3.3

VO MANAGEMENT SOLUTIONS
VO Management e-Services

Ugo Negretto[1], Jiří Hodík[2], Luboš Král[3], Wico Mulder[4], Martin Ollus[5], Lorenzo Pondrelli[6], Ingo Westphal[7]

(1) Enicma Gmbh, ugo_negretto@enicma.com
(2) Czech Technical University, Prague, Faculty of Electrical Engineering, hodik@labe.felk.cvut.cz
(3) CERTICON Corp., Applied Research, kral@certicon.cz
(4) LogicaCMG Netherlands, University of Amsterdam, wico.mulder@logicacmg.com
(5) VTT, Martin.Ollus@vtt.fi
*(6)*HSPI, *lorenzo.pondrelli@hspi.it*
(7) BIBA, Bremen, win@biba.uni-bremen.de

A virtual organization is usually considered to be a set of co-operating independent entities, which to the outside world provides a set of services and functionality as if they were one organization. Virtual organization management denotes the organisation, allocation and co-ordination of resources and their activities as well as their inter-organisational dependencies to achieve the objectives within the required time, cost and quality frame. Collaboration and management therefore have to be tackled by provision of adequate methods and services for the single users involved, in dependence of their roles and profiles within the network. Based on the outlined results described in the previous 2 Chapters the following chapter concentrates on the description of e-Services as Solutions for Virtual Organization management.

1. VIRTUAL ORGANIZATION MANAGEMENT SOLUTIONS

1.1 Introduction

As outlined previously in this book Virtual Organisations encompass a wide range of typologies in structure, topology, time span as well as life cycle phase coverage (Karvonen *et al.,* 2005). Even though specific categories of VOs are more and more understood (i.e. supply chains, extended enterprises and other types of Networks) and systematically supported by dedicated methods and tools, the "Management" of their operations in terms of fostering the coordinated target achievement is still in its beginnings. Although several projects like THINKcreative (www.thinkcreative.org) and Globemen (http://globemen.vtt.fi) produced concepts such as e.g. VERAM (Toelle M, 2004) and sometimes ICT platforms, still the Management of generic VOs is seldom systematically researched and tools for a coordinated support of operation initiation and monitoring are not available off the shelf. VO Management is not about the management of the constituent Members themselves.

The real challenge for VO Management resides in the ability to handle distributed operations in independent but interdependent organizations with their own aim, behaviour and culture. This means that the VO Management must relay on co-ordination to reach the objectives of the VO

- Without forcing power (at least as a normal rule)
- Through creating trust and considering risks
- Often acting on incomplete information.

The inter-organizational supervision, control and coordination of the activities and resources in a VO are the main tasks of the Manager. The ability of supervising the behaviour of a single business process enables synchronization and orchestration of the VO by adapting and optimizing the complete distributed business process. VO Management receives data and information of the status of the VO operation. Actions are based on comparison of the actual achieved or estimated behavior compared to the wanted behavior. The actions are supposed to be proactive in order to avoid also emerging deviations from the expected outcome. In a very dynamic environment this requires the development of an set of dedicated supporting services running on a common platform accessible from every partner of the network.

The previous chapters (3.1 and 3.2) described results from Virtual Organizations (VO) management achieved both from conceptual, as well as methodological side. This chapter concentrates on achievements reached in the development of e-Services and tools based on the presented concepts and methods. In the context of prototype development, a suite of VO management tools was developed within the ECOLEAD project. This suite supports the VO manager in managing the VO throughout its lifecycle *Instantiation – Operation – Evolution – Dissolution.*

Several processes and activities related to management, occurring from the instantiation until the dissolution of a VO, could be addressed, as is shown in Figure 1. It will be shown that a comprehensive transformation from previously elaborated methodologies into tools and e-Services was accomplished. Moreover, an integrative platform was defined and developed, open to accommodate additional services in the future. This openness relies on the use of common standards and on the foreseen integration options of the VO management tools. This chapter provides an overview of solutions for VO management taking the business and user view as main guideline.

To support the business related view, usage oriented descriptions of e-Services covering business processes are provided.

1.2 VO Management e-Services

The elaboration and definition of concepts and methods was targeted to allow a holistic VO management. Having succeeded in the theoretical approach, the aim was to proof these concepts by developing an integrated set of software tools supporting VO management tasks.

The development has reached a stage of completion, whereby most of the elaborated methods have been transformed into working prototypes, validated in pilot networks. The platform, as it is, consists of different tools providing specific functionalities for the VO management. The tools can be configured to collaborate

and exchange data to fulfill higher needs of the VO management. Based on the needs, VO specific configurations can be applied and described as business oriented VO management e-Services. They support collaboration between stakeholders in different situations and related to different processes. Using the integrated VO platform and its dashboard, they are configured for the individual VO from a set of tools realized as web services.

The e-Services are independently deployable in different VO contexts and they can cover different VO management aspects. The e-Services and their realizations are described within this chapter explaining the business context and the use of the services in this context. In Figure 1, the basic VO management processes are given, those supported by the developed tools are indicated in green, and the processes in yellow need further development. The provided e-Services are aligned to these processes.

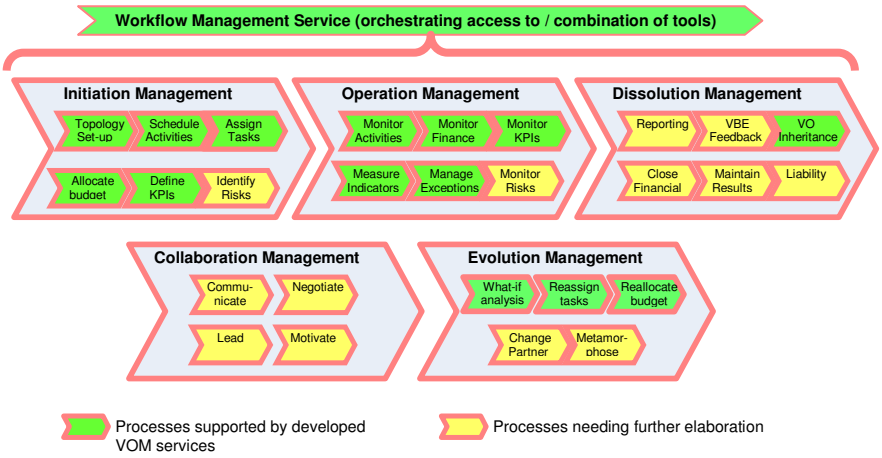


Figure 1: The VO management Processes

As shown in Fig. 1, the services within the block "Collaboration Management" is an area for further work, especially, in the area of managing and supporting collaboration between people. At the present stage of VO management Solutions, the collaboration support was based on tools available on the market (VoIP, groupware, etc.) or developed in the context of complementary work described in other chapters of this book, e.g. the agreement negotiation wizard (chapter 2.6).

2. FUNCTIONALITY OF VO MANAGEMENT SERVICES

In the previous chapter 3.1 of this book, a performance measurement based, real-time management approach was suggested and in chapter 3.2, the related performance measurement was described. The VO manager should be supported in the task of managing a specific case or instance, of a virtual organization. A common operational runtime environment is proposed for that purpose. In this

environment, individual management services can be configured to fit VO specific needs from a set of parameterized and configurable services.

The developed solution encompasses:

- A common management approach/methodology for all VOs and
- The configuration of the operational environment for each VO instance

Despite the diversity of the cases in task complexity, participant's cooperation skills, ICT integration etc., the provided platform proved to be suited to accommodate the needs of different networks used as pilots.

In some cases, the configuration task only needs some basic features and a simple instantiation process, without customization or integration with an own environment. It is proven that adoption of supporting mechanisms highly depends on the adequateness of the solutions to the problem in question. In these cases, the VO management platform would provide simple and basic process support. However, to ensure coverage of increasing VO management needs due to evolution of the VO environment itself or other reasons, the platform had to be based on a common but expandable concept.

The VO management functions are configured from the following services:

- VO management workflow support
- VO model development and management
- VO Indicator Identification and Definition
- VO automatic integrated performance measurement
- VO monitoring and exception management support
- VO simulation and decision support
- VO inheritance support

The center for the management is a model, which is defined as the common representation of the VO and its management approach. To allow setting up the VO Model and the supporting environment for the manager, a web user interface was developed, the VO-Mod Wizard. It provides a single entry point for the VO manager and other stakeholders to import, define and modify relevant data. It also allows them to instantiate the specific VO model, to configure parameters for monitoring and management and to support and manage the VO operation.

In the following subsections, the functionality of the services is described and section 3 gives descriptions of their realization.

2.1 VO Management Support

2.1.1 e-Service: VO management workflow support

The workflow for the tasks to be performed by the VO forms the basis for the VO management (Jansson et al, 2005, Hodik et al., 2007). Macro-processes and specific activities have been defined and developed as starting point for the identification of the correct workflow. The VO *management workflow support* aims at giving a

comprehensive solution to the VO manager to monitor and supervise all activities throughout the entire VO lifecycle.

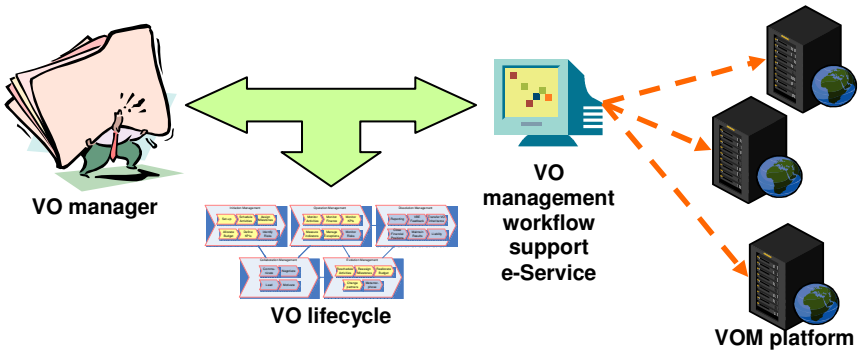


Figure 2: VO management workflow supports e-Service business context

A central user interface, the VO-Mod Wizard, was developed to provide both support for the initiation phase as well as a govern centre to enter dedicated e-Services and toggle in between them at managements need. Figure 3 shows the user interface to the VO management process. The user can navigate via the interface and access either all or only specific tools needed for the activity in course. Single activities with similar functionalities are collected in macro-processes representing the main phases of the VO lifecycle.

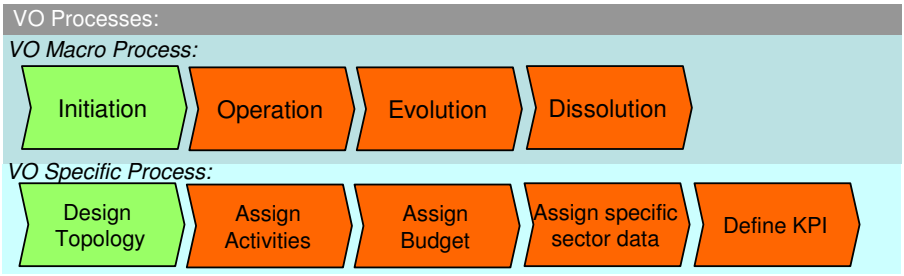


Figure 3: VO-Mod Wizard interface for following the VO lifecycle

The VO-Mod Wizard also provides links to external components:

- The VO model library to allow the management of different models simultaneously
- The VO-Mod Web service framework used to publish to external tools VO models information
- The performance measurement functions in order to share information about the VO performance indicators during the definition of Key Performance Indicators (KPIs) for the specific VO in question

2.2 Initiation Management

2.2.1 e-Service: VO model development and management

Supported by the VO-Mod tool, the VO manager uses this e-Service in order to define VO models of the Virtual Organizations to be managed. Using the components of the VO management, the user can describe the information concerning each single VO instance and manage the collection of these models in a coherent and flexible structure.

Guidelines for the definition of the basic VO information using a VO model schema are provided for the user. Figure 4 explains the workflow of the VO manager, who has to collect information from the VO partners in order to both setup the VO and manage the operations.

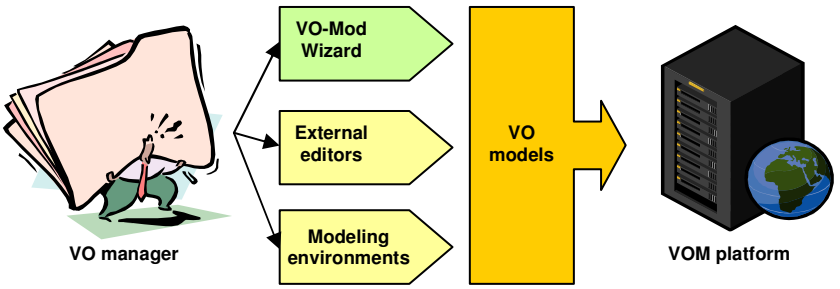


Figure 4: VO model development and management e-Service business context

In this context, the VO model management e-Service provides the VO manager with the instruments to collect VO information in a structured and reusable way, and to import data from external tools and applications. The main component involved in this service is the VO-Mod framework. It is composed by schemas of the main VO concepts, user interfaces for dealing with the instantiation and modification of the VO models, as well as Web services interfaces to allow information sharing with external systems. The main user of the environment is the VO manager, who can use the VO-Mod Wizard to perform the instantiation of the VO models and the management of the VO models library. If needed, external tools can be used to customize the models.

The Wizard provides support for the definition of the basic VO information:

- VO topology
- Work Breakdown Structure
- Budget
- Specific information can be added to this basic structure in order to cover the needs of a particular VO.

In relation to Fig.1 this e-Service covers:

2.2.2 e-Service: Identification and Definition of VO-indicators

The VO-Mod Wizard provides a simple option to allocate Performance Indicators to be considered in the specific VO. Whenever a need for more advanced definitions of performance indicators is requested, a service supports the VO manager in identifying the most appropriate performance indicators, specifying measured metrics, measurement frequencies, calculation rules, provision rules etc. The service also supports the definition of the operational procedures for automated measurements.

The support is based on a catalogue of pre-defined indicators, in which the VO manager can search for indicators that match the specific requirements of a specific VO and select them. The catalogue service can be used either by accessing the corresponding web page with a browser or via web service access. According to given application parameters, the web service provides a suggestion of potentially suitable pre-defined indicators.

Another service to support the initiation management is the configuration of selected generic indicators. To define and configure these indicators for the application in a particular VO, two possibilities are available:

- To select a particular indicator from the catalogue and assign it to a particular Work breakdown structure (WBS) tasks in the configuration function of the service
- To select certain indicators as standard indicators that should be considered for all WBS tasks. The provided auto-generate function creates these VO indicators for all WBS tasks and pre-configures them.

Information regarding VO members, WBS and KPI needed by the services is gathered and exchanged with the VO-Mod Web services framework.

In relation to Fig.1 this e-Service covers:

2.3 Operation Management

2.3.1 e-Service: VO Automatic Integrated Performance Measurement

To fulfill required management functions, the VO manager needs a sound information basis providing relevant information. The VO performance measurement service takes care of an essential part of this task.

In the instantiation phase, the relevant and valuable KPIs were defined. During the operational phase, the corresponding data has to be measured and calculated to determine the defined indicators. The experience from several networks shows, that "measurement" information in many cases is collected via telephone calls and mails. However, this is both time consuming and error prone for all involved parties. Therefore, a service for integrated measurement of data for VOs has been developed.

The measurement collection service is based on the measurement configuration, which defines metrics, measurement points, measurement frequency, calculation rule, provision rule for the data etc. Figure 5 indicates the measurement activities from measurement set-up to operative automatic measurements.

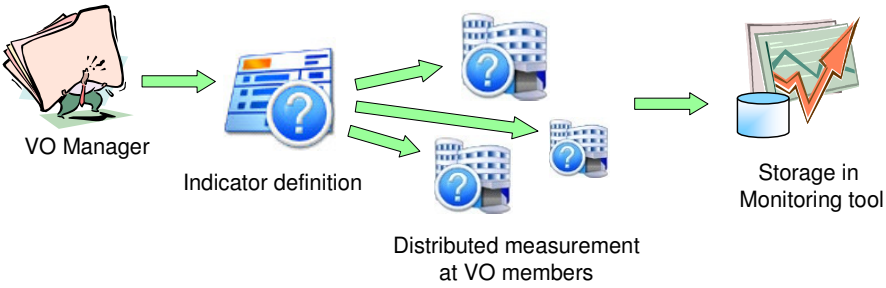
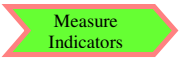


Figure 5: Automated measurement of VO indicators

The VO manager uses the measurement services via the monitoring services to have an overview of the status and to manage the VO.

In relation to Fig.1 this e-Service covers:



2.3.2 e-Service: VO monitoring and exception management support

The context of Virtual Organizations adds complexity to the common management activities due to the fact that the VO manager has to deal with multiple environments, different backgrounds and several frameworks at the same time. In this context, the control requires a clear view on the actual status. Consequently, the status monitoring of the VO is a key service needed to manage the VO and to identify and handle possible exceptions during the entire VO operational phase.

Most of the effort, spent in the set-up of the VO modeling and configure specific performance indicators, is devoted to the VO monitoring activities. Several components of the developed tools are, involved in the VO monitoring e-Service.

Figure 6 shows the context in which the VO manager can use the VO monitoring and exception management e-Service. An active monitoring support is provided to the VO manager by a complete set of tools, called the MAF platform, which is able to provide specific instruments for collecting raw performance data directly from the VO partners to be joined with management status information from the VO manager, in order to obtain a complete overview of the actual VO situation. This global overview feeds a proactive monitoring system, which supports actively the VO manager in the monitoring activities.

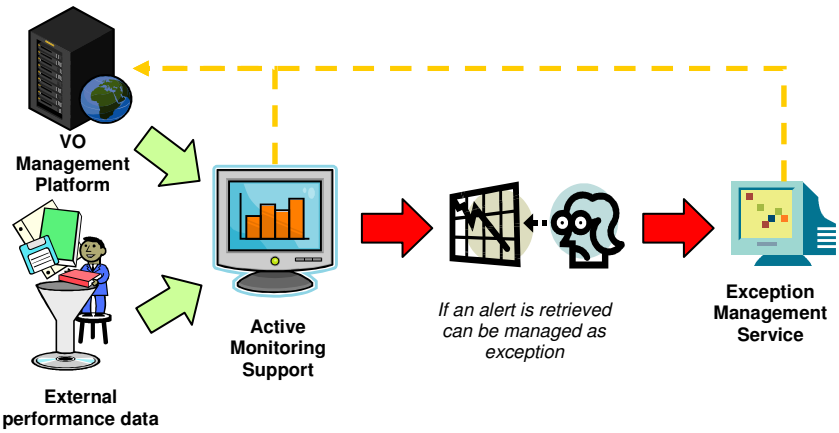


Figure 6: The VO monitoring and exception management e-Service

All alerts and warnings are collected in a coherent way and have been used to increase the knowledge base about each single VO and to engage automatically the partners involved in these problematic situations. The joint usage of these tools is driven by the VO-Mod Wizard, which guides the VO manager in all the steps needed to accomplish the model alignment and the alerts check.

In relation to Fig.1 this e-Service covers:

2.3.3 VO Qualitative monitoring

The VO manager may wish to establish a procedure for monitoring the internal state of the VO. VO qualitative monitoring is the collection and analysis of qualitative aspects which affect the performance of a VO. These qualitative factors include items like VO partner satisfaction, commitment and motivation. They do not typically have an immediate influence on the VO performance, but the effects develop gradually and can be seen in the quantitative performance measurements only in delay.

In relation to Fig.1 this e-Service covers:

2.4 Evolution Management

2.4.1 e-Service: VO simulation and decision support

For a long time, modeling and simulation have been used to support organizations in their value-adding activities e.g. for scheduling and rescheduling, optimizing the

production plan before the production itself is started and for finding solutions during the operation when the original plan cannot be kept (Haifeng and Yushun, 2003). This e-Service provides the VO manager with simulation of possible future performance of the VO by comparing various events and behaviors of the VO members. Such simulations and what-if analyses support the VO manager in judging possible needs for rescheduling or reconfiguration of the VO. The analyses also support discovering potential bottlenecks and help in search for possibilities of their removing.

The simulation contains two partially independent levels: the VO manager level, where the global schedule of the VO is created, and the VO members' level, where members' local schedules are created. Such architecture copies structure of VOs, which consists of one VO manager and team of, by that leader, coordinated members. The simulation is based on the state of the system as it is and the simulation provides the state how it could be. The decision making process uses the simulation to generate various possible futures, which are generated according to configured constraints. The simulation consists of three main processes, which are:

- Process of the Simulation Configuration
- Process of the Simulated VO Performance
- Process of the Simulation Evaluation

During the first process, the simulation is configured. It consists of collecting actual operational data of the VO and set of various events and behaviors of the VO members to be simulated defined by the VO manager. Then the simulated rescheduling is executed as many times as required and finally the simulation results are collected and evaluated. The final decision about the VO schedule and configuration adaptations are up to the VO manager

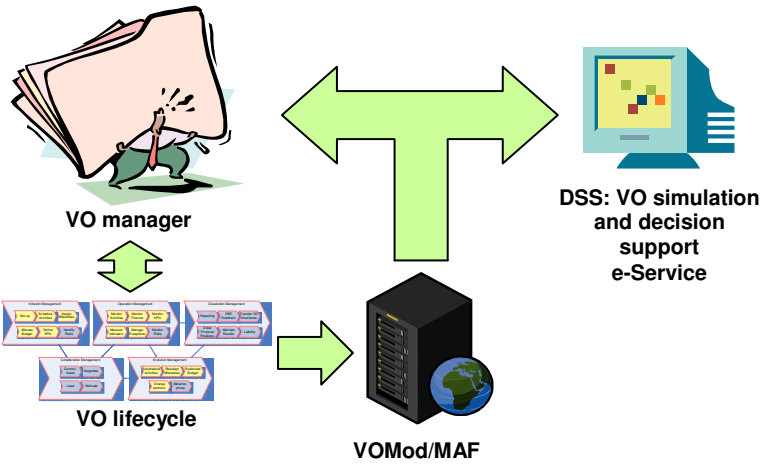


Figure 7: Business context of VO simulation and decision support e-Service

The figure 7 displays the information flow in case of application the e-Service of VO simulation and decision support. The actual VO operation data are collected at

run-time (Hodik et al., 2007) and processed by the developed Decision Support System -DSS (Hodík and Stach, 2008, Hodík et al., 2007). The results are presented to the VO manager, who decides about needed interventions on the VO.

In relation to Fig.1 this e-Service covers:

2.5 Dissolution Management

2.5.1 e-Service: VO inheritance support

Because a VO is created from a VBE, there is in many cases needs to have a feed-back about the performance and the success of the VO. The feed-back information could be used by future VOs for marketing purposes, for partner selection, as a basis for planning or for other tasks, where it is important to regard previous experiences of VOs.

To facilitate this performance feed-back, services to support inheritance have been developed. The VO manager can use them to transfer VO model data, as well as VO indicator data, to the VBE. The service for the VO indicator values is realized in two steps. First the VO manager has to define in the indicator management which VO indicators data should be transferred to the VBE. Based on these definitions, the inheritance procedure can start and collect all stored values of the corresponding indicators and calculates the relevant data that is provided to the VBE, as is illustrated in figure 8.

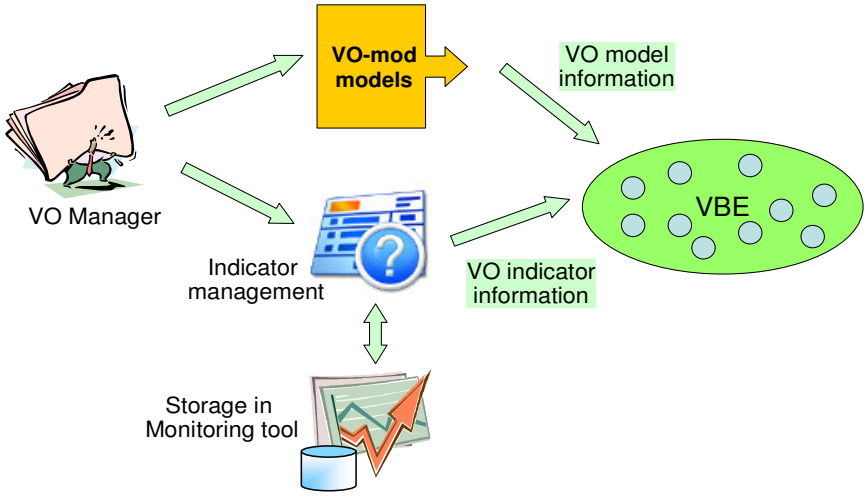


Figure 8: Inheriting model and performance data from VO to VBE

In relation to Fig.1 this e-Service covers:

3. REALIZATION OF VO MANAGEMENT e-SERVICES

3.1 Main components of the VO management services

The VO management support is realized as a distributed system consisting of several, partially independent, services and modules specialized for various tasks in order to fulfill the functions specified in the previous sections. The developed services and modules and their relationship are illustrated in figure 9.

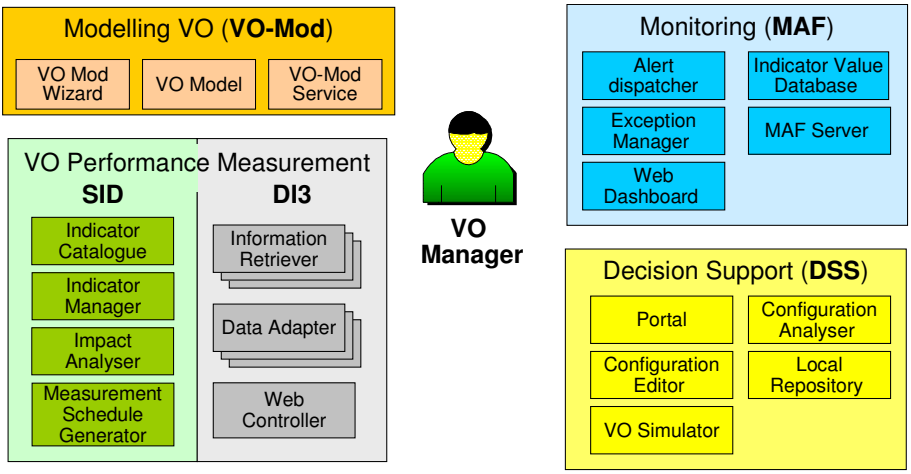


Figure 9: Component diagram of VO management toolkit

In the figure 9, the different components in the toolset are also indicated:

- VO-Mod (VO Modeling Environment)
  VO-Mod is a core component of the VO management. 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.

To give a better understanding on how the VO manager is supported in his daily tasks the following sections gives an outline in the typical tasks and situations a VO

manager is confronted with and needs to solve. First the set up of a VO is described and in the following the operational management of running VOs is shown.

3.2 Activities and support of the VO manager for the VO set up

The basic initiation procedure was explained in the previous section 2.2. In addition to this the VO Manager might have to adapt or define the basic parameters used by the monitoring eService. This has to be done specifically to each VO instance since what could be considered an exception in one case could be a normal value in another case. Of course when tasks and network settings do not vary much from one VO to the other the necessity to change alerting levels or rules might not be necessary.

The need for the VO Manager is to retrieve not only single measurements of the selected KPI's but "sensible" information about the actual status of the VO (Westphal et al., 2007). Therefore alerting rules and thresholds have to be defined by the VO manager (see Fig. 10). These alerting rules will trigger warning messages during the pro-active monitoring and support a management-by-exception driven approach.

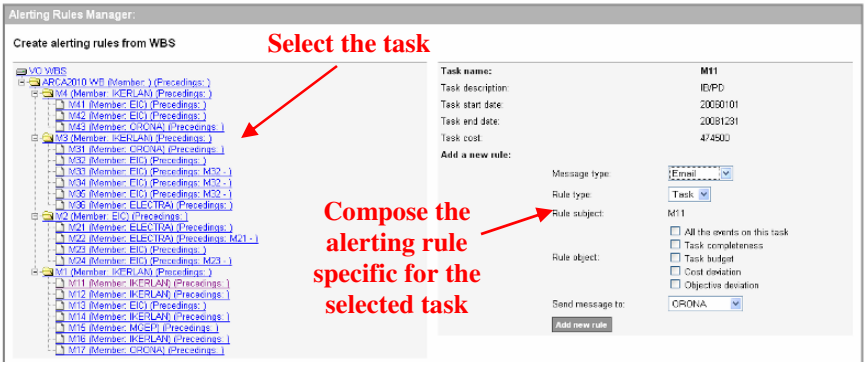


Figure 10: Creation of alerting rules and thresholds

3.3 Activities and support of the VO manager for the VO operation

The likely first task of the VO Manager when arriving at the office is to check the status of the VO (or more VOs if he manages more than one simultaneously). Therefore he starts the VO management environment: the MAF Web Dashboard. This Dashboard provides a general overview of the VO status, as shown in Fig. 11. In a single window the possible problems and the deviations from the planned KPIs, the budget and the completeness for all running tasks is displayed. The VO manager clearly understands the overall situation immediately by using the green/yellow/red traffic light system. In case more detailed information is needed the GUI allows drilling down and retrieving more accurate knowledge about possible issues and alerts.

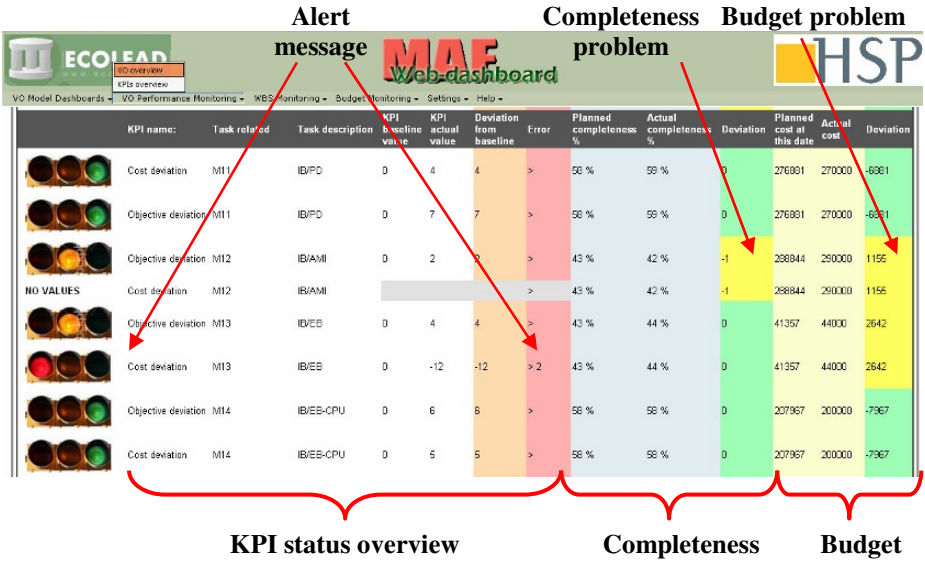


Figure 11: VO status overview highlighting current issues

The VO manager quickly scans the current situation. Since he sees that some partners did not completely update the information feedback requested the day before, he uses the indicator service to launch another information request. Although the distributed measurement service is still running, an extra request for information, this time via emails is now being send out.

While waiting he also checks the alert monitor to ensure a complete understanding before starting to take actions. From the Alert Monitor two issues are reported.

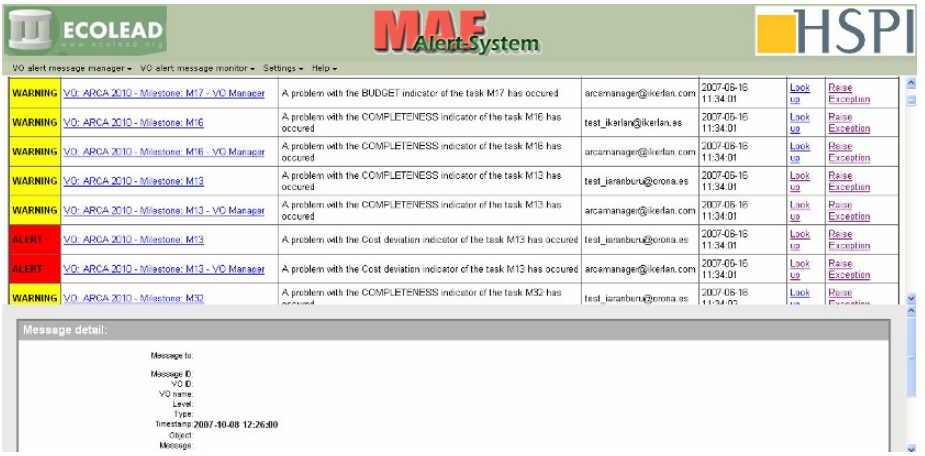


Figure 12: Alert monitor

After some time the single VO members answer to the request and the results are displayed to the VO manager.

Finally it is clear that one value exceeds the expected limit. The VO manager calls the partner asking for the reason of the issue. The partner reports serious problems and that he is not able to accomplish the task. The VO manager has now the problem to find an alternative production path and/or a suitable VO member.

For that he invokes the e-Service of VO simulation and decision support. To start reasoning about alternatives first the actual VO status is loaded (Fig. 12).

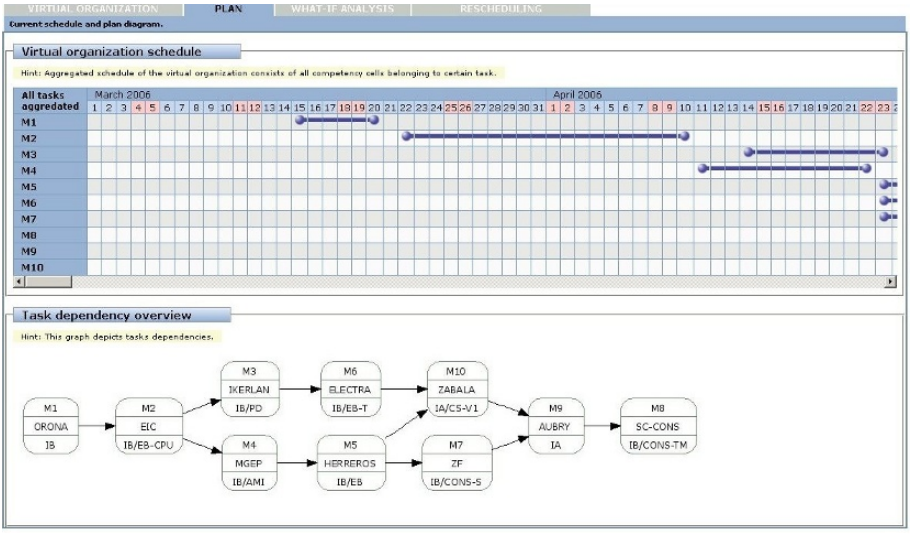


Figure 12: DSS-plan

The VO manager may choose to try manual adaptation of the VO configuration or schedule, semi-automated rescheduling of actual VO configuration, or simulation of future performance including injection of simulated events influencing the VO performance.

In all these cases the VO manager may manually modify resources of VO members dedicated to the VO as well as include new VO members into the consortium (Fig. 13). Doing that the VO manager may prove if alternative resources not used for the VO would help in its performance. Such resources could either be those contractually foreseen from the VO members as well as estimations of the VO manager, which would need a check of feasibility before really being considered. After simulation as well as during manual or semi-automated adaptation of the VO schedule and configuration the VO manager may evaluate actual modified state of the VO according to real state of the VO

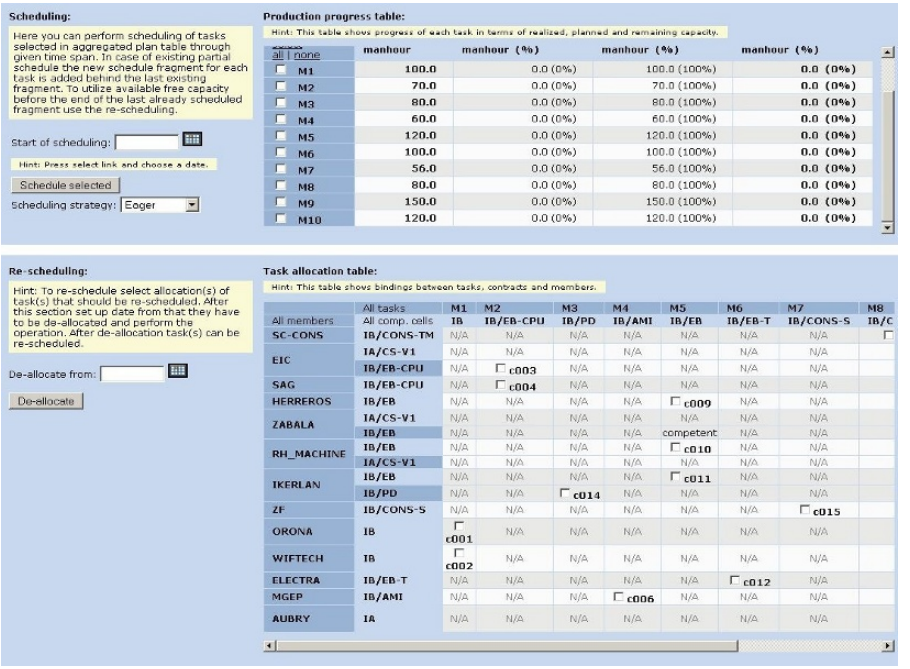


Figure 13: DSS-resources

The evaluation consists of three components. The first component provides a simple graphic overview of the original and final schedule. The second component concentrates to changes of overall VO start and end dates, if the modified schedule is fully covering all the requests for resources, and if they are provided in an appropriate time. This component also provides an overview of each task schedule and each VO member involvement. For the tasks the respective start and end dates are compared as well as an efficiency of the assigned time slot utilization. The member involvement overview presents a list of tasks in which they participate and their workload and day load over the all VO.

3.4 First application cases

The developed tools for the VO management have been evaluated in real business cases in three SME networks, which are partners in the ECOLEAD project. The results of this effort are reported separately. In this context the cases are only shortly described.

The *Virtual Factory* is a network of industrial SMEs. The network provides a full range of industrial services and production to the customers. The network enables the SMEs to act in collaboration with other SMEs in the same way as a very big industrial company. The "Backbone" of the Virtual Factory is a coordinated organization and information infrastructure; this is an obligatory standard for all groups. Thus VF brings knowledge and information in place – timelessly and purposefully to the application. Success in the market is realized by the activities of every individual partner of the Virtual Factory. The network aims to show the

impact for VO management in terms of efficiency, speed and overview of the progress of all relevant data of a VO.

Supply Network Shannon (SNS) is an open network of companies in the Shannon region of Ireland. SNS provides a framework for companies to collaborate in joint marketing, training development and collaborative quotation development for participation in outsourcing networks. As such SNS currently operates as a regional VBE with individual members currently creating sub networks on a global scale. Presently these networks are formed using ad hoc processes, which are very much dependent on the networking companies' own structures. This leads to unstructured and ad hoc VO management, which again is closely linked to the participating VO member's normal operating procedures. The main SNS implementation activities for the ECOLEAD project are based upon the introduction of the structured VO management techniques to assist with the control and coordination of existing VOs in the network. This will include the use of the VO-Model to maintain structured information about the VO, particularly in relation to the work breakdown structure, the individual management styles used in the network and the structured measurement of some VO performance indicators.

ORONA stands as the Spanish leading company in the lift industry and belongs to the MCC, one of the leading business groups (made of 220 companies & entities) in Spain. OIN, promoted by ORONA in 2002, is a research consortium supported by a network of experts (coming from universities, RTD Centers, companies in the sector, etc.), working in multidisciplinary and multi-company communities that centered their activity in:

- the discovery of new technological opportunities,
- the translation of said opportunities into innovative product ideas for short-distance transportation.

The final objective is to guarantee its independence and its position close behind the leaders of the sector through the promotion of the technological capacity and the competitiveness of the own product innovation. ORONA aims to use the VO management tools to monitor and manage the performance of the activities in the research consortium OIN.

4. CONCLUSIONS

The area of real time VO management has been tackled by developing comprehensive e-Services, based on a methodology and a supporting set of tools. In this chapter the functionality and the realization of these services have been described.

The proof-of-concept was done via iterative validation steps involving finally three SME partner networks as target user group. The tools and e-Services have reached a good prototype state and include also sound and tested user interfaces. The development of the individual tools is completed, although integration efforts, failure debugging and user friendliness efforts still continue.

Each e-Service for VO Management was developed based on the common concept outlined in Chap. 3.1 and following state of Art technology.

Single innovative aspects were integrated in each single service. The main innovation relies in the comprehensive set of e-Services dedicated to VO Management, encompassing the main functions to be supported and at the same time being based on a common conceptual and data model. Especially to be noted is the scalability and configurability of each service. This enables the capability to support simple VOs with simple management and monitoring means and more complex VOs with more sophisticated rules and functions for the VO manager.

The ongoing proof of concept within the partner networks will be used to communicate results and take-up options to other SME networks. Through the performed work, a foundation has been laid to allow and foster further exploitation both in a commercial as well as in the research arena.

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