TOWARDS A SEMANTICALLY AUGMENTED COLLABORATIVE WORKING ENVIRONMENT

Designing a Service Oriented Architecture Environment for eProfesionals

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Abstract: Both social and economic changes have favored the appearance of eProfessionals as workers whose business and tasks can only be achieved using modern cooperative technologies. To be able to achieve this vision there is a need to research and develop new collaborative working environments. This is the main goal of the ECOSPACE project. As part of the research in this project, in this paper, we introduce an architecture based on Service-Oriented Architecture (SOA) which has been improved by means of the inclusion of semantic information. This semantic information allows us to achieve a better level of interoperability than we can provide only by using the syntactic information provided by SOA technologies.

1 INTRODUCTION

Within few years, significant social, organizational and economic changes as well as a relentless technology evolution will lead the way of working for eProfessionals into a dramatic change. People will no longer work according to chain production models but rather more as dynamically and spontaneously assembled groups of people working together in a collaboration mode, which means a seamless work to achieve common goals. In the academic research community, these trends lead to the Social Computing, Social Desktop, and Social Web or Web 2.0 initiatives.

The "Experts Group on Collaborative Working Environments" of the European Commission coined the term eProfessional to address workers in such environments. We consider an *eProfessional* as a professional worker whose business and tasks can only be achieved using modern cooperation technologies. These technologies enable an eProfessional being part of groups and communities as well as knowledge networks, and being involved in distributed cooperation processes that have not been possible before.

According to this assumption, our vision is that "The Network" (in fact the Internet and the web of people) will become a global virtualized collaborative workplace where the contextual social exchange will be located through people-concepts connectivity. In a recent study it is shown that workplace innovations account for 89% of multi-factor productivity gains (source: Black and Lynch, San Francisco Federal Reserve, 2004). This global virtualized collaborative workplace which is one goal of ECOSPACE will enable knowledge workers to get access to both, their individual shared workspace and groups or communities shared workspaces wherever they are, whenever they need it independent of organizational boundaries.

To be able to achieve this vision there is a need to research and develop new collaborative working environments as it is reflected by the groups of experts of the European Commission in the idea of CWE 2020 (Laso-Ballesteros et als 2006) (Laso-Ballesteros 2005). This research must lead to a better understanding of the work environment, the development of an upperware and collaboration services as the collaboration platform, and new innovative user-centric collaborations tools that reduce the complexity of today's techno-centric communication applications.

A critical element in an increasingly interconnected world will be the software that will implement most functionality and will also ensure the secure and reliable integration and interoperability of mobile, fixed, personal and corporate heterogeneous resources and applications.

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This will require advanced technology for the development of highly functional and high-quality software, and a truly semantically enabled middleware infrastructure for its interoperability. Well accepted standards and open-source software are also crucial.

In this context the ability of organizations to embrace change, uncertainty and opportunities in the global economy are directly related to the empowerment of knowledge workers (eProfessionals) at all levels of the organizations. This means making collaboration with colleagues down the corridor or around the world as natural as working alone. It means making access to information secure, ubiquitous and unobtrusive. In that sense it is our intention to contribute to the European industry by means of defining secure, robust, common and open infrastructure standards for collaboration based on a middleware opened for seamless integration of components and their convergence into new types of systems and environments.

This middleware will be aligned with the methods, services and tools in order to define a collaborative support for combining these technologies into the defined architecture. In order to reach this goal, ECOSPACE major objective is the integration of existing platforms provided by partners in the project (Prinz et als 2006). They have been selected to represent state of the art systems in collaborative environments. At the same time we propose new approaches that will enable the integration of existing technologies across different usage environments, but also support the new concepts and services for an eProfessional workplace according to the paradigm shift advocated by the project.

The objective of ECOSPACE is to define a robust upperware that:

- Allows interoperation with open standards and contributes to them, to facilitate the integration of a range of technologies and platforms, including existing ones provided by partners as well from developers outside the consortia.
- Support the integration, sharing and distribution of content and concepts develop in the project based on semantic information in mediation between the structure and content of knowledge bases from different living cases.
- Allow the support of mobile, nomadic and fixed professionals in a seamless approach, as well as presence and awareness services that enable the integration of the context of users and their collaborative activities.
- Support security, trust and privacy, in the access and use of the services and tools defined over it.

In this project we extend classical middleware vision with the adoption of a semantic-based upperware to manage the interoperability, access and integration of distributed data and resources, and to provide a platform for value-added services. This middleware will contribute and collaborate in the definition of open standards for business and collaborative service processes.

The middleware that we will develop is able to structure and focus these needs, adding coordination and knowledge management. This middleware allows changes and adjustments to both the organizational structure and the coordination rules depending on how the global knowledge of the collaborative environment evolves along the time.

It is important to stress that the middleware will be compound by several layers that allow the independence of the computing paradigm specific aspects and at the same time provide the abstraction to access several components distributed in the network to offer the iterated view of the collaborative services required by the user. This will imply the location, discovery, naming, and in general invocation of the different distributed components.

As different computing paradigms need to be integrated in the same middleware (i.e. service oriented computing, P2P computing, Web 2.0 methods), the middleware should allow to work either on centralized and totally decentralized environments. Thus we need to address the aspect of synchronization and persistence for distributed workspaces. Further, appropriate protocols for knowledge dissemination and recovering must be defined to allow for an appropriate context information management.

At the ECOSPACE defines and develops the user-centric interoperability middleware and new core collaboration services: e.g. persistent distributed workspaces, group management, collaboration context and resource location.

The rest of this paper is organized as follows. Section 2 provides a description of the main feature that the ECOSPACE CWE should provide. Then, in section 3, we describe the initial steps that we propose to achieve the goals commented in the previous section. Then, in section 4 we mention some considerations about the involvement of the end-users in order to improve the results proposed. Finally, in section 5 we finish the paper with some conclusions and future work.

2 VISION OF THE ECOSPACE CWE

Future eProfessional collaborative working environments requires a shift from application oriented developments towards the design of collaboration-aware work environments that support cooperation and interaction in terms of activities instead of technical functions.

ECOSPACE aims to support this shift by applying a paradigm shift from simple cooperation services – currently often stand-alone applications – to user and activity oriented cooperation environment. ECOSPACE will develop such an environment based on the integration of existing services that the project partners contribute to the project, and which will be also open to include third-party services. For this purpose, a reference model and middleware for collaboration environments will be developed. On top of this middleware, innovative collaboration tools will be developed to increase cooperation awareness for users and tools (Figure 1).

The few basic components for such a cooperation environment is formed by existing cooperation services such as email, shared workspaces and application sharing or task management services. Among the new services, presence and awareness services will play an important role. These services are needed in distributed cooperation to support users in their mutual understanding of the status and progress of work as well as the work rhythms of other organizations.

On top of these services an open integration layer enables the horizontal and vertical integration of the services. It supports the interoperability of similar services, e.g. two shared workspace systems from different vendors, of complementary services, e.g. user management between workspace system and instant messaging system. An important pre-requisite for the realization of such a layer is the development of interoperability standards.

The integration platform integrates existing services on a technical level. This includes the exchange of authentication data (single sign login) as well as metadata of collaboration artifacts. In addition new core collaboration services are developed that are needed for the collaboration tools. On top of the service integration layer an activity and collaboration integration layer provides the user-centric integration of the collaboration service. This enables the organization of resources according to users' collaboration context.

The activity and process support level abstracts from the cooperation application to provide an activity-oriented collaboration environment. Within this environment, users can organize their resources according to their processes, activities, teams and communities. I.e. the documents and messages exchanged within a project will no longer be scattered over the attachments of emails in email folders, the local disk and a shared file system or a shared workspace. Based on a semantic integration of the cooperation activities as well as the services, users will be able to organize the environment according to their project, team or community contexts.

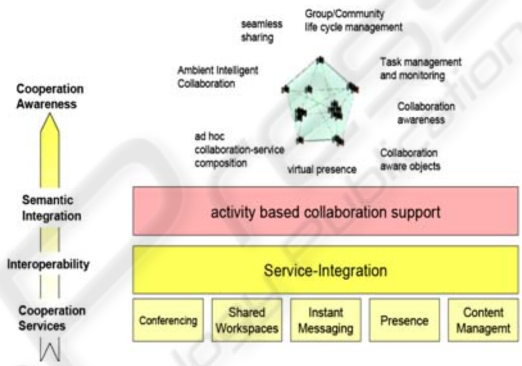

Figure 1: From Cooperation Services to Cooperation Aware Environments.

3 TOWARDS TO THE ECOSPACE CWE

In the previous section, we have introduced the ambitious goals required to the ECOSPACE CWE. Next, in this section, we provide the different steps followed in order to go towards this CWE.

In order to define a basic interoperable infrastructure for the collaboration, one important initial step is to analyze the architectures and interfaces defined in the different already existing platforms to define a cooperative architecture being able to cope with the different models. ECOSPACE has a significant number of systems provided by the partners such as shared workspaces (BSCW, BC, SAP NetWeaver KMC,…), virtual presence (Jaytown, OpenScape) and conference toolkit (Arel Spotlight, Isabel).

With the aim of establishing an interoperable activity-oriented collaboration environment we need to move from the standalone applications approach that presents the previous collaboration tools to the services approach. Therefore, we need to define the architecture as Service-Oriented Architecture (SOA) as we describe in the following section. For this architecture we are based on the initial results proposed in (Martínez-Carreras et als 2006), where the authors presented a generic architecture based on SOA. However, in this architecture we lack the incorporation several components, such as the need ones to discover activities as well as the incorporation of semantic information in order to provide a better level of interoperability.

3.1 Service Oriented Architecture

For this new collaborative working environment we propose the decomposition of the different tasks that can be carried out by a CWE using a set of web services (WS). Therefore, in this way we have a Service-Oriented Architecture. Between the main advantages of the SOA approach we can point out: the easy integration of applications with other systems, the adaptation of the applications to changing technologies, the reuse of code, the creation of business processes from the existing services in a faster way, better scalability, etc.

Then, according to this approach all new services are developed as web services. These web services are based on several technologies such as SOAP, WSDL, UDDI, etc. The access to a web service is based on the exchange of XML messages according to the definition of the service which is provided by means of the WSDL language. These service definitions are published in a repository in order to easily find where the services, that satisfy some requirements to carry out a task, are located. The repository could follow the UDDI specifications or other that is considered adequate. UDDI provides services for the description, discovery and integration of web services. However, this specification is not as broadly implemented as other specification related to web services such as SOAP or WSDL.

For the exchange of messages to access to the service we could follow the SOAP protocol or the REST protocol. SOAP is largely extended and has become a de facto standard used for communicating heterogeneous platforms due to it is transport-independent. Therefore, it is used as the main protocol to access to web services. Other important of SOAP is that it can be used several transport protocols, both synchronous ones, such as HTTP, HTTPS, SMTP…, and asynchronous ones, such as JMS. When this protocol is used, we recommend the definition of web services according to the document style because it fits better to SOA. More details can be found in (Erl 2004). On the other hand, REST is being used more and more in order to create lightweight access to the web services from the Web 2.0 technologies such as AJAX. Although for Web 2.0 are proposed this lightweight protocol, it is important point out that SOAP web service could be also used from Web 2.0, using a Web 2.0 technology such as AJAX. From our point view, for the definition of web services in this architecture both approach can work together. Then, in order to support them in a unified way we proposed the use of WSDL 2.0 since it supports the definition of both kinds of services.

However, as we have mentioned previously, we already have an important amount of tools that are not described as web services. The migration of these tools to the new approach would suppose a lot of effort and sometimes is not possible. In order to overcome this situation, we propose the use of wrappers, called Wrapper Web Services (WWS) (see Figure 2), with the aim of encapsulating the functionality already offered by means of these tools. Next, we provide a detailed description of these services.

3.1.1 Wrapper Web Services (WWS)

A Wrapper Web service is a web service that encapsulates a legacy or non-SOA application. There are several ways to develop this sort of service. It depends on the API provided by the legacy or non-SOA application. Most of the tools provide a HTTP interface that is based on the use of servlets, php, XML-RPC … Thus, the wrapper web service is a web service that receives SOAP or REST requests according to a WSDL specification and creates a request according to the API provided by the tool. Once, the web service receives the response from the tools, it creates the response as a web service response. The following figure depicts this interaction.

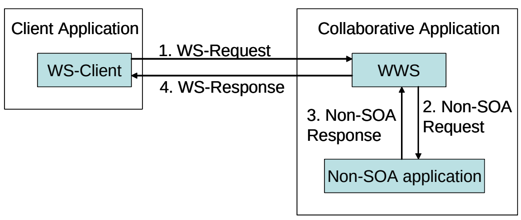

Figure 2: Wrapper Web Service.

Both WS and WWS are the base of the architecture that we propose because they can provide the desired interoperability between heterogeneous platforms and applications.

The whole design of our architecture is shown in Figure 3. The Service layer represents both the Cooperative Services and the Service Integration layers that we commented previously in Figure 1. On the one hand, it represents the Cooperative Services layers because it offers collaborative services from the different existing applications. On the other hand, it represents the service integration layer thanks to the definition of web services that allow us to achieve the interoperability between applications and platforms developed with different technologies. In that layer, we can see that there are some collaborative services that have been developed according to this approach. The new web services are only represented as a box with the term WS. Additionally, the web services that represents the adaptation of existing applications to this new approach are represented under a box named WWS. For example, so as to depict how we have included the shared workspace named BSCW as a web services through a wrapper web service, we have put a box with WWS on the top of BSCW.

At present, in ECOSPACE project we have several wrappers services that encapsulate part of the functionality of groupware such as shared workspaces, e-mail and Ldap. Among these services we have forum, document management, calendar, e-mail, Ldap, etc.

Moreover we have a service of presence and availability developed without using wrappers for invoking it.

We also point out that the new web services developed following this approach could use another web services or even other wrapper web services in order to make a task. This interaction is shown with an arrow in that layer.

3.2 Composition of Services

As we commented in Section 2, in any collaborative working environments it is required the provision of collaboration based on activities. With the previous layer we provide only a set of interoperable services. With the aim of reflecting the complexity of activities in any environment, composition and orchestration of the various collaboration services have to be considered.

For this purpose we propose the introduction of a new layer called Composite Collaborative Services (CoCos) layer. This layer is on top of Service layers as we can see in the Figure 3. The goals of this layer can be achieved by means of standards such as WS-CDL (Web Services Choreography Description Language) (Kavantzas et als 2005), WS-BPEL (Web Services Business Process Execution Language) (Alves et als 2006) or WSMO (Web Services Modeling Ontology) (Roman et als 2005). These different languages allow us to model the behaviour of business processes or activities and the messages to exchange in order to achieve the goals of the processes. The exchange of messages can be seen from the point of view of a particular user or from the point of view of all participants in the exchange of messages. These standards could be even combined in order to perform a particular business process. Then, these languages allow the definition of both sequences control between activities as concurrency and synchronization between them.

In this layer, a CoCos represents the combination of several services, in some specific way, in order to carry out a specific task or activity. In order to discover the different services that a CoCos may need, we can make use of the service repository that we commented in the previous layer. The task description carried out by a CoCos is stored in the Activity repository to facilitate its search. Hence, this new CoCos can be used in other services and/or CoCoS.

With this layer we satisfy the goals mentioned in Section 2. This functionality was shown in Figure 1 as the activity based collaboration support.

Based on the WWS previously mentioned, in this project, we have created several CoCos as a proof of concept. Some of them are: the event notification to several users by means of e-mail or the creation of a forum to discuss on a document that has been uploaded to the workspace. Currently, these CoCos are described by means of WS-BPEL.

3.3 Applications

From the services and the CoCos we can develop new collaborative applications. These applications are represented in a new layer on top of CoCos layer. These new applications follow the SOA approach. Then, taking into account the Model-View-Controller pattern, the new applications will be centred in the view and the controller. On the other hand, the access to the different functionality is provided by the services and the CoCos. This kind of applications is represented as the squared box in Figure 3.

However, we have non-SOA application. In this case, the question will be how we can enhance them and take advantage of this architecture. The approach to follow depends on the kind of application. In proprietary applications we have to find out if the new functionality could be provided by means of plug-ins. In this case, we would develop a plug-in that would access to web services. Otherwise, it would not be possible. On the other hand, in open source applications could be possible to recode some part of the code in order to incorporate the use of web services.

In this project, as a proof of concept we have developed an AJAX application that allows the users to use some of the CoCos previously mentioned to start the discussion on a document among a set of users.

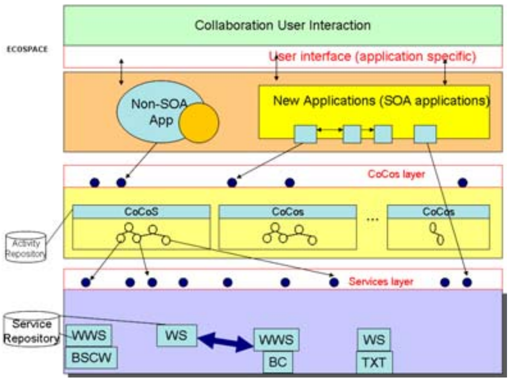

Figure 3: SOA-based CWE Architecture.

3.4 Semantic Augmented CWE

Until this moment we have commented a basic infrastructure based on SOA that be developed in order to achieve a minimum level of cooperation between heterogeneous collaborative working environments. However, in the basic Service Oriented Architecture (SOA), one weakness in adopting web services is its lack of semantic information.

The web services technologies SOAP, WSDL, UDDI etc, rely exclusively on XML for interoperations, but the structural XML guarantees only syntactic interoperability. Expressing message content in XML allows web services to parse each other's message but does not allow semantic 'understanding' of the message content. In order to overcome this limitation, the efforts in the Semantic Web hold great promise of making the Web a machine-understandable infrastructure. In the line within this project in order to be able to integrate the technologies and platforms and generate a new range of services available through the middleware, we adopt the extension of the classical middleware based on semantic information.

Nowadays there exist different proposals for including semantic in web services. Then, we propose to extend the previous architecture (Figure 3), that only supports interoperability at syntactic level, with the advantages of semantic solutions like WSDL-S (Web Services Semantics) (Akkiraju et als 2005), OWL-S (OWL-based Web Services Ontology) (Dean et als. 2003) or new proposals like WSMO (Web Services Modelling Ontology) (Roman et als 2005). These technologies allow formal representation of content to the web services specification and allow the semantic in the interactions and capabilities. This improves the retrieval of accurate information (services or CoCos) regarding the users' preferences

Then, as a final result what we generate is a collaborative SOA (c-SOA) that extends WS-I (Motahari et als 2006) recommendations and some of the existing proposals for peer-to-peer service composition and collaboration such as WS-CDL, WS-BPEL or WSMO that we commented previously. We also propose to improve these proposals with semantic information so as to improve both their search according to the user's preferences and the composition of these composite services into high-level composite services. This semantic information is included by means of ontologies as mentioned below.

Therefore, we add semantic information to the services layers obtaining a semantic web service (SWS), as it is represented in the Figure 4, on top of WS element. On the other hand, we extend the information provided in the definition of CoCos with semantic. This is also shown in Figure 4, on top of CoCos, we have a new box called CoCos with semantic.

Both in web services and composite services the semantic information is provided by means of ontologies. These ontologies are described using proposals such as RDF(-S) or OWL, Finally, in order to support this semantic c-SOA, in this project it is been working in the analysis and the definition of the ontologies needed for the description of the services mentioned. Subsequently, these ontologies will be used to improve semantically the description of services and CoCos previously described.

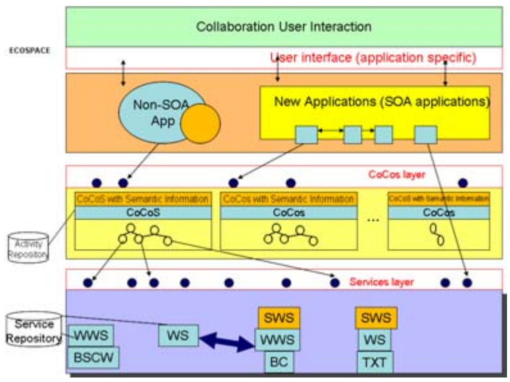

Figure 4: Semantically augmented SOA-based-CWE.

This semantic information included in this architecture comes to support the semantic integration that was commented as one of the goals of future CWE mentioned in Section 2.

From this semantic information we are able to compose and create new applications in a more intelligent way and achieving a better result in the end-user satisfaction.

4 USER INVOLVEMENT

The experimentation and evaluation methodology across the different lab settings will allow comparison and mutual learning. Each experience and application research cycle consists of selecting and defining the specific real-life scenario and later the project to be used in the living lab. The technology has then to be prepared for the experimentation with e.g. the functionality modules, data required, and user configuration. As experiments and longitudinal cases only become meaningful if users adopt new collaborative working methods and know how to use the environment productively, training becomes a crucial element.

5 CONCLUSIONS AND FUTURE WORK

This paper describes the motivation and objectives of one the central activities within ECOSPACE project in order to define an augmented middleware for a collaborative environment, to support not only interoperability between existing platforms but also to allow real shift in the collaborative integration based on a semantic layer that abstract the patterns of interactions and look for the most adequate mechanism to implement them. The initial steps in the development of this middleware have been introduced in Section 3 of this paper.

This collaboration environment will enable knowledge workers, and especially eProfessionals, to easily network together, form groups and professional virtual communities for stimulating creativity and innovation while increasing productivity.

Therefore, we have presented a collaboration platform reference architecture and corresponding upperware enabling the interplay and interoperability of collaboration services and tools in a collaboration environment. This architecture also facilitates the business process management, mobile and wearable computing. This result will be contributed to standards and will foster the seamless cooperation of users within and between organizations, teams and communities.

As future work, there is a long way of research in order to satisfy the full objectives of this project. Thus, context rules requires a deeper research in order to establish how these are going work with the different semantic services and activities and taking into account user's preferences. It is needed a clear definition of these context rules in collaboration services. Finally, the models to define communication between asynchronous and synchronous applications and services are required. This way will be able to cooperate between services based on synchronous modes, such as RPC, and others that are based on messages-event, such as MOM.

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