Planning and Control of Virtual Corporations in the Service Industry: The Prototype VICOPLAN

Dr Thomas Hess
University of Goettingen
Institute of Information Systems
Platz der Goettinger Sieben 5
37073 Goettingen, Germany
phone: ++49-551-39-9738
fax: ++49-551-39-9735
e-mail: thess@uni-goettingen.de

Abstract

Virtual Corporations as well as traditional companies need a planning and control system in order to guarantee the organization's competitiveness in markets. This paper outlines the design of VICOPLAN, a prototype of a planning and control system for virtual corporations in the service industry. VICOPLAN consists of three modules in order to support the management of virtual corporations. These modules allow the offering and allocation of sub-orders within the pool of partner companies of a virtual corporation. Furthermore, with VICOPLAN orders may be calculated and costs may be controlled during the execution of orders. VICOPLAN also offers multiple analysis methods including the analysis of the behavior of the partner companies, the allocation of sub-orders as well as the goals of the partner companies. Finally, the implementation and the testing of VICOPLAN is described shortly. An outlook of the "next generation" of VICOPLAN will also be given.

1. Introduction

Since the beginning of the 1980's inter-company networks as a specific form of cooperation between independent companies have become more popular. Inter-company networks have appeared in the construction industry and in the automobile industry for a long time. Today, they may be found in any line of business. Specific driving forces of this development are modern, standardized information technologies (IT). Especially the internet drives down costs of coordination over the boundaries of organizations significantly. One form of inter-company networks is the Virtual Corporation (VC), which has been the subject to research activities since the early 1990's [1;2]. VCs may be frequently found in the software industry or the consulting sector, but the concept is not limited to this sector. The appearance of VCs is based primarily on modern IT. Although VCs have been subject to several research activities, e. g. the relevance of IT infrastructure for VCs or the economical reasons for their appearance, questions of how to manage VCs have rarely been discussed in theory as well as in practice. Meanwhile, different issues of planning and control in VCs have been taken up [3;4;5]. Above all, the distributed, shared performance of a VC leads to the question of implementing IT based tools in order to support planning and control in VCs. The goal of this paper is to present a innovative tool for planning and control in VCs. The perspective taken in this paper is that of the VC itself. The perspective of the members of the VC will not be considered. The second chapter explains the background of the work on the prototype. Chapter 3 describes the conceptual framework of the virtual-corporation-planning-and-control-system (VICOPLAN) prototype. The implementation and testing of VICOPLAN will be explained in chapter 4. Chapter 5 shows that VICOPLAN is the third step in the "history" of prototypes developed in Germany. The paper closes with an outlook on future research activities in the field of planning and control tools in VCs.

2. Background

To design a tool for planning and control in VC´s, three aspects have to be clear: the underlying concept of a VC, the general requirements and the special technical requirements for a tool in a VCs. These aspects are discussed below.

0-7695-1435-9/02 $17.00 (c) 2002 IEEE

2.1 A Definition of virtual corporations

There is still a disagreement in literature about the definition of a VC. In this paper we see a VC as a special form of cooperation between at least three, but usually ten or more, legally independent companies [6]. The involved companies coordinate their operational functions within the network without merging them into a joint venture. The cooperation's objective is to realize a market performance, a so-called order, together. When realizing orders, the partners of a VC usually make use of IT. However, the cooperation is not limited to the time of a single order or project. VCs exist on a long-term basis. Therefore participating companies find agreements for example on the goals, the internal rules of transferring goods and services, the use of IT or the marketing issues of the cooperation. On the basis of these agreements temporary operational teams are configured, mostly for each single order. A distributed shared performance is the result where single partner companies are responsible for sub-order processes. It has to be mentioned in addition, that only a few members of the VC's pool of companies are involved in such a team. The companies' competencies in the so-called "pool of companies" typically overlap. Moreover, companies may resign from the pool as well as new members may join the VC quickly. Figure 1 demonstrates the fundamental idea of a VC graphically.

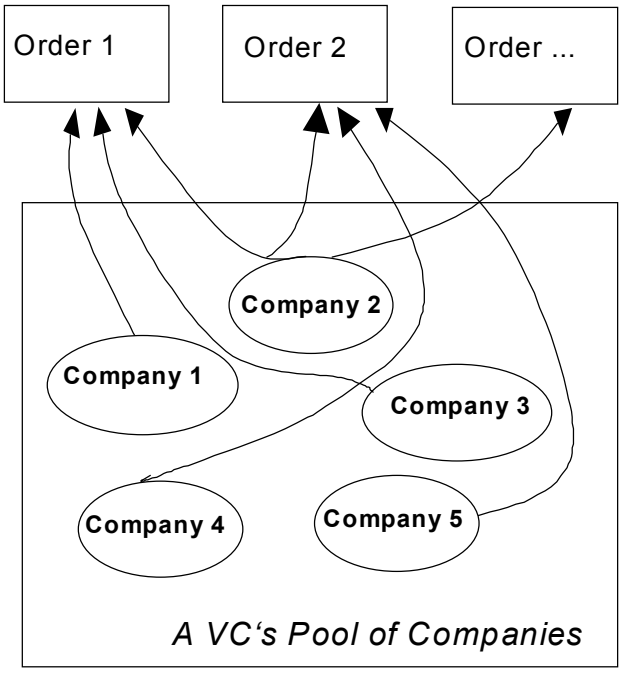

Figure 1.The Idea of a VC

Another important characteristic beside the distributed shared performance and the flexible process-oriented configuration of a team is the equality of the partners in the pool of a VC. This means, that all partners of a VC have equal rights when making strategic decisions concerning the VC (e. g., when deciding on the fields of cooperation or the integration of a new company into the pool). This fact does not exclude the possibility of a VC to choose one partner within the pool, that coordinates the orders of a VC.

2.2 General requirements for planning and control tools in virtual corporations

The key challenge from a planning and control perspective derives from the unstable and polycentric structure of a VC. A planning and control tool for a VC has to take account of specific requirements. They may be described as follows [7;8]:

- Distributed shared performance: VCs do not have any owned resources. For any order, the most competent companies have to be selected from the pool of partners to perform a sub-order with their own resources. The interfaces evolving between the performing partners gain major importance.
- Flexible process-oriented configuration: In contrast to traditional organizations, tasks are not necessarily assigned to a partner but are allocated for every type of order. In consequence, the process to be performed to fulfill an order is the main planning and control object.
- Autonomy of the partners: In decentralized organizations, the organizations' units (e. g., profit center) act autonomic to a certain extent. Still their actions are restricted by the overall management's right to instruct the unit. Consider a management holding that decides, which markets are going to be accessed and what product lines are going to be produced by the affiliated group. From a formal point of view, such a right to instruct does not exist in a VC. Due to actual dependencies, a dominating partner in a strategic network may be in a position to instruct a supplier.

Since planning and control tools are designed to support the management of a VC, the planning and control tasks to be supported by the tool will be described in the following [8;9].

The tasks of the management of a VC may be divided into such tasks carried out for each order and those tasks executed for a set of orders. The first mentioned planning and control tasks shall be discussed under the synonym of order-related tasks. The latter shall be called above-order tasks.

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

As VCs compete with other forms of coordination in markets, their products and services have to be competitive. Thus, the main objective of the order-related management of a VC is the execution of orders in line with market requirements and at the same time with the goals of the VC. An adequate order-related performance is essential for realizing the medium- and long-term goals of the VC. From the management's perspective and following the cybernetic approach, an order has to be planned, information on the execution has to be gathered and the realization of the order has to be controlled. Contingent on the flexible process-oriented configuration of a team planning in VCs must contain the allocation of sub-orders. Besides, an order needs to be specified, including the decomposition of an order into detailed activities, as well as it needs to be priced. When realizing the above mentioned three order-related tasks, the management of a VC must represent the goals of the VC towards the individual goals of the partners.

In addition to these order-related tasks the management of a VC needs to build up the potentials of the inter-company network, that are necessary to realize orders. In the first place the specific competencies of the VC´s partners have to correspond with the markets requirements. Therefore the management of the VC has to plan the partner pool and has to update its composition, as soon as market requirements change. If e.g. a new company wants to join the VC, the Management also has to check, whether the competencies of the new company provide any additional use for the VC. Secondly for each field of cooperation, in traditional companies known as a business segment, the VC´s management has to develop strategies and survey the competitors in this line of business. In the long run a VC can only exist, if it satisfies the partner companies´ goals. Thus the third important task for the management is to evaluate the VC´s success, which results of the individual success of the partners concerning their performances in the network.

On both levels the tasks should be supported by a planning and control tool, whereas these are all performed in a typical planning-mapping-control cycle. Figure 2 gives an overview of the above described management tasks in a VC.

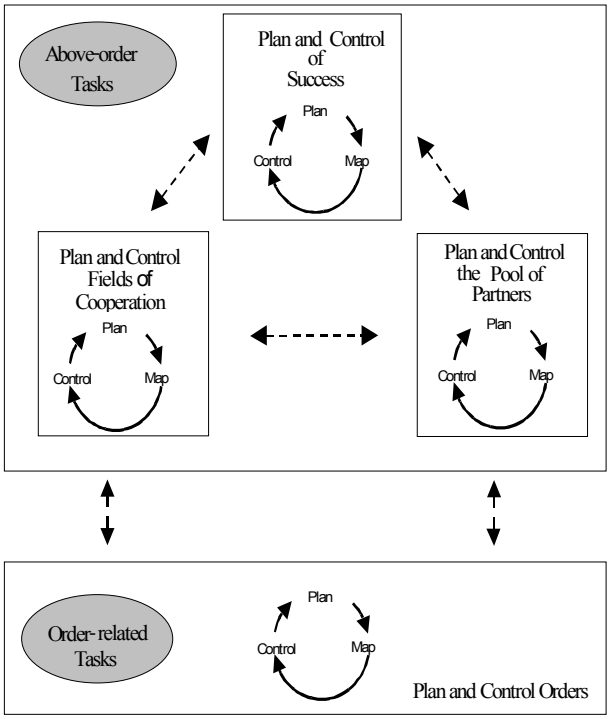

Figure 2.Typical Tasks of the Management in a VC

2.3 Special technical requirements for tools in virtual corporations

The role of IT systems in VCs is discussed in different ways [10;11]. In order to design a tool to support planning and control in this organizational form, the special question of integration arises [12]. Each partner company typically disposes of IT systems, that meet specific requirements resulting from the sector the company works in. Two general strategies of integration may be employed: the usage of the same (homogeneous) system or the linking of different (heterogeneous) systems. A characteristic of a homogeneous IT system is, that all users access the same data pool and functions. Since the partners of a VC do not act exclusively for a VC in general, homogeneous IT systems may be only applied in single cases. Usually, heterogeneous IT systems will be linked in a VC. This means, that the partners of a VC make use of their individualized IT systems, which are linked loosely by interfaces. Still it needs to be considered, that the companies of a VC cooperate in multiple configurations. This leads to the fact, that not proprietary but only standardized interfaces may be applied in most of the cases.

An important issue when integrating heterogeneous IT systems is the applied communication standard. Today, numerous communication standards exist that are also

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

relevant in VCs. The exchange of electronic messages or files using the communication standards of the internet is most important. But also specific communication standards for inter-company cooperation have been developed under the synonym of Electronic-Data-Interchange (EDI). These too are of relevance for VCs. The best known standard is the ODETTE (Organization-of-Data-Exchange-for-Teletransmission-in-Europe) standard, which was developed for the electronic exchange of data in the inter-company networks in the automobile industry. The producers of standardized software products also work on new linking concepts. E. g., SAP developed the ALE (Application-Link-Enabling) concept, that among others provides standardized interfaces for non-SAP-systems. In addition, a prototype exists, that converts data between partners of a VC. Last but not least, systems evolve, that support the inter-company employment of workflow management systems.

3. The concept of VICOPLAN

The main requirements for a planning and control tool in VCs are not adequately covered by the tools available today. This was the starting point for the development of VICOPLAN in order to meet the requirements and support the VC´s management better than today.

Underlying method in the development of VICOPLAN was the systems engineering approach [13]. Based on this approach the requirements discussed above were substantiated by a requirements analysis in an existing VC in the service industry. This chapter points out the result of the development leading to the prototype VICOPLAN, that was realized at the Institute of Information Systems at the University of Goettingen, Germany in 1999. VICOPLAN is designed mainly for use in the service industry and consists of three modules: Order Management, Analysis and Master Data Management. Concerning the content all three modules, which will be described in the following, are based on the above described conceptual framework of planning and control in VCs as well as on empirical studies. The order management module covers all order-related requirements discussed above, as will be shown in the following. The main requirements of the above-order tasks may be found in the module analysis, only the planning of the fields of cooperation is not adequate covered - a task for the further development of VICOPLAN.

3.1 Modul 1: Order management

According to the order processing cycle as described in chapter 2.2, planning and control with VICOPLAN begins with the capturing of order related basic data. A verbal explanation of the order and the planned space of time for the order execution have to be defined in particular. On the basis of these preliminary tasks, the order is decomposed into detailed activities that create a sub-order. The competencies needed to realize an order are indicated on the basis of a given catalogue and specified by the necessary capacities. The exchange of goods or services between sub-orders may be defined in addition.

Next, the defined sub-orders may be advertised within the pool of partner companies. Based upon the specified competency and capacity and the information about the competencies and capacities given by the partners, VICOPLAN creates a pre-selection of relevant partners. The order manager then may choose those companies, that shall be asked to submit an offer for a sub-order. The companies willing to submit an offer detail their bid using a particular calculation form. This special form shows the assignment of different costs (e. g., material or personnel costs) to a sub-order which evolve during the realization of a sub-order. The basis for calculating personnel costs with VICOPLAN is a standardized cost rate. This cost rate is fixed for all partners. Figure 3 shows the screen mask used for calculating sub-order costs.

After the offering time has expired, the order manager may see all submitted offers. VICOPLAN may also display existing evaluations of partners. When a partner has made capital expenditures, that are useful for multiple offers (e. g., investing in specific equipment), this will also be indicated by VICOPLAN. With these information on hand, the management of the VC may choose the most suitable offer. The planning of an order is terminated successfully, as soon as all sub-orders have been allocated. If a sub-order can not be allocated and an offer may not be realized by the VC, e. g., when capacities are not available, the planning of an offer comes to an end. The reasons then must be stated for an analysis.

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

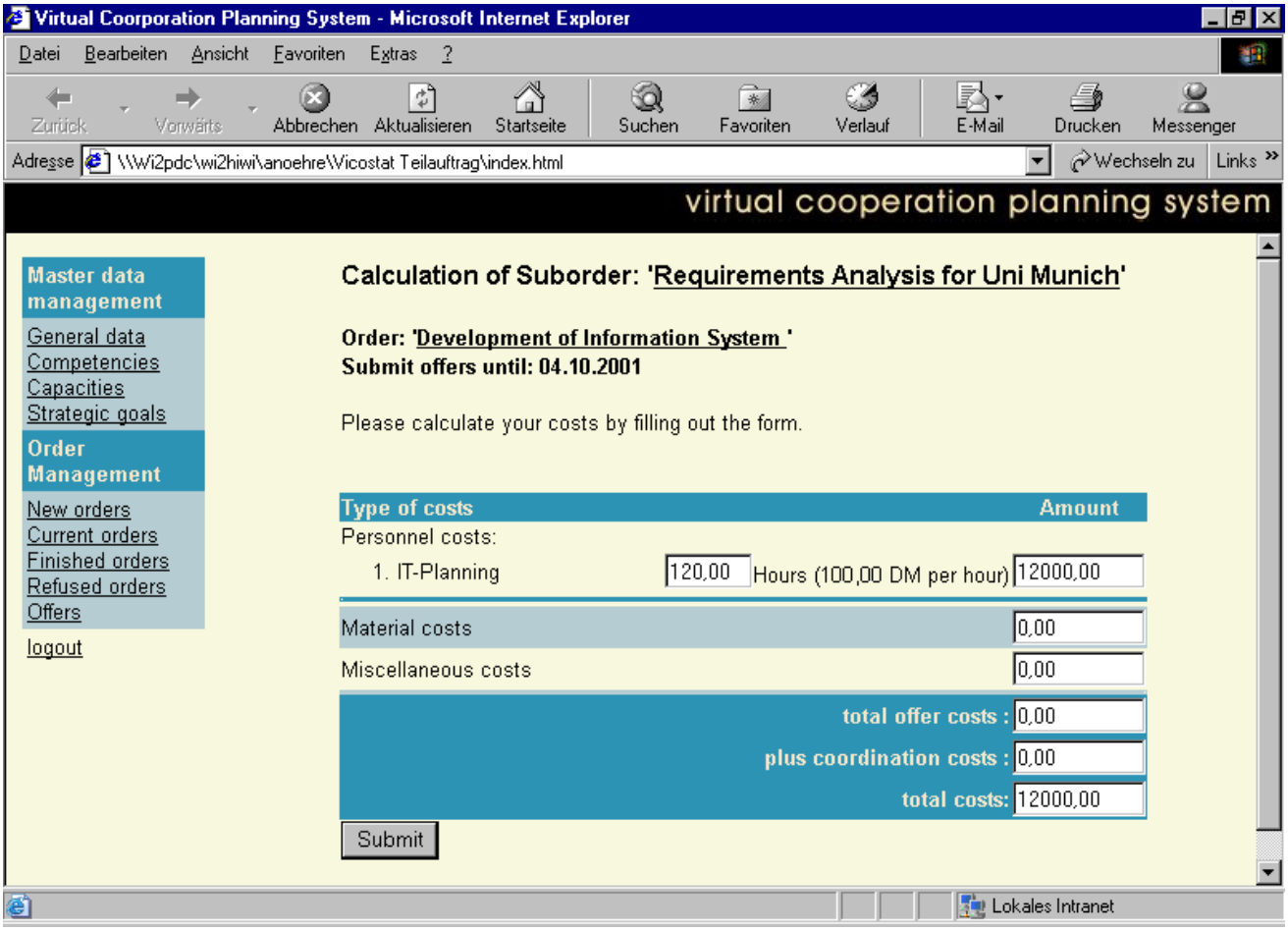

Figure 3.Calculating Sub-Order Costs with VICOPLAN

The price of an order is usually determined by simply summing up the prices for each sub-order, including the price for "indirect" services such as the acquisition and coordination of an order or for taking the risk of the order. Thus, order pricing in a VC might be described as a summing-up calculation method. VICOPLAN calculates indirect service costs as a percentage of the total order cost volume. In order to evaluate such a standardized cost rate, the exact costs of indirect service activities may be computed on the basis of the activity-based-costing concept as part of the further development of VIOCOPLAN.

Special calculation requirements may derive from the fact, that products may need to be exchanged between the partners when performing an order. This is usually the fact in vertically integrated VCs in the manufacturing industry. Due to intertwined performance processes in VCs a specific aggregation method is needed in order to avoid double calculating costs as well as to map the structure of the costs correctly [6].

Information on the status of the sub-order realization are added by the partners during the processing of the whole order. The realized costs for a sub-order as well as the state of completion need to be entered into the system. A sub-order is entirely finished when the state of completion is 100 %. An order is completed when all sub-orders are performed. To control the realization of orders, the management of a VC has an overview of the state of completion of all sub-orders related to any particular order. In addition, VICOPLAN offers detailed information on the realization of each sub-order.

Comparing the systems features of this module with the requirements discussed in Chapter 2.2 shows, that the entire order process from the decomposition of an order to the termination is supported by VICPOLAN. Each partner can become the order coordinator, what ensures a flexile, process-oriented configuration as postulated in the

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

requirements. Due to the cybernetic approach the order management module also includes a mapping and control function in order to guarantee the typical planning-mapping-control-cycle.

3.2 Modul 2: Analysis

VICOPLAN's second module, the analysis, provides six different standardized analyses concerning several orders:

1. The analysis of the behavior of each partner company within the VC provides information on the performance of the partners. The number of sub-orders accepted by each partner, the frequency of time delays and of cost overruns concerning these sub-orders as well as the number of positive and negative evaluations of the performance of sub-orders by other partners are gathered. Additional information on each partner may be obtained by a second step of analysis. For each realized sub-order of any partner, time delays and cost overruns as well as the performance, evaluated by the management of the VC, are supplied.
2. The analysis of the process of allocating the sub-orders supports the control of the allocation process: All offers for sub-orders submitted by the partners can be displayed. Thus, every allocation decision made by the management of the VC is checkable.
3. The order analysis allows statements concerning the performance process of the whole VC: Sub-order information on time or cost deviations are aggregated. As a result, VICOPLAN makes available reports on different aspects of orders.
4. The analysis of refused orders allows an overview of the reasons for rejecting orders.
5. VICOPLAN offers a survey of the efficiency of a VC by analyzing the competencies and capacities. The number of partners per competence as well as the sum of available capacities per competence referring to a calendar year in a VC are indicated. If needed, information on capacities may be presented in detail to a week as well as per each partner.
6. The analysis of the goals of the partners supports the evaluation of the VC's success [14]. VICOPLAN shows the goals of each partner pursued with the participation in the VC. The degree of the goal attainment is presented additionally.

Figure 4 shows the analysis of the allocation of sub-orders with VICOPLAN.

The first two mentioned analyses are important resources to keep up the functioning of the internal market of a VC. Only when these information are unfolded, and e. g. are the basis of discussions during partner meetings in a VC, opportunistic behavior of partners in a VC is made difficult.

The main above order tasks as discussed in Chapter 2.2 are realized in this analysis module, whereas the planning and controlling of fields of cooperation is not adequately covered by today – a challenge for the further enhancement of VICOPLAN.

3.3 Modul 3: Master data management

The main focus of the third module of VICOPLAN, the master data management module, lies on the administration of competencies and capacity data. Every partner company is responsible for the actuality of their data. Whereas the information on the competencies of partners usually remain stable in the medium-term, the information concerning the weekly capacity, given in hours, needs to be updated permanently. Moreover, with the data management module, each partner of a VC may specify, plan and control his goals pursued with the participation in the VC.

In addition, the management of the VC needs to customize the system. Beside the administration of the catalogue of competencies offered by the VC as well as the catalogue of goals, the management of the VC may modify the standardized cost rates used to calculate the orders.

0-7695-1435-9/02 $17.00 (c) 2002 IEEE

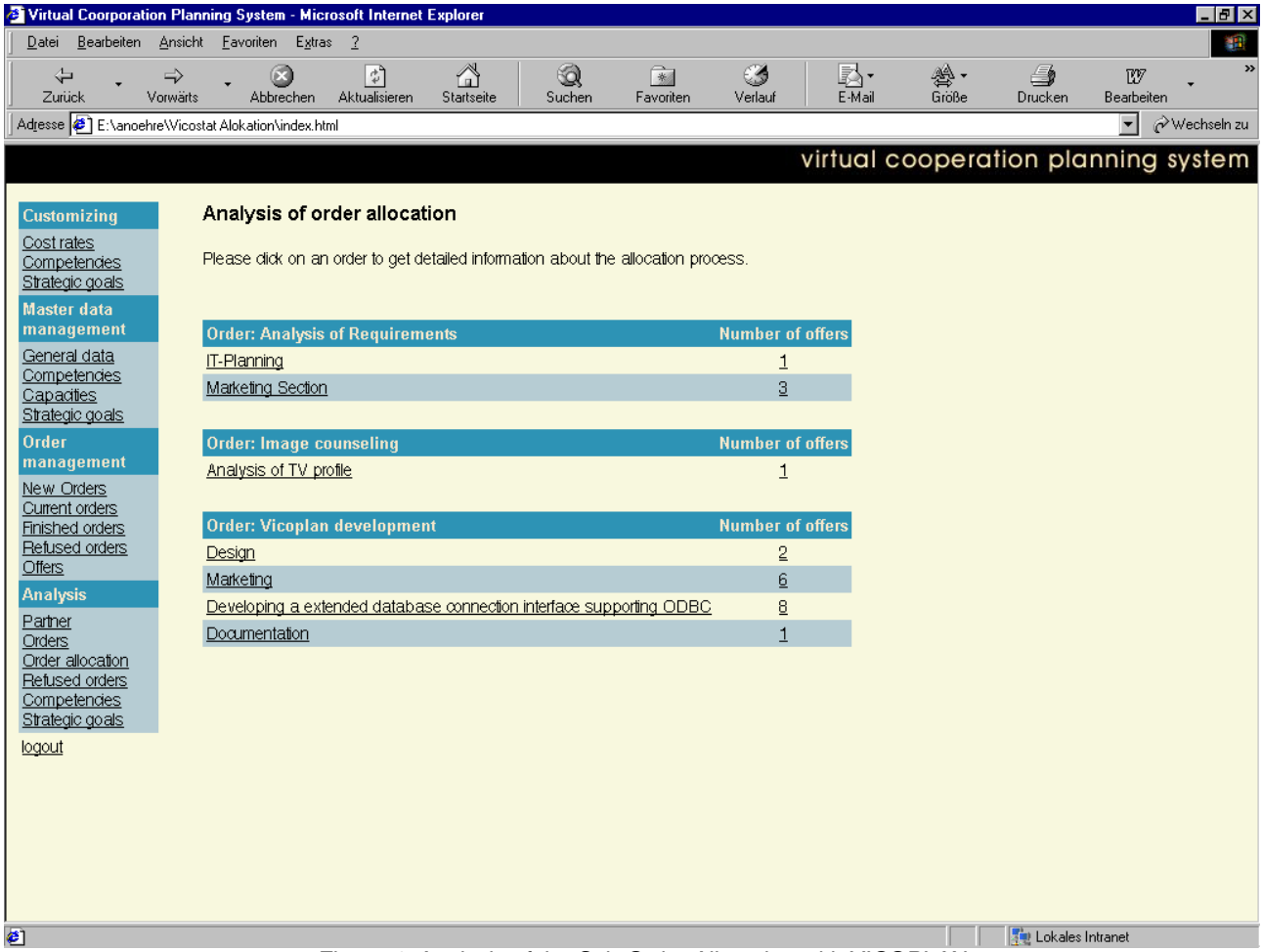

Figure 4. Analysis of the Sub-Order Allocation with VICOPLAN

4 Implementation and Testing of VICOPLAN

At present, VICOPLAN is realized as a prototype based on a client/server-architecture based on a relational database. Usual WWW-Browsers work as clients. This solution allows an unproblematic integration of the client into the heterogeneous architectures of IT systems of the partners. The solution makes the integration of new partners into the VC very easy, since technical hurdles of entry are eliminated right away. Concerning the server, HTML Web pages are generated dynamically. The creation of theses pages follows by using the PHP scripting language as well as embedded SQL-statements. The access to the database is realized by SQL-statements and an ODBC-interface. Figure 5 illustrates the system-architecture of the prototype in an overview. The prototype uses an Apache Server and a Microsoft Access database.

In order to administrate the data of planning and control systems, both relational and multidimensional database-systems are applied today. Relational systems can be found mainly in the accounting - oriented systems of single companies, whereas multidimensional systems (e. g., OLAP-Systems) often appear in the planning-oriented or the inter-company context. Since order-related tasks dominate the planning and control tools in VCs, a relational database system was chosen to be applied in the VICOPLAN system.

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

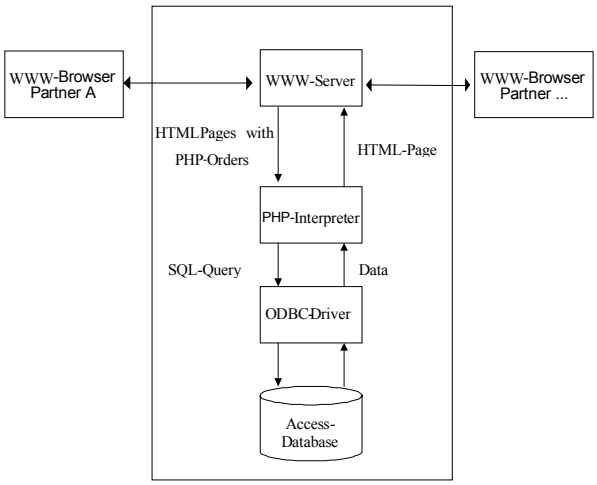

Figure 5. The Architecture of the VICOPLAN System

A user-concept was established additionally. It is based on the three roles: the network-coordinator, the order-coordinator and the executing partners. The role of the network-coordinator is imparted for several orders. The other two roles are assigned per order. Generally, the partner that generates an order in the system becomes the order-coordinator. However, this partner may transfer his role to another partner company later. The allocation of sub-orders is a dynamic process, as described before. As a result, the role of an executing partner is assigned per sub-order.

Besides the functional testing of the system during and after the development process, the focus was on the acceptance testing of VICOPLAN, in order to meet usability and the VC´s needs. The testing phase of VICOPLAN is still in progress, but shows good results already. As one step of the acceptance test plan the virtual cooperation TECHNOPOOL, located at Darmstadt, Germany uses VICOPLAN for miscellaneous tasks of the order-related management and tests the usability [15].

5 VICOPLAN as step three

In Germany we can find a small “history” of tools to support planning and control in virtual organizations. VICOPLAN is step three in this history, the steps before are described now.

First the system EXECUdesk has to be taken into consideration [16]. EXECUdesk system is a result of a research project carried out by the Technical University of Berlin, Germany at the beginning of the 1990s The essential element of the system is the modeling and control of inter-company business processes. EXECUdesk thereby supports established modeling languages. Within the control of the processes, EXECUdesk indicates the desired and the realized processes and their divergence. In addition, EXECUdesk integrates communication systems (e. g., video conferencing) and tools for the shared processing of documents. EXECUdesk also disposes of traditional corporate planning methods. From 1996 until 1998 a research team at the University of Saarbruecken, Germany developed the system DEVICE [17]. DEVICE supports the planning and control of the entire order processing in a VC from the acquisition of an order over the generating of a team to its breakup. The emphasis lies on a five-step method for the automatic selection of partners processing sub-orders. DEVICE also supports the recordation of electronic agreements, the realization of the order and allows a final evaluation of the partner companies. Another specific element of DEVICE is the integration of the client of the VC. E. g., the system makes it possible for the client to specify his order and to check the status of the realization of his order directly. Neither of the tools described above supports the management of a VC in the necessary extent and form. EXECUdesk was developed in the early 1990s and therefor represents the state-of-the-art in research at that time. Recent results of research, like e. g. methods supporting the entry of new partner companies, have not been put into practice yet. DEVICE concentrates on the order-related management tasks and does not dispose of any methods concerning above-order planning and control issues. VICOPLAN includes such solutions to a lesser extent. Still, VICOPLAN does not e. g. provide the aggregation of revenues in order to measure the performance of a VC financially.

6 Outlook

This paper presented a prototype of a tool for planning and control in a VC. Additional research activities include the proving of VICOPLAN in the practice of a VC as well as its further development. Moreover, the application of new technologies need to be verified. As a result, VICOPLAN shall become an applicable and enhanced system for planning and control in a VC. These further research activities are supported by the German Federal Office for Education and Research. The new project started on June 1st, 2001. TECHNOPOOL, the VC mentioned above, was chosen to test and advance VICOPLAN. The application of XML for the interchange of data between several partner companies and the VC as well as the use of multi-agent systems for decentralized placing of tasks will be proven by TECHNOPOOL in particular. Methods that support planning and control of several orders in VCs, e. g., performance measurement tools, will also be part of the enhancement of VICOPLAN.

Proceedings of the 35th Annual Hawaii International Conference on System Sciences (HICSS-35'02)
0-7695-1435-9/02 $17.00 © 2002 IEEE

References

[1] W.H. Davidow and M.S. Malone, *The Virtual Corporation, Structuring and Revitalizing the Corporation For the 21st Century*, New York, 1992.

[2] J. Sydow and A. Windeler, "Managing Inter-Firm Networks, A Structurationist Perspective", in: C.G.A Bryant, D. Jary,. (eds.) and A.Giddens, *Critical Assessments*, Vol. 4, London 1997, pp. 455-495.

[3] M. Scott Morton, "The Effects of Information Technology on Management and Organization", in: T. Kochan and M. Useem (eds.), *Transforming Organization*, New York et al., 1992, pp. 261-279.

[4] C. Snow, R. Miles and H. Coleman, "Managing 21st Century Network Organization", in: *Organizational Dynamics*, Vol. 20, No 3, 1992, pp. 5-20.

[5] B. Konsynski, "Strategic Control in the Extended Enterprise", in: *IBM Systems Journal*, Vol. 32, 1992, No 1, pp. 111-142.

[6] T. Veil and T. Hess, "A Basic Approach Towards Cost Accounting for Virtual Web Organizations", in: U. Franke (eds.), *Managing Virtual Web Organizations in the 21st Century: Issues and Challenges*, New York 2001 (accepted).

[7] E. Fleisch, H. Österle, " A Process-oriented Approach to Business Networking", in: *The Electronic Journal of Organizational Virtualness*, Vol.4, Bern, 1999, pp. 1-21.

[8] T. Hess, *Instrumente und DV-gestützte Werkzeuge für das Controlling in Unternehmensnetzwerken*, Göttingen, 2000.

[9] M. Fritz and M.L. Manheim, "Managing Virtual Work: A Framework for Managerial Action", in: P. Sieber and J. Griese (eds.), *The Electronic Journal of Organizational Virtualness*, Bern, 1998, pp. 123-135.

[10] W. Faisst, "Information Technology as an Enabler of Virtual Enterprises: A Life-cycle-oriented Description", in: *Proceedings to The European Conference on Virtual Enterprises and Networked Solutions*, Paderborn, 1997.

[11] R. Wigand,. A. Picot and R. Reichwald, *Information, Organization and Management: Expanding markets and corporate boundaries*, Chichester, 1997.

[12] B.Wangler and S.J. Paheerathan, "Horizontal and Vertical Integration of Organizational IT Systems", in: S. Brinkkemper, E. Lindencrona and A. Solvberg, *Information Systems Engineering,* London, 2000.

[13] J. Mylopoulos and J. Castro: "Tropos: A Framework for Requirements-Driven Software Development", in: S. Brinkkemper, E. Lindencrona and A. Solvberg, *Information Systems Engineering,* London, 2000, pp. 261-274.

[14] O. Wohlgemuth and T. Hess, "Evaluating the Success of Virtual Corporations with CONECT: Basic Procedural Indications and Practical Applications", in: U. Franke (eds.), *Managing Virtual Web Organizations in the 21st Century: Issues and Challenges*, New York, 2001 (accepted).

[15] A.M. Langer, *Analysis and Design of Information Systems*, New York, 2001.

[16] M. Mueller-Wuensch., „The EXECUdesk Project: Managing the Virtual Corporation", in: J.E. LaBarre. (eds.), *Proceedings of the International Conference on Information Systems and Global Competitiveness*, Toronto, 1995, pp. 66-73.

[17] C. Odendahl, "DEVICE - An Electronic Cooperation Exchange for the Continuous Design of Virtual Enterprises", in: *Proceedings of the Seventh International Symposium on Manufacturing with Applications*, World Automation Congress 2000, Maui, June 2000.

0-7695-1435-9/02 $17.00 (c) 2002 IEEE