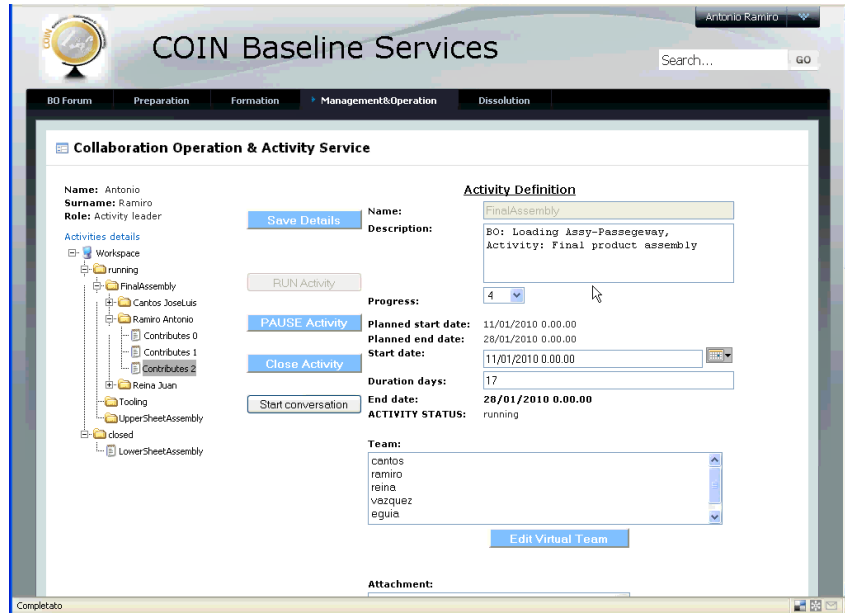


Figure 2: Activities related to the final assembly

Our future work is to support advanced EC services, such as collaborative project management, production planning, and interaction trust management. Furthermore, we plan to integrate this platform into a generic service platform to enable automatic composition of collaboration services.

Acknowledgement: This work is mainly supported by the European Union through the IP project COIN (FP7-216256). We thank our colleagues in the COIN consortium for their supporting during the development of this work.

7. REFERENCES

1. Bennett, K., Layzell, P., Budgen, D., Brereton, P., Macaulay, L., Munro, M.: Service-based software: the future for flexible software. Asia-Pacific Software Engineering Conference 2000 (2000). DOI <http://doi.ieeecomputersociety.org/10.1109/APSEC.2000.896702>
2. Camarinha-Matos, L., Afsarmanesh, H.: Collaborative Networks: Reference Modeling. Springer Publishing Company, Incorporated (2008)
3. Camarinha-Matos, L., Afsarmanesh, H., Ollus, M., Camarinha-Matos, L., Afsarmanesh, H., Ollus, M.: Methods and Tools for Collaborative Networked Organizations. Springer Publishing Company, Incorporated (2008)
4. Romero, D., Galeano, N., Molina, A.: A virtual breeding environment reference model and its instantiation methodology. In: L.M. Camarinha-Matos, W. Picard (eds.) Virtual Enterprises and Collaborative Networks, *IFIP*, vol. 283, pp. 15–24. Springer (2008)
5. Sitek, P., Eschenbacher, J., Sesana, M., Truong, H.L., Aguilera, C.: D4.1.1 -state of the art and baseline ec services specification (2008). COIN Consortium