Next Generation Collaborative Platforms in Business Environments

Matija Pipan, Julija Lapuh Bele and Dušan Gabrijelčič

***Abstract*—**In business environment a collaboration platform is an information system that adds social networking capabilities to increase information and knowledge sharing in order to foster development and innovation. Such system enables teammates to solve business problems effectively and efficiently with the use of collaborative tools and with the appropriate knowledge management incorporation. The research is based on collaborative system that includes both the general collaborative infrastructures and specific applications for supporting the requirements for human-centric applications and services. The collaboration platform has been designed based on use cases typical for business and educational environments. A number of cases has been thoroughly studied like a meeting, lecture, consultations, seminar, discussion room, lectures recording, tutoring, etc. The issues of providing interoperability between applications, efficient content delivery and distribution, skill-based content search, security and usability were discussed to design and develop a conceptual collaborative platform eCampus.

***Keywords*—**Collaboration, Business environment, Content Delivery, Educational Technologies, Future Internet, On-line Communication, Privacy and Security, Skills and Competences.

I. Introduction

THE Internet, electronic mail, and the Web have revolutionized the way we communicate and collaborate - their mass adoption is one of the major technological success stories of the 20th century. The field of networking is facing a qualitatively different problem, information overload, that necessitates smarter and more fine-grained computer support user-centered and with high quality regarding the human factors demand in communicating and exchanging the networked information.

Here is also a growing need for effective and efficient collaboration among business entities; therefore a lot of research and development in last years was allocated to a category of business software that adds broad social networking capabilities to work processes. The goal of a collaboration software application is to foster innovation by incorporating knowledge management into business processes, so employees can share information and solve business problems more efficiently. Sharing information, knowledge and new ideas, peer learning and brainstorming should be facilitated in each business environment. Therefore ICT tools or more precisely an appropriate collaborative platform has an important role in business development. Enabling and fostering collaboration among the employees is necessary but not sufficient. In addition to getting the information and knowledge from coworkers, an employee needs other sources of knowledge to develop personal working skills. The employee competency development is a process which should be systematically carried out in each organization.

Different pieces needs to interact and provide the necessary collaborative services based on new design based on the architecture for the next generation future internet. According to the 2020 Collaborative Working Environments (Vision CWE2020) [19] this way of working will be based on collaborative systems that include both the general collaborative infrastructures and specific applications for supporting the requirements for human-centric applications and services [6]. The collaborative infrastructures will be based on seamlessly integrated context-aware flexible support for distributed collaboration among individuals and will provide service-oriented reference models for massive collaboration. Pro-active support for pervasive human collaboration within their own communities and with other virtual communities is one of the goals to be pursuit. Collaborative infrastructure consist of system components that comply with the Service Oriented Architectures (SOA) allowing specific applications for group-driven composition of systems for provision of synchronous and asynchronous teamwork freeing users from routine and enabling the focus to be on creativity [19].

In accordance with the Vision of CWE2020 next generation collaborative environments/platforms are expected to increase the effectiveness of the service in both directions: horizontally among individuals and within communities and vertically among communities and different infrastructures. In that direction, several requirements and research challenges are indicated:

- Service composition and integration where the collaborative

Matija Pipan, MSc is with the Laboratory for Open Systems and Networks, Jozef Stefan Institute (www.ijs.si), Jamova cesta 39, 1000 Ljubljana, Slovenia, EU (matic@e5.ijs.si).

Dušan Gabrijelčič, PhD is with the Laboratory for Open Systems and Networks, Jozef Stefan Institute (www.ijs.si), Jamova cesta 39, 1000 Ljubljana, Slovenia, EU (dusan@e5.ijs.si).

Julija Lapuh Bele, PhD is with the company B2 d. o. o. (www.b2.eu), Tržaška cesta 42, 1000 Ljubljana, Slovenia, EU (julija.bele@b2.eu).

functions are offered as services (generic services, domain-specific services and context-specific services) either to the user or to the application developer.
- Incorporation of existing Web 2.0/3.0 social network platforms and collaborative tools (e.g. authoring tools, tagging, ranking, ontology, wikies, blogging etc.) [1].
- Integration between synchronous & asynchronous cross domain communication / collaboration.
- Proactive collaboration aware artifacts and objects needed to transform static data so that the entire life cycle of shared artifacts is also a property to be supported.
- Since context information can be aggregated from many sources, it is a challenge to build a highly distributed context management environment in the paradigm of the Future Internet, where all relevant sources are taken into account.
- Building scalable collaborative working environments includes a multitude of architectural approaches that should be taken in account e.g. P2P, Cloud computing etc.
- Collaborative services need to be instantiated on a multitude of devices ranging from desktops to mobile devices such as lightweight SmartPhones and PDAs. This challenges development of proper user interface accommodated to the new device and equipped with required applicable security and privacy mechanisms.

II. Research Problems

According to directives addressed in the Vision CWE2020 in the process of design and development of Next generation collaboration environments is faced with several research problems, which have not been yet adequately elaborated [24]. For that reason we plan in the framework of the development of collaboration platform to focus on few of them as follows:

- Lack of interoperability of higher level services in existing collaborating platform with focus on systems for e-learning. Here main problems are related to enabling access, quality control and filtering of the open content from many sources integrated in the collaborative service and the related functionalities that depend from the platform and the system used
- Lack of functionality for searching regarding the user skills and competency needs, which becomes crucial for obtaining the most appropriate content. The research here is oriented into development of effective skill-based federated tools that allows search, access, re-use and recommendation of content (User-generated and user-improved content) to meet target competencies.
- Lack of usable security and privacy services and mechanisms in the services enabling collaborative environments. A number of issues in that area have not been completely solved yet; including for example protection of users' sensitive personal data in social communities, seamless access to resources in heterogeneous collaborative environment, access control to certain types of content in P2P based content delivery systems, and usable authentication mechanisms for mobile users of collaborative platforms.
- Lack of effective content distribution. In the context of collaboration among the individuals/communities that generate large amounts of multimedia content (e.g. video conferencing records, video/audio/text based documents) the problem of effective distribution of content to end users still has no proper and adequate solution.

III. State-Of-The-Art

A. Integration (integrative platform)

Web services have bestowed newfound importance on Service-Oriented Architectures (SOA) by providing a standard-based approach to interoperability between applications. SOA provides a set of principles, patterns and practices to provide and consume services which are orchestrated to realize an agile infrastructure, being able to support a pluggable service infrastructure where providers, consumers, and middleware services can collaborate in the famous 'Publish -- Find -- Bind' triangle [5]. The requirements to provide an appropriately capable and manageable integration infrastructure for new Future Internet designed services are coalescing into the concept known as the Enterprise Service Bus (ESB). There are two key ideas behind this approach [6, 15]: loosely couple the systems taking part in the integration and break up the integration logic into distinct easily manageable pieces. The Enterprise Service Bus is an open standard based message backbone designed to enable the implementation, deployment, and management of these solutions based on SOA (Service Oriented Architecture). An ESB is a set of infrastructure capabilities implemented by middleware technology that enable an SOA and alleviate disparity problems between applications running on heterogeneous platforms and using diverse data formats. It supports service, message, and event-based interactions with appropriate service levels and manageability [23].

Major research challenges recognized as being beyond State of the Art are related to: Dynamic connectivity capabilities, Topic and content-based routing capabilities, Enhanced service discovery, End-to-end security solutions, etc.

B. Content delivery and distribution

One of the most successful multimedia content distribution methods in the last decade are based on P2P technologies. The technologies have been developed through number or generations, enriching their features and pushing scalability, robustness and dependability to the limits. P2P technologies present a natural content distribution technology that could effectively support future Internet collaborative working environments.

The prevalent P2P technology today is based on BitTorrent protocol [29]. The reason for this is its orientation towards effective and scalable data transfer of a single data unit (file) or collection of units. Additional features were added for effective distribution in the past, like DHT, PEX and the

others. Users can utilize the protocol with one of numerous BitTorrent clients. Current development trends in advanced BitTorrent clients like µTorrent, Azureus, Miro and Tribler, are oriented towards extending basic client functionality. Content search, rating and presentation are main features being developed. The integration of the P2P transport and presentation within a browser [4] (support for Wikipedia multimedia content distribution) and rich metadata and limited interactivity enable contribute to unified content distribution. While efficient content distribution is of crucial importance it is even more obvious that the user friendly and tailored consumption of the content should not be neglected. Content delivery networks based on this technical paradigm will be used in the integrated collaborative platform which implementation is described in the Work Program of this proposal.

C. Skill-based content search

Abundance of digital content puts a user in front of the problem of making the "right" choices from an expansive list when searching for content either for information, entertainment or e-learning and training. Finding the relevant resources remains an issue, because searching for example of learning content is based on keywords and metadata that often reflect a technical cataloguing perspective, rather than the needs of the users. Personalized skill and competence-based search promises to improve this situation. There are several reasons why skill and competence-based content search is almost inexistent today: skill and competence related data structures (e.g. IEEE Reusable Competency Definitions standard or HR-XML) do not support semantic relations; ontologies for skills and competences are missing, as well as extensions in learning opportunities standards (e.g. in CEN Metadata for Learning Opportunities specification [16]) for associating structured skills and competencies to learning opportunities; and quality of content metadata is low.

When developing a technical infrastructure that enables skill and competence-based services, such as federated search, we will base our work on the recently finished ICOPER [10] and OpenScout [21] projects from the EU eContentplus programme.

D. Security and usability-based service

- Graphical passwords-based authentication.

  Research and practice in the past years have shown that security problems that arise because of low level acceptance of the end user can be solved only by considering the usability perspective of the user. In an attempt to create more memorable authentication mechanisms, several approaches based on graphical and image password have been devised where the authentication is based on image clicking as opposed to typing character based passwords. In general, two types of mechanisms exist for graphical authentication: recognition-based and recall-based. In recognition-based ones, a user is authenticated by challenging him/her to identify one or more images he or she chooses during the registration stage. Examples of such system are Passfaces, developed by the Real User Corporation [26], and the PassPoint system [28]. In recall-based techniques, a user is asked to reproduce something that he or she created or selected earlier during the registration stage. Examples of recall-based systems can be found in [14].

- Content access control

  As the collaborative platform of the Next generation is based mainly on the infrastructure that uses P2P way of communication the problem of content protection of the content offered via the collaborative platform requires some basic solution [22]. The importance of security and the main security requirements for the emerging infrastructures in the Future Internet content delivery networks has already been emphasized, for example in [8]. According to access control on the content being shared can be achieved either directly or indirectly by: a) directly protecting the content; b) restricting the access in the network where the content is being delivered; or c) restricting the access to the peer that possesses the content. Zhang et al propose a mechanism that can be considered as digital rights management (DRM) mechanism for BitTorrent [29]. Another mechanism for access control on data that utilizes encryption is described in [11]. In this scheme, all peers that are involved in the content delivery process receive content encrypted with a same key for all peers. One form of providing access control on the P2P network itself is by using private tracker, as specified in a BitTorrent protocol's extension. An access control mechanism on each peer enables the peers to recognize the authorized peers and to avoid communication with the non-authorized ones. Such mechanism for a BitTorrent P2P network, called Closed Swarms protocol, is presented by Borch et al. [4].

IV. Development of the Collaboration Platform

A. Design through use cases

The collaboration platform has been designed based on use cases typical for business and educational environments. A number of use cases has been thoroughly studied like a meeting, lecture, consultations, seminar, discussion room, lectures recording, tutoring, etc. The most general the meeting use case is further described below.

Mrs. Ann leads a project working group. The group is responsible for few forthcoming project tasks. To synchronize and ensure smooth continuation of the work she decides to organize a meeting. She studies the tasks, prepares agenda proposal, carefully pick the meeting participants and collects all relevant information and documents related to the tasks. She selects the meeting place and the time of the meeting. From her experience the meetings are most effective when their duration is limited. If someone couldn't join the meeting the materials collected and the meeting recordings will be available. The agenda and materials prepared have been made available to the participant for review and possible comments or additions.

During the meeting some additional documents have been

discussed clarifying the participants' views on the tasks. One of the tasks had considerable uncertainties related to its plan execution. Additional expert has been invited to the meeting to clarify possible outcomes and related risks. Due to limited meeting duration needed actions and their expected outcomes has been quickly agreed and decided.

After the meeting Mrs. Ann has collected all additional documents and recordings, prepared minutes and made them available to the group. She tagged and provided notes to the materials so the work and knowledge generated through their collaboration will be easier to follow, find and reuse.

Through the use case analysis a number of functional and other requirements were collected. Every use case has brought in new aspects, functional and non-functional, additional actors or stakeholders to make the requirements broader but more precise as well [16].

Basic requirements led to a number of collaboration platform building blocks fulfilling the requirements excerpted from the use cases. Example of such building blocks are synchronous multimedia communication, shared white-board and screen, chat, bulletin boards and forums, meeting minutes capture, event recordings, voting and other govern tools, collaborative on-line space with dedicated storage, calendar, publishing and word processing capabilities, aim oriented annotation and search and scalable content distribution system. But there is a number of nonfunctional requirements as well, related to security, privacy, usability, scalability and performance. In particular security has been recognized as crucial for business oriented collaboration platform usage. Various security services needs to be provided from authentication, confidentiality to access control. In addition individual stakeholders have specific requirements related to the building blocks implementation, licensing, deployment capabilities and management which need to be taken into account.

B. Conceptual plan and implementation

There are number of different platforms, systems and services that implement a part, whole or a number of the building blocks discussed in Section II. They are often unconnected and do not present the expected functionality of the target collaborative platform as a whole. Nonfunctional and other specific requirements are often not taken into account.

A conceptual collaborative platform plan that takes into the account mentioned requirements is presented in Figure 1. In the center of the system is a user that uses a number of available and (in the project) designed and implemented systems to achieve his collaboration goals.

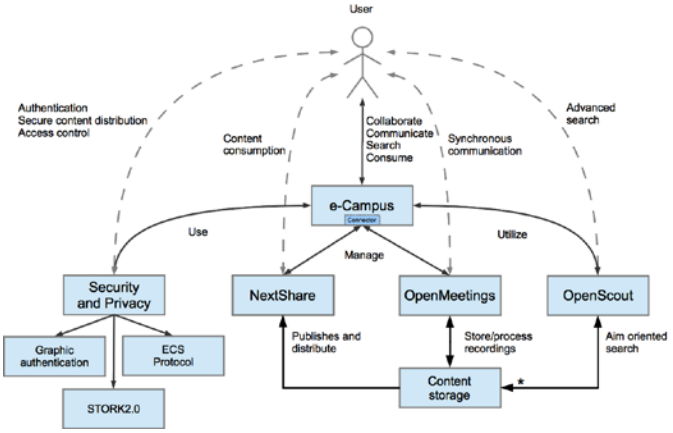

Figure 1. Figure 1.Collaboration platform conceptual plan

The system focal point is eCampus [7], a learning management system (LMS) acting as a single user interface for collaboration. Mrs. Ann can easily create a 'place' for the meeting, add meeting materials, prepare the agenda, select system internal and external users for participation and schedule the meeting according through system calendar facilities. An example screen-shot of such functionality is shown in Figure 2, denoted with (1).

As main synchronous communication facility the OpenMeetings system [20] is used providing a needed base for multimedia communication, shared white-board, chat and screen recordings. The system interface was simplified as possible to improve its usability, keeping only essential elements [27]. A screen-shot showing Ann in communication, presenting the slides, essential event control and ability to invite new participants is shown in Figure 2, denoted with (2).

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Aim oriented search is important concept for more efficient discovery of materials relevant for particular use case implementation. The search is utilized through OpenScout framework [21]. The framework enables competence and skill based tagging of learning materials and search according the tags. The project Mrs. Ann is working on related to development of a skill based curriculum in the field of economics. The tags as being developed in the project are used

as well to tag the project material as is shown in Figure 2, denoted with (3) - search for material and (4) - material sources including with material/recordings tagging.

The preliminary research and review of best practices related to the competencies and skills, we have created scenarios, which are used as a basis for the development and implementation of services that enable efficient search and the e-content enrichment based on sought-after competencies and skills. We also use semantic technologies to improve searching and personalized e-content delivering. The data on the skills and competencies of employees is necessary to make these processes effective and efficient. Acquiring this data and business analysis are services which have to be implemented in the platform to improve knowledge management. Employees that use PC computers, tablets, hybrids or smartphones participate in the collaboration processes. The platform should be designed to use in a different display sizes in a user-friendly way to enhance collaboration and increase data collection. We have been developing new opportunities for more efficient and user-adapted e-learning in eCampus. The research started in the context of international research and applied project OntoWiki from FP7 programme [13]. With the use of semantic technologies, an intelligent search of the entire knowledge base has been implemented. Sometimes the employee does not know exactly what he/she was looking for. A collaborative platform allows the formation and functioning of interest groups where experts or those interested in that specific topic or employees from the same occupational field can share their knowledge, experience and ideas[25]. However, we have a lot of data and huge resources including those that are not reliable. In addition, sources of knowledge may be inadequate to our prior knowledge, needs or abilities. Consequently the searching of suitable information or knowledge is time consuming. Presently, online content where the meaning is defined with meta tags, assigned by the authors, is available. However semantic technologies are providing standards and models to enable better results in searching for information. Typical web ontology contains definitions of classes, objects and links between them, as well as inferential rules. Ontology over the semantic web offers the foundation for the enhancement of information with meaning and delivers it in a format that is understood by computer programs. Ontologies can be used to create learning groups according to the competences that students have. Learner-centric concept is one of the basic paradigms of e-learning. We want to offer the contents that entirely fit employees' knowledge, abilities and needs to develop their personal skills [9]. Semantic technologies could be the key to tackling this problem. Semantic technologies also offer the possibility of collecting and storing data about students, e.g. analysis of their current and past behavior, progress and acquired skills etc. which could provide personalized content to anyone. Semantic technologies founded on knowledge base and built from metadata about learning e-content, e-courses and participants' activity will enable new features which are stated below. Search function in the current system works in a 'normal' way – meaning it searches the data base using the typed-in keywords. Semantic technologies enhanced search will be able to take into account the meaning of the search term and will consequently offer potential hits of a significantly higher quality. For example if the key 'analysis' is used in a search query then also the learning e-content 'Using Pivot Tables in Microsoft Excel' would be taken into account among search results, although the explicit word 'analysis' wouldn't be present inside learning pages. With the introduction of semantic technologies into the system we have implemented different analysis, especially in the field of participants' learning practices in e-learning.

To enable scalable and low cost content distribution the platform utilizes NextShare, a P2P content distribution developed in the EU FP7 P2P-Next project [22]. In this way Ann can ingest collected materials and recordings into the distribution system; its users are noted about the material based on information published through an Atom feed including with data needed for P2P distribution. The content is consumed through browser plugin [2] developed in the project.

As already noted in Section II security has been considered as very important aspects. In the platform we had incorporated three distinct security mechanisms: graphical authentication suitable for smart mobile devices [17], pan-european, cross border authentication framework STORK 2.0 (www.eid-stork2.eu) and an access control protocol for P2P networks - Enhanced Closed Swarm (ECS) protocol [12]. Ann can use NextShare content distribution mechanisms to support bulk delivery of public content to large audiences like students. But through ECS protocol usage she can specify and enforce who can access private group materials. Two authentication mechanisms enable authenticated access to the meetings, pan-european, STORK based access is presented in Figure 2, denoted with (5).

On the end a connector, presented in Figure 1 with blue box within eCampus LMS system, act as a bridge between most of the presented building blocks (except security mechanisms). The connector exports RESTful interfaces to eCampus system, enabling subsystems functionality utilization and management in unified, programmable way. The interface API is briefly presented in Figure 2, denoted with (6).

The design of the connector and subsystems provides enough flexibility to be deployed even independently of the eCampus base. In one way the interfaces developed can be reused by another LMS system (e.g. LMS Moodle) or a part of the subsystems be seamlessly replaced without interfering with the base system OpenMeetings with BigBlueButton [3]. The system can be easily deployed into cloud environment to gain all the environment advantages.

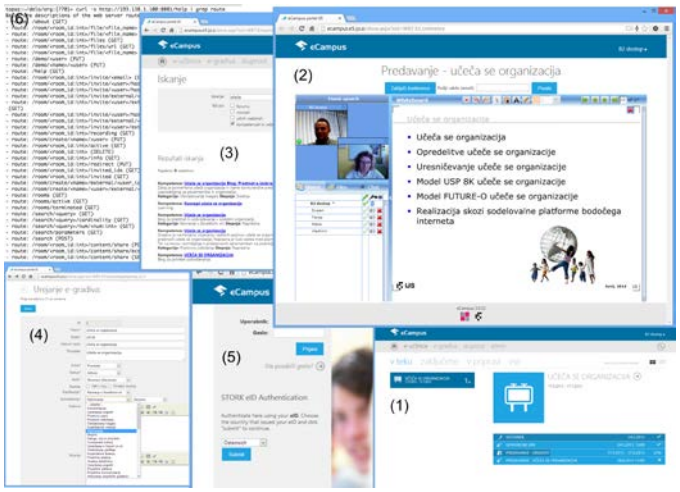

Figure 2. Implementation view

V. Conclusion

The development of the platform is addressing several important and challenging research problems that are part of the Future Internet Networks and Enterprise Systems scientific agenda. The main contribution of the presented next generation platform will especially be in the development of new product based on the achievements that are beyond the state of the art as defined in the scientific agenda of future internet collaborative environments, content distribution systems, privacy and new security solutions in advanced systems and networks. The impact will be in the development and adoption of new challenging technologies and services in business collaborative environments. The major importance is certainly in the investigation of a number of technological problems and the associated policy domains that have bearing on the network and service infrastructure elements of the Internet of tomorrow. The research will have impact in the area of the engineering and scientific field known as Future Internet Technologies, Digital Agenda but in same time the impact will be noticeable in the business environment as new competitive services to be put on the market will be enabled.

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