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FEATURE-BASED ANALYSIS FRAMEWORK FOR INTER-OPERABILITY IN NETWORKED ORGANISATIONS

Sobah Abbas Petersen
Dept. of Computer and Information Science, Norwegian University of Science and Technology Trondheim, Norway, Email: sap@idi.ntnu.no
Paolo Paganelli
Gruppo Formula SpA, Italy, Email: Paolo.Paganelli@formula.it
Burkhard Schallock
Fraunhofer IPK, Berlin, Germany, Email: Burkhard.Schallock@ipk.fraunhofer.de

Several forms of collaborative and networked organisations have emerged due to increased alliances, outsourcing, globalisation and improvements in distributed information systems. Interoperability demands and challenges are rising. There is a need to meet these interoperability challenges. This paper proposes a framework to assess how well a networked organisation supports interoperability. The framework is based on a set of features that describe the interoperability aspects of a networked organisation. By using such features, it is possible to identify business interoperability requirements for the networked organisation. This work has been conducted as a part of the EU project ATHENA, Workpackage B3.

1. INTRODUCTION

Several forms of collaborative and networked organisations have emerged due to increased alliances, outsourcing, globalisation and improvements in distributed information systems. Interoperability demands are rising, but a number of obstacles prevent fast solutions from spreading. The EU Integrated Project 507849 ATHENA, (Advanced Technologies for Interoperability of Heterogeneous Enterprise Networks and their Application), [1], will improve interoperability from the results of several research projects and community building activities, including development and application of some business concepts. The overall objective of ATHENA B3 is to lay down the foundation work for the long term research into interoperability, identify key business drivers and provide an impact assessment model to address interoperability systematically in a business context rather than a technical context.

A new way of assessing a network of organisations, and how it can be improved, is by analysing the partners' ability to interoperate at a business level. In such a case,

the partners need to be able to share their strategies and business information and interoperate at the strategic level as well as the operational and data levels. We propose a framework for analysing networked organisations. The framework is based on a set of features, which indicate the level of interoperability in several aspects of collaboration. The framework will also help in detecting business interoperability requirements which can lead to improved interoperability and show the business value it creates. The framework will be illustrated using an example.

2. THE NEED FOR A FRAMEWORK

The subject of networked organisations and collaborating organisations has received enormous attention, both by the research community and industry, in the last decade. This area has also been the interest of a number of different disciplines, for example the manufacturing community, e.g. GLOBEMEN, [7], and the information technology community, e.g. COVE, [5]. This has resulted in a number of different concepts and numerous definitions of organisational forms, see [10] for an overview. However, each of these concepts and definitions are mostly influenced by the interest of the community, e.g. a concept proposed by the information technology community may focus on the distributed nature of the applications within a networked organisation while another community may focus on the collaborative nature or the lifecycle of the networked organisation. To illustrate the diversity of the concepts and definitions in the literature, a few definitions are presented below:

- A Virtual Enterprise, which is defined as "*an interoperable network of pre-existing enterprises that collaborate by means of specific information technology components towards the achievement of a common goal*", [6]. The use of information technology is explicitly stated in this definition.
- A Virtual Enterprise, which is defined as "*a composition of several companies, which enable them to make joint commitments to their common customers*", [8]. This definition is focussed on the joint commitments of the organisations within the network.
- An Extended Enterprise Network is defined as "*a network of companies that form Virtual Enterprises to deliver specific customer solutions*", [11]. This concept assumes that the network is formed by each company assigning a set of core competencies and that several Virtual Enterprises may be formed during the lifecycle of a network.

Previous attempts to analyse the different definitions and concepts have used the notion of characteristics of the networked organisations. Examples of such attempts are [3] and [10]. While these provide useful characteristics to describe and analyse a networked organisation, they do not provide an adequate set of characteristics and the flexibility to analyse a networked organisation in terms of interoperability. In order to be able to clearly identify interoperability issues and requirements, we need to have a flexible framework that takes into account all aspects of networked organisations. We believe that an open, flexible framework that helps to identify interoperability issues within a network must fulfil the following requirements:

- Incorporate very diverse aspects of networked organisations.

- Provide the possibility to adapt to the desired situation.
- Facilitate the extraction of interoperability requirements.

Such an approach is currently missing in the literature. We propose a "soft", feature-based interoperability analysis framework to address the above requirements. The rest of this paper is organised as follows: Section 3 describes the interoperability analysis framework; Section 4 explains in detail the kinds of features that can be used to describe networked organisations and Section 5 illustrates the use of the framework using an example.

3. ANALYSIS FRAMEWORK

A particular form of a networked organisation (e.g. a Virtual Enterprise) is called an *approach*. The central elements of the framework are *features* and they describe the various aspects of an approach. Features also relate an approach to *interoperability requirements,* described through further dimensions added on another plane of the framework. A conceptual view of the framework and how the features relate an approach to business interoperability requirements is shown in **Figure 1**.

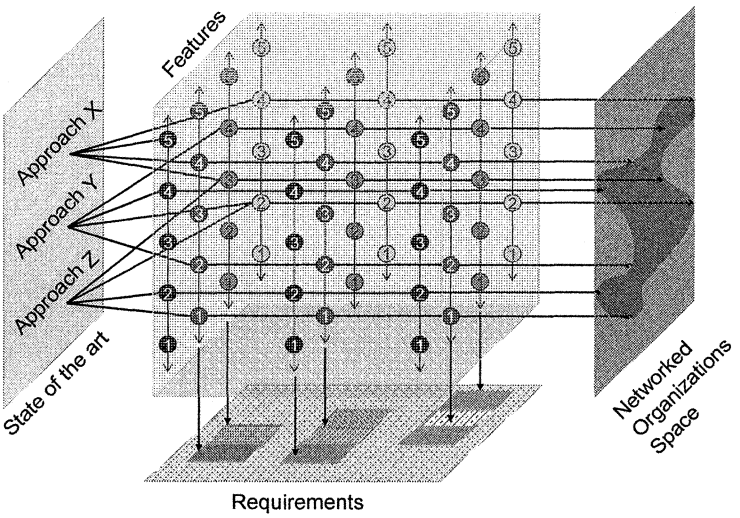

Figure 1: Networked Organisation Analysis Framework

A feature is not a fixed or discrete value; it is a range of values, with a minimum and a maximum. It allows the description of approaches when a certain organisational condition is partially fulfilled rather than either fulfilled or not. The range of values for the features indicates the degree to which a particular approach supports interoperability. This indication of the degree of interoperability facilitates the identification of requirements, which if fulfilled, will increase the degree of interoperability of that approach.

The combination of different approaches mapped through the set of features, sets the boundaries of the Networked Organisations Space. Within this space, we can look for similarities, redundancies and juxtapositions between the different approaches that are analysed. Outside the Networked Organisation Space, we can look for innovations to be pursued or unidentified requirements.

This analysis framework can be considered as a "soft" framework for the following reasons:

- It is tolerant of approximated or partial definitions of approaches, allowing the indication of a degree of fulfillment for a certain organisation condition through the value of the corresponding feature.
- It can be enhanced to include approaches that were not known or not completely specified at the time the framework was designed.
- It allows the inclusion of new features as the list of features to cover all possible approaches at all times will never be complete.

3.1 Features to Describe a Networked Organisation

An initial selection of features that can be used to describe and analyse different approaches are described in Table 1. The features are derived from our own experience as well as from literature, e.g. [3] and [10]. Each feature has a maximum and a minimum value and a value within this range can be used.

Feature	*Min*	*Max*
Extension The potential highest number of independent parties (companies, organisations, individuals) forming the Networked Organisation.	Pair	Open community
Duration The life time of the Networked Organisation.	Spot	Permanent
Involvement The level (and nature) of each partner involvement in the Networked Organisation.	Transaction	Strategic Alliance
Goal orientation The partners' degree of commitment to the Networked Organisation's common goal(s).	Individual purposes	Common mission
Interests Balance How much the individual partners' interests are represented in the Networked Organisation.	One dominant player	Democracy

Holistic Value-added The "virtual" value-added by establishing the Networked Organisation. (Assuming that the whole is greater than the sum of the parts.)	None	Virtual business
Subjective relevance (enterprise) The relevance of the collaboration initiative from the individual enterprise perspective.	Routine initiative	Strategic challenge
Association Cost How much individual partners have to invest to join the Networked Organisation.	Normal spending	Big Investment
Information sharing The relevance of information to be shared from an enterprise perspective.	Transaction data	Corporate Knowledge
Organisation evolution How much the networked organisation changes in terms of its partners, organisation, etc.	Stable	Continuous transformation
Trust level The level of trust among the partners.	Mistrust	Blind faith

Table 1: Initial set of Features

3.2 Business Interoperability Requirements

The features to describe the approaches are also considered as a means of identifying the business interoperability requirements of an approach to make that approach more interoperable. For example, if a particular feature is very low for an approach, there is likely to be a business interoperability requirement that must be met to raise the level of that feature. Interoperability requirements are mapped onto another plane of the analysis framework, where key issues are identified into three main areas: *Strategy, Organisation* and *Infrastructure.*

4. EXAMPLE

An example of a networked organisation approach is CPFR (Collaborative Planning, Forecasting and Replenishment), [4]. CPFR© is a standard approved by EAN.UCC[1] and promoted by the VICS Association[2] to "create collaborative relationships

[1] The EAN.UCC System (http://www.uc-council.org) standardizes identification numbers, Electronic Data Interchange transaction sets, Extensible Markup Language Standard schemas and other supply chain solutions, presiding over several standardization initiatives like, e.g., RosettaNet and U.P.C. Bar Codes.

[2] The VICS consortium (http://www.vics.org/) is the entity promoting and maintaining the CPFR standard.

between buyers and sellers through co-managed processes and shared information". The CPFR standard provides definitions and specifications for a set of collaborative processes between buyers and sellers in a consumer-oriented supply chain.

CPFR is analysed as an approach using the features in Table 2. The range of values for the features is from 1 to 5, where 1 is the lowest and 5 is the highest. The interpretations of the values of the features are also provided in the table. Using this framework, it is possible to obtain a very quick overview of the approach and identify areas where it can improve in interoperability.

Feature	*Value*	*Interpretation*
Extension	1	Bilateral relation.
Duration	4.5	Very long-term.
Involvement	4	Collaborates at the strategic level.
Goal orientation	1	Each partner follows individual goals.
Interests balance	3	The partners' interests are represented well in the approach, but it's not democratic.
Holistic Value-added	1	No new product or business is delivered through collaboration.
Subjective relevance	4	The initiative is perceived as strategic by each involved company.
Association cost	4	The partners have to make significant investments to join the network.
Information sharing	4	Corporate knowledge is shared (e.g., promotions, customer intelligence).
Organisation evolution	1	Little changes to the processes over time.
Trust level	4.5	Very high level of trust required between the partners.

Table 2: Analysis of an Example Approach

4.1 Extracting Requirements

By analysing the values of the features, it is possible to extract business interoperability requirements. Some examples of requirements are shown in Table 3. For example, the feature "involvement" has a value 4, which indicates that the agreements among the partners in a CPFR (who are retailers and manufacturers) are closer to the strategic level rather than the transaction level and have a strategic value. However, this can be further improved by improving the ability of the partners to share their process logic, thus improving their collaboration at the strategic level. The value for the feature "association cost" is high indicating a threshold for CPFR adoption that could be lowered by removing some technical difficulties. One of these is the need for product data consolidation, hence the requirements for shared catalogue services such as, e.g. UCC.NET provided by EAN:UCC.

Feature	*Value*	*Business Interoperability Requirement*	*Requirement level / Interoperability area*
Involvement	4	1. Shared Process Logic for collaboration.	Organisation / Processes
Interests balance	3	1. Shared Process Logic for collaboration.	Organisation / Processes
		2. Establish and share collaboration agreements.	Strategy / Objectives
Association cost	4	1. Consolidation of master item data through third-party service provider.	Infrastructure / Catalogue management

Table 3: Extracting Business Interoperability Requirements

4.2 Extending the Framework

Consider the approach a Virtual Enterprise. Different types of Virtual Enterprises have been described in the literature; for example, a Virtual Enterprise for one-of-a-kind manufacturing or for repetitive productions, [2]. To describe such Virtual Enterprises, we can add a new feature that describes the nature of the product: product orientation. The minimum value for this can be "once", which can be used to describe Virtual Enterprises for one-of-a-kind manufacturing. The maximum value can be "repetitive". Thus, a Virtual Enterprise that has the value closer to maximum (e.g. 4.5) for the feature product orientation and the value 4.5 for the feature duration is likely to be a long-term collaborative effort that delivers the same product over a long period of time.

5. CONCLUSION

The framework can be described as dynamic and inclusive as it allows the inclusion of new features, approaches and requirements at any time during its use. In general, the framework can be used for the following purposes:

- Capture similarities between apparently distant models, creating a unifying space where different approaches from different disciplines can be compared and combined.
- Map specific real organisations' situations, along with theoretical models and solutions, thanks to the "soft" quality of the framework.
- Relate approaches to Interoperability Requirements through Features. This enables the analysis of requirements from an organisational perspective, independent of the models and solutions addressing them.
- Facilitate the extraction of interoperability requirements

In addition to analysing and comparing existing approaches, the framework can also be used to design new approaches, either by combining features of existing approaches or by just focusing on specific features. Thus, this framework is aimed at supporting the design of new networked organistional approaches.

We plan to focus further on the features to make it a more comprehensive set as well as consider better ways to allocate values for the features. At present, features address specific aspects of the network that can be assigned a value to (e.g. extension) as well as aspects that indicate a relevance of that aspect to the network, (e.g. trust level). We plan to continue working on incorporating more flexibility into the framework to support different aspects of networked organisational approaches.

We also plan to use ideas of Active Knowledge Modelling, [9], to create a model of the framework and use the capabilities provided by the modelling environment to support the analyses. The results of this work presented as a model can be used by academia and industry for analysing networked organisations. Implementing the framework as a model will also make it easier for enhancing it in the future and to address business interoperability in a holistic manner.

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7. REFERENCES

1. ATHENA 2004, Advanced Technologies for Interoperability of Heterogeneous Enterprise Networks and their Application, URL: http://www.athena-ip.org/
2. Bernus, P., Bertok, P. and Nemes, L., "Modelling Dynamic Management Features of Virtual Enterprises", in eds. Plonka and Olling, *Computer Applications in Production Engineering*, Chapman and Hall, London, 1997, pp. 643-655.
3. Camarinha-Matos, L. M., Afsarmanesh, H., Garcia, C. and Lima, C., "Towards an Architecture for Virtual Enterprises", in Proc. of the 2nd IMACS International Multiconference on Computational Engineering in Systems Applications (CESA'98), Nabeul-Hammamet, Tunisia.
4. Collaborative Planning, Forecasting & Replenishment (CPFR©), Version 2.0, June 2003, Voluntary Interindustry Commerce Standards (VICS) Association, URL http://www.cpfr.org.
5. COVE 2003, COllaboration infrastructure for Virtual Enterprises and electronic business, URL: http://www.uninova.pt/~cove/
6. Garita, C. and Afsarmanesh, H., "A Study of Information Management Approaches for Support Infrastructures", Cove *Newsletter*, (1), 2001.
7. GLOBEMEN 2002, Global Engineering and Manufacturing in Enterprise Networks, URL http://globemen.vtt.fi/
8. Jain, A. K., Aparicio IV, M. and Singh, M.. P., "Agents for Process Coherence in Virtual Enterprises", *Communications of the ACM,* Vol .42, No. 3, March 1999, pp. 62-69.
9. Lillehagen, F. "The Foundation of the AKM Technology", Concurrent Engineering: Enhanced Interoperable Systems, eds. Jardim-Goncalves, Cha and Steiger-Garcão, Balkema, The Netherlands, 2003, pp. 700-715.
10. Petersen, S. A., "Extended and Virtual Enterprises - A Review of the Concepts", Technical Report 02/02, Norwegian University of Science and Technology, 2000.
11. Vesterager, J., Larsen, L. B. and Gobbi, C., "Architecture and Methodology for Creating Virtual Enterprises" - Results from Globeman 21, Presented at the IMS Globeman 21 Open Day, Time24, Tokyo, Japan, March 1999.