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Smart organisations are one example for business networking which ranks amongst the most important capabilities businesses will need in the information age. However, there is a serious lack of knowledge on how to set up smart organisations. This situation was the starting point for the Infranet¹ project. This best-practice pilot shows us typical problems for SMEs to build up smart organisations. Thus, it intends to disseminate the lessons learned and to set up new research questions concerning virtual organizations. Based on the experiences within our best-practice pilot we propose a new framework of ontology-based smart organizations in this paper. Specific focus is set on the application of Semantic Web technologies to enable or improve the partner fitting and matching process.

1. THE APPLICATION SCENARIO

Infranet is a Best-Practice-Pilot performed by a group of SMEs from five European countries, the Infranet-Partners, which are combining their individual marketing, technical and support resources under a single brand, to grow the market for their products and services in Europe by exploiting new project opportunities, especially in market sectors where their technologies not widely used today. These SMEs are typical for the European marketplace of tomorrow, they provide highly specialised services and products and can only survive, if they succeed to cooperate in an efficient and effective way. The improvement of the business practices of INFRA-NET partners will be done by introduction of the information-management-system GenesisWorld², which assists the demands of internetworked organisations, serves the above mentioned requirements and allows co-operation, inter-operation and on-line employee consultation between the business partners.

Based on the experiences within our best-practice pilot we propose a new framework of ontology-based smart organizations in this paper. We will set a specific focus is set on the application of Semantic Web technologies to enable or improve the partner fitting and matching process. The organization of this paper is

¹ see <http://www.infranet-web.org>

² see <http://www.cas.de/Produkte/>

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: [10.1007/978-0-387-35585-6_68](https://doi.org/10.1007/978-0-387-35585-6_68)

as following: In the rest of the introducing section we will shortly motivate the essential requirement for smart organizations and discuss potential IT-solutions. In our concrete projects we have identified the problem of trust and partner fit as essential for setting up successful smart organizations. Section 2 discusses this aspects and gives concrete examples. We propose an ontology-based approach using Semantic Web technologies to approach the partner fitting and matching problem. Section 3 introduces the generic notion on ontologies and the vision of the Semantic Web and show how we support the partner fit and search problem. Section 4 concludes this paper with a short summarization and outlines future work.

1.2 Benefits for the Customers

The successful co-operation between the partners creates some significant benefits for their customers:

- *Attractive prices:* Their low-cost structure, without big corporate overheads, helps keep their prices low. Because they design and produce so many of the products they sell, the partners are able to pass the savings on to the customers. For larger projects or OEM arrangements the partners are always willing to discuss individual commercial arrangements.
- *Reliability:* The partners have undertaken demanding projects for some of the world's leading companies. When you buy products or services from Infranet Partners, you can rely on their engineering experience to deliver a solution that works, and one that lasts!
- *Flexibility:* Because Infranet Partners consists of a series of independently owned and managed businesses, the partners can respond flexibly to the customers needs.
- *Prompt delivery:* The partners aim to have most of their products available from stock, or on short lead times. For projects, they will agree a schedule with the customer and provide regular feedback, so he can have confidence in the overall progress of the development.
- *International coverage:* With their network of partners in many European countries plus India, the partners are able to offer unbeatable international coverage. Their unique combination of extensive local knowledge and global reach makes them the ideal choice for the customers' next international project.

1.3 IT - Solution

The business practices of the participating user SMEs are typically improved by adopting an innovative IT-solution, which assists the demands of DNO. This means the introduction of a well-proven tool and appropriate methodologies for a DNO and virtual organisation, which allows co-operation, inter-operation and on-line employee consultation between the business partners. But nevertheless technology is not even more than an enabler, the catalyst is the relationship between the entities

within such dynamic networks and finally the employees, persons, people and their roles and skills.

The participating user SMEs are under intense pressure to get the best product in hands of their costumers, in the right quantity, at the right time, for the right price and very important in the required quality. To do this, they have to expand considerable time and resources on planning their supply strategy to respond to consumer demand. Yet traditional supply planning, once a sound and logical approach, is no longer enough. It takes too long and costs too much in terms of lost opportunity and marketing and sales efforts. Furthermore there is also the problem of the under-utilised production, distribution, and material resources. This goal can only be reached, if the participating user SMEs introduce an usable and innovative tool which serves the above mentioned requirements. This tool must enable distributed project-teams to work together across different and possibly mobile locations. Moreover it must support the sharing of management and technological information.

Virtual Organisations as well as Dynamic Networked Organisations (DNO) are also discussed under the term Smart Organisation in literature. Six characteristics of smart organizations can be identified which are similar to the Infranet partners network [2]:

- (1) a common business understanding between the partners based on trust in order to cooperate without written agreements,
- (2) combination of core competencies in order to leverage resources,
- (3) one corporate identity so that the customers can be served from “one face”,
- (4) prevailing renunciation of the implementation of additional central management functions with a view to prevent extra bureaucracy,
- (5) efficient information and communication technologies in order to reduce coordination costs,
- (6) a specific “mission” for a limited period of time.

Characteristics (3), (4), and especially (5) stand for the main differences between networks and virtual organisations. With the start of the project the business partners are better described with the characteristics of a network. With the end of the project the partners will be more like a smart organisation. Thus the emphasis of our work is on the field (4) and (5).

2. TRUST AND PARTNER FIT

The success of virtual organizations depend largely on building and maintaining trust between the network members. Trust has been identified as the most important component, which makes partnerships and networks of small firm successful. Within such networks the partners are loosely coupled and dynamically form up to offer solutions and products combining the core competencies of each entity. The network is based on more or less established relationships and as mentioned before on trust between the business partners. It is obvious that the trust in DNO is the key catalyst of performance. High efficiency can be only achieved within the DNO in trust atmosphere. DNO spread with distrust can be definitely predict to be unsuccessful. Thus, in some degree, the evaluation of trust in DNO can be

equivalent to the evaluation of DNO. And trust is even important in DNO. In normal organization people can see each other working every day and there are constraints of complain. Facing the DNO, one go on criticising others for a long period and say things they would not say in face-to-face communication. The integration of new partners in such a network is in practice a difficult and time consuming task which run contrary to the basic idea of flexibility and fast reactions for virtual organizations. To integrate and a new partner to a network platform several interfaces have to be adapted. Our experience is that partner fit is a crucial point for success of virtual organizations. Our investigation of virtual organizations determined several criteria in our opinion essential for partner fit and barriers for a easy and fast docking of partners to communication infrastructure. In this paper we propose a framework for partner integration in virtual organizations.

2.1 Infranet Partners Criteria

To be a member of the Infranet Partners, a company has to meet some certain criteria:

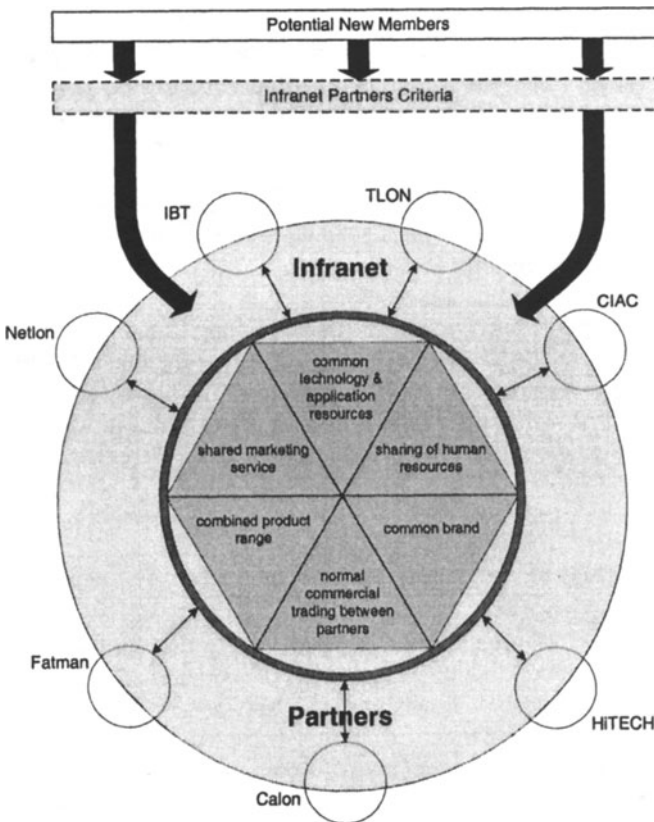


Figure 1 - Overview

- The partners decided to empower only one partner per country to participate.
- Each partner must bring to the group a specific competence in an area of Infranet technology, or a specific market sector.
- Furthermore, each partner must make a net contribution to the group. This means: each new partner has to bring something new (more sales opportunities, interesting products or technologies, a new market, maybe some cash ...). But he may also bring some products which directly compete against existing products of the group, he will need training, he needs time to learn the Infranet Partners way of doing business, the Infranet Partners have to change marketing materials (e. g. the map of members) etc. All these are costs. So the Infranet Partners say, (however you measure it) the new partner must make a net positive contribution to the group (what he brings – what he takes out = net positive).

The search of suitable partners and the integration of new enterprises in the network is an difficult and undefined process. The business partners have defined certainly several adequate criteria for partner selection. But finally these criteria are not sufficient for them. The situation is that they need methods and more formalised criteria to validate potential partners with regard to partner fit before they enter the network. This makes the partner network more flexible and efficient what means of higher quality and enhanced competitiveness. Within the project we have identified the following criteria. We distinguished between a strategic (individual long-term strategy, business objectives, core competencies) and operative fit (technology usage e.g. ICT, business behaviour e.g. contracts, trust and information exchange). Nevertheless, besides of discussion and disputes about virtual organisation technology and tools (e.g. groupware, workflow management systems, interoperability, business process analysis methods (e.g. tools and methods), **partner fit** is seen crucial for the success of the network. Many discussion and efforts could be prevented if the business partners have a tool or method in hand to validate potential new partners on network fit before entering the smart organisation. In the following we will propose a generic approach that supports partner search on the Internet and measuring the partner fit of potential partners for a given smart organization.

3. AN ONTOLOGY-BASED APPROACH

In this section we introduce our ontology-based approach for supporting communication within virtual organizations between the internal partners and to external partners. This includes as well the process of partner search as the process of measuring how well a partner fits into a running virtual organization.

3.1 Introduction of Ontologies and the Semantic Web

Currently computers are changing from single isolated devices into entry points into a worldwide network of information exchange and business transactions. Support in data, information, and knowledge exchange is becoming the key issue in current

computer technology. The current web is an impressive success with a growing number of users and information sources. However, this growing complexity is not reflected in the current state of Web technology. The heavy burden in information access, extraction, interpretation and maintenance is left to the human user. Tim Berners-Lee, the inventor of the current WWW, coined the vision of a **Semantic Web** in which background knowledge is stored about the meaning of web resources through the use of machine-processable (meta-)data. The Semantic Web will bring structure and meaning to the content of Web pages, being not a separate Web but an extension of the current one, in which information is given a well-defined meaning. Thus, the Semantic Web will be able to support automated services based on these descriptions of semantics, seen as a key factor in finding a way out of the growing problems of traversing the expanding web space, where currently most web resources can only be found through syntactic matches (e.g., keyword search). **Ontologies**, formal vocabularies explicitly representing meaning of data, will play a major role in supporting information exchange processes in various areas. They will enable the Semantic Web which provides on-line access to large volumes of information and knowledge based on **machine-processable semantics of (meta-) data**. Ontologies are typically restricted to a specific domain or application, e.g. describing the relevant concepts and the relationships between concepts within one specific virtual organization, one smart company or even one department within one company (e.g. human resource, finance, sales, marketing). Figure 2 depicts an example of a simple project-person ontology. It consists of concepts (like PROJECT, PERSON, DEPARTMENT-MANAGER), relations between the concepts (hierarchical (subConcept) and non-hierarchical relations like worksIn) and axioms. Using this ontology, relational metadata can be defined on top of existing web pages, thus, formalizing the content and making it machine processable. In this concrete case the relationship between the EU-IST funded project Ontologging and Alexander Maedche is formalized (Alexander worksIn Ontologging).

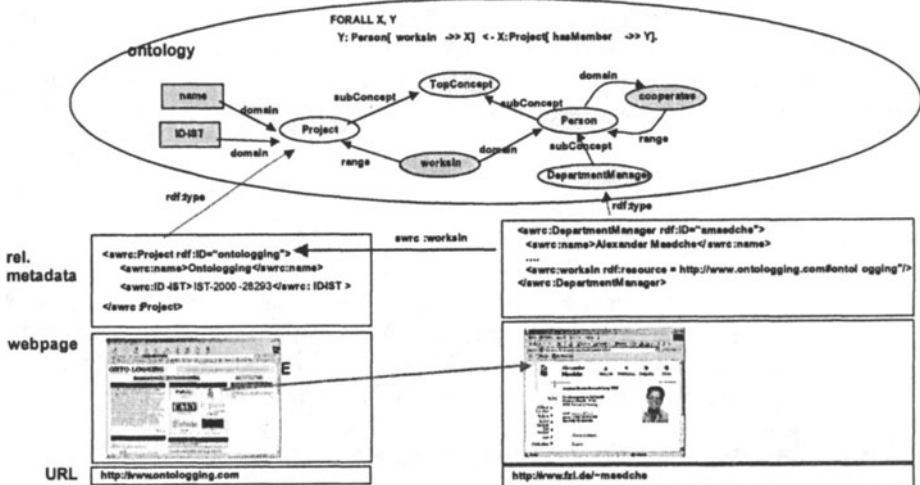


Figure 2 - Example for an Ontology and Relational Metadata defined on top

We propose to use ontologies for the specification of virtual organizations and embed this idea in a comprehensive framework for developing virtual organizations. The usage of ontologies within our framework has several advantages: Members of the virtual organization (at the company, team or person level) agree on a common terminology and have a common understanding of the meaning of their communication. Additionally, electronic communication becomes easier using ontologies. Existing data sources (like database, documents, etc.) are mapped onto the ontology and semantically enriched. Thus, information integration is done at the semantic level. As mentioned above ontologies provide complex schemata for metadata. In this sense they allow a semantics-oriented description of data that is exchanged in the virtual organization (e.g. project reports, images, ...). Finally, in our framework a virtual organization web portal is semi-automatically generated on the basis of the ontology and its corresponding data to provide a common access to the virtual organization for all members. A detailed description of the technologies used for supporting the process of setting up ontology-based semantic portals is described in [4].

In the following we will focus on the **partner fit and search** process using ontologies. The required steps for bringing the overall approach to work are the following:

- Collect requirements for **describing smart companies using ontologies** (what is relevant within a smart company) in general. In our work this has been done on the basis of the existing Infranet virtual organization described earlier in this paper. We are currently formalizing this ontology and will provide it to other virtual organizations.
- The ontology is instantiated (the concrete description of a company is generated) and used to **generating smart company descriptions** in the daily work (e.g. including financial figures, competencies, etc.). The ontology will be used by partners within the smart organization and by smart companies willing to be integrated into smart organizations. Using relational metadata this information will be made available on web pages or on specific partner search portals.
- Finally, means for collecting distributed smart company descriptions using a focused description crawler and techniques for querying and browsing within smart company descriptions are provided. Specific focus is set on ranking and matching techniques.

4. CONCLUSION

In spite of the very good cooperation between the partners there are still some problems within the Infranet partner network to solve. This network could deal as a best practice pilot for other SMEs and networks to benefit from the lessons learned during this project. These problems motivated us to develop an ontology-based framework for enabling interoperability. Thus, ontologies are means to enable machine and human communication.

In the future much work remains to be done. First, the smart organization ontology has to be further developed and refined based on a detailed requirements analysis. Second, the ontology-based tool suite for setting up smart organizations is still in an early stage. Based on applications we will have to collect feedback and evaluate our approach. We will have to pay specific attention on how to integrate the tool suite in the concrete working process.

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