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Criteria for Modelling Languages in the Domain of VOs

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Abstract: This paper explores the challenges encountered by virtual organizations. It goes on to justify and suggest the basic criteria that a modelling language claiming to model virtual organizations should have incorporated. These criteria are a preliminary effort towards developing a yardstick against which a modelling langue for virtual organizations can be weighted.

Keywords: Virtual Organizations, Modelling languages, criteria

1. INTRODUCTION

Virtual Organization is a temporary alliance of autonomous entities (organizations, individuals, etc) that strategically share skills and resources supported by computer networks, to achieve some benefit not possible otherwise (Cummings, *et al.*, (2008)), (Camarinha-Matos, *et al.* (2005), (Foster, 2001). A Virtual Organization (VO) is a dynamic organization that is formed according to the needs and opportunities of the market and remains operational as long as these opportunities persist; once the opportunity ends, the organization usually dismantles itself.

Some of examples of virtual organizations are:

To compete in business environment where opportunities are predominantly captured by large organizations, small and medium (SME) organizations come together to appear as a single large organization to increase profitability or to compensate for the missing skills.

Incident management, disaster rescuing processes and emergency response teams, where it is necessary to immediately coordinate activities of a large number of entities such as fire brigades, army, volunteers, police, hospitals, local government, non-governmental organizations.

A VO achieves these attributes by allowing companies to seek complementaries that allow them to participate in competitive business opportunities and new markets, by creating partnerships to achieve its goals (tasks) or to achieve critical mass and appear in the market with a larger "apparent size". They can also achieve cost and effectiveness by sharing responsibilities between members if one member is either incapable to do it alone or will take longer.

All these attributes shape the composition of a VO in terms of who is assigned to what responsibility (task), how different tasks of a VO are shared between its members, which member is contributing how much of its resources, what the relationship between the members is, etc.

To understand and describe this complex composition of VOs we need to model them first. The unique nature of VOs and VBEs and the unpredictable and hostile environment in which they operate demand for special considerations to be taken into account while choosing either a general purpose modelling language or developing a specific modelling language tailored for (VOs) Virtual Organization and (VBEs) Virtual Breeding Environment specifically.

The contribution of this paper is to elaborate on the specific nature of the VBEs and VOs and the environment in which they operate and, based on that, extract out the preliminary criteria against which a modelling language (whether general purpose or specifically developed for VOs and VBEs) can be evaluated. This work is conducted as part of PhD dissertation (Rajper, 2012).

2. MATERIAL AND METHODS

Before delving into and elaborating on the criteria under which a modelling language should be evaluated for its usefulness as well as its weaknesses in capturing the concepts of VOs and VBEs, let us draw out the aims first that chalk out the motives behind selecting the given criteria.

Aims

The overall aim of the proposed criteria is to ease the modelling of VBEs and VOs whose agility demands may also affect its operational model (with respect to underlying execution environment). It is useful to identify the particular problems that need to overcome. In particular, the modelling language should:

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1. *Offer domain concepts as "first class" entities*.

This aim includes the provision of domain concepts the domain experts relate naturally and intuitively to and at the level of abstraction which is comprehensible to different stakeholders of domain without any technological expertise.

2. *Allows to express the structure of VOs independent from its operational aspects*.

This aim includes provision of modelling constructs which are able to describe basic structural composition of VOs such as the members of VOs, the responsibilities assigned to them, the relationships between members, etc irrespective of the underlying execution environment.

3. *Provides Return on Modelling Efforts (RoME).*

This aim includes provision of reconfiguration constructs for the VO models, impact of reconfigurations both at structural and operational level and lending models for formal analysis.

4. *Ensures developing correct by construction operational models from structural (domain) model*.

This includes provision of rules which correctly transform a structural model into corresponding operational model.

Criteria for Modelling Languages in the Domain of VOs

From the discussion in previous section, the author has extracted a number of preliminary criteria that a modelling language attempting to be useful for VBE and VO domain must possess. These criteria also help in identifying the limitations and strengths of any modelling languages (generic or VO specific) chosen for specifying models of VOs. Given below is criteria:

C1. Expressibility: Representing domain concepts as modelling language constructs.

The limitation of readily available general purpose languages however, is that they require fluency in the chosen notation by the stakeholder (domain experts) in order to model the system. Whereas, domain experts are usually not familiar with language constructs of these general purpose modelling language. This affects the quality of the models developed and usually takes longer than required to model and analysis any VO. Besides, the reluctance of domain experts, the general purpose languages are not tailor-made for the VOs, therefore, they fail to satisfy the demands of VOs completely and naturally.

The benefits of having a specification language specifically geared towards a particular domain are manifold and advocated in the literature. Key benefits are: first of all modelling languages abstract away unnecessary details of implementation; secondly it helps to work directly with notions and concepts of the domain at hand; thirdly having precise models allows for various analysis to be conducted on the blueprint of a VO rather than developing a fully-fledged running VO).

C2. Ability of the language to evolve the model.

The language chosen for modelling VOs and VBEs must be rich and flexible enough to allow for diverse range of reconfigurations to be accomplished. Adaptation demands of VOs range from simple case of replacing one entity with another entity which is exact replica of the entity being replaced in terms of structure and function, to altering the goal and hence basic composition of VOs. Therefore, the modelling language in general offer constructs to reconfigure different aspects of VOs as smoothly and naturally as possible.

C3. Represent changing association of members with VBEs and VOs. Some members remain part of a VO from its inception to dissolution, while others keep changing quite frequently.

The adaptation to the goal of VOs can affect the members of the VOs as well. If a previously required competency is no longer required due to change in goal, then it might makes the member(s) providing that competency no longer needed as well. This change in competency might also create the need to invite new members into VO. Hence the modelling language for VOs might also offer this flexibility; it should allow a VO to reorganize itself by adding new competencies into VO along with constructs to add new member into VBE as well as allows to expel deprecated members from the VO and update the required competency list of VO as well.

C4. Capture the concept of collaboration by:

1. Allowing more than one member to carry out a particular task.
2. Sub-dividing a task into more than one task and assigning each subtask to be performed by individual member.

The composition of a VO is determined by the need to associate the most suitable set of capabilities contributed by the distinct organizations. To compete in business environment where opportunities are predominantly.

Captured by large organizations, small and medium (SME) organizations come together to appear as a single large organization having more resources and skill collectively than each individual member participating in the VO to increase profitability or to compensate for the missing skills. A VO achieves these attributes by allowing companies to seek complementaries that allow them to participate in competitive business opportunities and new markets, by creating partnerships to achieve its goals (tasks) or to

achieve critical mass and appear in the market with a larger "apparent size". They can also achieve cost and effectiveness by sharing responsibilities between members if one member is either incapable to do it alone or will take longer.

Ever-changing business demands and market turbulence demand of organizations to continuously and quickly adapt in order to remain competitive. This quite often requires new skills and resources which many organizations fail to have at their disposal. The most affected are small and medium organizations (SMEs). Hence it has become necessity in the existing highly dynamic market for the organizations to collaborate and coordinate with other autonomous (sometimes competing) organizations to make up for the skills and resources or capacity they lack to respond better to a business opportunity or even take the modest share from large organizations.

These challenges are forcing entities (organizations or otherwise) to seek complementaries and join efforts that allow them to better participate in challenging and competitive environments, expand businesses and enter new markets, compete against business giants by collective size and capacity of the partners.

C5. Define different kinds of relationships between members for example member cooperating or competing over a task.

When a task is allowed to be performed by more than one member or when a task is sub divided into smaller tasks each performed by different members, it has consequences on the type of relationship between member performing such tasks. It is possible that the member might represent other relationships then one usually advocated by the VO and VBE community i.e VO members are partners.

It is possible in long-term VOs, that when multiple members are performing the same task they collaborate when they can't individually satisfy the quantity demands of VOs goal (customer) but when they both have amount of resources required to satisfy the demand they become competitors and try the get the opportunity.

Therefore, a modelling language mush allow for different types of changing relationships between members of a VO.

C6. Adapt the goal of a VO to meet changing business circumstances.

A VO is expected to be flexible in its composition and structure so that it can adapt the goal of the VOs with the changing circumstances. To satisfy the goal of a VO, the VO lists respective competencies that can lead to the satisfaction of the goal eventually. Hence a modification in goal is represented by altering the competencies list. Therefore, the modelling language capturing models of VO must offer provisions that let new competencies added to the VO and also allow for removing competencies no longer required or replacing one competency with equivalent one.

This can only be achieved if the underlying structure and composition of VOs is flexible enough to allow for these changes. These trends require organizations to be agile, that is for them to have "the ability to recognize, rapidly react and cope with the unpredictable changes in the environment, with the smooth adaptation of its structure to the new current reality" (Camarinha-Matos, *et al.* 2003).

C7. Resilience

The ever changing and turbulent environment which lead way to the concept of VOs demand VOs to be resilient by nature. VOs must cope with changes in the environment by adapting their selves instead of failing to operate and provide the promised service as long as possible such as by proving provisions which allow VOs to operate with degraded performance.

C8. Preserve the autonomy of members.

As VO is a consortium of partners who have come together to collectively achieve a goal not possible for individual members to achieve on their own. It is very likely the members who are partners in one VO might be competitors beyond that VO. As a consequence, members are reluctant to open up their business secrets (workflows, processes, etc) and give complete or direct control to other members to use their resources. Hence, it is crucial that members should manage and control their own resources and at the same time let others use their resources but within given boundaries set by the member owning the resources.

A modelling language henceforth, should also be able to offer this autonomy that let members be responsible for managing their resources while sharing them in VO with others.

C9. Free from fixed "organizational structure" i.e able to modify the operational model.

The prevailing system engineering approaches representing such organizations with "fixed organizational structures" obstruct such agility and resilience (Nguyen, *et al.* 2006)), (Norman, *et al.* 2004), (Patel, *et al.*, 2005). A VO is derived by the business opportunity; hence any aspect of it might need to be changed in order to keep the VO goal aligned with the business opportunity. This not only affects its membership but may also be reflected in its structural organization which forms challenge for modelling VOs.

While developing modelling languages for specific domains, two aspects of the system are mostly

ignored or abstracted away: (a) the application aspect of the system i.e the actual goal or service (specification of business functionality) offered by the system, and (b) the coordination and communication model close to the underlying execution environment.

However any restructuring (reconfiguration) which adds something new, modifies or deletes something from the system does change the coordination and communication model representing the business aspect. Consider a scenario in which a VO demands a certain level of resource stock for some task; at the domain level (abstract level) of modelling it is just a matter of adding more than one member using a construct equivalent to an Add operation. What is usually left untouched is that at the operational level it is not just the matter of a simple Add operation. The implications are that now more than one member needs to be communicated with, which implies addition of some coordination, communication and possible computation operations and a possible increase in the number of components or other concrete entities representing the elements of the underlying execution paradigm. Such complexities in the more concrete operational models are usually left out and provisions for such changes is specified at more abstract level. This approach, nonetheless plays a key role in understanding and describing systems in the early stages of system development. However, the picture remains incomplete without describing the affects of reconfigurations on the operational and communication model of the system which is closest to the actual implementation of the system.

Therefore, the modelling language for VOs should not only capture both aspects but should also provide a way to map elements defined in one aspect to another. This helps to identify what part of operational level gets affected by any reconfiguration done on its corresponding part at the domain level and how it gets affected.

C10 : Tool Support:

Modelling language should be supported by tools for different sort of analysis. One of the main reasons behind modelling systems is that the models could be evaluated and analyzed for different sort of properties. A modelling language therefore, should be aided by the tools for different sorts of analysis.

There are many existing modelling languages which have been used to specify VOs. The inherited benefit of modelling VOs in already established generic formal modelling languages is that there are readily available tools that are helpful for carrying out different sorts of analysis over models of VOs and verifying specific properties. One such example is (Jones, *et al*, 2006) which has resulted from the GOLD project (GOLD,

4. CONCLUSION

In this paper it is attempted to elaborate on particular challenges that VOs face and based on which devise a preliminary criteria that can serve to evaluate the strengths and weakness of a modelling language targeted to model VOs.

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