

Adding trust to ontology based peer-to-peer networks

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Abstract. This short paper starts with an overview of existing approaches of ontology based peer-to-peer solutions. It then focuses on trust issues within ontology based peer-to-peer networks and closes with requirements that are needed for a successful and trustful network and a possible approach to increase trust with the help of ontologies.

1 Introduction

The success of an enterprise highly depends on their ability to communicate and collaborate within all layers inside and outside. During the last time, peer-to-peer approaches became increasingly popular. It is a promising approach to build reliable and agile networks for exchanging information.

Finding trustful and high quality content within a peer-to-peer network is getting harder with a bigger amount of content. Acceptance and trust is needed for a network to succeed. Ontologies can help to increase trust within a distributed network by providing vocabularies and enabling services that are urgently needed to create a trustful network and to find trustworthy sources. The topic trust is often disregarded, although it is getting more and more important to find not only information but high-quality and trustful information, especially when using large peer-to-peer networks.

2 Ontology Based Peer-to-Peer Networks

Peer-to-peer networks are an agile basis for connecting enterprises and they are an excellent technological basis for virtual organizations as described in [5], since the dynamic structure of peer-to-peer networks reflects the dynamical processes of a virtual organization (structural allegory).

It is not enough to store and exchange files within a network but also to *find* the content that is needed. The simplest way of searching a peer-to-peer network is a keyword search, based on pattern matching. However: In other scenarios like exchanging educational or business related content, a much more complex level of retrieval functionality is needed as mentioned by Terziyan and Zaharko [11]. This includes an adoption of semantic for finding information that is needed. This adoption is not done when using pattern matching. Adding ontologies to peer-to-peer networks offers a

comfortable and highly flexible solution for retrieving information. “While in the server/client-based environment of the World Wide Web metadata are useful and important, for Peer-to-Peer (P2P) environments metadata are absolutely crucial.” [11]

By using ontologies, it is possible to find a document by its semantic description and it is also possible to find documents that are similar or related to the actual document. All documents stored in the network can have a semantic neighbourhood which classifies the documents sphere. Those ontologies are mostly described using the Resource Description Framework (RDF) that offers a highly flexible and scalable solution for describing ontologies (compare with [9]). There are several approaches for integrating ontologies to peer-to-peer networks.

*Edutella*¹ [8] is a project that builds on Sun's peer-to-peer solution JXTA². *Edutella* provides ontology based services to enhance the JXTA functionalities. These services include a query service for a standardized query and retrieval and an annotation service for annotating materials stored anywhere inside the network.

*SWAP*³ is another semantics-based peer-to-peer system [2]. *SWAP* uses ontologies for knowledge representation. It uses peer-to-peer concepts to exchange the data and each peer may share knowledge from different data like databases or file systems.

3 Trust Issues

Trust is a key to success when depending on sharing and exchanging information like a virtual organization does. Because of this, the trust management is an important part of peer-to-peer architectures as discussed in [1]. This especially applies to ontology based peer-to-peer solutions, since the data might be handled automatically between different software systems by using interoperability-concepts.

A powerful approach is using ontologies to increase trust. The approach is to use ontologies to describe business partners and all contained information. There are several existing approaches for ontologies that support trust. It is possible to use ontology concepts by using a trust vocabulary to enrich the information stored in peer-to-peer networks. An approach developed by [4] aims in connecting resources and partners on the network by describing their trust-relationship: The vocabulary provided by this approach allows adding properties that offer a trust-relation between several resources. Another possibility is to include mechanisms for storing “fingerprints” to the desired ontology. Using ontologies like this can lead to a network of enterprises that trust each other.

¹ <http://edutella.jxta.org>

² <http://www.jxta.org>

³ <http://swap.semanticweb.org>

The described approaches can only be used to find persons that trust each other and already know each other directly or indirectly. This is very unsatisfying, since it is most likely, that many users do not know each other before exchanging content.

To add trust to ontology based networks, several functional requirements have to be fulfilled. There are basically two different possibilities to determine the credibility of a source. The first is trust which is based on individual *properties*. This approach can be realized using logic and reasoning to analyze the resources. The second is trust which is based on *explicit trust statements* like a trusting a certificate or a special source explicitly. Both possibilities have to be provided by successful and trustful networks and can be supported by using ontologies.

4 Approach

To support all requirements, the authors develop an ontology for trust which will be embedded in the European funded project SEEMseed. This ontology will be able to support the improvement of trust within ontology based peer-to-peer networks. The ontology contains properties to mark explicit sources that are trustful, so that the “trust based on explicit trust statements” is supported. Those properties can have different degrees so that it is possible to trust a single resource or person by using a certain trust level. This trust level can be seen as a scale for trust. For example a person has trust level 4 (while 10 is the maximum). Furthermore, it is possible to add a sub-property for trusting a resource only for a certain matter and distrust the source for another area. These properties can create a network of enterprises that trust each other, similar to [4]. With these levels, it would for example be possible to execute a simple trust related search by finding only those resources that are at least trusted by 8 other resources with at least trust-level 4.

Moreover, the ontology includes a large number of attributes for realizing the “trust based on individual properties”. It contains trust properties that reference to trusted third parties for proving the integrity or that reference for a responsible parties that can confirm the integrity of the information that was found. A property containing the date of the last change and a checksum for the data can provide even more trust by making sure that the resource was not changed without knowledge. A fingerprint of the creator enhances this and helps identifying the creator without losing privacy aspects.

Peer-to-peer systems are distributed and therefore not controlled by a single instance to preserve their agile structure and for offering a flexible way whenever changes occur. This means, that it is important to add a link that contains possible references to third parties that are using this resource. This can be an indication for the distribution because a concept that is used by many other persons is usually more trusted than an unknown and new concept. Furthermore, there are attributes to indicate, that a resource was already reviewed by containing a list of reviewers.

Privacy items are considered by including the visibility of the resource (public, private, or a reference to a special group), the expiration and other properties, adapted from the Platform for Privacy Preferences of the W3C. A value for rating and a text for annotations can be recorded or (if the resource itself is an annotation) a link to the main-

resource and be set. However: It is also possible to reference external services that contain rating- or annotation-data. Another property allows the storage of a certificate and a link to the organization of this certificate and also a reference to an existing reputation service can be added.

The complete ontology will offer an extension for ontology based peer-to-peer networks that can be used by software to find trustful content. This helps, selecting information of much higher quality and security. If services are offered over the network, the ontology can help existing software solutions to find trustful services to interoperate with.

4 Summary

Exchanging information is an emergent requirement today. Peer-to-peer networks allow a great flexibility and scalability within this process but they lag in finding the desired information. Combining peer-to-peer technology with ontology-concepts can adjust this problem by providing help with the information retrieval process. This paper emphasizes the importance of trust in such a system. Adding trust to ontology based peer-to-peer systems is required to be accepted by users. It is most important to support a numerous security related techniques to increase trust on all layers within a system. Ontology vocabularies can be used to add trust-properties to content which is referenced within the network. They can help finding trustful sources and providing additional information about the quality and the trust-level of information.

5 References

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