

# Virtual Organizations: Trends and Models

Mohammad Reza Nami<sup>1</sup> and Abbaas Malekpour<sup>2</sup>

<sup>1</sup>Faculty of Electrical, IT, and Computer Engineering,

Islamic Azad University- Qazvin Branch, Iran

nami@iau-saveh.ac.ir

<sup>2</sup>Department of CS & EE, University of Rostock, Germany

abbas.malekpour@uni-rostock.de

**Abstract:** The Use of ICT in business has changed views about traditional business. With VO, organizations with out physical, geographical, or structural constraint can collaborate with together in order to fulfill customer requests in a networked environment. This idea improves resource utilization, reduces development process and costs, and saves time. *Virtual Organization (VO)* is always a form of partnership and managing partners and handling partnerships are crucial. Virtual organizations are defined as a temporary collection of enterprises that cooperate and share resources, knowledge, and competencies to better respond to business opportunities. This paper presents an overview of virtual organizations and main issues in collaboration such as security and management. It also presents a number of different model approaches according to their purpose and applications.

**Key words:** Collaborative Networks, Virtual Organization, Virtual organization Breeding Environment (VBE), Virtual Enterprise (VE).

## 1. Introduction

The terms of like virtual team, virtual company, or virtual corporation have been introduced in the early 1990s, including the work of Davidow and Malone [1], and Introna, More, and Cushman [2]. Then a large body of literature has been produced mainly in two communities, the ICT and the management. However, the concepts of VE/VO are still evolving. Advances in computer networks also affected marketing and business systems so that traditional business systems have been metamorphosed.

Virtual Organization has been introduced as a new organizational schema including a temporary set of geographically organizations collaborating sharing skills and resources to fulfill customer requests in a networked environment [3]. Network or Breeding Environment [4] is the source of virtual organizations. It is used for a long-term supporting network in order to enable efficient collaboration in virtual organizations and handle virtual organization activities. The preparation actions for a network are the development of procedures, ICT, and common processes to support customer deliveries. This preparation sets up a virtual organization to fulfill a customer task.

Main reasons for collaborating in a VO include saving time and decreasing development process, spreading costs and risks with partners, improving resource utilization, and access to new markets through partnership. Modeling is a suitable means for designing, communicating, and implementing virtual organizations. There are different types of VO modeling approaches that are explained in this paper. A practical VO modeling moves from high level architectural design to more detailed levels according to the project requirements.

## *1.2 Structure of the Paper*

This paper is organized as follows. Section 2 presents related works. An overview of VO concepts are presented in Section 3. In section 4, VO modeling approaches are described. Section 5 discusses important challenges such as VO management. Finally, conclusions are presented.

## **2. Related Work**

Although VO is still studied, but many researchers are working on different issues and various projects are defined in this field. The most researches have been categorized in the following:

- **Planning and launching:** R. Camacho et al [5] have presented a reference model that integrates all information related with VO planning. On the other hand, it integrates the elements involved in the VO creation in three dimensions: VO lifecycle, modeling views including resources, organizational, functional, and information views.
- **VO management:** As a VO model represents interactions of VO members, resources, organizations, knowledge exchanged among VO members, and functions views form the basis of VO modeling and VO managing is based on the VO models. In fact, a VO management should allocate and coordinate resources, manage VO member cooperation, evaluate partners, and define some rules to achieve the goal.

Effective management needs to VO respond to fast changes in the environment. I. Karvonen et al have presented some VO management approaches in [6].

- **VO characteristics:** With respect to VO nature, Eckstein has described basic characteristics of a VO in [3]. They are explained in this paper.
- **VO modeling:** Since the analysis of past VO modeling indicates that researchers are not fully aware of a suitable modeling process and methodology, the VO modeling approaches is one of important issues. Authors in [7] [8] present some enterprise models.
- **VO products:** Different projects and case studies have been performed in virtual organization field. L. M. Camarinha-Matos, H. Afsarmanesh, and M. Ollus [3] have outlined some of these products.

### 3. VO Core concepts

There are three concepts used in this context: Virtual Organization (VO), Virtual Enterprise (VE), and Virtual organization Breeding Environment (VBE). This section presents definition, properties, and some concepts.

#### 3.1 VE, VO, and VBE Definitions

A virtual enterprise is defined as a networked, reconfigurable, and temporary collection of enterprises that cooperate and share resources, knowledge, and competencies for better responding to business opportunities. A VO is defined as a temporary coalition of reconfigurable, independent, networked, geographically dispersed organizations including high level trust and competencies that collaborate and share their resources and competencies in order to respond to the customer request.

As mentioned, partners in a VO should collaborate in order to achieve business opportunities. Trust among them and operation according to a common agreement are essential things for collaborating. Networks or breeding environments are an appropriate context for effective creation of dynamic VOs. Authors in [9] have called this context as Virtual organization Breeding Environment (VBE) and defined it as "an association of organizations and their related supporting institutes, adhering to a base long term cooperation agreement, and adoption of common operating principles and infrastructures, with the main goal of increasing both their chances and their preparedness towards collaboration in potential VOs".

VBE can be local and global. Local VBE initiates dynamic VOs from organizations located in one geographical region while global VBE incorporates involved organizations from geographically distributed regions to effectively create VOs.

### **3.2 VO Properties**

Virtual organization characteristics help researchers to gain competitive advantages outlined in the following:

- Combining competencies and resources from different VO partners (*Integrative Atomization*)
- Project-oriented organization with fast recombination of partners (*Temporalization*)
- No legal or other formal structures (*Dematerialization and Non-Institutionalization*)
- Geographically dispersed working (*Delocalization*)
- Improving competitiveness and better fulfilling customer demands and capturing market (*Individualization*)

These properties can be categorized in three groups: product and service (Dematerialization and Individualization), VO conditions and environment (Temporalization, delocalization, and asynchronous), and effective VO operational characteristics (Integrative atomization and non-institutionalization) too.

### **3.3 VBE Functionality**

Efficient creation of dynamic VOs requires a proper environment that the members of new VOs are selected in it according to their capabilities and trust among them. The main goal of VBE is to improve the preparedness of its member organizations for efficiently creating VOs.

#### **3.3.1 VBE Members**

VBE Members can be different organizations such as business entities, ministries, legal service providers, and environmental organizations. These organizations should be registered at the VBE, accept the general VBE rules and policies, and have access to common information and tools for operation in a VO.

A VBE member can have different *roles* in different VOs established. The different member roles are listed in the following:

- **VBE Member:** The basic role for organizations that is registered in VBE for participation.

- **VBE Administrator:** Responsible for providing better cooperation among VBE and VBE management. It can find some organizations with high competencies from outside the VBE as a member.

- **VBE Broker:** Responsible for identifying and obtaining new business opportunities.

- **VO Planner:** Identifying, evaluating, and selecting the best partners for creating a new VO in terms of the competency and capabilities are performed by VO planner. In some cases, the roles of broker and planner are performed by the same actor.

- **VO Coordinator:** Responsible for coordinating a new VO during its life cycle.

Of course, some researchers believe that other roles can be defined in a VBE with considering needs. VBE advisor and VBE service provider are some examples in this context.

### 3.3.2 VBE Life cycle [2]

VBE life cycle consists of three stages: *creation, operation, and dissolution*. Each stage can be divided into sub stages. The VO life cycle is similar to VBE life cycle. It is also formed from three stages: *creation, operation and evolution, and termination*. The stages are described in the following:

1. **Creation:** VBE initiation and start up are two steps at this stage. Initiation is related to define objectives of the VBE, load base information of the domain, and establish plans and rules. Next step is to create common database, find new VBE members to join the VBE, and set up the VBE.

2. **VBE Operation and evolution:** This stage is the main part of VBE life cycle. Evolution occurs for the reason of some small changes in memberships or daily changes in working principles. Operations supported at this stage include management of rules and common knowledge, registration of new members including characterization of competencies, management of competencies and resources, and evolution of ontology for the considered domain. It also holds a history of past performance and collaborating members, uses this information for partner selection, creation, and registration of a new VO into the VBE and prepare assistance tools for the VBE members.

3. **VBE Dissolution:** After fulfillment of the business opportunity by VO created into a VBE, the VBE should reorganize and keep knowledge collected during the VBE operation. This knowledge can be transferred to the VBE members or other organizations. As the large number of members and open systems are involved and integrated in E-business and VBE creation, the virtual world will need the automation in reconfiguring and healing them. If one of them is modified in VBE or added to VBE, the entire VBE will need to act correctly and effectively

[9]. Autonomic Computing [10] can manage e-business and VO field with the minimal human intervention. VO challenges can be considered as important challenges in the design and implementation of a VBE.

#### **4. Virtual Organization Modeling Approaches**

Modeling and models are derived either by human thinking or formally using drawing and other representations including computer models. The models must be the simpler and easier to understand. Complexity of the model and the flexibility to change the models are major problems in enterprise and VO modeling [7]. This section presents a number of different VO model approaches.

##### ***4.1 Management Models***

Management models depict the elements, architecture, and core concepts of the VOs. They usually set high-level architecture of the VOs and provide a structure for thinking about and defining organizations. There are two types of management models: framework models that are used as structures to design organization, and concept models that depict the principle of structure and operations. Concept models will provide a library of architectural reference models [8] for different types of virtual organizations.

##### ***4.2 Management-oriented Process Models***

Business and management processes are defined as operative work in organizations. Such processes define the order and relationships between activities to reach a business objective such as fulfilling a customer order. This type of models must depict the collaboration and coordination spanning different locations or organizations. They often do not need to be very detailed. They are suited for building reference process libraries for VO processes.

### ***4.3 Enterprise Engineering/ System Requirement (EE/SR) Models [8]***

Different model notations such as UML (Unified Modeling Language, [www.uml.org](http://www.uml.org)) and modeling tools such as Rational Rose were developed to support the translation of the business domain and its requirements into suitable system designs and configurations. System engineering drives EE/SR models. Management does not drive this type of modeling. A developer can derive from this model the requirement for the system design. EE/SR models provide tools and applications for supporting virtual organizations.

### ***4.4 Enacted Models***

Capturing the business activities, necessary data, and driving IT applications and tools are supported by enacted models. Enacted model approaches seem to accelerate the process from definition to system deployment and to support fast re-configuration.

## **5. Virtual Organization Management**

As a VO is composed of different members located at dispersed sites, different issues can affect the VO. Therefore, the VO management [11] must be examined in different aspects. They can be categorized in human issues, technology and context issues. Communication between the partners, trust among them, VO planning, and security are important challenges from technical point of view.

### ***5.1 Virtual Organization Planning***

VO planning activities include receiving and analyzing business opportunities, selecting proper partners, determining high level Work Breakdown Structure (WBS), and setting up VO. R. Camacho et al [5] present a reference model for VO planning and launching. This model integrates the elements involved in VO creation in VO creation, modeling, and knowledge management dimensions. After VO planning activities mentioned in above, VO modeling is created in four views: Resource, organization, functional, and Knowledge. Resource view represents all resources used in the VO operation. Organization view represents responsibilities and authorities of the elements involved in the VO. Functional view represents the

behavior of the elements involved in VO life cycle. Knowledge view represents the structure of knowledge among the elements involved in the VO and relationships between these elements (VO partners). This knowledge includes VO structure, VO members profiles, procedures of VO member responsibilities, and reports developed into VO life cycle [9].

## ***5.2 Security Management***

Due to Altering in the organizational structure of institutions and changes in information system configuration security management is a continuous process. The objective of security management in VO is to reach and maintain the optimal security level of the entire system and the components of the system [11]. To assure security of VOs, the following issues are addressed:

- Communication security with confidentiality and integrity of information being preserved
- Authentication of the members participating in the operation
- Authorization and access control to resources managed
- Security elements and policies that are categorized into legal, organizational, and technical security policies

There are different threats to VO security such as threats caused by an activity that breaks the protection in order to illegally use resources or threats resulting malfunction of the system.

## ***5.3 Trust Management***

Trust among VO members (partners) is one of important issues in collaboration and VO creation, and affects the result of VO operations. It means that one organization as a VO member expects other to behave reliably in performing their tasks for achieving desirable goal of the VO [12].

VO modeling is based on Trust. Modeling is an appropriate tools to enhance planning and implementation. The basis of trust management are Trust Parameters (TPs) such as customer response time as an operational TP and damages by natural disasters as a Economic TP. Jochen Haller [13] has defined trust, reputation, and recommendation, as master concepts in creating a successful VO whose partners trust to each other to perform their roles and actions. He has categorized TPs in operational TP, economic TP, organizational TP, and legal TP. He also presents some trust requirements such as identifying and selecting TPs, aggregating them, considering trust values for reputation, and managing trust in collaboration. Trust accelerates collaboration among VBE members, enhances information sharing and



knowledge creation, and reduces the management cost and transaction costs between the members.

#### ***5.4 Competency Management***

Competency of an organization is defined as the validated capability of an organization to perform business processes, in collaboration with associated partners, having available the necessary resources (e.g. human, physical, technological), and applying known practices, with the aim to offer creation services/products to customers. The competencies allow to perform processes and require resources as input that have product or services as output. The processes are supported by associated partners. The advance functionalities of competency management [14] include as follows:

- Automatically collecting competency data from organizations
- Competency gap analysis: This is based on matching domain competency ontology and a set of competencies existing in the VBE database
- Discovery of new competency in VBE: This is based on matching competencies needed for future business strategy and a set of competencies existing in the VBE database

Competency ontology is a part of the VBE ontology.

### **6. Conclusion and Future Work**

Virtual Organization has been introduced as a new organizational schema including a temporary set of geographically organizations collaborating sharing skills and resources to fulfill customer requests in a networked environment. This idea improves resource utilization, reduces development process and costs, and saves time. This paper addresses some issues and open challenges in virtual organization such as VO management, and security management. It also presents a number of different model approaches according to their purpose and applications. With merging autonomic computing and virtual organization, an autonomous model can be designed and implemented as future research.

### **ACKNOWLEDGEMENTS**

*Mohammad Reza Nami* is a PhD researcher in autonomic computing domain. He got a scholarship from the MSRT (Ministry of Science, Research, and Tech-

nology) of Iran. He has more than 15 journal and conference papers. He has run many projects in formal methods, software engineering, virtual organizations, and self-managing systems. He has worked at Delft University of Technology with Prof. Stamatis and Dr. Bertels. Some of his research has been supervised by Prof. Afsarmanesh at Amsterdam University.

## REFERENCES

1. Davidow W. and Malone T., *The Virtual Corporation*, Harper Business, 1992.
2. Introna L. D., More H., Cushman M., The VO technical or social innovation? Available at <http://is.se.ac.uk/wp/pdf/wp72.pdf>
3. Camarinha-Matos L. M., Afsarmanesh H., and Ollus M., *Virtual Organizations: systems and practices*, In Springer Science, 2005.
4. Camarinha-Matos L. M. and Afsarmanesh H., *Creation of virtual organizations in a breeding environment*, In the Proceedings of INCOM 2006, 12<sup>th</sup> IFAC Symposium on Information Control Problems Manufacturing, Saint-Etienne, France, May 2006.
5. Camacho R. et al, *An integrative approach for VO planning and launching*, PRO-VE'05, 2005.
6. Karvonen J., Salkari I., and Ollus M., *Characterizing virtual organization and their management*. In PROVE' 05, September 2005.
7. Toole M., et al, Reference models for virtual enterprises, Collaborative Business Ecosystems and virtual enterprises, L. Camarinha-Matos, Kluwer publisher, pp. 3-10, 2002.
8. Chen D., et al, Developing an Unified Enterprise Modeling Language (UEML)- Requirements and Roadmaps, Collaborative Business Ecosystems and virtual enterprises, L. Camarinha-Matos, Kluwer publisher, pp. 247-254, 2002.
9. Afsarmanesh H. and Camarinha-Matos L. M., *A framework for management of virtual organization breeding environment*, PRO-VE'05, 2005.
10. Nami, M.R., Sliarifi, M., 2006, in IFIP International Federation for Information Processing, Volume 228, Intelligent Information Processing III, eds. Z. Shi, ShimoharaK., Feng D., (Boston: Springer), pp. 101-110.
11. Magiera J. and Pawlak A., *Security frameworks for Virtual Organizations*, In Virtual Organizations, Springer, 2005, pp.133-148.
12. Dimitrakos T. et al, *Towards a Trust and Contract Management Framework for Dynamic Virtual Organizations*, Proceeding of the e-Challenges 2004, Vienna, Austria, October 2004.
13. Haller J., *A stochastic approach for trust management*. In 22nd International Conference on Data Engineering Workshops (ICDEW'06), Atlanta, GA, USA, April 2006.
14. Ermilova E. and Afsarmanesh H., *Competency and profiling management in VBEs*, in the Proceedings of PRO-VE '06, Springer, Helsinki, Finland, September 2006, pp. 131-143.