Sharing through Collaborative Spaces: Enhancing Collaborative Networks Interoperability

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Abstract. Within collaborative networks, information sharing and knowledge creation are the main drives for value creation, wherever collaborative spaces (CS) has been used as the means to enable collaboration among the different social actors involved. Despite of technological availability, CS still a challenge in practice, mainly due to the lack of methods to support its development and to its tight coupling with the collaboration model adopted by the network. Thus, the main focus of this paper in on enhancing information sharing through the design of what we call agnostic collaborative spaces (ACS), supported by linked data approaches. Beyond this new perspective over CS, it is discussed a technological solution through which ACS are implemented.

Keywords: Collaborative spaces, semantic interoperability, Linked-data, Information sharing.

1 Introduction

Although the concept of collaborative networks (CN) are well defined [1], effective collaboration across organizations still a challenge, not so much technologically, but on how to manage information and share specific domain knowledge, between different social actors within dynamic and heterogeneous environments. Commonly, CN are driven by distributed activities requiring high levels of social interaction, wherein the processes of information management and knowledge sharing are of particular importance. The interest for knowledge management emerged, on one hand, driven by the need to be aware of all organization's stakeholders and their needs, and, on the other hand, to increase creativity and innovation by interrelating information towards the development of new techniques and technologies [2]. Nowadays, these demands (creativity and innovation) have gained a new dimension, and traditional approaches to information management, which merely collects and transmits items of static and un-contextual data, are no longer efficient. Beyond interlinking companies it is necessary to interlink data and people, mapping it all together. That is the way to effectively reach new levels of collaboration, fostering collaborative learning, innovation and creativity. This paradigm shift changes the view over the CN, whereas

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a network of organizations, to a wider view comprising a major network combining data, people and concepts. Collaborative spaces (CS) appear as the technological implementation of the different CN models, assuming different formats according to the model of collaboration and formality level. We share the view that the operationalization of CN in practice might be supported by the concept of CS, however without a commitment to a particular formalism, technology or collaboration model and capable to support network actors to share and retrieve information within and beyond CN boundaries. Hereupon, the main focus of this paper is on enhancing information sharing through the design of what we call agnostic collaborative spaces (ACS) supported by linked data approaches. ACS are virtual spaces in which all participants in dispersed locations are able to interact as if they were in the same local organization, but ensuring an independence of the collaboration model adopted by the CN. Furthermore, ACS intend to provide an environment giving support for participants to gather, search, retrieve and share information, assisted by semantic artifacts (ontologies), either individually or in group, and without the need to commit the participants to a specific workflow and without any social and cultural barriers. Our view is that linked data might play a crucial role to implement such an environment.

2 Background Knowledge

2.1 Collaborative Networks and Collaborative Spaces

The concept of CN encloses several formats, including: Virtual Enterprise (VE), Virtual Organization (VO), Dynamic Virtual Organization, Extended Enterprise and VO Breeding Environment (VBE). Each of these categories is very well defined in literature [3]. Some authors argue that CS might be used as mediators for information sharing in CN, supporting its basic operations [4]. Additionally, we consider that CS should encourage creative and critical thinking by means of clear and intuitive communication and information retrieval mechanisms, implemented as a service. The literature discusses around how different types of CS (e.g. community of practice [4], social networks [5] [6], community of interest [7], professional networks, etc.) support collaboration between organizations, or about what are the effects of inter organizational collaboration for the organizations [8]. From here, knowledge creation is evidenced as a key benefit. As mentioned earlier, technological solutions do exist to implement such collaborative environment. Yet, it is easier to talk about collaboration and CS than implementing it in practice. Despite of some authors argue about the lack of methodological support to develop such environments [9], some efforts have been developed to setup virtual spaces for individual and groups to discuss around domain knowledge within a CN, by means of dedicated methods and tools [10]. An additional challenge relates to the fact that a CN does not remain forever in time; it follows a life cycle, which might comprise five different states, from its creation to its dissolution [11]. In fact, it is possible for an organization to establish several partnerships (during its existence) through the formation of new CNs. This would imply a considerable

effort for an organization since in each case, there may be the need to (re)adapt itself to: i) new collaboration and network model; ii) new information sharing workflows, supported by different CS and tools. This could be an unaffordable situation for many organizations. By analogy, if CS are the vehicle of collaboration, in order to ensure information transfer within and between organizations, it shouldn't be necessary to acquire a new drivers license, every time we change from vehicle. This research work provides a new perspective over CS as the means to share information in CN, performing a semantic shift by providing contextualized information retrieval mechanisms implemented as a service. By setting up ACS, domain experts are enable to search and share information, guided by specific domain ontologies, accessible through ACS. Additionally, it is intended that such a configuration could allow domain experts to choose the tool that will accommodate their own collaboration space. That means one individual could use a particular social network and another one a Wiki, but both contributing to the same CN.

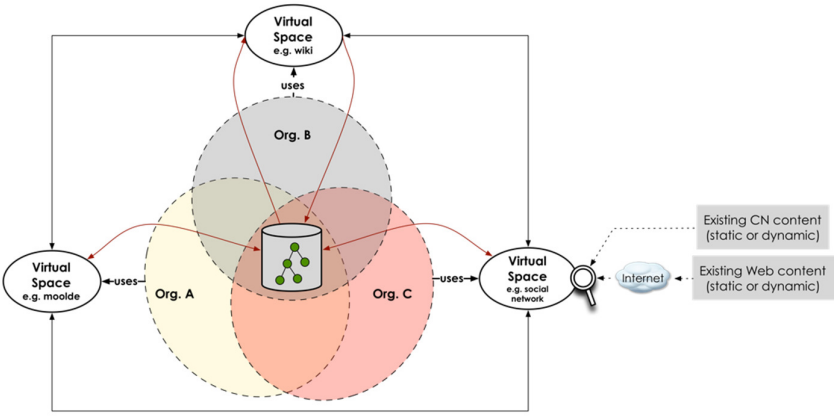

Fig. 1. ACS conceptual view

One of the main claims stated in this paper focuses on the need to interlink people, data and concepts, enriching CS in order to empower knowledge creation capabilities. This calls for semantic-based approaches for exchanging and retrieving large and heterogeneous amounts of information. In this context, semantic interoperability [12] plays an important role by providing technological frameworks capable of improving the intercommunication through Internet, addressing how to deal with a considerable variety of information sources, which implies producing information characterized to be sharable and reusable. Great part of these goals is feasible, thanks to the web semantic stack[1], allowing information to be accessible using a common architecture. By means of semantic web, information acquires a new dimension, being possible to relate information in a standard way. However, and according to W3C[1], for individuals, organizations and communities to benefit from this simplified way of

[1] http://www.w3.org/

sharing and reuse of information, it is necessary to keep large amounts of data available, accessible and manageable, which means that beyond describing resources and their relations (e.g. using RDF[2]), it is necessary that those resources could be made available in a shareable form - to this is called linked data. By following linked data principles [13], when setting up CS information is easily accessible from the CN. Furthermore, the effort employed to gather, treat and distribute data for avail of the network is much less, once it is provided access to contextualized information, this is, information semantically described, referenced properly and uniformly accessible.

3 Technical Architecture Proposal: Semantic Search Service

Advancing towards the definition of scientific artifacts that could address the problem posed by this article, an architecture was designed and used to support an experiment, further discussed in this document. This solution engineering was built considering the following assumptions: a) the CN is formed and its objectives defined, shared and understood by all participants; b) there is a data structured platform that works as the CN's knowledge base; and c) there is an ontology that defines the common domain vocabulary of the CN. These assumptions correspond to a part of the results obtained during the H-Know[4] Project. Current approach is based on those achievements, extending the resulting artifacts to cope with our view of ACS. Hereupon and in order to decouple the CS from the CN's format or platform, the design of the architecture followed a service-based approach developed upon virtuoso universal server[3] (the multi-model data server), which implements a high variety of linked data services.

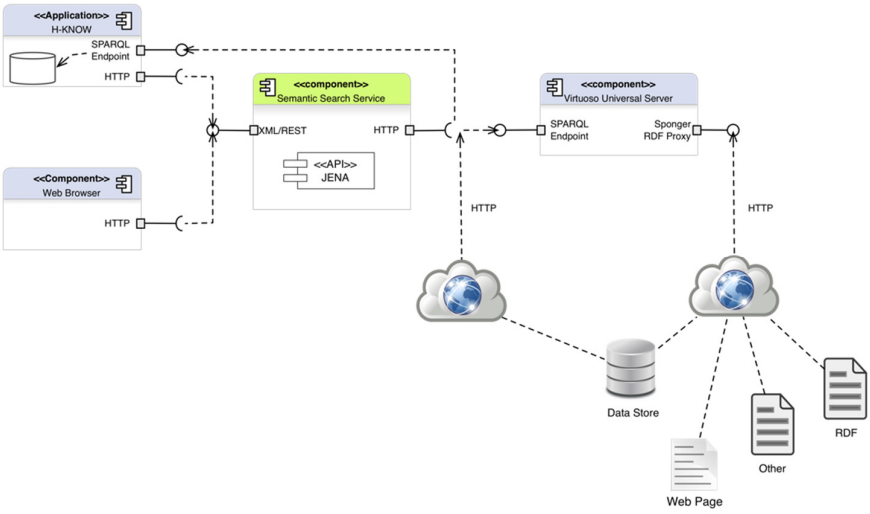

Fig. 2. Semantic search service architecture

[2] http://www.w3.org/RDF/ (RDF is a standard model for data interchange on the Web).
[3] http://virtuoso.openlinksw.com/

From the architecture depicted above (see figure. 2), the semantic search service component stands out, as the main instrument to promote a contextualized search by means of a concept-based approach (using domain ontologies), retrieving a more "ready-to-(re)use" information. Nevertheless, the architecture also allows ordinary searches, either internally or externally to the CN. The semantic search service accepts a couple of interaction scenarios, namely: a) using a web interface via a regular browser; or b) through the CN's platform (e.g. H-KNOW[4]) or other organizational application integrated to semantic search service using XML/REST[5] API. With these two options, participating in a CN, won't be such a burden for small enterprises, since the technological integration efforts and the commitment to specific platforms are much less. The semantic search service interacts with virtuoso server by means of SPARQL endpoints running over HTTP, through which it is possible to query and retrieve information from any source (recognized on the server) on the Internet (either a data store or a document), beyond all internally accessible data. Additionally, it is possible to use virtuoso local triple store, both to keep relevant metadata (obtained with the searches) that could be relevant for the CN, and to increase the search performance.

4 Solution Validation

4.1 Practical Experiment and Main Observations

This experiment was conducted based on the European project H-KNOW (Advanced Infrastructure for Knowledge Based Services for Buildings Restoring). H-KNOW was a project funded by the European commission (NMP-2007-214567) from 2009 to 2011, with 15 partners from 5 countries. H-KNOW project aimed at developing a system to provide the ability to share, to create and to reuse information and knowledge in an interactive fashion within a CN. To meet the needs of SMEs to network innovative knowledge-based, an electronic platform was built according to a perspective of collaboration enabled by a social network approach. The technological description of H-KNOW platform may be found in [14]. The semantic description of platform socio-collaborative activities and their connection with domain knowledge and the formalization of the platform domain knowledge may be consulted in [15].

The validation of the solution followed an experimental approach aiming at studying the research result artifact (the designed solution) in a controlled environment [16]. The objective was to assess the relevance of the description around our vision about collaborative spaces (the ACS) and to understand the facts behind the approach. For this experiment, the solution was executed with the existing data in the H-Know platform and conducted in order to illustrate and legitimize a possible scenario for the CS usage during the network operation. The described scenario was set up to be able to run into two different configurations (see figure 3). The experiment took into consideration (in a first iteration) two or more entities (organizations) that enroll themselves within a virtual environment wherein each

[4] `http://h-know.eu`

[5] Representational state transfer.
See: `http://docs.oracle.com/javaee/6/tutorial/doc/gijqy.html`

organization has a H-Know platform in-house (see figure 4). Thus, each organization may organize their information according to a common classification model, once the existing domain ontology was "shipped" within the platform. Additionally, users may use other semantic vocabularies, such as FOAF[6] and SIOC[7], to identify specific organizational structures and people. This configuration scenario of the first iteration, intended to demonstrate how the *semantic search service* allows interlinking several CS from several instances of a particular structured data platform, such as H-Know, since *semantic service* is accessible as a RESTful service via HTTP. With this configuration it is possible to ensure the interoperability between different platforms and, simultaneously, each organization guarantee the responsible for the degree of privacy of their own contents. The contents annotated as being "public" are transferred to a triple store, while the remaining contents are kept in private databases. Despite of providing an interesting level of semantic interoperability and decrease the coupling level of the CS involved, current configuration might not be interesting in all situations, special for smallest enterprises that could not afford for such a technological environment. However, their participation may be considered as a valuable asset due to their expertise in some aspect of the domain. In a second iteration, it was addressed two additional aspects to the scenario configuration (see figure 4): i) it was introduced a new component used by *semantic search service*, the Virtuoso Sponger. This component is used to manage a caching mechanism to enhance information retrieval from several data sources (not only from triple stores, but from any resource described in RDF or in other semantic formats); and ii) smallest enterprises are able to interact directly to *semantic search service* to gather domain relevant information, without the need to commit to any existing CN platform, just by using a web browser. The usage of this scenario configuration in a real business context can be an added value, as it allows interaction with a larger number of data sources. However, the administrator need to have a greater control over the data sources that are defined in Virtuoso Sponger[8], in order to not unreasonably extend the search domain. As expected for this second iteration, the number of obtained results from the *semantic search service* increases as more data sources are to be considered. Nevertheless, the navigation and retrieval of information from large amounts of data, might be mitigated by means of a concept-based search using the domain ontology. Although the increasing volume of data, its is possible to navigate in a accurate way across the obtained search results, streamlining the information retrieval tasks, which sustain the information sharing activity. Note that, in this particular scenario, the *semantic search service* deals with a more heterogeneous configuration. It is in the context of this scenario that the versatility of the work presented in this paper emerges, for the benefit of the CN operation. In this case, at any time, and in order to ensure the network operability, it is possible to include others organizations with particular interest to the network, notwithstanding of the adopted solution for information management. This can be easily accomplished, through minimum configuration.

[6] http://www.foaf-project.org/
[7] http://www.sioc-project.org/
[8] http://virtuoso.openlinksw.com/dataspace/doc/dav/wiki/Main/VirtSponger

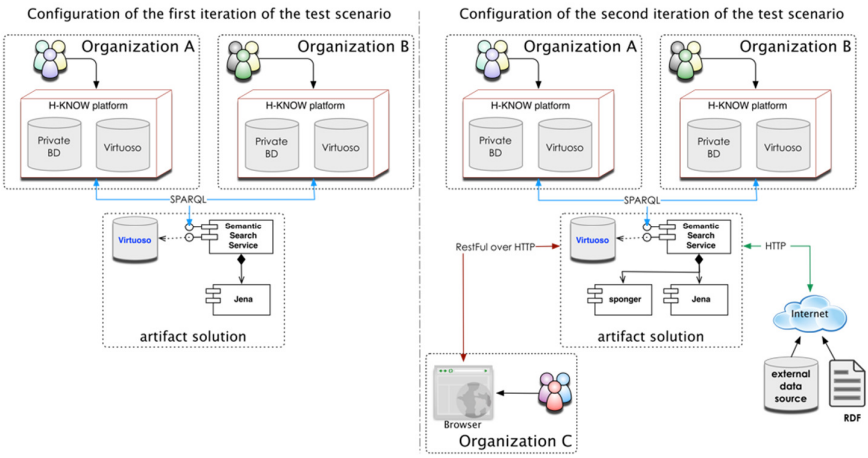

Fig. 3. Configurations for the test scenario

5 Conclusion and Future Perspectives

The discussed technological solution and the underlying vision over CS, showed to foster information sharing by focusing on content integration, through contextualized information retrieval mechanisms. The undertaken experiments allow observing that the implementation of ACS endows a CN of greater flexibility. The results, although obtained by means of controlled experiments with artificial data, prove to be significant and promising, which are motivating the authors to conduct larger studies around the subject, including other domains (using different classification models - ontologies). Nevertheless, it was evidenced that information sharing through CS assume a new dimension when supported by linked data principles, allowing broader searches, but sufficiently accurate, once they are supported by a domain ontology. Furthermore and benefiting from the fact that semantic search service are able to integrate several other semantic vocabularies (e.g. FOAF and SIOC), this technological solution also keeps a perspective of content integration between enterprise platforms. Hereafter, beyond the refinement of the designed solution, namely in what regards to the performance of the developed services (not considered by this experiment), is to be planned an extended exploratory research, aiming at evaluate, qualitatively, the use of different CS (e.g. social networks, wikis, etc.) by different organizations belonging to a virtual community, on performing their daily knowledge-based activities, such as information retrieval and information sharing. Through the execution of more case studies we intend to increase the number of organizations that recognize the need and advantages of content/information classification, showing that the classification improves the information and knowledge sharing and reuse, as well as the collaboration between several partners.

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