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THE CHALLENGE OF COLLABORATIVE WORK AS A POSSIBILITY TO SUPPORT DISTRIBUTED RESEARCH NETWORKS

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Abstract: - In this paper, we describe our view for a successful collaboration in Virtual Manet, a distributed academic research network. It works as a test bed for an organized set of tools that could assist also distributed collaborative manufacturing. Our aim is to design, implement and experiment E-Manet, a software environment that supports both synchronous and asynchronous computer-supported scientific e-collaboration. The idea can be generalized to encompass the manufacturing business or a collaborative production in virtual enterprises.

Key-Words: - Collaborative research networks, manufacturing, architecture, cooperation, coordination

1 Introduction

Scientific research activities can be considered as a foundation for cooperative work. In a world-wide or country-wide context, scientific communities have been built through remote collaboration to handle conference planning and face-to-face collaboration during meetings. However, joint research projects and research networks are suitable structures for scientific collaboration and constitute the interest of this paper. We aim to reinforce the existing evolution, where communication and publishing technologies are used to increase the collaboration scope by widening and planning face-to-face meetings.

The main idea is to provide a cooperative electronic space based on a software framework for scientific collaboration integrating different technologies, from synchronous to asynchronous cooperation, coordination and knowledge sharing, providing services as interests maps, electronic scheduling and meetings or topic awareness, for example.

This framework is being developed to support the e-organization of the scientific collaboration within the Manet (Manufacturing Automation Network) research Network. Such research environment has problems that resemble a virtual enterprise environment for one side, or a big manufacturing corporation with a big amount of business processes on the other side. Consequently, it makes as a good test bed for the proposed collaborative environment and also a good insight for the general problem of collaborative and cooperative work.

This paper is structured as follows: Section 2 describes the structure of the Virtual Manet organization; Section 3 discusses the components of the collaboration support environment, E-Manet and its layered integration architecture. Section 4 describes the deployment architecture and presents the first experiment results. Section 5 describes concluding remarks and future work steps.

2. Structure of Manet network

Manet is a non-profit, multi-institutional, multidisciplinary and distributed network of researchers, with representatives from many of Brazil's biggest universities and research centers. MANET is one of the participating in the Network of Cooperation and Research Program -RECOPE- created by the agency FINEP of the Brazilian Ministry of Science and Technology. Manet is responsible for aggregating professionals working in manufacturing automation and related topics, which involves mainly the participation of electrical, mechanical and computer engineers distributed throughout the Brazilian territory.

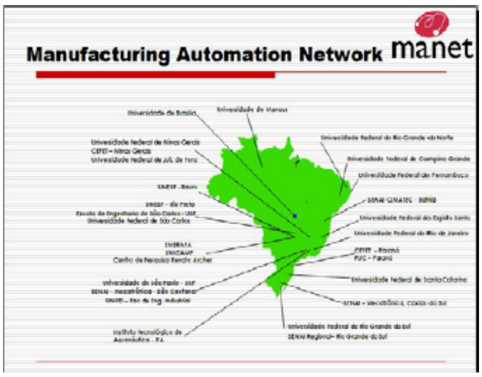

Fig.1. Virtual MANET geographical distribution

Some of Manet's participants share the same research topics, which allow them to behave like partners and competitors at the same time, just as companies belonging to the same branch. Other members work as complementary labs, similar to companies with their suppliers and partners.

Similarly to a virtual enterprise, where companies are focused on competence areas, Manet's participants often join their key technical knowledge and assets to fulfill the process of a product or system creation.
Therefore, Manet can be seen as a metaphor for a distributed manufacturing team which goes from the early design to the final production of the artifact.
Virtual Manet Project is intended to be a test bed for cooperative tools and techniques. It includes activities ranging from basic spontaneous communication to a controlled process of project and manufacturing (by controlling the shop floor throughout the network) and covering all phases of collaboration. The system is oriented to achievements, and thus is very close to a decision making system. In the framework of Manet, such achievements are visible results such as join papers, technical reports, experiments or join software developments.

2 Virtual Manet organization

We identify different levels of collaboration contexts. First, we have the *context of a team*, that is, the context for a group of individuals (inside a corporation for instance, or inside an open network as MANET). There is also the *context of a group*, where teams are aware of other teams and envisage the cooperation between them. In MANET, for instance, there are actually six research teams, each one with a general theme: robotic, robotized welding, manufacturing systems, discrete systems, rapid prototyping and building automation. The organization is flexible and it is possible to organize a new group any time, since a context could be recognized by the general coordination. There is always a coordinator for the new group that is also the administrator of the respective team context. The context of group is managed by a committee composed by MANET team coordinators and the general chair.
Finally there is a community context where all groups are considered together with what they have in common. The existence of this level of context is associated with the possibility of relations among communities. In the case of MANET, the community relationship is associated with the relation between MANET and IMS (Intelligent Manufacturing Systems), or with the e-learning community, or even in the relationship between the net and companies that act as partners. The principal interest of these companies is in using the net as support for innovation and automation. More recently associations of companies on specific fields (electric goods, informatics, mechanics, etc.) created special groups called Institutes of Research and Development. It is now possible to experience a connection between communities in a new approach to the relation between academy and industry.

As depicted by table 1, Virtual Manet users have different role classes and may be member of one or more organizational context. Each class may take benefits from specific collaboration functions which are not possible in a classical organization. E-Manet provides opportunities for PhD students for cross-discipline learning. It provides a support for knowledge publishing by domain-specific experts. It also provides group-wide co-work tools for R&D actors and managers. Such tools include document editing for collaborative authoring and review activities, shared work spaces for exchanging design documents, reports and files, and distributed project management support for scheduling and planning group activities.

Virtual Manet user classes	Provided E-manet collaboration functions
PhD Students	Cross-discipline learning support
Domain-specific experts	Knowledge publishing
R&D managers&actors	Group-wide document editing, Shared workspaces, Distributed project management support

Table1. Virtual Manet Users and associated E-Manet functions

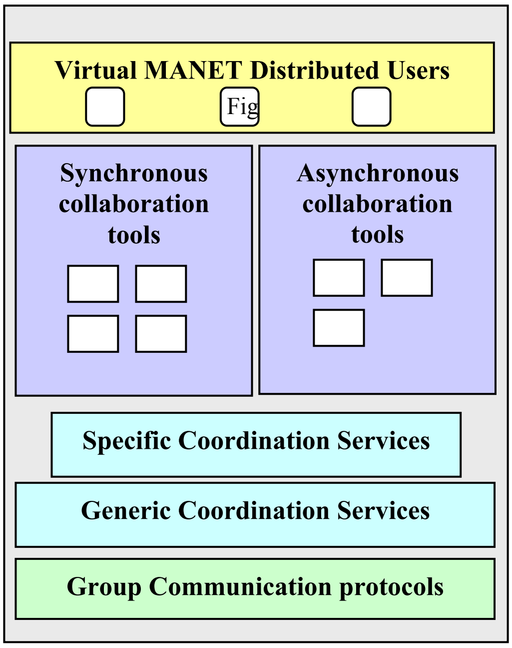

Fig2: The architecture of E-Manet

3. Collaboration support environment of E-Manet

Two categories of collaborative activities are considered: asynchronous and synchronous activities [7]. In the first category, users act according to sequential or parallel procedures on data dedicated to the group work. Research works of the asynchronous framework are generally addressed within the Workflow domain, according to sociological or organizational theories and approaches, where business process automation constitutes a particular case [1]. Asynchronous collaboration is mainly devoted to the coherent workgroup data management, to make their values evolving in a coherent way, according to the workgroup associated to the participants. People are working in an asynchronous way that does not require their co-presence in the same time.

Synchronous collaboration is constituted by interactive services where participants act simultaneously from distributed access points on shared objects. Synchronous collaboration requires the co-presence in time of the participants [2]. The latter have to meet in order to coordinate their contributions using virtual presence during work sessions. They use a set of collaboration tools (videoconferences, shared spaces) to maintain the virtual synchronous co-presence, which allow them to progress in a coordinated way, according implicit or explicit collaboration rules.

Supporting both synchronous and asynchronous collaboration activities constitute the purpose of the collaboration support environment for the brazilian project V-MANET.

For this purpose, the E-Manet environment has a layered architecture (Fig.2) that involves synchronous and asynchronous collaboration tools supported by domain-specific and generic coordination services, and by group communication protocols. Generic coordination services

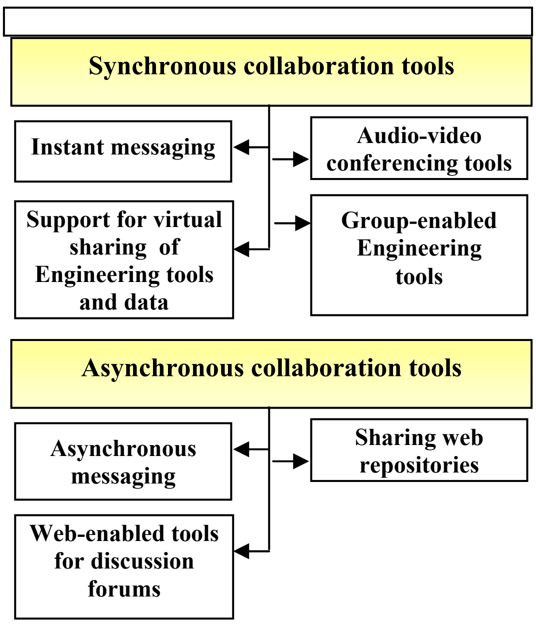

Fig3: Synchronous and asynchronous collaboration

provided functions include “electronic meetings scheduling and management” [3], “interdependencies-enabled group management” [4], and floor control [6]. Communication layer provides QoS and order-enabled N-to-M communication protocols [5].

As depicted in Fig.3, synchronous collaboration tools include generic functions such as “Instant messaging” and “Audio-video conferencing” capabilities. They also include additional capabilities allowing “virtual sharing of legacy applications” initially designed for a unique user, and “Group-enabled Engineering tools” specifically designed for group collaboration.

Asynchronous collaboration tools include capabilities for: “asynchronous e-messaging” web-enabled “discussion forums”, and “shared web repositories”.

4. E- Manet deployment architecture and first experiment

E-manet deployment will rely on the infrastructure of the MANET Excellence Center in Manufacturing Automation.

The final deployment scenario will cover 20 different cities distributed on an area of 8.5 million of kilometres square.

For this purpose, an iterative deployment plan was set. It divides the deployment geographic space in three regions: North-northeast, East-southeast and South. Each region has a complete e-manet sub-system composed by a central system where all servers are installed. Each region may be client of the others and can host servers serving for supporting running applications such us document managers and multimedia applications.

Each black box in Fig. 4 represents a center of a cluster which can also be linked to the East-Southeast. This center plays a double role of local and country center. Thus it is also composed of distributed servers located in two cities (the white circle) and in three different laboratories. The red circle represents the cities and labs connected to Kiatera sub-network, that is, centers that

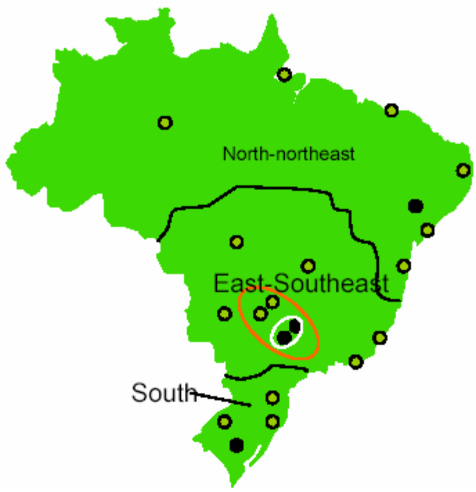

Fig. 4: Deployment architecture for E-manet

also share the use of small CIM Labs, exactly to study its flexibility and implementation process. All data would be shared with the region and with the whole network.

The major deployment constraint was related to the bandwidth available in the net, principally when multimedia applications have to be used. This difficulty has been solved, for the red circle, by using the Kiatera networking infrastructure.

So far the white circle has been deployed successfully and now the red circle deployment is in progress and is scheduled to be working in few months, by June.

However, it has to be stated that the deployment, at this step, included only the generic components developed by LAAS, as a first deployment strategy. A new set of domain-specific tools and services, that will use e-manet as a test bed, are now being developed and tested separately.

Such domain-specific tools include a Manufacturing Information System (Mfg-Is) which is important to provide the proper vertical and horizontal integration in a CIM environment.

The Mfg-IS is scheduled to work with detailed information about the manufacturing of items in the shop floor. Thus a system to read and store information gathered from the items by RFID readers. The database system works (and all data servers) at the same place in the D-Lab/EPUSP, located in the city of São Paulo.

Similarly, the experimental work with learning CIM is done in the LAR/UNICAMP where a special flexible arrangement was developed and is now being prepared to be controlled through the network.

4.1 The first experiment results

We experienced a first prototype of the proposed organization within collaboration scenarios involving participants distributed on three sites: two in Campinas, and one in Sao Paulo. During these sessions, participants need to asynchronously exchange documents, and then synchronously review design and authoring issues in collaboration with remote partners.

The first experiment phase has demonstrated the possibility to use E-Manet features in collaborative activities, where the following functions have been used:

- To remotely participate/manage a test session with a chairman control.
- To share documents (access to documents, published documents, modify some of them, etc.),
- To solve technical problem in a distributed meeting with geographically distant people,
- And to be informed of specific events related to actions performed by a community of people working in a collaborative mode.

5. Conclusion

We presented in this paper the principal concepts included in e-manet, a virtual environment to collaborative work dedicated to MANET Network. These concepts are implemented over a base of tools and services initially developed at LAAS. Additional tools and services are being developed in Brazil in the context of the Brazilian FAPESP Project Kiatera. These tools and services focus on the support of learning functions, and manufacturing domain-specific functions. They will be integrated in the future version of E-Manet.

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