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8-15-1997

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Abstract

Because today's commerce is information intensive and requires sophisticated computer support, it is difficult for the traditional corporations working individually to adapt the new environment to utilize information and build multinational teams effectively and efficiently. The need for global competitiveness makes multinational corporation (MNC) shift to a new team style: virtual teams, which are groups of individuals collaborating in the execution of a specific project while located at multiple individual sites or multiple group sites [1]. The environment of a virtual team is a cyberspace in which virtual project groups communicate mutually. In this paper, we focus on the functionality and structure of this highly abstract system. The groupware available for the teamwork collaboration is briefly introduced. A web-based teamwork environment served for MNC is then presented. We present a conical management architecture combined with a network topology: a peers and client/server mode instead of the traditional client/server and pure peers mode. It provides an orderly teamwork environment to replace the crowed and chaos-like teamwork space used currently. A design and implementation of the framework is finally described based on Sun Microsystems' Java language.

1. Computer-Supported Collaborations in Internet

A MNC must decide how to organize its operations geographically to obtain the competitive advantage. International teamwork is one of the core components of MNC. As World Wide Web (WWW) has gained broad acceptance, developing teamwork services that support teamwork management within the WWW is an excellent and natural approach.

Over the last years, Web-based collaborative applications emerged from traditional group support systems, such as AltaVista Forum, BSCW system [3], TCBWorks [10], Teamware [12], and WebShare [14]. Actually most of those systems are annotation systems using "dynamic HTML generator" technologies to achieve the functions like Usenet newsgroups (threaded or non-threaded). The annotation system simply means Web software for asynchronous group discussions using stored text messages. They use form-based interfaces that rely on Common Gate Interface (CGI) or Server Side Include (SSI) technologies. The shortcomings of using these approaches are tediousness, inefficiency, semi-interactiveness and especially non-awareness in teamworking. The team members are not notified by each other who is working at the moment or simultaneously.

A collaboration supported system for MNC must provide a general, orderly, and effective administration environment for each level of the team belonging to the same MNC. The current systems can provide a virtual environment for teamwork. However, many of them could not support impeccable commercial administration. Some of them are just used for remote communication (chat systems) or for entertainment; some of them could not avoid chaos which causes the disorderly and anarchical situation in the teamwork environment; some of them are deficient in overall administration for corporation purposes. In the light of the shortcomings mentioned here, we take disciplined collaboration among globally dispersed virtual teams as our goal. Here we present a virtual team management architecture with virtual teamwork framework which provides a fully collaborative environment for teamwork organizers and participants. It provides an open virtual environment for geographically dispersed team communications. The teamwork environment must be an integrated environment for collaboration and information sharing within and between teams, throughout any size of organizations.

2. Virtual Teamwork Environment

A collaboration support system for organizations must provide a general, orderly, and effective administration environment for each level of the teams belonging to the same organization. This system must support team working, team meeting, planning and consensus building, etc. The current or traditional teamwork/groupware systems can provide a networked environment for teamworks. However, the deficiencies of them are:

- Weakness in the teamwork management mechanism: Teleconferencing systems and email/newsgroup style systems are all teamwork tools instead of teamwork environment. Although these tools are indispensable parts of a teamwork environment, they need more articulation works, such as a scheduling process or workflow management.
- Platform dependence: some systems rely on a local area network (LAN) and do not support a globe, mobile and cross-platform access effectively.
- Not standard: Currently there is no uniform or international criteria for data forms. Different teamwork systems have their own internal data sheets or they are using a plaintext format.

Just like addressed by Lotus corporation, today's business environment is characterized by several key features:

- Companies must respond immediately to changes in a fast paced marketplace to remain competitive. Companies need to stay close to customers to understand their needs. The marketplace demands better customer service, product quality, and lower cost.
- Employees are often widely dispersed; many work on the road from home or from other remote locations creating a "virtualization" of the workplace.
- Companies need to work closely with people outside the organization, notably suppliers and partners. Effective cooperation across company boundaries is essential to responding quickly to changes in the marketplace.

In addition to changes in the business environment, technology is evolving rapidly, networking technology, in particular. The emergence of the Internet and Intranet offer wider bandwidth at affordable costs to a broad population. The Internet and the related HTML, TCP/IP, and Java standards provide the public network backbone that business can leverage information exchange between any two points on the globe [6].

Here we present a virtual team management architecture with a virtual teamwork framework which provides a fully collaborative environment for teamwork organizers and participants. It provides an open virtual environment for geographically dispersed team communications. The teamwork environment must be an integrated environment for collaboration and information sharing within and between teams, throughout any size of organizations. Main issues are listed here:

- Support to platform independence,
- Support to team working, e.g. scheduling, project tracing,
- Support to use of existing corporate infrastructures, e.g. electronic mails and newsgroup,
- Support to extensiveness, e.g. create new team groups, recruit and dismiss,
- Support to compatibility with other teamwares, e.g. Notes and TeamWARE,
- Support to openness, e.g. Internet and Intranet, and
- Support to security, e.g. identity certifiers and object behavior certifiers.

3. Collaboration Architecture

A MNC can be regarded as a virtual world which is composed of many sub-corporations. Each sub-corporation holds an ad hoc network server over Internet to manage different team groups (virtual teams) dispersed around the world. Besides managing its virtual teams, the server is also open to other sub-corporations (servers) belonging to the same virtual environment (MNC). The databases in each server

compose the center of information shared by each team. Of course, the access priority must be defined among the virtual teams to maintain information security and data consistency. Each server will give each user the qualification to visit it accordingly. A super manager layer exists above all the servers, which represents the headquarters of a MNC. We call it "super" because it has the highest priority to access to and coordinate all the servers directly, although it is not a server entity. It is thus a virtual headquarters.

Each server is divided into different departments according to the practical function requirement. Each department is responsible for the communication among virtual team groups dispersed in different places. It should be noticed that the department can use current office management tools, such as Teamware [12], MS Team Manager 97 [11], and Lotus Notes [6], to make it possible for different levels of users to collaborate on a project electronically, and to keep the workflow model running smoothly throughout the life of each project. Such design is actually one of our goals in this study, *i.e.* to design a system with a concise and orderly structure by utilizing current software to make the whole system simple and compatible. Each server has a specific teamwork department in charge of the virtual team management, such as recruit new team members, open/close virtual teams, receive/dispatch information which team members require to other departments (teams).

Figure 3.1 shows the architecture of a virtual corporation from the view of the organization. It is a conical organization structure. The virtual headquarters is the top point of the cone, which manages all the sub-corporations with the highest priority. The server of each sub-corporation is controlled by the "superuser", headquarters, but these servers have the same level relationship mutually. We choose the peer-to-peer approach as our decentralized servers model. In the peers model, the distinction between a client and a server is pushed down into the objects which are actually communicating. This means that certain objects with a critical state might have a server component for just that state, but communicate as peers for other states. This provides a significant flexibility and the advantage of the "functional specialization" of different objects. In particular, a model can be built where you have client and server objects, but with respect to particular operations [5]. A sub-corporation (server) accompanying with the corresponding virtual team groups (clients) forms a client/server model in this design.
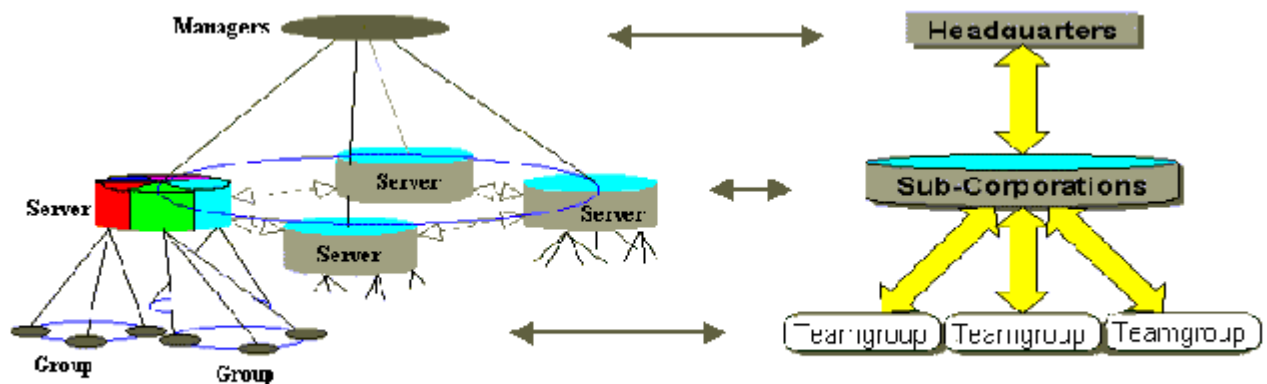

Figure 3.1 Conical architecture for the organization of a virtual corporation

4. Design Aspects for Virtual Teamwork

4.1 Network Topology
Virtual communities provided via the Internet traditionally depended on a centralized server mode for session management. With the growth of communication requirements, the client/server mode is neither flexible nor scaleable [5]. In our study, we combine the client/server mode with the peer-to-peer mode, and choose a peer-to-peer mode for our servers communications and a client/server mode for server to team groups. That is to say: different servers (sub-corporations) hold equal status in the virtual teamwork environment, and they have the same priority to access each other. When a new server is registered to the

system, all data, included static and dynamic, must be duplicated from the "alive" server (which can be any active server in the server group).

4.2 Teamwork Web Server

Teamwork Server is a multi-threads and multi-tasks TCP server whose executive architecture is an umbrella structure: some branches are distinct executive threads matched with the related team groups and other branches are used for executing internal commands and communicating with local teamware and other servers. Each sub-corporation has its own teamwork server accompanying with HTTP server (internal or external). The server provides enough internal management commands to support communication requirements. Team members including participants and managers access to a server by using a teamwork client.

4.3 Teamwork Client

More and more companies select Web browsers as clients for their groupware products. It makes large potential teamwork participants into reality. For choosing a browser as the client tool, the venders need to create the server side more effective and efficient. Then the teamworkers (in the client side) can choose the best suitable browsers to adopt the server side. We do not need worry about the revolution of technologies, because the Web browser venders do this for us. That is another reason for choosing the browser as the groupworking client. Some of teamwork servers require specific browser components, for example, ActiveX controls, to enable group communication, while some use Java-enhanced browsers. We choose Sun Microsystems' Java language as our developing tool for the teamwork server (HTTP enabled) and the client application/applet. A standalone application mode must be used at the same time when the teamwork server is only used without combining a Web server, since the Java applet can not access to other Internet sites directly for security reasons.

5. Conclusion

A conical structure of virtual teamwork environment for MNC over Internet was presented in this paper. We currently focus on the system structure and study some design aspects of our work. In the future, we will formalize the internal command set as a standard and build the common interface with other groupwares to make the virtual system more compatible. There are some expected characteristics of this system:

- Support to product exhibitions and problem solving (opened/half-opened),
- Support to asynchronous/synchronous communication,
- Support to team meetings and conferences (opened or confidential),
- Support planning scenario development and decision making,
- Support highly compatible features with other teamwork tools or groupware, and
- Support awareness in team workers and projects.

The newest information about the virtual environment can be found from our web site [15].

References

References available upon request from (first) author.