

# ICT services supporting virtual organization management

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## Abstract

The Virtual Organization Management toolkit (VOM) is a distributed system consisting of several partially independent modules specialized in supporting Virtual Organization (VO) manager during the operation phase of the VO. The task of the whole VOM is to assist the VO manager by monitoring performance of VO, alerting in case of upcoming or impending deviation in a VO performance, and on up-to-date data simulating alternative VO schedules and configuration to optimize the VO future performance. In this paper the architecture of the VOM toolkit is presented as well as a simple use-case.

**Keywords:** Virtual Organization, VO Management, toolkit prototype

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## 1. Introduction

This paper introduces elements of a Virtual Organization Management toolkit (VOM) developed according to generic requirements of Virtual Organizations (VO) formed by SMEs.

In a B2B e-commerce environment, collaborating partners may operate virtually as one (virtual) organization. Such an organization is able to manage opportunities that its members could not be able to do on their own. Commonly referred work of Davidow and Malone [1] from early 90's suggests the virtual corporations as the industrial strategy for the twenty-first century. Although it is innovative, it is a logical continuation of existing collaboration strategies (Walters in [2]); one of the virtual corporation concept descendants is the Virtual Organization (VO) (e.g. Jägers in [3]).

The VO is a task oriented, temporary (dissolved after the task fulfillment) consortium of mutually independent partners. Such consortium may be created within (and supported by) an organized background network of partners that have agreed to potentially participate on tasks coordinated by the other partners. Such Virtual Organization Breeding Environment (VBE) (described by Camarinha-Matos e.g. in [4]) may provide its members with information resources, and VO creation and management tools that individual members could not afford by themselves or would not ever exist without the VBE.

The management of a VO including a corresponding performance measurement (PM) is a subset of workflow management, as the workflow is defined by the WfMC<sup>1</sup> as as “*The automation of*

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<sup>1</sup> Workflow Management Coalition – organization of

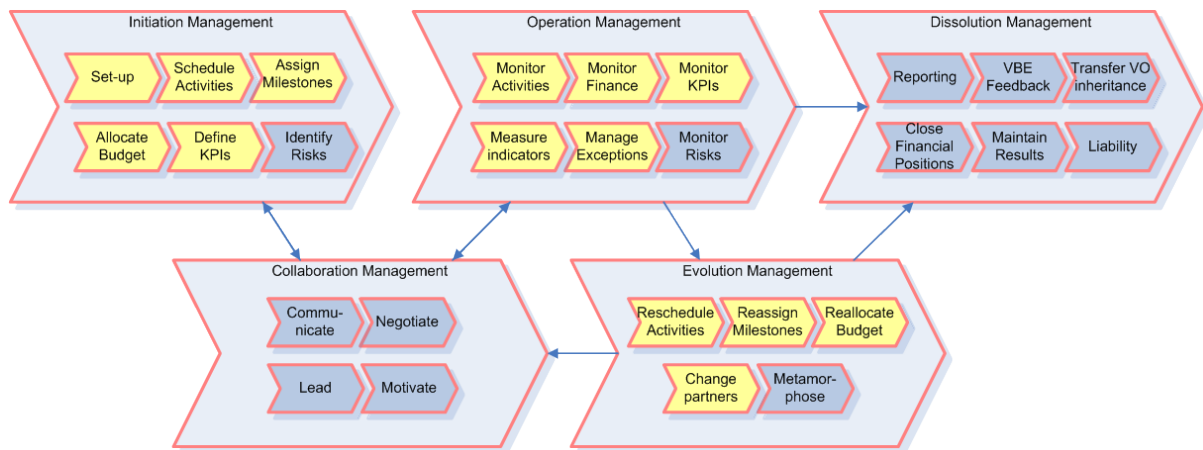


Fig. 1. VO Management Processes

a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules.” [5].

As VOs are temporary, unique organizations that usually have to be created in dynamic processes, the supporting solutions must be very flexible in order to be able to adapt quickly to the specific needs of a particular VO. Although they are well established today and several research works have been done in this area (e.g. [1,6,7], there is still a lack of software tools and services designed for the specific needs of these organizations.

Chapter 2 of this paper summarizes the VO lifecycle from the VO management point of view. Chapter 3 describes how a set (marked with bright colour in Fig. 1) of VO management processes is supported in a prototype of a VOM toolkit. Chapter 4 presents an example of the VO management scenario.

## 2. VO lifecycle

The life-cycle of a Virtual Organization consists of several phases. A number of lifecycle definitions have been already presented and all of them contain three basic phases.

- *Creation*, which is the first phase after discovering a business opportunity. During this phase the VO is formed.
- *Operation*, which contains all the value-adding processes of the VO.
- *Dissolution*, which finalizes and evaluates the VO operation and potentially opens future cooperation.

These lifecycle phases are further extended by various authors. The first main phase is the creation; this phase is aimed by most of the works. Fischer et al distinguishes two phases of a creation process. In the first phase the product is defined and the related business process is separated to partial processes; in the second phase the team of members is negotiated about and formed [8]. Extending Fischer’s work Faisst replaces the creation phase by other three phases: *identification*, *formation*, and *design* [6]. The creation phase is also extended by van Wijk et al, who define 7 steps in the VO lifecycle: *Modification of strategy*, *Co-operation strategy*, *Weigh co-operation alternatives*, *Selection of partners*, *Design and integration*, *Management*, *Dissolution and evaluation* [9].

On the other hand, there are authors like Camarinha-Matos and Afsarmanesh, who concentrate also on other phases. Their VO lifecycle contains four phases: *creation*, *operation*, *evolution*, and *dissolution* (e.g. in [7]). The evolution phase contains significant adaptations of VO that cannot be executed during the operation phase.

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researches/developers/vendors/users interested in Business Process Management)

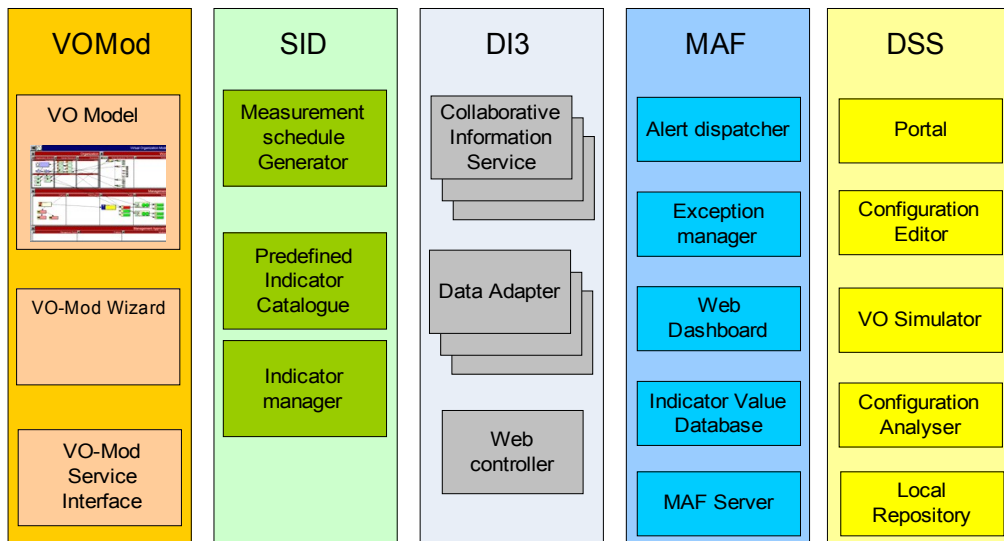


Fig. 2. VOM toolkit overall architecture

### 3. VOM architecture

The presented VO Management toolkit (VOM) is designed to create a modular, web-service oriented solution – the VOM is a distributed system consisting of several components, which are partially independent of each other. This means that the components are in principle self-contained, supporting a VO manager in particular aspects, but they are also able to work together, forming a set of collaborating services, and they are interconnected by pre-defined interfaces. The modular architecture ensures usability of the system even if some components are not present in the system and usage of any component in any other VOM. Fig. 1 gives an overview of the major management processes. Fig. 2 presents VOM components and their high level dependencies.

The VO Management toolkit consists of:

- VO-Mod (VO Modeling Environment)
  - VO-Mod is a core component of VOM. It models the structure of the contracted VO and contains all the information about the VO definition (e.g. VO topology, a detailed Work Breakdown Structure, budget elements, measurements of key performance indicators, etc.).

- SID (Supporting Indicator Definition)
  - SID is a component that provides a catalogue of pre-defined indicators and functionality to configure selected indicators for case-specific application.
- DI3 (Distributed Indicator Information Integrator)
  - DI3 is responsible for information retrieval from VO member locations according to VO management demands. It fulfills the measurement process that provides data for performance indicators.
- MAF (Monitor and Finance Functionalities)
  - MAF is a set of tools for monitoring of the VO performance during its entire lifecycle.
- DSS (Decision Support System)
  - DSS provides simulated (re)scheduling and (re)configuration of the VO.

#### 3.1. VO-Mod (VO Modeling Environment)

As a core component of VOM, the VO-Mod tool stores all the information regarding a particular VO in an information system capable of collecting all the data in a structured way. Such structured information is the basic knowledge used during the entire VO lifecycle, including performance measurement, analysis, and rescheduling.

The VO-Mod provides two basic functionalities:

- The modelling environment for setting all the specific details about each single VO member using a powerful visual interface and implementing the part of the business logic necessary for running the VO. The modelling platform is used mostly as a flexible data repository but with the advantage of providing a human oriented visual interface and a powerful way of defining formal information definitions using meta-models.
- A powerful wizard helps the VO managers in the instantiation process of a new VO. This component also provides a single point of access for handling and following the entire VO lifecycle.

### 3.2. SID (*Supported Indicator Definition*)

VO performance measurement provides essential input for VO Management. Performance indicators help to assess the state of a VO and the accomplishment of its tasks. The two main components that support the performance measurement are the SID described in this section and the DI3 that is covered by the following section.

The general objective of the SID is to assist the structured selection and management of performance indicators for the VO. Their purpose is to offer an automated pre-configuration based on the data obtained from the VO-Mod tool, e.g. the work-breakdown-structure and the VO Members.

The main functionalities of the SID are:

- A catalogue of pre-defined performance indicators that also cover the perspective of collaboration performance. The VO Management is supported in identifying and selecting suitable indicators.
- An indicator management to handle the specific indicators of a VO. The selected indicators are configured for the practical application. This covers information like the responsible VO member, the linkage to the VO's work-breakdown-structure, target definition or measurement frequency. There is also an option to analyse the cause and effect relations between different indicators. (The results can be fed back into the VO-Mod).

- The initiation of the actual measurement process. Therefore an XML-Measurement-Schedule is generated and transferred to the DI3 web-service that aims at the automated measurement of performance data.

### 3.3. DI3 (*Distributed Indicator Information Integrator*)

DI<sup>3</sup> (pronounced dee-triple-eye) is a measurement system based on interacting components situated at the locations of the VO members. DI<sup>3</sup> fetches the actual data in a configurable way as defined by the SID. Information that is retrieved from the member locations is gathered and integrated into indicator values.

Using the concept of Service Orientation, the system can be configured to provide different types of information, in different ways. This means that values can be fetched automatically from ERP systems, databases or manually, by means of emails and manual input on a web page.

DI<sup>3</sup> consists of mainly 3 components:

- An Information Service (IS), responsible for controlling the measurements and provisioning the results to the other prototype components.
- A Data Adapter, taking care of technical and semantic translations in the communication with existing systems in particular local domains.
- A Controller, enabling a proper configuration for each different partner location.

Measurement tasks are received in the form of messages and interpreted by the IS. At each member's location an IS is installed. The IS communicates with a Data Adapter, responsible for fetching actual data from a particular local system in a specific, pre-defined way. The Controller monitors the status of DI<sup>3</sup>. Through it a local system administrator (on the VO member's side) can configure an IS and attach suitable Data Adapters.

The structure of the DI3 is an answer to the requirement of VO members to provide only the data to the network level of the VO that is relevant for the partners and keep other data, especially confidential data, in the company. As the data adapters are owned by the VO members they are in control of the data flow.

### 3.3. MAF (Monitor and Finance Functionalities)

The MAF component provides a single access point for the entire monitoring process of the VO status. The system provides a complete alert system which can be used for providing a pro-active alert dispatcher for sending updated information directly to the VO members. These alerts raise specific VO exceptions that can be managed during their entire lifecycle by the MAF itself.

The MAF consists of five components:

- A repository to store the data retrieved from the VO partners during the operational phase.
- A server capable of managing and scheduling the VO updates.
- A complete set of intelligent dashboards capable of visualizing the right information to the right user.
- An alert dispatcher that performs the proactive alerting.
- An exception manager that helps the VO manager to handle problems caused by exceptions occurring during the entire lifecycle of the process.

### 3.5. DSS (Decision Support System)

The DSS mainly supports VO operational and strategic management by simulated rescheduling and reconfiguration of a VO. The simulation is one of the core functionalities of the workflow management systems [11]. It allows “what-if-analysis”, verifying and comparing various configurations, discovering possible bottlenecks, and pre-preparing potential adaptations of VO configuration and schedule.

The DSS gathers VO configuration and the latest VO operational data from the VO-Mod, or expert knowledge of the system user (VO manager). The results of simulations are used for identification of potential risks or bottlenecks of the running VO and their minimization. The outputs are presented in a “human-friendly” way to support the user when making decisions concerning possible negotiations about the VO adaptation as well as during such negotiations. More about the DSS can be found in [12].

The DSS consists of 3 functional modules:

- VO configuration editor, which allows the user to maintain the VO configuration within the

DSS. It allows editing configurations already present in the local repository of the DSS as well as creating new configurations. To get the configuration and the actual state of the VO, the editor is connected to the VO-Mod.

- An Alternative configuration analyzer, that compares selected configurations (the original VO configuration and results of the simulation). The differences are presented to the user as a set of details that should be discussed with the VO members to adapt the VO. Ability to evaluate alternative configurations is one of the most important features of the DSS.
- A simulation module, which is the core module of the DSS. It utilizes multi-agent technology, where each (existing as well as potential) VO member is represented by an agent. The employed technology allows simple configuration of each of the partner’s model resources and behavior independently of other models (agents). The VO schedule and configuration simulated adaptations are negotiated about by agents upon request and under control of the VO manager.

## 4. Scenario

During the VO creation process or before the VO operation, the VO manager sets up a VO model in the VO-Mod as the first step of using the VOM toolkit. The next step is the configuration of performance data retrieval. To do it, VO manager uses the SID to define indicators that should be monitored. The SID downloads VO configuration (WBS, team of VO members and assignment of VO members to tasks from WBS) and provides an automated pre-configuration of the indicators selected by the VO manager from the catalogue of pre-defined indicators. Then the VO manager finalizes the indicators configuration and activates the configured indicators’ Measurement Schedules. These schedules are sent to the DI3 that is responsible for data measurement and indicator calculation. During the VO operation the DI3 collects the operational data and provides MAF with values for the defined indicators. The MAF uses such data for updating the VO model in the VO-Mod. Analysing data from the VO-Mod the MAF generates information for the VO manager and VO partners about the VO performance.

During any phase after the VO-Mod is set up, the DSS may be started to simulate the VO. In the ideal case, there is no need for any change in the VO configuration or schedule during the VO lifecycle. Otherwise, DSS may download the current VO configuration and state from the VO-Mod and simulate VO schedule and configuration adaptations to provide guidelines for the ongoing negotiation on adaptation within the VO.

## 5. Conclusion and future work

Effective workflow management tools increase agility of Virtual Organizations. The tools for their management may be inherited from intra-organizational workflow management tools or newly developed to cover all specific requirements of the supported organizational concept. The VOM toolkit presented in this paper is a system that consists of several interconnected specialized modules assisting the distributed organization coordinator (VO manager) by modeling the organization, monitoring its performance, alerting in case of upcoming or impending VO performance deviation, and on up-to-date data simulating alternative VO schedules and configurations to optimize the future performance.

The next step of our work is instantiation of the VOM toolkit on the side of the real business environment operating subjects to prove the systems' features and to get feedback for finalization of the toolkit to be as much effective in the real B2B environment as possible. Our goal is to increase the business value of the VOM users by cutting their costs and response time.

## Acknowledgment

The work is (part-)funded by the European Commission's FP6 programme within the project ECOLEAD (European Collaborative Networked Organizations Leadership Initiative) (contract NO. FP6 IP 506958), and I\*PROMS Network of Excellence and the Ministry of Education.

Any opinions expressed in this paper do not necessarily reflect the views of the European Community. The Community is not liable for any use that may be made of the information contained herein.

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