ROLE-BASED VIEW CONTROL IN WEB-BASED SIMULATION ENVIRONMENTS

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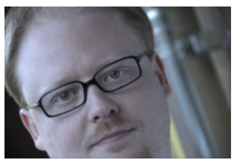
Abstract

In the last years simulation tools have been developed for all disciplines of nuclear engineering. Many of these were only designed for the needs of an expert, familiar with the physical models and the implementation details of the simulation tool. Therefore most of the simulation tools have an optimized physical model but their user interface is neglected, so often results are presented in cryptic output files.
This paper shows how the role-based view control (RBVC) in combination with web-based simulation environments enables the re-use of existing simulation tools for training and education. The RBVC model is introduced and the resulting architecture for web-based simulation-environments, that offers a plug-in interface for proprietary simulation tools, is presented.
A web-based simulation environment extended by techniques and methods for computer supported cooperative work (CSCW) and computer supported collaborative learning (CSCL), is described. The benefit of the extended simulation environment for common face-to-face teaching as well as expert support in a world wide cooperation and collaboration via internet is presented. The paper shows the integration of remote participants and lecturers in face-to-face courses and the possibility of repetition with expert supported course content via the internet afterwards.

Keywords: Simulation Environment, Education, RBVC, RBAC, CSCW, CSCL.

Presenting Author's biography



Andreas Piater. The author was born in 1973. In the end of 2002 he finished his studies in mechanical engineering at the University of Stuttgart where he continued working as a scientific assistant in the field applied informatics for nuclear engineering. Since 2003 he has been working on his doctoral thesis in the field role-based access and view control for nuclear engineering. There he works on role models and implements these in an architecture for web-based simulation environments in the field nuclear sciences. He has been working with Apache Web Server, Apache Cocoon, Java/J2EE, MySQL, Db4O, SOAP, and the newer AJAX technologies like Google Web Toolkit for many years. Today the resulting software architecture is used in different German and European scientific projects.

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1 Introduction

Simulation tools are used in all disciplines of nuclear engineering research and development. These special simulation tools are regularly written in the programming language FORTRAN and offer a wide variety of application scopes (e.g. reactor neutronics, thermal hydraulics) for the simulation of complex systems.

Many of these special simulations tools were developed only to fulfill the needs of an expert, familiar with the physical aspects of the simulation model and the implementation details of the simulation tool.

Most of the simulation tools were only optimized in their physical model behavior but not in their user interface, which often results in cryptic output files. Therefore there is often a large gap between the benefits of the tool, which an expert of the physical behavior can obtain, and the high effort of learning, necessary for an efficient handling of the tool. By minimizing this existing gap, not only experts can benefit from a shorter training period. Also students, who are familiar with the physical details, benefit from using the simulation tools in practical exercises during academic courses.

Often potential participants are not able to attend meetings or courses because the journey to the venue takes too much time or there is a time overlap with other events. To allow those participants the instant join in face-to-face courses, CSCW and CSCL techniques and methods have been introduced. Additional the course lectures will be recorded and provided by a special environment which offers asynchronous lectures. These lectures can be attended remotely by these participants.

Experiences made using web-based simulation tools in the nuclear engineering field have shown, that users of simulation tools often need help and support from experts who are generally not located in the same place.

The main focus of this paper lies in supporting communication and collaboration of team members who are located in different places. In this context different places can be different rooms in one building or different buildings in one town or even different places worldwide. A possible time shift has to be considered in the latter case.

2 Role-based view control

The model introduced in this chapter has been developed in the field of nuclear engineering, but it also fits for other engineering branches if access control is not negligible.

2.1 Role-based access control

Access control is an important aspect using simulation tools in nuclear engineering. Therefore security is one of the key issues in nuclear engineering and science. So the applications need to be secured by an adequate underlying access control model.

Studies on established security models like discretionary access control (DAC) [1] and mandatory access control (MAC) [2] have shown, that they lack in the functions they provide for the nuclear engineering. DAC do not offer enough flexibility and MAC is too difficult for being administrated.

In 1992 Ferraiolo and Kuhn [3] introduced a new access control model, called role-based access control (RBAC). In 2004 this new approach resulted in the standardized ANSI RBAC model (RBAC) [4,5].

Fig. 1 shows the core part of this model, which is the base of the underlying security model described in this paper. It is a very flexible model that offers easy administration effort.

In this and in the following figure line ends with arrows indicate the 'many' part of a relationship. Line ends without an arrow indicate the 'one' part of a relationship. The ANSI Core RBAC model includes sets of the basic RBAC elements called users (USERS), roles (ROLES), sessions (SESSIONS), and permissions (PRMS). The latter consists of permitted operations (OPS) on objects (OBS). If a role has a specific permission assigned and a user is assigned to this role, he is allowed to perform the operation on the object. In this context the term role represents duties in an organization where users and permissions are assigned to (many-to-many relations).

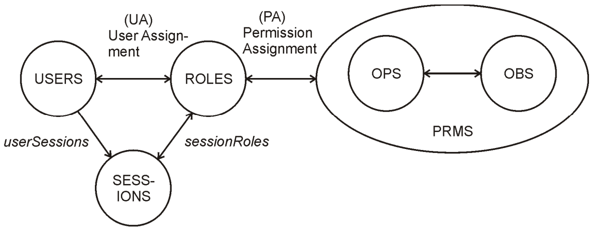

Fig. 1 ANSI Core RBAC model [5]

A session maps between a user and his active roles and represents a subset of the roles a user is assigned to.

2.2 Role-based view control

In this new approach the roles of the RBAC access control model are also used for view control duties. Therefore an extended control model which is based on RBAC was developed, and it offers characteristic views on common simulation tool functions. The resulting model is called role-based view control (RBVC) [6].

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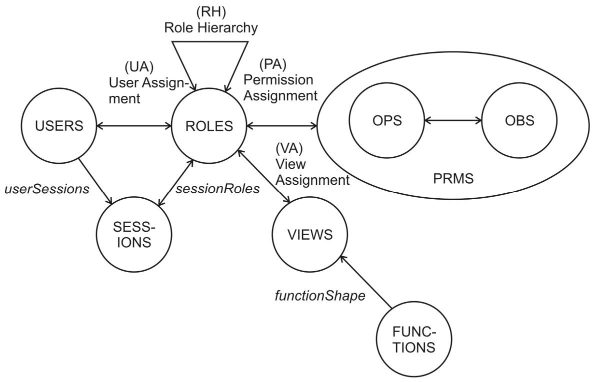

Fig. 2 View extension of the role-based view control model [6]

Fig. 2 shows the view extension made for the new RBVC model. The term view in this context is used for a special shape of a function and includes the behavior of the presentation and the controller of the application. As a result views can offer optimized functions for the duties in a special role.

The figure also shows the standardized role hierarchy (RH) which is a many-to-many relation between roles. In difference to the ANSI RBAC model the inheritance of the RBVC can be controlled by role types. New in this approach is the possibility to use more than one role hierarchy scheme at the same time depending on the role type. This offers more flexibility in using the RBVC model for self administrated and integrating systems.

2.3 RBVC architecture for web-based simulation environments

If there is a demand on the distributed use of simulation tools, the best way to achieve this goal is the inclusion of these tools in a web-based simulation environment. Today's web applications offer a great flexibility for the distributed use of simulation tools in learning environments, using new web technologies like Asynchronous JavaScript and XML (AJAX) [7]. These advantages in combination with better graphical user interfaces using AJAX technologies compensate the benefits of normal applications.

Based on the RBVC model the new architecture for a web-based simulation environment has been developed, which supports different kinds of applications and objects. The applications can support different data sources like knowledge bases and other data bases via web services. The applications are connected with a standardized plug-in interface for the integration of simulation tools. All these information bases and tools can be combined in courses which can be provided for education and other academic needs.

Fig. 3 gives an overview of the underlying three tier architecture. The logic tier in its center position completely decouples the presentation tier from the data tier.

When the presentation tier (web browser) initiates a request to the server's logic tier the access must be granted by the access control part of RBVC. If the access is permitted then the controller gives the request to the corresponding application. The application can either be remote via web service interface or local. The access to the data layer is also done via web service.

After the application has finished the processing of the request, the response data is given to the view control of RBVC. After calling the view generator, which generates the optimized view for the current role, the view control gives the response back to the browser.

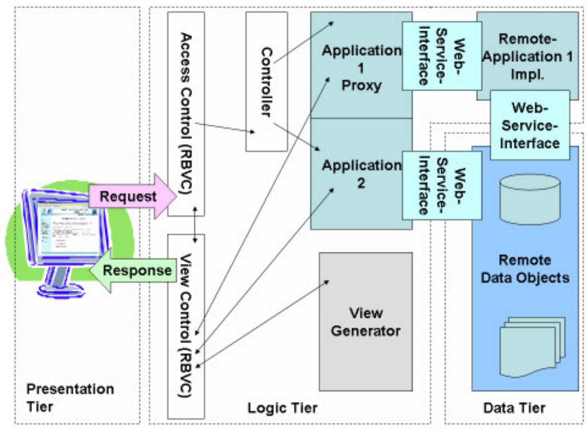

Fig. 3 Three tier architecture overview [6]

2.4 Plug-in interface for simulation tools

The connection of proprietary simulation tools is done by a plug-in application interface. The simulation tools are wrapped with a small control unit, which implements the plug-in interface. The method allows the connection of remote simulation tools via web service interface, when the appropriate proxy application implements the plug-in interface.

The plug-in interface for simulation tools is a very powerful method to re-use existing simulation tools (e.g. FORTRAN programs with cryptic input and output) in combination with optimized views e.g. for web-based education purposes.

2.5 Example implementations

Example implementations have shown, that these optimized views help to minimize the learning effort for simulation tools, which were formerly only accessible for experts as mentioned before. They provide a better dissemination and exploitation of existing knowledge, because training by example is available to a broader number of students and young engineers. The following chapter shows an example of simulation based teaching, which is implemented using this architecture for web-based simulation environments.

3 Computer supported collaborative learning (CSCL)

CSCL combines the benefits of collaborative and distant learning via networked computers. The purpose of CSCL is to support participants in learning and working together effectively (e.g. expert and students or course lecturer and participants). Contributions of CSCW research, didactical and theoretical learning knowledge as well as experiences in e-learning are forming the frame of CSCL. CSCW and CSCL are research topics on supporting cooperative working and collaborative learning with the help of computers. They are located in psychology, computer science, and education.

3.1 What do we mean by 'collaboration'?

In general the term collaboration can be considered as joint problem solving. It means working with others on shared goals, to find solutions that are satisfying to all collaborating sides. Collaborative success is, when a problem is solved in a group, which could not be accomplished by an individual. A successful collaborative project must establish a definition of the team, identify their outcomes, ensure, that there is a purpose of the collaboration, and assure the interdependencies between the participants. [8]

3.2 Collaborative architecture for web-based simulation environments

As shown in Fig 4, the collaborative architecture for web-based simulation environments consists of three main components: 'RBAC/RBVC', 'Collaboration Server' and one or more clients.

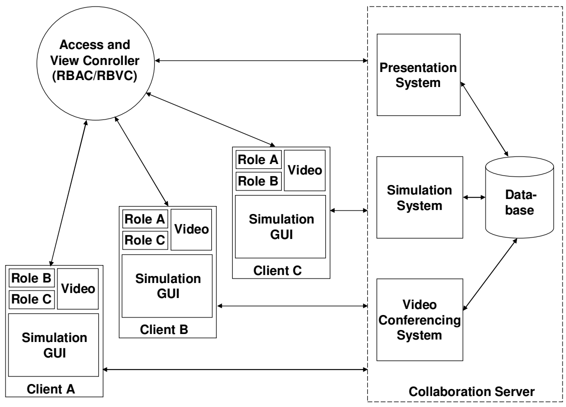

Fig. 4 Web-based collaboration architecture

RBAC/RBVC

The architecture of RBAC respectively RBVC is described in chapter 2 in detail.

Collaboration server

The 'Collaboration Server' itself consists of three components 'Presentation System', 'Video Conferencing System' and 'Simulation System'.

The 'Presentation System' is needed to share the presentation of the lecturer between all connected clients. If the lecturer shows the presentation within the collaborative web-based environment the active page is displayed at all connected clients. With this technology it is possible to integrate participants located on a remote side as well as a remote located lecturer.

The second component is called 'Video Conferencing System'. It was integrated for the distribution of audio and if requested video streams. This provides the possibility to listen to the explanations of the lecturer and if requested to watch him. Because of the high bandwidth needed for video streams it is recommended to use it only in appropriate networks, but at least audio has to be available.

Another functionality of the web-based simulation environment is the supply of electronically recorded presentations which can be used asynchronous.

The last component is called 'Simulation System'. The simulation system can be used in course lessons to perform exercises to consolidate the course contents. This can be done during conventional face-to-face lessons and seminars as well as from remote sides. In the web-based simulation environment the teacher will have the possibility to connect to a specific student session if required to support students, answer questions, and discuss results.

All the described functionalities to share presentations and simulations are realized by using web servers and new web technologies like AJAX. Therefore every change of the active user has to be sent to the server to be distributed to the connected clients. For implementation details parts of the system has been realized using Google Web Toolkit (GWT) [9].

Clients

The prerequisite for a client is a standard web browser (e.g. Internet Explorer, Firefox, Opera, Safari) and a internet connection. All information will be visualized in the browser including the lectures, the graphical user interface (GUI) of the simulation as well as the information about online users and video if used. Therefore no special software – except standard plug-ins – is required to use the web-based simulation environment.

A very important point within the scope of the web-based collaboration is described by the term 'awareness'. Collaborators need to be assured that their partners are 'there'. They need to know which access to tools and resources their counterparts have. They need to know the relevant information of their collaborators and what they do expect, as well as their attitudes and goals. These issues are often subsumed under the banner of 'awareness', which has been dissected into several types: social awareness, action awareness, workspace awareness and situation awareness. [10]

The presented collaborative simulation environment supports awareness by showing a role specific icon for every remote participant completed by his username, so all group members can see who is currently online and what role this member represents. In Fig. 4 the awareness is shown by "Role A", "Role B" and "Role C" in the browser on the left top. If e.g. "Client B" is defined in the system as remote lecturer, the icon for lecturer with the name of the user will be shown for "Role B" within "Client A" and "Client C" but only if the user is logged in and online.

3.3 Simulation based teaching

One example of simulation based teaching was the first seminar of the EUROCOURSE on Very/High Temperature Reactor (V/HTR) Technology [11] that was organized as part of the Education & Training activities of the European 6th framework project RAPHAEL [12]. It was addressed to students e.g. working on their master and Ph.D. thesis and young researchers and engineers. The whole course consisted of 3 seminars allowing the course participants to follow the projects progress and to discuss with experts (see Fig. 5). All presentations of this seminar were recorded electronically and will be published on the internet as described in chapter 3.2. The recordings of the course allow participants to repeat the learned issues and prepare themselves for the following seminars.

The topics covered in the first seminar taken place in March 2007 at the University of Stuttgart were introductions to HTR technology, core physics and thermal hydraulics of the core.

Fig. 5 EUROCOURSE 2007 on HTR Technology [11]

One part of this seminar was an exercise on the transient behavior of an HTR core. This offered the participants the opportunity to improve the memorization by training. In this special case a web-based tool was provided to simulate the withdrawal of the control rods at different velocities. In optimized views forms for the input data of the most important core parameters were offered and the results were displayed (e.g. neutron flux, temperature distribution in the core).

3.4 Simulation based training

In the education of nuclear engineering there is not only the aspect of university teaching but also of simulation based training. Two different training types will be described, the training on how to use software systems for example ABR-KFÜ and the use of simulators in simulation training centers.

Within the governmental tasks to ensure people health in case of possible accidents in nuclear power plants the Institute of Nuclear Technology and Energy Systems (IKE) has developed a tool to simulate the dispersion of radioactive nuclides and the resulting doses, called ABR-KFÜ (see Fig. 6). Based on the results of these simulations, decision makers plan necessary actions like informing people, distributing iodine pills or evacuating specific areas. [13]

Obviously in case of an accident people who operate the system are in stress situation and must be well trained, not only to use the system correctly but also to interpret the simulation results properly. Therefore training is an important task. This training is divided in two sections. The first section is a face-to-face training using the system and the second section consists of tasks which have to be solved outside the training course by training participants. The results of these calculations are stored in the database of the simulation system for review by the trainer.

Parallel to the system ABR-KFÜ a more flexible system has been developed which is called ABR-Research. It is based on the same physical models as used in ABR-KFÜ but with a quite different user interface which allows experts and/or students to simulate special scenarios and explore situations which were not foreseen in ABR-KFÜ (e.g. the release of radioactive nuclides in other places than nuclear power plants).

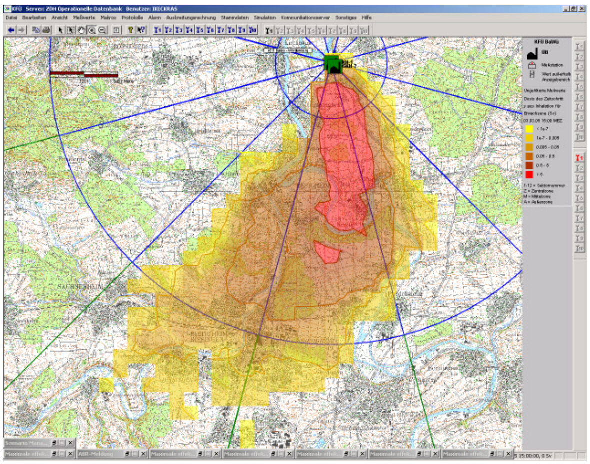

Fig. 6 Distribution of the toxic substance [13]

Simulation training centers are industrial institutions, where employees of nuclear power plants are sent to learn and to practice how to operate different nuclear power plants under all possible conditions on several simulators.

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Pure theoretical training makes it very difficult for people to imagine, how they feel in an emergency and how to react in a special situation. The simulator ideally fulfils the requirements for training the operation of a nuclear power plant in process, and, in comparison to simulation based teaching – described in chapter 3.3 –, it looks like an original control room, it behaves correctly in terms of dynamics (temporal behavior), it simulates all conceivable plant operation situations and can reproduce these as often as desired (frequent experience). The simulation contains hardware as well as software. In comparison to simulation based teaching, simulator based training, is a very resource-intensive form of training, but it is absolutely essential in the field of nuclear engineering.

3.5 Nuclear European platform for training

Another project the IKE is involved in is called "Nuclear European Platform for Training and University Organizations (NEPTUNO)" [14]. The aim of the NEPTUNO project is to better integrate European education and training in nuclear engineering and safety to combat the decline in both student numbers and teaching establishments. This allows providing the necessary competence and expertise for the continued safe use of nuclear energy and other uses of radiation in the industry and in different medicine disciplines. The project focuses on a harmonised approach for education and training in nuclear engineering in Europe and its implementation, including the better integration of national (governmental as well as industrial) resources and capabilities.

The expected result is an operational network for training and life-long learning schemes as well as on academic education at the master, doctoral and post-doctoral level, underpinning:

- Sustainability of Europe's excellence in nuclear technology, thereby contributing to the creation of a European Nuclear Knowledge Management Strategy
- Preservation of competence and expertise for the continued safe use of nuclear energy and other uses of radiation in industry and medicine
- Harmonized approaches to safety and best practices, both operational and regulatory, at European level within and across all Member States
- Harmonized approach for training and education in nuclear engineering.

These results can only be achieved by using massively modern computer-based communication and co-operation technologies. For education and training this will include a common knowledge base for nuclear fission to disseminate and transfer nuclear knowledge as well as e-learning methods which use both multimedia and network technologies

- to make courses in nuclear engineering more attractive
- to motivate students to increase their knowledge in the field of nuclear engineering
- to support nuclear engineers in their attempt to increase their competence by life long learning.

To achieve the described aim three different manners to extend conventional teaching have to be distinguished (see Fig. 7):

- Isolated e-learning
- Blended e-learning using a mixture of presence and distance learning methods
- Just-in-time learning to get access to new information whenever needed

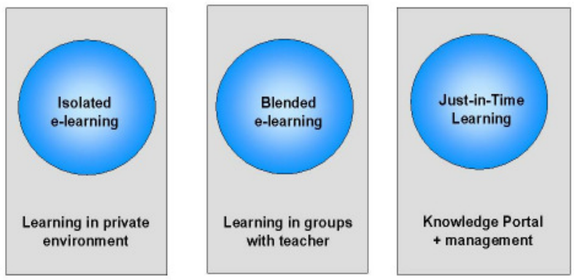

Fig. 7 Different manners to support conventional teaching [14]

Isolated e-learning means that we provide learning units which can be used for self-study. They should be completely self explanatory and guide the learner in his private environment. Blended learning means that we combine conventional and e-learning technologies to improve teaching and to make learning more professional. Just-in-time learning means providing access to additional learning material which can be used by the learner on special demand only. The NEPTUNO knowledge management and communication system is a platform which will allow the realization of this approach.

Fig. 8 describes the different roles applied for the tasks of knowledge production, dissemination and exploitation.

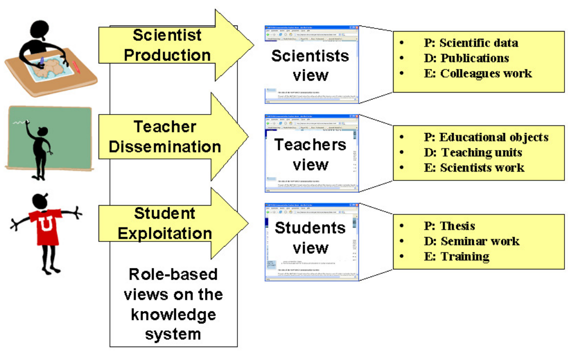

Fig. 8 Role-based access in NEPTUNO [14]

4 Conclusions

The direct link between access control and view control in the new RBVC model and the resulting architecture for web-based simulation environments offer a new flexibility in using applications like simulation tools in optimized views for special duties. This allows the re-use of existing simulation tools e.g. for education.

Using new web technologies like AJAX enhances the behavior of web applications. Thus today's web applications offer distributed use of simulation tools in learning environments with nearly the same comfort than normal applications.

The plug-in interface for applications offers an universal method to connect different proprietary simulation tools. The realization is done by implementing the plug-in interface.

Web-based simulation tools help to achieve a low cost infrastructure for CSCW and CSCL. Based on CSCW/CSCL techniques and methods combined with the RBAC/RBVC model a collaborative web-based simulation environment was developed and introduced in this paper which allows distant users to work together in a shared virtual workspace.

The experiences made in simulation-based teaching in combination with the introduced web-based simulation environment opened a new dimension by means of easy integration remote participants in face-to-face lectures and support of the collaborative work on simulations between experts and students who are located in different places. It improves the effectiveness and flexibility of the communication and collaboration in education in a sustainable way.

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