

Multi-Agent System for Informational Support of Collaborative Researchers Work in a Computer Network

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Abstract

The article considers the model of researchers' interaction when conducting a collaborative project. We also propose a multi-agent system architecture for informational support of the process of collaborative research using Internet technologies.

1 Introduction

The contemporary scientific community tends to extend international collaboration. This collaboration may be realized through the creation of collaborative virtual international laboratories (collaboratories) in the Internet for different scientific and technical fields. But this process puts forward the problem of developing efficient facilities supporting interaction between group members. These facilities ought to provide quick data exchange, access to tools and distributed data and knowledge bases, computational resources, etc.

A well-known example of such a system is Worm Community System (<http://www.canis.uius.edu/wormsystem/index.txt>). This project includes software developed for Sun workstations running Solaris OS and connected to the Internet. Worm Community System is designed for biologists studying worms. It allows several specialists to simultaneously view the accumulated information, edit it, append new data, exchange opinions with other scientists. And all the changes are instantly made available for every user of the system. We can also note a prototype collaboratory at the Spectro-Microscopy Facility of the Advanced Light Source (ALS) Beamline 7.0 at Lawrence Berkley National Laboratory [1] and Global Engineering Networking, which enables companies from different sectors to use and exchange engineering information and services [2].

The work under the project “Computer Bank of Russian European North Toponymy” (supported by grant 5988f of Russian Federation Ministry of Science and Technical Policy) has entailed the necessity of developing technology which allows for a new kind of collaborative specialists’ work organization when carrying out research into toponymy and applying the results to practice. As the basis for this technology we took the idea of collaboratories creation to organize carrying out collaborative research and development in the toponymy field.

This article describes an approach to the construction of computer facilities intended for informational support of processes of carrying out collaborative research and development using Internet technologies and multi-agent systems.

2 Model of Collaborative Researchers’ Work on the Internet

The work under the project of creating a problem toponymy Web-site with integrated databases (<http://toris.krc.karelia.ru>) has entailed the necessity of developing technology which provides informational support of collaborative researchers’ work on the Internet. Figure 1 depicts the model of this technology.

Supposingly, a group of scientists (specialists) who work in the same problem domain (for example in the field of toponymy) and situated in different regions of the country (world) decides to unite its resources (in-

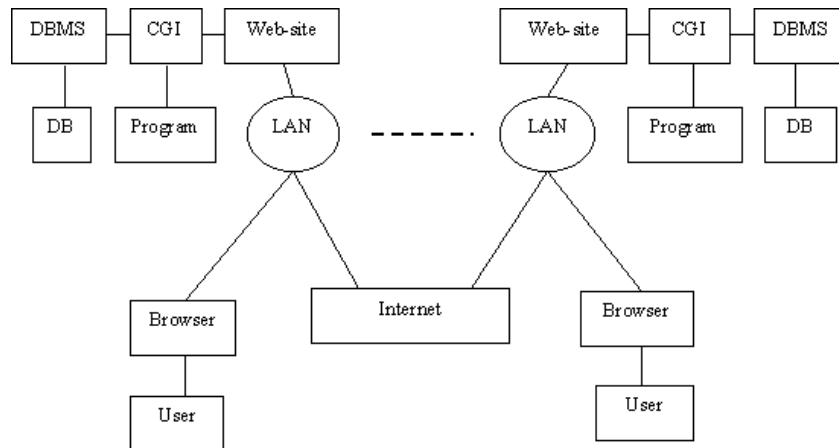


Figure 1. The model of collaborative researchers work in the Internet

tellectual, informational, computational, etc.) in order to solve sophisticated scientific-technical problems. To accomplish this they create the system of problem Web-sites interconnected in the Internet with integrated databases and custom software.

While working on the collaborative project the information content of the sites is developing to reflect the results of solving intermediate problems. Doing this, the project participants can exchange information efficiently, access distributed databases and computational resources.

We suppose that, as a rule, the collaborative project participants interact with the system without assistance. And we are heading for the case when the developers of the system's problem Web-sites have different (often not high enough) qualifications and experience in creating HTML-documents. Due to that the documents may contain a lot of errors. It is also worth of noting that the problems connected with the creation and development of problem Web-sites increase as the number and volume of created HTML-documents enlarge, they are often corrected, Java-applets are used, new hyperlinks are added and so forth.

We also assume possible lack of action co-ordination between specialists collaboratively working on the project and putting their activity results on the Web-sites. For example, someone can change an HTML-

document or add new material to his Web-site without informing the other project participants on time.

The analysis of problems solved by toponymy specialists has shown the necessity of their close co-operation when searching for the information needed, particularly when retrieving data with queries from databases located in the other servers of the system. While this is so, a specialist may need help in constructing a query for the search of information and also in providing an acceptable time of the system's reaction to the queries.

Thus, on the proposed model basis we can conclude that the process of collaborative project work on the Internet needs informational support of user interactions by the means of a higher level of automation of Web-site state control functions, organization of work with databases and programs, and optimal allocation of information among the servers.

3 Multi-Agent System Architecture

Multi-agent system technology has been jointly spawned by artificial intelligence, telecommunications systems, and Internet-technologies. Its development is caused by the necessity of creating applications solving difficult problems in distributed computational (networked) environments. Taking into account the proposed model of collaborative researchers' work on the Internet, we consider the development of a multi-agent system having the following functions to be expedient:

1. check-up of HTML-documents created and corrected on the system's Web-sites for syntactical correctness;
2. discovery of the changes of the system's Web-sites informational content and notification of all the collaborative project participants interested in this in proper time;
3. organization of search for information among the other sites of the system;
4. giving help to the user in entering and editing data in the databases, creating queries, correctly using data process programs;
5. organization of effective user query execution in a distributed information system;
6. optimal information reallocation among the servers of the problem Web-sites system distributed in the Internet in order to provide a system query reaction time acceptable for the users.

Figure 2 shows the architecture of the multi-agent system for informational support of collaborative researchers' work on the Internet.

At the beginning of the work the user connects to a system's problem Web-site through the local area network by a usual browser like Netscape Navigator or Internet Explorer. Then he can perform a number of actions concerned with viewing information contents of his/others' Web-site of the system, working with databases or custom data process programs. If the user has enough authority, he may add new data to the site's databases, edit or delete the existing data. When new data are being added to the database, the Data Monitoring Agent checks them for consistency and prevents data duplication.

The Database Agent aids the user in constructing the correct SQL-queries, and in co-operation with the other agents, organises the process of running queries in the distributed information system.

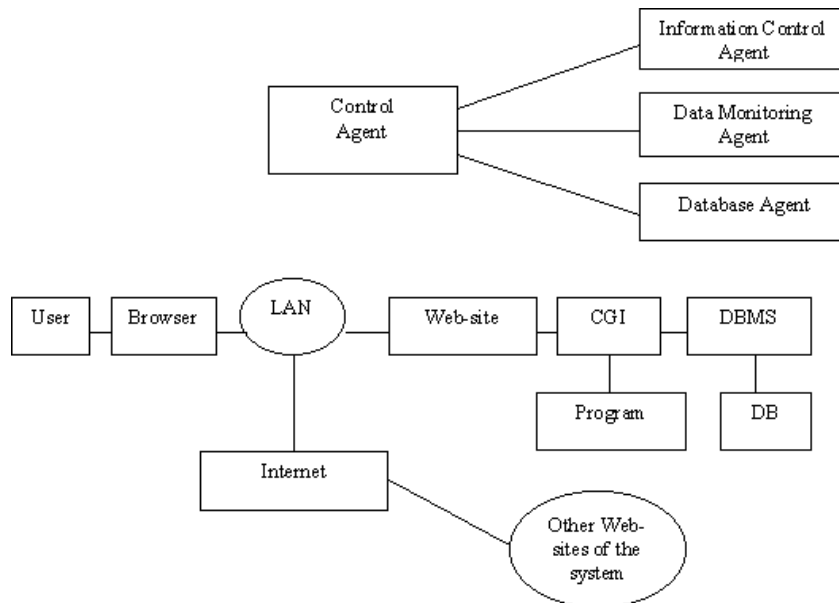


Figure 2. Multi-agent system architecture

The Information Component Agent helps the user to modify HTML-documents at his site. Doing this, it performs a check-up of the created (modified) documents for correctness and also notifies the other agents about changes made. Then it receives from the other agents information about changes made at the other sites and informs the users about this.

The Control Agent controls the operation of the whole Web-site. It is responsible for providing interoperability between all the agents and site components. It also acts as a mediator for the other sites of the systems (for example, when running SQL-queries in the distributed system or solving tasks of data reallocation among the servers).

4 Related Work

Paper [1] describes the prototype collaboratory at the Spectro-Microscopy Facility of the Advanced Light Source Beamline 7.0 at Lawrence Berkely National Laboratory and also presents the software architecture and components that are being developed to provide a toolkit for bringing future experiment equipment on-line. Paper [2] proposes the Global Engineering Networking approach for building up global electronic marketplaces for engineers. Paper [4] describes the information system for the toponymy field—the TORIS system, and paper [6] considers the task of optimal data reallocation among the system's servers using the Nash bargaining scheme.

5 Conclusions and future work

This article proposes the multi-agent system architecture intended for information support of collaborative researchers' work on the Internet. The main benefit of this approach is the increase of quality of user information services when carrying-out a collaborative project. It can be achieved by increasing the level of automation of the following functions: monitoring the Web-sites information contents, providing aid to the user in creating queries to retrieve information, running queries in the distributed information system.

During the future work we plan to improve and work out in detail the multi-agent system architecture and also to create and implement a research prototype of such a system for information support of collaborative researchers' work in the toponymy field as a part of the TORIS system development.

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