Sakai VRE Demonstrator Project: Realise e-Research through Virtual Research Environments

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Abstract: Scientists today are tackling increasingly difficult challenges. More and more advanced technologies are required to support such kinds of research activities. With the development of the information technology it is now possible to perform research activities within virtual research environments (VRE). In this paper we describe a Sakai-based VRE system aiming at providing an improved platform for supporting scientists. Besides benefits from the advanced e-Learning framework, Sakai, of its collaboration tools like chat and discussion, our VRE system extends the Sakai framework by providing additional functionalities for integration of existing web components, JSR 168 portlets, and managing documents.

Key–Words: Virtual research environments, e-Research, Portlets, Document management

1 Introduction

Research activities today normally involve more than one individual/group. This naturally demands collaboration among researchers who are geographically distributed so that they can focus on tackling the same challenge. With the development of today's information technology, in particular, the Internet, such kinds of research activities can now be performed online. We define these activities as *e-Research* activities. While e-Learning systems are widely adopted and deployed for helping education, e-Research systems are still at their early stage. Starting from 2004, the UK Joint Information Systems Committee (JISC) has funded a set of projects investigating virtual research environments (VRE) under different circumstances aiming at helping *"researchers in all disciplines manage the increasingly complex range of tasks involved in carrying out research"* [1]. Although there does not exist a precise definition of VRE, according to this JISC statement, a VRE system can be treated as a flexible framework which is equipped with collaborative services for supporting research process across all disciplines.

Naturally such a VRE system can be constructed on top of existing e-Learning systems. While e-Leaning systems are designed to support learning activities, they can also be *borrowed* to support research with proper extensions. The key of VRE relies on efficient collaboration and precise information provided to researchers. First, a VRE system should be able to act as a communication platform, which typically provides services such as instant messaging and online discussion. Furthermore, services like audio and video conferencing are also required. This requirement is aiming at providing researchers an efficient environment so that they can easily share/exchange ideas/knowledge/data, work plans, etc. Second, a VRE system should at the same time act as an information provider. For example, making use of the portal technology, a VRE system can collect user preferences and therefore it is possible to filter information retrieved from various sources and provide end-users information they are probably interested in.

To support research, VRE systems are not limited to research related actions mentioned above. It may also support tasks involved in project management, e.g., risk assessment and task assignments. Therefore a typical VRE system provides both research and management support.

In this paper, we are going to present our recent research progress at the CCLRC Daresbury Laboratory on building up a general purpose VRE system to realise e-Research by making use of an existing advanced e-Leaning system called Sakai [2], which is a Collaboration and Learning Environment (CLE) developed by the University of Michigan *et al.* targeting the high education market. The JISC funded Sakai VRE Demonstration Project [3] led by the University of Lancaster is a joint project with three other partners - the University of Oxford, the University of Read-

ing (previously Portsmouth) and CCLRC Daresbury Laboratory. While at different sites different tools are under development, for example at Lancaster, audio/video conference and blog tools are being developed; at Daresbury we are focusing on groupware services and portal/portlet integration.

The rest of the paper is organised as the following. First some related work is described, and then our understanding of VRE systems is followed. After that, our Sakai-based VRE system is described with focus on integration of existing web components, JSR 168 portlets and document management. In the last section, conclusion remarks and future work are presented.

2 Related Work

A VRE system typically has a web-based front-end which makes it available with only a web browser required on the client side. This could be on desktop or mobile devices like PDA. The development of the web highlights ideas of e-activities including e-Research. Therefore in this paper, when we talk about VRE systems they are all web-based if not specified.

In [4] web-based research support systems (WRSS) are proposed as a specific type of web-based support systems (WSS) [5] for supporting research activities for scientists. In [4], Yao examined the principles and issues of WRSS by going through the general research process and methods. And functionalities like resource and data/knowledge management are pointed out for designing such a WRSS system.

While there is no implementation in [4] but with only guide lines, CUPTRSS, a prototype WRSS system, was discussed by Tang *et al.* focusing on management support [6]. CUPTRSS aims at providing researchers with accurate and up-to-date information, improving research management and integrating public research resources at the Chongqing University of Posts and Telecommunications in China.

VOSON (Virtual Observatory for the Study of Online Networks) discussed in [7] provides a web-based environment facilitating research into networks. VOSON provides a web portal through which researchers can access various storage and computational resources. VOSON is data focused as it provides functions like web and text mining, data preparation and visualisation by adoption of various open-source packages. Although developed for social scientists, the system aims at supporting research in other disciplines such as biology and applied physics in the future.

Recently with the concept of grid emerging [8, 9], virtual organisations (VO) are built up around the world to construct and maintain dynamically extensible research platforms. These VOs are aiming to link research resources including not only facilities such as instruments, computing and data resources but also research staffs. The key of the grid is its ability to plug-in/remove resources dynamically if required. This brings VOs great flexibility to meet today's always changing challenges in research.

NEESit [10] is such an example which links earthquake research scientists together across USA by providing them a virtual research laboratory. NEESit makes use of the grid technology so that geographically distributed computing resources and engineering facilities can be combined together to support collaborative research activities.

According to our understanding, WRSS systems have the same objective as VRE systems, that is, to improve research quality and productivity by providing research support systems; while the grid technology can be used to implement such a VRE system. Since 2004, UK JISC funded a set of VRE projects to investigate the development of an infrastructure to support research activities in various disciplines. These projects are aiming at four different aspects as stated on JISC VRE Programme web site [1]: *a) building and deploying VRE systems based on currently available tools and frameworks; b) assessing their benefits and shortcomings in supporting the research process; c) improving and extending them to meet the future needs of UK research; and d) developing or integrating new tools and frameworks where appropriate solutions do not yet exist.* The Sakai VRE Portal Demonstration Project [3] we are involving meets the first standard to investigate the possibility of building up VRE systems using existing frameworks.

3 Build up a VRE System Based on Sakai

3.1 VRE Architecture

VRE systems should be designed as flexible as possible because the user requirements are dynamically changing. Furthermore, there is always demand on re-usage of existing components. Therefore we adopt the service-oriented architecture (SOA) for VRE systems. As depicted in Fig. 1, a VRE system contains a bundle of services that meet user requirements, for instance, authentication and authorisation service, communication service. Besides these core services, this VRE system should be able to be extended to meet new requirements. This could be done by plugging in new services or making use of external services as shown in Fig. 1. Ideally, a VRE system can be built

up with many services integrated from external (VRE) systems.

In general VRE systems also obey the three-tier layer architecture. Typically, web portals act as the presentation layer while business logic and data layers are sitting behind it. A web portal provides a single entry point for end-users to access all kinds of resources either inside or outside of the VRE system. In particular, portals provide users' customisable gateways for retrieving and rendering information. A VRE system can make use of the latest portal technologies with additional service like information filtering added. Today web portals are standard based. In Java community, there are two portal standards - Java Portlet Specification 1.0 (JSR 168) [11] and Web Services for Remote Portlets (WSRP) 1.0 [12]. We will talk about them later in the following section.

According to our experience in grid portal development in the past several years, we realised that although general purpose used functionalities such as remote job submission and file transfer can be packaged as reusable services, ideally these services should act as templates only. This means that different projects always have their own requirements even for execution of standard services. For example, research scientists from various background are making use of the UK National Grid Service (NGS). They all want an user-friendly user interface to submit jobs remotely. But they will have their own specific requirements. For example. a researcher in the computational fluid dynamics field is interested in locating geometry meshes pre-defined for numerical simulation while in bioinformatics these geometry meshes normally do not exist. Only when these requirements are met, scientists are happy to continue using these services.

VRE systems face a similar situation. Hence when we talk about VRE architecture we are focusing on services for supporting research, i.e., without touching *real* research. That's why in Fig. 1 only collaboration services are listed in "Research Support". This leaves space for techniques like portal to provide services such as information filtering as mentioned above to fit user requirements better.

3.2 Sakai

As aforementioned, Sakai is an open-source e-learning system developed by the University of Michigan *et al.* targeting the higher education market.

The Sakai architecture obeys our proposed VRE architecture very well. Sakai consists of two parts: the Sakai framework and Sakai tools [13]. The framework provides presentation and common services to form a basic system while tools are designed for specific purposes like chat room and discussion. Tools can be treated as components and can be plugged-in or removed from Sakai dynamically. Tools can make use of common services such as retrieving current user information.

In the past two years, a world-wide community has gradually been built up which involves deployment and development of Sakai at universities all over the world. Sakai provides generic collaboration tools such as announcement, chat room, email archive, as well as learning and teaching tools, for example, assignments, grade book and module editor. Inevitably, many universities have their own requirements to meet demands from their end-users. For example, internationalisation is a common issue outside of English-spoken countries. Hence there are many tools such as blog and wiki being developed by the community rather than the USA based core Sakai development team. In fact, Sakai itself is now developed collaboratively around the world which makes the growth of Sakai itself proves the power of collaboration.

3.3 Extensions to Sakai

Because of its flexible architecture and well developed tools/service for collaboration, Sakai has been selected as the basis of our VRE system. In this paper, we describe part of the work done at the Daresbury Laboratory for the Sakai VRE Portal Demonstration Project.

3.3.1 Integration of JSR 168 Portlets

Portlets are web components that can be utilised to compose a full web page. Through portlet technology, portal can be combined with various portlets such as weather forecast and stoke price query. The JSR 168 specification standardises communication between portlet and its container which enables development of re-usable portlets. These web components can now be deployed under different portlet containers if both of them conform to this Java Portlet Specification.

Currently, Sakai does not provide support for JSR 168 portlets. As shown in Fig. 2, there are basically two approaches to make Sakai support this standard: a) to develop a portlet container for Sakai, and b) to develop a WSRP (Web Services for Remote Portlets) [12] consumer for Sakai if JSR 168 portlets are published by a WSRP producer.

WSRP was proposed by OASIS in 2003. In general, this specification aims at solving the interoperability issue among different portlet containers. The WSRP 1.0 specification defines several actors among which *Producer* and *Consumer* are the two most important ones. WSRP producers are responsi-

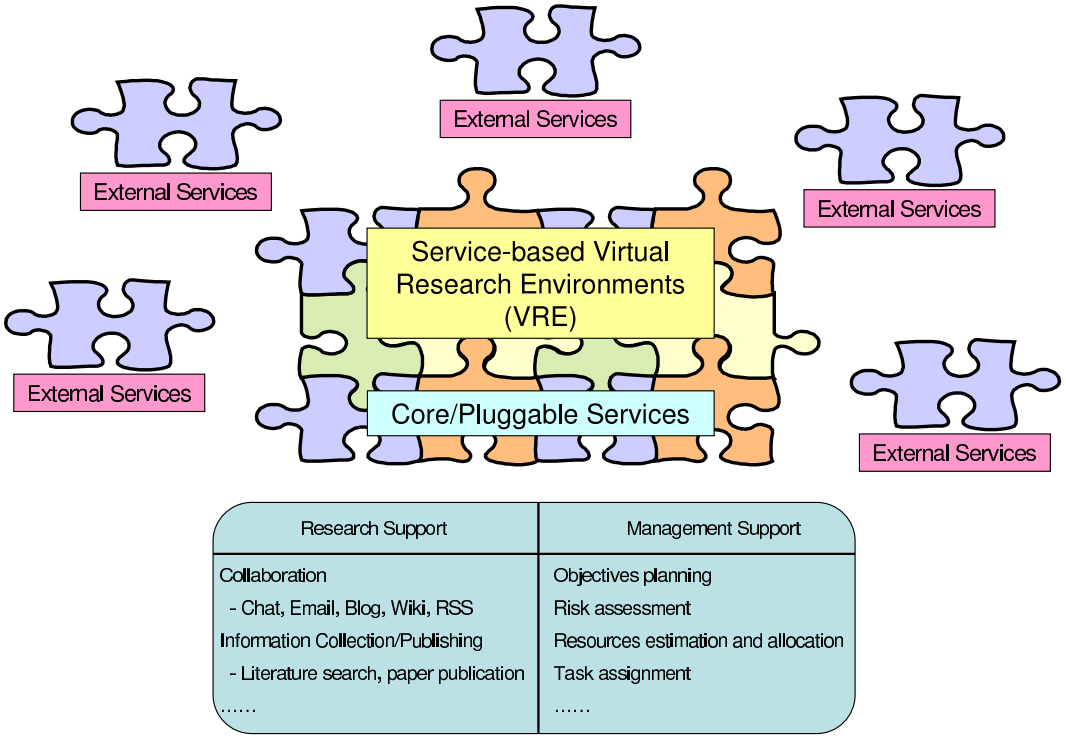

Figure 1: Service-based VRE architecture.

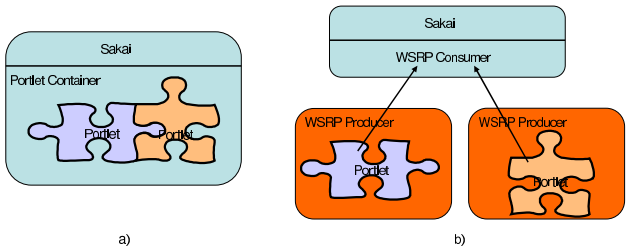

Figure 2: Two approaches for Sakai to support integration of JSR 168 portlets.

ble for publishing portlets as remote portlets so that they are accessible externally. On the other hand, WSRP consumers are designed to consume these remote portlets so that they are used to build up a complete portal page. Since WSRP is based on web services, communications between producers and consumers are SOAP-based, which enables WSRP programming language- and OS-independent. With the help of WSRP, portlets can be re-utilised at different portal sites without even re-deployment if these portals are equipped with WSRP consumers. For more information about the two portal standards, JSR 168 and WSRP 1.0, see [14].

Now come back to the two approaches mentioned above for Sakai to support JSR 168 (see Fig. 2), the first approach provides the best support for portlets but will involve a lot of work on Sakai itself. Moreover, portlets are required to be deployed inside Sakai locally. Recently we notice that there is work ongoing for integration of Pluto, an open-source JSR 168 reference implementation by Apache, in Sakai for JSR 168 support. The second approach relies on the WSRP specification, and external WSRP producers are required to deploy JSR 168 portlets. The benefit of this method is that there is no requirement to maintain 3rd-party portlets inside Sakai. They can simply be used on demand while upgrade and maintenance of these portlets are the duty of their providers.

As the grid technology gaining more and more attention, we have developed the UK National Grid Service (NGS) Portal [15] for researchers to seamlessly access the UK NGS computing and data grid. The second release of the NGS Portal is portlet based. A set of grid portlets have been developed to perform tasks like proxy credential management, job submission and file transfer. To make use of these portlets inside our VRE system, they are published as remote portlets and a WSRP consumer has been written for Sakai so that it can consume these portlets remotely. Obviously, with the help of this consumer, Sakai can also consume other 3rd-party portlets. This greatly extends Sakai's ability. For example, besides our grid portlets, a search portlet provided by the University of Oxford has been successfully tested. For more in-

formation about WSRP support of JSR 168 portlets in our Sakai based VRE system, see [16].

Unfortunately support of WSRP 1.0 in different open-source portal frameworks is still not mature according to our early test [17]. With WSRP becomes more the more mature, this is a promising approach for integration of portlets to information systems including VRE systems. Fig. 3 gives a screenshot of a remote JSR 168 portlet called proxy manager running inside Sakai through WSRP. This portlet is used to retrieve a proxy credential from a MyProxy server (MyProxy is an online credential repository for grid, it has been widely adopted in grid portals for management of proxy credentials. For details of MyProxy, see [18]). The credential can then be utilised to perform grid tasks like job submission and file transferring through GridFTP (GridFTP is a FTP-based protocol designed for high-performance, secure, reliable data transfer. It has been optimised for high-bandwidth wide-area networks. For more information, see [19]).

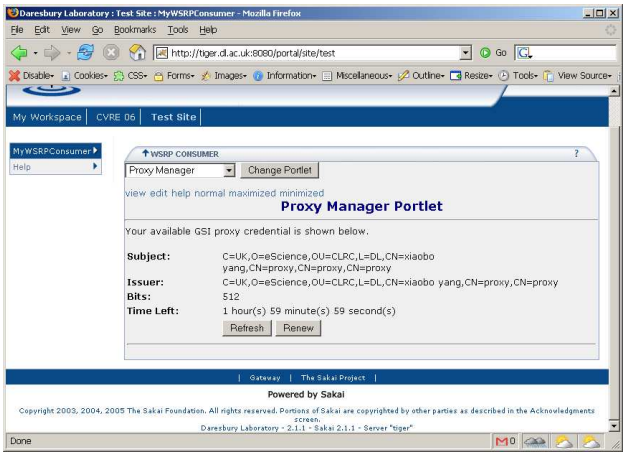

Figure 3: Proxy manager portlet running inside Sakai through WSRP.

3.3.2 Document Management System

The document management system (DMS) is a tool developed for Sakai which provides support for organising conferences/workshops. Conferences are good platforms for researchers to share their ideas and knowledge. It is a very important part of research. To help organise conferences, the DMS tool has been proposed and is now under development for Sakai. From the beginning to the end of a conference, there are a lot of communications among conference organisers, authors, reviewers, etc. The DMS tool aims at making such kind of communications easier.

Benefits from Sakai's existing collaboration tools like announcement, chat, discussion, DMS is focusing on paper/review submission, and communications mentioned above. Within Sakai, for each conference, a work site can be created. This work site has its own calendar which can be shared by all members of the site. This feature enables Sakai to host more than one conference easily. As aforementioned, the announcement tool can be used for conference organisers to announce notices related to this conference. The Sakai provided resource tool is a good tool for organisers to publish information in particular in binary format like word, PDF, and multimedia documents. These resources are permission-aware, i.e., they can be shared or kept private according to settings by their owners. For conferences, the resource tool can be utilised to store documents such as registration form and copyright transfer form.

DMS first provides authors the ability to upload their papers, check paper status, etc. It also provides reviewers a platform to submit their reviews easily. Moreover, DMS makes it easy for authors, reviewers, and organisers to communicate through email besides the existing chat tool inside Sakai. During above interactions, meta-data may be recorded behind the scene which can then be utilised for analysis purpose. For examples, conference organisers may be interested in the period with most papers submitted, how many papers each author submitted.

A prototype of the DMS tool has some services to handle database operations while the tool itself is focusing on providing presentation layer using the JavaServer Faces (JSF) and business logic. A screenshot of this tool is illustrated in Fig. 4. This "Document Management" page is provided so that a conference organiser can manage submitted papers, e.g., to set/update reviewers of a paper, to change paper status.

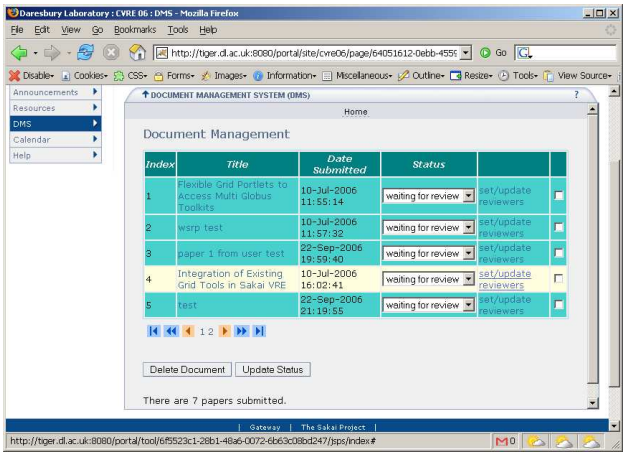

Figure 4: Document management of the DMS tool.

Furthermore, work of groupware integration by accessing Microsoft Exchange server through WebDAV is reported in [20]. Integration of Sakai calendar and Microsoft Exchange server calendar has been discussed in that paper.

4 Conclusion Remarks and Future Work

Scientists today are tackling more and more complex challenges. Collaboration among them is becoming increasingly important. To provide better support for research, we describe virtual research environments (VRE) for realising e-Research. In particular, a general purpose VRE system has been built up on top of Sakai, an open-source e-Learning framework. Sakai has been extended to support JSR 168 portlets which makes it possible to consume 3rd-party portlets like the grid portlets developed for the UK NGS Portal. A document management tool has also been proposed and is now under development which provides help for organising conferences.

Support for research is not limited to research activities themselves. In fact, more support in research management activities are to be included in VRE systems. For example, VRE is not only a system which helps researchers to perform numerical simulations. It is a much more broader concept. It should consider all aspects of research activities including administrative tasks so that e-Research can be truly realised.

Service-based VRE systems are ideal candidates for sharing services. In the future, we will investigate how to make use of SOA for integration of existing resources. One interesting point is to realise single sign-on (SSO) among different VRE systems. This may involve adoption of techniques like Shibboleth.

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