COLLABORATIVE WORKSPACE OVER SERVICE-ORIENTED GRID

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Grid computing has evolved dramatically, migrating to service oriented Grids: the third generation Grids. As a result, there has been great interest from both industry and the research community in enabling collaborative service provisioning through operational virtual communities over the grid. However, the existing service providing mechanism of the Grid is too rigid to provide the flexibility for a wide range of collaborative services. Lacking virtual community support at the operation level becomes a major barrier to promoting collaborative services over the Grid environment. In this paper we propose a collaborative workspace over service-oriented grid for developing operationally transparent virtual communities in a wide variety of domains.

1. Introduction

Grid is a type of parallel and distributed system that enables the sharing, selection, and aggregation of resources distributed across multiple administrative domains based on their (resources) availability, capability, performance, cost, and users' quality-of-service requirements [1]. Grid computing, since its emergence, has been an active research area for facilitating large-scale collaborative scientific research in many application domains such as geographic study, physical science, Genomics and etc. The initial focus is on the sharing of expensive resources, such as super computational power, storage and rare/expensive facilities. For example, the U.S. Network for Earthquake Engineering Simulation Grid (NEESGrid) connects experimental facilities (e.g., shake tables), data archives, and computers [2]. Nowadays grid computing has evolved dramatically, migrating to service oriented Grids: the third generation Grids [1, 3]. However, the existing Grid environment handles well how data and services are stored, represented and accessed, not the high level collaborative services in a virtual community. The existing service providing mechanism of the Grid is too rigid to provide the flexibility for a wide range of collaborative services. Lacking virtual community support at the operation level becomes a major barrier to promoting collaborative services over the Grid environment. As a result, there has been great interest from both industry and the research community in enabling collaborative service provisioning through operational virtual communities over the grid. For example, over the NEESGrid, a virtual community has been formed for information/knowledge sharing among earthquake scientists and engineers.

The advantages of having virtual communities on the grid are well known at the concept level, where like-minded individuals/groups share their knowledge/services for the benefit of all who participate, however, the practical implementation is still far from expectations. There have been recent efforts for exploration and deployment of domain specific virtual communities over the grid [4, 5]. However, the lack of a common and widely accepted methodology as well as supporting framework is still forcing every vertical development project to design and implement its own home-grown mini virtual community framework in a specific application domain.

Collaborative services provision needs the real collaboration in operation level in a collaborative workspace of virtual community environment. Without efficient support from dynamic virtual community formation mechanisms, transparent virtual community operation tools, virtual community support services, virtual community management services etc., collaborative services cannot be effectively composed. In order to leverage the potential benefits of virtual community paradigm, there is a great need for proposing practical methodology and developing flexible and generic framework to support the formation, and operation of virtual community in various application domains. To date, little work has been reported on Operationally Transparent Virtual Communities that supports collaborative workspaces over the Grid.

In this research we propose and design and implement a collaborative workspace for developing operationally transparent virtual communities in a wide variety of domains such as manufacturing grid, bioinformatics grid, digital media grid, and various collaborative e-research, e-science and e-services grid. This research aims to provide a systematic solution to Operationally Transparent Virtual Communities over the service-oriented Grid in a wide range of application domains and attempts to meet the challenges we faced.

Following this introduction, Section 2 describes the architecture of our proposed collaborative workspace. Section 3 presents the implementation of the community portal built on top of the collaborative workspace. Users can work collaboratively using the proposed workspace through this portal. Finally the paper is concluded in Section 4.

2. Collaborative Workspace

The Virtual grid community is based on a service-oriented grid infrastructure. The collaborative workspace supporting the virtual communities is composed of six components, as shown in Figure 1, which are virtual community (VC) management, transparent collaborative tools for virtual community operation, process management for automating the collaborative processes, virtual community supporting services, knowledge management and trust management in virtual community.

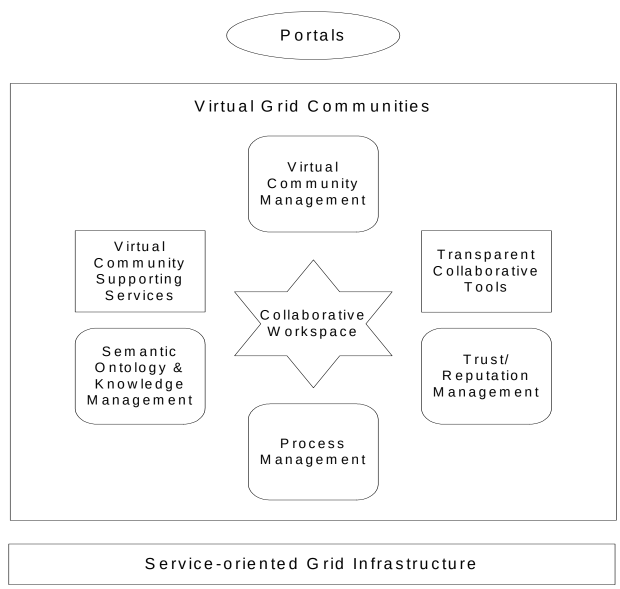

Figure 1 A Reference Model for Operational Transparent Virtual Community over Service-oriented Grid

The component transparent collaborative tools for virtual community operation, process management for automating the collaborative processes, and trust management in virtual community provides sophisticated framework and transparent collaborative tools for collaborations in an operation level for the need of meaningful collaboration between VC members across organizations, locations etc. in the collaborative workspace over grid environment.

2.1. *Goal Oriented Process Modeling and Scheduling*

One important aspect in the VC is to model and schedule the processes in the collaborative workspace. The activities carried out by a company are usually organized in groups of inter-related activities called processes that can be seen as a set of activities, rules and constraints specifying the steps that must be taken, and conditions that must be satisfied, in order to accomplish a given goal. In this research, we adopt goal-oriented approach, Goal Net [6], for process modeling and scheduling. The advantages to use Goal Net include:

- Goal Net is a novel goal oriented process modeling tool which can decompose a complex process to executable sub-processes for achieving a common goal.
- Goal Net is a multi-agent modeling tool by which a multi-agent system can be derived from the process modeling for automating the processes.

With Goal Net, the composition of each process is designed in order to achieve a specific goal. A business process can be decomposed into a hierarchy of sub processes and activities. Parts of the decomposition of this process are assigned to different organizations or VC members. A combination of various processes takes place at different members in order to achieve the global goal of the high level process. The problem of the supervision or coordination of such a process at its various levels of decomposition is critical, in this context, where its definition and activity are not limited to a single organization, but to a set of autonomous, distributed, and heterogeneous nodes that need to cooperate. With Goal Net, the supervision and coordination are automatically derived during the process decomposition phase.

The development framework and tool, MADE (multi-agent development environment) [7] is used and extended to web platform in our research for business process modeling, agent creation, service scheduling and execution of distributed processes that dynamically compose/integrate the services provided by different community members. UDDI [8] from web service community is used for service specification/definition and service registration.

2.2. *Collaboration Workspace and Transparent Collaborative Tools*

To enable operational transparent virtual community, it is required to integrate multiple participates into a coherent, structured, and collaborative management process. Such a collaborative management process can be built on the basis of the shared collaborative workspace, where team members exchange their updates on the shared artifact and maintain a consistent state of it.

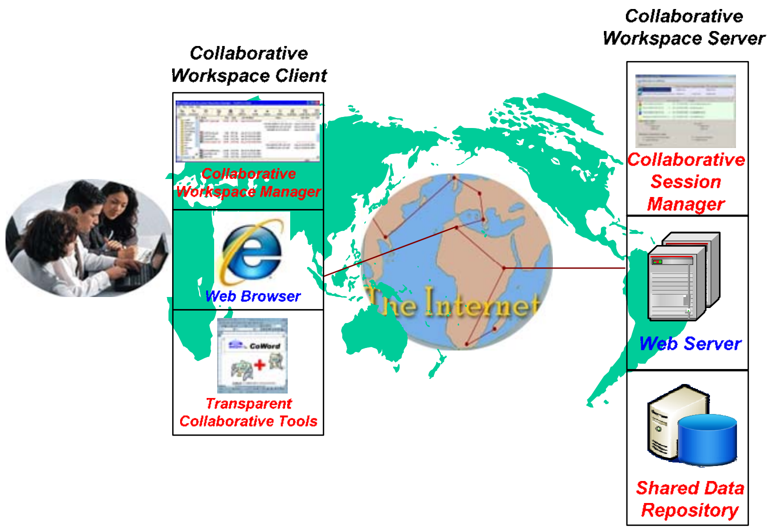

Figure 2: A Collaborative Workspace

As shown in Figure 2, a collaborative workspace consists of a server component and a client component. The server component provides a data repository for storing artifacts to be shared by a virtual community and a collaborative session manager that coordinates collaborative users, e.g., joining into and quitting from a collaborative session and exchange of updates made on shared artifacts. Accordingly, the client component has a collaborative workspace manager [9] for viewing and manipulating the shared data repository, such as creating, deleting folders and files and changing their access rights; for viewing collaborative session information, such as what are available sessions, who are the participants in each session; and for starting a new session or joining an existing session by launching a collaborative tool.

To take advantage of Web's ubiquitous accessibility and file sharing capability over the Grid, the collaborative workspace is built upon the Web platform. In particular, the server component extends an existing web server to support collaborative session management and shared data repository management. The client component has been specially designed to manipulate the shared data repository, and to start a new session or join an existing collaborative session by launching a collaborative tool. As file management of web folders are often integrated in web browsers such as Internet Explorer (IE), our approach extends a web browser to support collaborative workspace management. This approach is called Transparent Adaptation (TA) [10, 12], which extends an off-the-shelf single-user application for collaborative use without modifying the original application, thus being transparent.

Figure3: The Transparent Adaptation approach

The TA approach provides a bridge between state-of-the-art collaborative technologies and off-the-shelf mainstream single-user applications. As shown in Figure 3, the TA approach consists of three major components. The top component is the Single-user Application (SA), which provides conventional functionalities. The SA can be any existing or new applications such as Web browsers, Office applications, and Integrated Programming Environments. The base component is Generic Collaborative Engine (GCE), which provides advanced collaborative capabilities. The GCE component can be reused in adapting different single-user applications. The middle component Collaboration Adaptor (CA) bridges the gap between the SA and the GCE components.

Collaborative tools that have been investigated or are under investigation in this research include collaborative web browsers, collaborative office applications [11, 12], and collaborative integrated programming environments.

2.3. *Trust Management*

In the collaborative workspace environment, services from virtual organizations are shared and cooperate among all the members. Security and trust is an important issue for the successful collaborations. Traditional security analysis cannot sufficiently protect each sub-service atomically. The manufacturing grid environment provides an open, decentralized infrastructure that spans multiple administrative domains. Trust Management (TM) is an emerging framework for decentralizing security decisions that helps users in asking "why" trust is granted rather than immediately focusing on "how" cryptography can enforce it. In this research, we propose and implement a pragmatic method for Trust Modeling and Management in virtual grid community [13]. TM is integrated into the collaborative workspace for document authoring and distribution, content filtering, and service provision/selection.

3. Community Portal

In the last section, the major components of the transparent workspace are presented. To allow VC members to work collaboratively in this workspace, we design and implement a community portal on the Web. With this portal, VC members can share their services to other members and use available services for their own business needs without knowing where the services are located. In the following sub-sections, the system architecture is introduced first. Then, the system design and implementation are described. Finally, the application areas of this research are discussed.

3.1. *Collaborative Workspace Architecture*

The system is designed in a layered structure.

<table>
<tr><td colspan="6">Portal – Web-based User Interface</td></tr>
<tr><td>Document Management</td><td colspan="2">Member Management</td><td>Security Management</td><td>Process Modeling</td><td>Collaborative Tools</td></tr>
<tr><td colspan="6">Supporting Services / Trust – Service Evaluation</td></tr>
<tr><td colspan="2">Document Server</td><td colspan="4">Ontology Repository / Grid/Web Services</td></tr>
<tr><td colspan="6">Grid Simulation – Globus GT 4</td></tr>
<tr><td colspan="6">Operating System - Linux</td></tr>
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Figure 4 the Collaborative Workspace Architecture

As shown in Figure 4, the lowest layer is the operating system running on different grids. Then it is the GT4 [14] layer which provides grid services. Layer 3 is the service layer containing the Grid services, web services, and content services, etc. Layer 4 provides the trust evaluation service at which all the grid/web services will be evaluated. During the business process execution, the grid/web service will be selected dynamically through the trust service. Layer 5 is the interface support tools including content management, community member management, security management, process modeling tool, and the collaborative tools. Finally Layer 6 is the portal layer at which users can access the collaborative workspace through the community portal.

3.2. *Implementation*

As shown in Figure 5, the system contains the following components:

- Application server that supports web server, java servlet container, and web service adaptor;
- UDDI server that provides UDDI registry services;
- Database server that stores the data;
- Transparent tool engine that provides the transparent collaborative work environment;
- Trust service engine that provides the trust service;
- MADE framework that provides business process modeling, agent creation and agent execution services; and
- Other tools that provides other services including content managements, member management, chatting, and forum, etc.

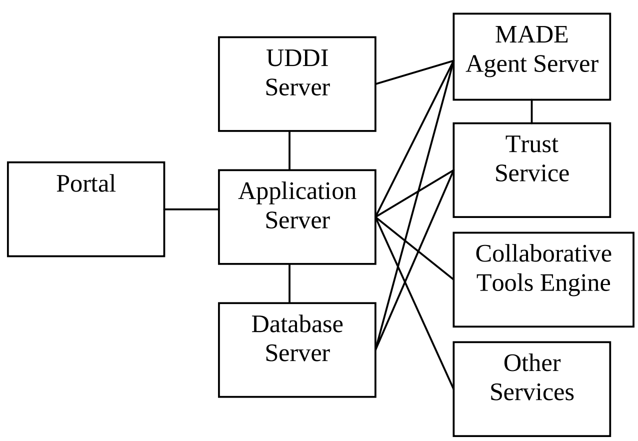

Figure5 the Portal System Structure

As shown in the screen shot in Figure 6, the portal provides many services for users to join the community and do the collaborative work with other community members. For examples, users can share documents by clicking the resource button, chat with other members by joining a chatting room, join the forum to discuss with other members by entering a forum group.

To work with the collaborative workspace, users can join the community as service providers or service consumers. When a user provides a service, he can register the service through the service registration page by clicking the service button. Then the service will be automatically registered into the community UDDI server. To consume the service, users can design a business process using the process modeling tool by clicking the process button. When you define a process in the modeling tool, the available services in the UDDI server and functions will be shown in the service panel and function panel respectively. Users can model the business process by drag and drop the selected service or function into the process modeling panel. When the process is executed, the agent will invoke the services according to the process model. The services will be evaluated timely by the trust service when they are used. When there is more than one the same service available in the protal, the trust service will be used to select the service.

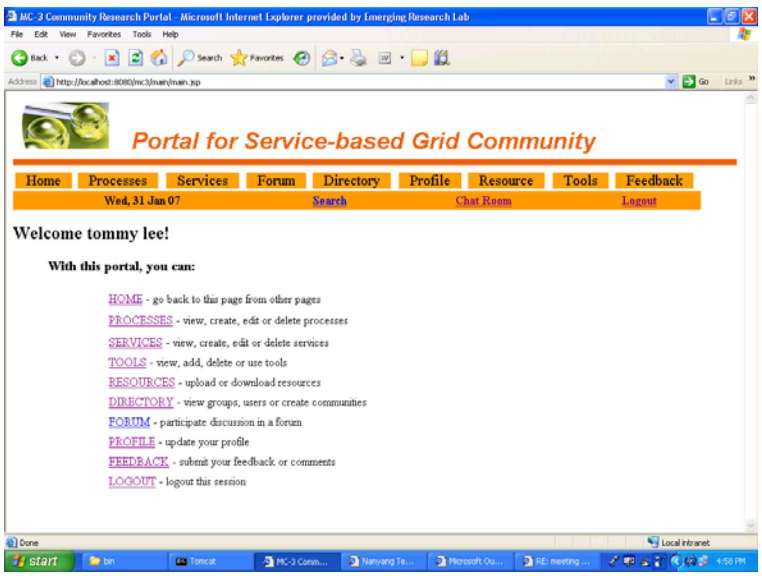

Figure 6 the Screen Shot of the Community Portal

3.3. *Applications*

Grid enables sharing, selection and aggregation of resources distributed across multiple administrative domains. However, the success of the Grid requires effective community mechanisms to realize collaboration among the collaborators. The transparent collaborative workspace and operational virtual community environment developed in this research can be applied to many application domains. In this section, we outline a few potential applications and areas that can be exploited:

- Virtual Community for Integrated Manufacturing Grid Services

Currently, most organizations/enterprises are connected to the Internet. With manufacturing Grid, the service-oriented view of resources of supply chains as services enables on demand services. Users are able to select services for their business objectives without being aware of the suppliers and locations. Operational Virtual community and transparent collaborative workspace provide users a single place to collaborate with others for composing new services.

- Virtual Community for CAD/CAM Collaborative Design

In this application, we intend to apply the transparent adaptation approach to some commercial systems such as CAD/CAM tools, Knowledge Management tools, and Web browsers so that users are able to conduct collaborative design through these tools in a virtual community.

- Virtual Community for Life Science Product Design

Recently, there has been interest in the need to extend high throughput life science research to bio-manufacturing. This initiative in bio-manufacturing is to connected the current broad base of life science research to manufacturing areas and translate the technological know-how and research output into designs and manufactured products. In this application, we provide operational virtual community mechanisms to manage participants and grid services for life science, and provide collaborative workspace for users to share resources, schedule services and make collaboration plans, etc.

- Virtual Community for Collaborative e-Research

The virtual communities allow their members to share research resources and grid services, and interact with one another for both collaborative work and social purposes. Members at different offices and those working from home can share a mutual sense of presence provided by the virtual community.

- Virtual Community for e-Learning

A virtual learning community enables learners to interact in a common online environment to gain understanding of subject matter. Learners can select and assemble learning objects provided by different learning grids and obtain personalized learning paths. They can share a common learning goal and interact socially through the community.

4. Conclusions

In this paper, an operational transparent virtual community environment that supports collaborative workspace is proposed and developed to provide a common platform to enable collaborative service provision in a grid environment. Compared to other Grid community portals, the presented transparent workspace has the following advantages:

- VC members can provide and consume services in single place in the consistent manner without knowing where the services are located;
- VC members can use the goal oriented process modeling tool to model their business processes using the available services and functions provided in the community through the portal; and to execute the process through the same portal;
- VC members can work on the same design work or the same documents collaboratively, and simultaneously at different locations using the transparent tools; and
- Trust service can evaluate the services that are used by consumers so that it can provide recommendations to the service selection when the same services are available.

We have also discussed the potential applications of our research. In our ongoing project, we are building communities in bioinformatics and e-learning domains respectively using the proposed collaborative workspace. The research results, including system architecture, development framework, prototype system, research documents are not tied to a specific domain. They can be transferred to a wider range of application domains including manufacturing, digital media, engineering, life science, chemistry, physics etc.

Acknowledgement

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