A Decision and Transparency Support Service for Moderation Management of Virtual Enterprises in Collaborative Networks

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Abstract
Successful management of collaborative business in company networks calls for efficient moderator processes in assigning companies to a particular request. The moderator makes configuration decisions that generate a Virtual Enterprise (VE) as a set of companies from the network members. Alternative configurations are evaluated and the most fitting VE configuration is chosen. The moderator is furthermore required to make the configuration decisions transparent in order to achieve decision acceptance by the network members. We present corresponding information technology based services that allow moderators to meet these requirements by supporting the decision making as well as supporting the distribution of the corresponding decision information. The decision support service computes ranked configuration alternatives according to a given search profile. The transparency support service generates decision explanations which contain the rationale behind the final decision as well as both the aggregated decision information and individualized data directed towards the single company.

1. Introduction
The concept of the virtual corporation evolved about 15 years ago [8]. The virtuality is launched from collaborative networks [3, 9] in which companies come together to jointly act on the market in a well coordinated manner by (after a selection process) forming suitable temporary virtual enterprises. The concepts of networking and collaboration have been promoted as a successful approach when dealing with the present business challenges especially for small and medium sized enterprises (SMEs). Parts of the hypothesis and theory behind this recommendation of collaboration are based on the theory and analysis of successful industrial clusters [17]. Interestingly the vehicle for stronger global awareness goes hand in hand with regional collaboration. More recent research on virtual organizations includes the ECOLEAD Project [4] which is targeted at new frameworks, methodologies, and tools for the present and also the future networking practice. Among others the preliminary results of ECOLEAD include the concept of virtual organization breeding environment as a sort of basic-level collaborative environment. This environment is being especially prepared to enable fast virtual organization creation processes so that companies may quickly get engaged in collaboration processes to meet business opportunities. The general objective of such technology-mediated communication support is to deal with the coordination and control tasks implied by the collaborative networks [14].

For the coordination of such collaborative business processes in collaborative networks and also the handling of general administrative and strategic network management tasks an authority has been suggested [12, 16, 19]. We refer to this managing authority as the network moderator or moderator in the form of a person. The moderator role is well known from early internet research into email list servers [13] and also the area of computer supported collaborative work [18]. In collaborative networks the moderator is often an elected person from one of the member companies or from outside the network to whom responsibilities and power is given according to the agreed network regulations.

Successful coordination and management of collaborative business processes requires effective company selection processes for building virtual enterprises. Consider in this context that network members naturally tend to demand as many as possible participations in virtual enterprises. Depending on the competencies of the network members this demand can lead to competitive situations where the moderator needs to make a choice from a set of alternative companies. Therefore, a sophisticated decision problem is imposed to the moderator by each individual selection process where many different selection criteria and constraints are to be addressed. Human moderators can easily be over-challenged by these decision problems which will lead to virtual enterprises that only fit little to or even conflict with
the actual needs of the network. Such inappropriate decisions especially if they occur repeatedly can jeopardize the loyalty and collaboration spirit of the network members and thus endanger an open and trustful collaboration climate within the overall network. As described in [14] business trust is one of the key factors of success for collaborative networks. In the worst case the network can even fall apart as a result of such inappropriate selection decisions. In addition to this dependency between selection decisions and the collaboration climate within the network the communication measures that are chosen for the evaluation of these decisions within the network will also affect the collaboration climate. Consider in this context that each selection decision divides the network in members that are included and others that are excluded from the virtual enterprise to be formed. Obviously if the network members are not informed explicitly about the decisions or if the communication is imperfectly performed it is unlikely that the decisions become well accepted within the network. If selection decisions frequently are not well enough accepted by the network members, as a possible result one may observe a low acceptance of the moderator and the overall network, respectively.

This article presents results of our research on new concepts for effective ICT based coordination and management of virtual enterprises in moderated collaborative networks. In this context we especially consider new services that intend both to improve the effectiveness of coordination and the maintenance of the collaboration climate. The current focal point is on support services for moderators that address the decision making and communication task as described above. First of all, our decision support service enables moderators to perform the selection decisions effectively. The service provides the moderator with the possibility to start from an initial search profile for a virtual enterprise for which a ranked set of configuration alternatives is generated. By performing several iterations with modified search profiles the problem space is explored and more and more assurance about the choice of the best fitting virtual enterprise is gained and thus support for the moderator’s final decision is accumulated. Note that the search criteria of the search profile apart from company related criteria also contain criteria that refer to the network as a whole. These criteria are especially useful when addressing the more long term strategic goals and policies of the network such as an equal revenue distribution between the participating companies within the network.

Secondly, our transparency support service allows for an automated completion of the moderator’s communication task. When a proposed virtual enterprise configuration alternative is chosen from the result list of the decision support service the moderator can instruct the transparency support service to generate and distribute within the network data rich decision explanations. These explanations contain comprehensive background information about the decisions including information about the anticipated impact of the decision on the network and the company. The explanations not only inform about the rationale for each selection decision they also contain data that is useful for benchmarking as well as for the strategic alignment of the company to the network. Both services are based on a comprehensive data repository on which complex data analyses are performed.

The overall framework of our research has been the internationally funded eBusCo.net project (Electronic Business in Company Networks) [21]. We intend to integrate the proposed services into available and forthcoming platforms for collaborative networks. Furthermore, the project also includes an empirical survey [20] with focus on ICT readiness and networking maturity amongst SME companies in the production industry of the KERN region of Northern Germany and the region of Southern Denmark. Some more practical insights for company networks are gained by observations in two existing company networks and with the active involvement of two regional business development agencies as well as some qualitative studies within single companies.

In our article this first introductory section is followed by a section presenting a more comprehensive investigation of the particular tasks of network moderators addressed in our research. The third section introduces our proposed services and section four describes details and examples for the decision explanations. A system architecture and implementation details for a first prototype of the services are presented in section five. Section six discusses related work while some concluding remarks are given in section seven.

2. Investigation of Moderator Tasks

The decision making tasks of moderators of collaborative networks include the configuration of specific subsets of the network members that form temporary alliances regarded as Virtual Enterprises (VE). The moderator is called to perform this task for every new business request for which a collaborative request handling within the network is demanded. Naturally, it is a primary goal of this task to configure a VE that precisely fits to the request. Therefore, the companies’ profiles and competences, resource utiliza-
tion states, and other company specific criteria as well as criteria that relate to the network as a whole are to be considered in this task. For this reason, the configuration of a VE imposes to the moderator a complex multi-criteria decision problem [21]. To be considered in the context of this problem are hard and soft selection criteria that relate to single network members. But also criteria that relate to the network as a whole need to be considered. Not only are the number of selection criteria increasing with the size of the network; the number and complexity of the offered products, and the number of interdependencies between the network members such as overlapping competences between companies are also growing fast. Furthermore, the criterions’ relevance for the VE configuration are also changing over time as a result of market changes but also changes in the relations among the network members.

As a response to the high degree of complexity of the VE configuration task specialized decision support services have been proposed by different groups [2, 4, 15]. An overview of our own approach to such a service is given in Section 3.

It lies in the human nature that members of collaborative networks will feel uncomfortable if configuration decisions concerning VEs are not communicated in a way that is regarded as robust decision downloading [5]. By this notion a mode of communication is conceptualized where the following information about decisions will be conveyed to those who have not been directly involved in the decision making process: 1) how and why the decision was made, 2) what alternatives were considered, 3) how the decision fits with the organizational mission, 4) how the decision impacts the organization and employees. Making available these information items that explain VE configuration decisions will lead to better decision transparency and acceptance.

Research on organizational justice has shown that robust decision downloading will lead to a number of advantages with respect to implications on individual employees. These advantages include a stronger support of and commitment to the organization, a higher identity with the organization, and an employee perception that the organization is well managed and headed in the right direction [5]. It is a hypothesis of our research that these findings are to a large extent valid to decision making in collaborative networks, too. We assume that the members of such networks, i.e. companies of typically smaller and medium size, can be compared to the individual employees in the classical decision downloading context.

For obvious reasons robust decision downloading in collaborative networks is especially useful for decisions that influence the network members’ economic situation. This condition holds true for the configuration of VEs that in general imply a separation of the network members into two groups. On the one side there is the group of members that will benefit from the decision because they will be assigned to work on a business and thus experience or at least expect a revenue opportunity. And on the other hand there is the group of network members that cannot expect benefit from the decision because they are not selected to participate in the VE. The group of non-benefiters can be further divided into network members that for more obvious reasons have not become a member of the VE. For example, they might not offer any service or product needed for the fulfillment of the business request. However, the group of non-benefiters can also consist of companies that offer exactly the services and products needed and that have been considered for the VE but for other less obvious reasons have not been selected for the VE. For example, they might have participated in many previous VEs or they might have been explicitly excluded as potential collaboration partners by other members that are definitely needed for the VE.

Understanding the reasons for VE configuration decisions can require a complicated decision analysis including a projection into a future status of the network as a whole.

In terms of the above discussed two groups of network members communicating VE configuration decisions properly is especially demanded by the group of non-benefiters. In our view a proper communication mode will contribute to a broad acceptance for the configuration decision within the entire network (and not only by the group of benefiters). This will in the long run be beneficial for a pro-networking spirit and an open and trustful collaboration climate. Consider in this context that most often the network members will have some non-benefit experience when we assume the facts that required competencies and configuration criteria for VEs will be different from business request to business request and that the network consists of a large number of rather specialized companies.

Given the need to communicate VE configuration decisions openly and transparently within the network as discussed above we argue for a corresponding support service for moderators that is in the following regarded as “transparency support service”.

### 3. Description of Services

Figure 1 contains a conceptual view of the proposed services. The four activities at the top of the drawing correspond to decision making and decision downloading activities that are supported by the services. A general principle for decision support...
technology. The analytical information in our approach analyses based on Data Warehousing and OLAP (OLAP) where users perform multi-dimensional data about VE configuration decisions is different from data. That partly include individualized company-specific targeted at the composition of decision explanations. The analyses of the transparency support service are generation and scoring of VE configuration proposals. As it is explained in the following sections our proposed ranking of alternative VE creation proposals. As it is possible through the definition of such constraints that particular companies are definitely included in or excluded from the targeted VE. We therefore refer to these criteria as collaboration constraints. Soft selection criteria are used for scoring single companies and VE configuration alternatives, respectively. We refer to these criteria as configuration criteria. At the current stage of our research we consider as criteria for scoring single companies the financial power, production/service quality, price level, and collaboration experience. The current set of criteria for scoring entire VE configuration alternatives includes the geographical proximity of the VE members, the current

![Diagram](https://example.com/diagram.png)

**Figure 1.** Conceptual view of proposed services

The creation of a new VE is performed in three steps. In the first step, the external business request is screened and decomposed into a set of corresponding categories of request handlers that are needed for the fulfillment of the request. In principle these categories refer to products and service offerings of the network that are usually supplied by multiple competing network members. The Decision Support Service (DSS) allows the moderator to browse through these categories and the associated companies as defined within the information base. By the use of this service the moderator can prepare for a suitable decomposition of the request into a corresponding set of request handlers.

In the second step, an initial search profile for the demanded VE is specified which states the set of needed request handler categories and a set of criteria for selecting companies and evaluating possible VE alternatives. In order to allow for convenient specification of the search profile a corresponding interactive template is supplied to the moderator. The content of the template’s selection boxes are dynamically queried from the information base. The predefined selection criteria of the template are divided into hard and soft selection criteria. Hard selection criteria consist of inclusion and exclusion constraints. It is possible through the definition of such constraints that particular companies are definitely included in or excluded from the targeted VE. We therefore refer to these criteria as collaboration constraints. Soft selection criteria are used for scoring single companies and VE configuration alternatives, respectively. We refer to these criteria as configuration criteria. At the current stage of our research we consider as criteria for scoring single companies the financial power, production/service quality, price level, and collaboration experience. The current set of criteria for scoring entire VE configuration alternatives includes the geographical proximity of the VE members, the current
state of revenue distribution and workload distribution within the network. A numeric weight has to be assigned to each of these predefined criteria of the search profile template. We consider the discrete set of numeric values given by \(\{0, 0.1, 0.2, \ldots, 1\}\) as an initial standard domain from which weights are to be chosen. We will substitute this domain by the continuous number interval given by \([0;1]\) if future evaluation results will show that more fine grain weights are required. In general, by prioritizing the different criteria through a corresponding assignment of weights the moderator may flexibly customize the scoring process of the DSS to address individual requirements. A more comprehensive and more formal specification of the different criteria can be found in [21].

Once the search profile is fully defined it is submitted by the moderator to the DSS. The service in turn generates valid VE alternatives that meet the hard selection constraints. Following that, the alternatives are scored with respect to their goodness of fit to the soft selection constraints. This computational step includes a comprehensive data analysis of the information base in order to compute corresponding scores. In the third step, a ranked list of VE alternatives resulting from the scoring process is returned to the moderator for further evaluation. Either this will lead to another iteration starting with a modified search profile. Or it is decided for one of the proposed VE alternatives in the result list. The final decision is declared to the DSS where the decision and all preceding interactions between the moderator and the DSS are recorded for later analysis by the transparency support service.

Through the use of the proposed DSS moderators may achieve what is generally regarded as “informed decision making” [7]. That is, by iterating over the above described three steps several times with different versions of search profiles the moderator can obtain deep insights into the decision problem space and explore corresponding VE alternatives. The decision security will increase with more and more iterations until the final decision can be made.

3.2 Transparency Support Service (TSS)

The DSS provides to moderators an effective means for efficient decision making concerning the configuration of VEs. IT support for the task to bring a chosen VE configuration alternative into being has been studied elsewhere [10]. Apart from this task there exists a further moderator obligation. As we have discussed in Section 2 in order to achieve a high level of acceptance for VE decisions by the network members accordingly prepared information are to be communicated in a proper mode of communication within the network. The Transparency Support Service (TSS) is intended to provide an effective means for a highly automated and efficient completion of this communication task regarded as robust decision downloading in an earlier part of this article. By the use of the TSS moderators can complete the decision downloading task with only a minimal time effort. Well prepared information regarded as decision explanations of the rationales behind the VE configuration decisions will be automatically generated and distributed in the network. An automated generation of the decision explanations is enabled by a machine processible representation of the final decision and the path from the initial search profile over all the completed iterations up to the final choice.

The explanations are generated in three steps. A comprehensive data analysis of the information base is performed in each of these steps. Firstly, the relevant decision justification information is derived from the individual decision-specific criteria, global policies, and strategies defined for the network, and corresponding information about the current global status of the network. In a second step this information is augmented by further context specific background information to make it easier for users to perform a decision diagnosis and to gain understanding about the decision justification. In a third step the TSS generates decision explanations in the form of data views that are easy to read and understand by humans. By these data views we mean pre-computed views that partially consist of quantitative data. At the current stage of our research we consider the different types of views described in the next section.

The set of views is stored in a corresponding view repository. For the distribution of the views within the network several alternative distribution mechanisms can be considered. In the current version of our TSS individualized email announcements are sent to all network members. The common general parts of all announcements contain general information about the new VE and the corresponding business request. The receiver-specific parts of the announcements consist of individually generated access information given in the form of an URI [1] address for the corresponding views maintained in the view repository. This information enables network members to conveniently fetch their own data views at any time from the view repository.

4. Sample Decision Explanations

In the following we describe the different data views that are automatically generated by our service. Some parts of the views contain individualized data about the user’s own company. These parts will
automatically be replaced for each company by corresponding company-specific data. Note that at the current stage of our research the views are limited to a pure tabular presentation of information. In future versions we will make use of more advanced information visualization and layout techniques. Furthermore, up to now we have limited our investigations to views that are prepared for network members. Views for moderators may contain an even richer set of information. Moreover, our ongoing research is targeted on extending the views by more detailed information about other generated VE alternatives. As described later in this section the proposed views include comparison information in the form of single scores obtained by the chosen alternative and corresponding scores as computed for the global set of all considered alternatives such as minimum, mean, and maximum score value.

We present for each type of data view a concrete example that is based on an application scenario. For this scenario we suppose a fictive company network specialized on the production of passenger seats for planes, ships, trains, and busses. We assume that this network has received a request for quotation from a shipyard asking for an offer for 400 passenger seats with an integrated infotainment system. From a corresponding process description for the production of the requested seats the moderator can deduce that the following set of activities is needed for the order fulfillment: (1) production of metal seat frames, (2) production of seat upholsteries, (3) production of circuit systems, (4) production of monitors, (5) production of harnesses, (6) final assembly of seats. From the total set of all categories of request handlers available in the network the moderator will choose six categories accordingly. This choice is made from a corresponding list offered by the search profile template. The further specifications defined by the moderator within the search profile are in the example (Table 1) as follows:

- The network member with the company name “SUM Microelectronics Ltd.” has to be included in the VE. This include constraint can arise from a corresponding inquiry of the requester.
- The network member with company name “Iron Experts Ltd.” is to be excluded in the VE which is expressed through a corresponding exclude constraint.
- The configuration process for generating scored VE alternatives has to consider two company-related configuration criteria. As one criterion “Collaboration Experience: 0.6” is selected and as further criterion “Financial Power: 1.0” is selected. This choice means that the scoring of individual members is performed with respect to these two criteria and their assigned weights, respectively.

The initial search profile as described above is processed by the DSS which will deliver a resulting list of scored VE alternatives. Let us assume that the moderator will not perform further iterations and directly decide for the top scoring VE alternative. This decision is in turn downloaded to the network by the TSS which implies that data views are generated and delivered to the network members.

Examples of data views that the TSS will generate for the above described scenario are presented in the following. The description of each example starts with a general introduction of the particular type of data view.

Table 1. Search profile view of application scenario.

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Collab. Constr.</td>
<td>SUM Microelectronics Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Search Profile View presents the search profile as specified by the moderator. It is divided into three parts as shown in the example of Table 1 that is reflecting the above described application scenario. The first part contains the set of request handlers. The second part shows the collaboration constraints. Note that multiple include and exclude collaboration constraints, respectively, can be given in the Search Profile View in general. However, in our sample scenario only one concrete constraint of each type is given. The third part of the view presents the configuration criteria.
The Search Result and Criteria Evaluation View is intended to clarify to the company representatives the reasons for the final decision. In particular arguments are provided as to why their company is a part of the VE or, in the opposite case, why their company has not been selected. The corresponding clarification information is grouped into four sets as the example of Table 2 shows.

Table 2. Sample search result and criteria evaluation view for network member SUM Microelectronics Ltd.

<table>
<thead>
<tr>
<th>1. Request Handlers</th>
<th>SUM Microelec. Ltd.</th>
<th>Cp. 2</th>
<th>Cp. 3</th>
<th>Cp. 4</th>
<th>Cp. 5</th>
<th>Cp. 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chosen set of request handlers</td>
<td>SUM Microelectronics Ltd.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Total Scores</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VE-score of chosen VE alternative</td>
<td>VE-scores found among set of all considered VE alternatives</td>
<td>Min.: 78</td>
<td>Mean: 126</td>
<td>Max.: 199</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total VE score</td>
<td>199</td>
<td>Min.: 78</td>
<td>Mean: 126</td>
<td>Max.: 199</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3. VE-Related Scoring Data</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring criterion</td>
<td>VE-score of chosen VE alternative</td>
<td>VE-scores found among set of all considered VE alternatives</td>
<td>Min.: 67</td>
<td>Mean: 72</td>
<td>Max.: 91</td>
<td></td>
</tr>
<tr>
<td>Equally Balanced Revenue: 0.8</td>
<td>89</td>
<td>Min.: 67</td>
<td>Mean: 72</td>
<td>Max.: 91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equally Balanced Workload: 1.0</td>
<td>110</td>
<td>Min.: 56</td>
<td>Mean: 83</td>
<td>Max.: 110</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4. Company-Related Scoring Data for SUM Microelectronics Ltd.</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring criterion</td>
<td>Company-score of own company</td>
<td>Company-scores found among set of all considered alternatives</td>
<td>Min.: 58</td>
<td>Mean: 62</td>
<td>Max.: 73</td>
<td></td>
</tr>
<tr>
<td>Collaboration Experience: 0.6</td>
<td>73</td>
<td>Min.: 58</td>
<td>Mean: 62</td>
<td>Max.: 73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial Power: 1.0</td>
<td>120</td>
<td>Min.: 49</td>
<td>Mean: 72</td>
<td>Max.: 120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The first set contains the moderator’s final decision by showing the companies that participate within the chosen VE as request handlers for the given business request. The second set shows the total score as obtained by the chosen VE in comparison to the minimum, mean, and maximum scores concerning the set of all considered VE alternatives. The third set consists of VE-related scoring data. For each considered network-related scoring criterion the score of the chosen VE alternative is given and contrasted with the corresponding minimum, mean, and maximum scores concerning the set of all considered VE alternatives. The fourth set of the view consists of company-related scoring data which is individualized on a per company basis. For example, the data presented in Table 2 is individualized for the network member with company name "SUM Microelectronics Ltd.". One can find in the fourth set of the data view the scoring results of the own company with respect to the company-related scoring criteria.

In order to allow for a better interpretation of this scoring information the corresponding minimum, mean, and maximum scores concerning the set of all considered companies are given, too. A network member may use this benchmarking information for a strategic alignment of the company to the specific properties and strategy of the collaborative network. For example, this alignment may lead to particular long term investments in production facilities and employee skills.

The Decision Impact View (Table 3) is based on a projection of quantitative data into the future. It is the intention of this view to clarify the anticipated consequences of the given VE configuration decision for both the network as a whole as well as for single members of the network. In order to allow insights into the possible decision impact on the network this view describes current network states and their assumed future development as resulting from the decision. By “resulting from the decision” we refer to what will result from the process of handling the business request by the chosen VE. Note that in the description of the future states other factors of influence on the state are ignored. The states are described from an economic and collaboration point of view by quantitative and qualitative indicators. For some of these indicators the corresponding number for the entire network and also for the own company are given. For example, the company-specific data presented in the sample view of Table 3 are individualized for the company "SUM Microelectronics Ltd.". At the current state of our research we take only a limited set of indicators into account. The following economic indicators are considered:

- Revenue: Accumulated revenue number for the current business year as obtained through the network. The number for the entire network and the mean number for the members are given.
- Revenue distribution: Description of revenue distribution within the network in the form of values on an ordinal scale that ranges from unbalanced, slightly unbalanced, and balanced.
- Utilization: Degree of utilization of the resources given in the form of values on an ordinal scale that ranges from low, normal, up to high. The description of the future development is based on a
separation into short term, medium term, and long term development of the utilization.

- Inventory: Description of amount of material on stock stated in the form of values of an ordinal scale that ranges from low, normal, up to high. Also for this indicator the future development is separated into corresponding values for short term, medium term, and long term.

Table 3. Sample decision impact data view for SUM Microelectronics that is participating in the chosen VE

<table>
<thead>
<tr>
<th>1. Decision Impact on Entire Network</th>
<th>criterion</th>
<th>current status</th>
<th>future development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>network: 10500200 per member: 620000</td>
<td>network: 11800000 per member: 710000</td>
<td></td>
</tr>
<tr>
<td>Revenue distribution</td>
<td>unbalanced</td>
<td>slightly unbalanced</td>
<td></td>
</tr>
<tr>
<td>Utilization</td>
<td>low</td>
<td>Short term: normal Medium term: normal Long term: -</td>
<td></td>
</tr>
<tr>
<td>Inventory</td>
<td>normal</td>
<td>Short term: low Medium term: normal Long term: -</td>
<td></td>
</tr>
<tr>
<td>VE size</td>
<td>Min.: 4 Mean: 12 Max: 24</td>
<td>Min.: 4 Mean: 10 Max: 24</td>
<td></td>
</tr>
<tr>
<td>VE value</td>
<td>Min.: 80000 Mean: 650000 Max: 1500000</td>
<td>Min.: 80000 Mean: 5665000 Max: 1500000</td>
<td></td>
</tr>
<tr>
<td>Waiting Time</td>
<td>Min.: 4 Mean: 8 Max: 15</td>
<td>Min.: 4 Mean: 6 Max: 15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Decision Impact on SUM Microelectronics Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>criterion</td>
</tr>
<tr>
<td>Revenue</td>
</tr>
<tr>
<td>Utilization</td>
</tr>
<tr>
<td>Inventory</td>
</tr>
<tr>
<td>VE size</td>
</tr>
<tr>
<td>VE value</td>
</tr>
<tr>
<td>Waiting Time</td>
</tr>
</tbody>
</table>

Apart from the economic indicators other indicators more related to collaboration are also considered. In general, these collaboration specific indicators are considered in two variants: one referring to the entire network, and the other one referring to the user's own company. For each of these indicators three numbers are given that provide the minimum, mean, and maximum value. The collaboration specific indicators are as follows:

- VE size: Size of VE in terms of number of participating companies. In the context of data for the own company VE size refers to VEs that the own company has participated in.
- VE value: Overall monetary business value of the referring business request. The numbers given for the own company refer to the VEs that the own company has participated in.
- Waiting time: Time span in days between end date of the prior VE and start date of the next VE where the companies are to participate in. Like above in the context of data for the own company the numbers concern VEs with participation by the own company and not all the VEs.

In the decision impact data view the information is grouped into two sets as shown in the example of Table 3. The first set contains the indicators and numbers for the entire network. The company-specific numbers individualized for the own company are provided in the second set.

5. Prototype

A first standalone prototype of our proposed services is currently being developed. Figure 2 shows the major components of the prototype for which we apply the typical technologies of web-based multi-tier software architectures in combination with the JAVA programming language and other JAVA technologies. The XML standard is used as data interchange format between the system components. For example, session logs, search profiles, search results, and decision explanations are exchanged as XML documents.

The prototype offers to moderators a web browser-based front end and another front end for network members specialized on the visualization of the data views.

The components of the prototype store and maintain data in a common data base which can be logically divided into the four repositories shown in Figure 2. The Company Network Directory (CND) contains descriptions of the companies in terms of their product and service offerings and also their competencies and technical abilities. The VE Creation Log contains recorded sessions in which VE proposals have been generated by the system according to search profiles. The third data repository contains as the name indicates data about the economic status of the network and also about collaborative processes and business transactions as completed within the network in reality.
decision criteria are considered. Because of the negotiation process in which a multitude of different VEs are the result of a decision or example, in the ECOLEAD Project [3]. In many of collaborative network has been investigated, for channels.

Figure 2. System architecture of prototype

Decision explanations are administered in the Decision Views repository.

The Collaboration Proposal Generator takes the Search Profile of the moderator and completes a sophisticated orchestration algorithm. A resulting ranked list of VE alternatives is delivered back to the moderator. During such a moderator session the Collaboration Proposal Generator records data about search profiles, processing steps of the orchestration algorithm together with intermediate results, and proposed VE alternatives. These data are stored in the VE Creation log for the purpose of automatically generating decision explanations.

The Decision Download Manager is called interactively from the moderator GUI when a final decision for a VE alternative is available. The chosen alternative is selected first in the ranked list of alternatives presented to the moderator. This selection is recorded in the VE Creation log and the Decision Download Manager is activated when the moderator has confirmed the selection. The Decision Download Manager then retrieves information from the database to generate the corresponding decision explanations. The generated explanations are made available in the Decision Views Repository where they may be accessed by the network members. In addition to such a direct access, the decision explanations can also be published on the network’s intranet. The members are automatically notified by the Download Manager through email messages.

6. Related Work

The configuration of VEs from the members of a collaborative network has been investigated, for example, in the ECOLEAD Project [3]. In many of these studies VEs are the result of a decision or negotiation process in which a multitude of different decision criteria are considered. Because of the complexity of decision criteria it is often difficult to understand the rationales behind such decisions for those uninvolved in the decision making process while the decision makers often believe that the long labored decision needs no explanation [5]. The general role of business trust for the success of collaborative networks has been analyzed in [14]. However, so far little attention has been paid to the dependency between business trust in collaborative networks and how decisions in general and configuration decisions in particular should be communicated within such networks. Only in few studies this issue has been investigated [15]. This is a surprising fact since decision making and communication in companies as single enterprises and the impact of the outcome and the communication on the individual employee perception of justice or fairness in the company has for long been an area of intense research in the concept of “organizational justice” [6, 11]. "Organizational justice" as a perception can be subdivided into or being dependent upon types of justice as “distributive justice”, “procedural justice”, and “interactional justice” [6]. The distributive concept of justice concerns the fairness of the output given the input. The extend of input from a given company might be more transcendent to all companies as well as to the single company itself due to the use of an information service. Secondly, the "procedural justice" that is covering the fairness in the process will certainly be demonstrated by the proposed service. The software cannot obtain any bias that is not presented as arguments and parameters in the logic of the system. The service will demonstrate how the companies have presented themselves as well as demonstrate the iterative logic in finding the most adequate outcome. The concept of "interactional justice" is about how people are treated with dignity and respect. The procedural aspect mentioned before can be said through the transparent and unbiased system to provide and signify dignity and respect for the individual company. We thus consider these concepts and findings of research on organizational justice as also being relevant for the companies forming collaborative networks. We intend to explore this research field in the future by simulation studies based on the core models for our moderator services and the prototype.

7. Future Work and Conclusions

A great deal of work still lies ahead in elaborating the proposed services. For the transparency support service we will especially investigate information visualization concepts [22] with the goal to develop an approach that fits to the specific needs of effective
visualization of decision explanations. This will also include solutions allowing the network members to customize the visual presentation of decision explanations to their individual needs. A more long term goal will be the study of the services’ effectiveness with respect to network health. We intend to perform experiments with the services on the basis of simulation of the central model. Live tests and first experience with the implementation of the model will necessarily lead to further investigation into the different decision explanations and especially their set of indicators.

We understand that the business trust and the collaboration climate within the network are crucial success factors of collaborative networks. Among others, the decision making practice of the network is having a strong influence on these factors. Without proper IT support it will be very difficult for moderators to effectively complete the required selection decisions for the creation of VEs and to properly communicate these decisions within the network. The article has presented some main results of our research that is targeting on effective IT based management of VE in successful collaborative networks.

12. References


