Using a Room Metaphor for E-Forensic Working Environments

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ABSTRACT

Cooperation and communication, a fundamental part of daily working life, usually take place within rooms. Both the underlying data as well as the conversation, proposals and results may be sensitive. Therefore, protective environments are needed. Since more and more electronic material has to be handled and because of the increase of communication via electronic media, the demand for safe, intuitive and efficient information management is rising rapidly. A virtual room concept reduces information traffic and makes the necessary traffic safer in an intuitive way. In this context we discuss required features of virtual rooms, the virtualization of data, integration of electronic tools, design of data, tools and accounts based on a room metaphor.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces; K.4.3 [**Computers and Society**]: Organizational Impacts; K.6.5 [**Management of Computing and Information Systems**]: Security and Protection

General Terms

CSCW, Security

Keywords

virtual environments, cooperative work, room metaphor, data sharing

e-Forensics 2008, January 21-23, 2008, Adelaide, Australia.

1. INTRODUCTION

Cooperation and communication, a fundamental part of daily working life, usually take place within rooms. This fact implies the need for a deeper research about the meaning of "room" in cases in which part of that work is electronic. E. g. when the material is digital data, the medium is the internet or the actors are accounts so that room concepts do not seem to apply naturally.

Here is an example. When a piece of "illegal" data is to be presented as proof in a trial a defending lawyer might try to cast doubt on the authenticity of the document. In fact the original data is just an array of bits, which has to be manipulated to harvest its semantics. To clear such doubts, the jurisdiction may demand, that the original data is *present* and that the manipulation *takes place* with certain persons being *in the same room.* Also the data may need to be protected against "public" viewing. One would not want to install e-forensics equipment in a court room and to have a certain expert to appear and perform physically, but instead let persons log in remotely to a laboratory. One may accept a virtual kind of *presence* and *room* but a solid and intuitive definition is needed.

Setting aside the question whether a virtual court room is reasonable or desirable, we claim that an e-forensic working environment should be geared to such challenges because a cooperative analysis, preparation and distribution of compromising data demands that.

In this paper we describe how data and communication can be combined within a safe virtual environment. We propose an integrated management of data, tools and users based on a room metaphor. Rooms not only serve as security containers but additionally as protected zones for dialog and interaction among the users logged in.

2. VIRTUAL ROOMS

In this paper the authors propose an integrated management of data and users following a room metaphor. Data- and user-management are not new. The *room* metaphor, however, adds cooperation, intuition, and awareness.

Table 1: Permission system in CURE

Rights on keys	no right	give back	delete	hand over	copy
Rights on rooms	no right	enter	copy	create	delete
Interaction rights	no right	read content	communicate	create annotations	alter content

By using a room metaphor, "gaps that make it difficult for people to move easily between different styles of work" [9, p. 203] can be overcome. In fact, room-oriented systems help to enhance distributed work and sharing of underlying data as well as of derived results that may be sensitive. In such "online environments within which users can engage socially with one another, and in the process discover, develop, evolve, and explicate knowledge relevant to shared projects and goals" [7, p. 299] knowledge arises from cooperative analysis of data and information.

However the requirements (as well as the possibilities) on data and user management transform, when using a room metaphor. Content management means not only the storage of static data. For example to enable cooperation, the tracking of developments by version control is needed, but this can be done in a conventional way since it remains untouched by *room* matters.

Furthermore, electronic content often requires to be read- and write-protected. Standard models of permission base on *user groups*, which performs well, but often lacks flexibility (dynamics) and awareness (transparency). In section 3 we describe how such a system of access control can be based on *communities* of logged in users together with a key driven room access control.

Another challenge is that of the semantic organization of material. Content management has to address the much researched issue of *finding documents* in a mass of information. Search engines perform quite well. However, related to scientific work this problem is often shifted to *navigate to contexts* rather than *search for documents*. After collecting hand-picked sets of documents or their representations into rooms, these rooms figure as such contexts. To make it easy to find a special room, we give it a location in the form of euclidean coordinates in a virtual space, hence a map of rooms can be visualized. This is further discussed in section 4. We claim that a proper implementation of the room metaphor must support locations as identifiers.

The authors of this paper are currently developing a cooperative knowledge space for mathematics, natural sciences and engineering. The *ViCToR-Spaces* (Virtual Cooperation in Teaching and Research for Mathematics, Natural Sciences and Engineering) [4, 3] are built on top of the existing CSCW (computer-supported cooperative work) platform CURE [10] which follows a general room metaphor known from multi-user dungeons (MUDs) or massively multiplayer online role-playing games (MMORPGs). ViCToR-Spaces focus on networking students as well as researchers of the technical disciplines, providing in particular virtual laboratories, remote experiments and rooms for team work.

In the following the core aspects of the room concept will be described to show the possibilities for the use of a ViCToR-Space system in other disciplines such as e-Forensics.

3. SAFEGUARDING

ROOMS AS FEATURES

The first and foremost room feature is that objects (e. g. documents and tools) as well as subjects (actors/users) can be *inside* or *not inside*. This allows users to move to where the data are stored rather than the other way round. This reduces information traffic, because the state of the room implies a limited amount of present entities.

Users can enter and leave a room according to clear rules. For example, various key rights are used in ViCToR-Spaces [2]. Table 1 shows the permission system in CURE. A single key can rule precisely the access and interaction rights as well as what is allowed to do with the key itself.

Since "knowledge management is not just an information problem but is as well, a social problem that involves people, relationships, and social factors like trust, obligation, commitment and accountability" [7, p. 322] it is not surprising that rooms serve in daily working life as a natural means of defining, organizing and supervising groups, their work and work areas. Rooms regarded as a natural feature of virtual worlds can help support joint behavior in the knowledge space and help to create trust among the users having access to the same areas and the same data, being *inside* the same room.

Approved systems of document access control are based on *user groups*. In contrast, we define *user communities* to be the set of users that are present in a specific room. Standard software methods are used to perform permission checks based on these communities. This extends the room-access key system with an intuitive and flexible permission control scheme.

4. ROOM ENTITIES: VIEW FROM ABOVE

ROOMS AS OBJECTS

As already denoted, our system is subdivided into different rooms. Each single room will in the end be an entity in a database. A set of such entities will be called a space, e. g. a ViCToR-Space.

As a tool for content management, rooms will serve as containers for documents, as will be described in the following chapter. The usual concept of organizing a set of containers is hierarchical (usually trees). This applies the concept of nesting: room A is *contained* in room B - with the explicit or implicit implication that the latter one is *parent* of the first. As a consequence of this hierarchical structure the arrangement of rooms in CURE in a map-like overview is currently done automatically and can not be changed.

In the ViCToR-Spaces project efforts are made to break up these hierarchies in favour of a rhizome-like arrangement [6] of the rooms. A symbolic illustration of this structure is shown in figure 1. Our current research work focuses on how to implement a structure of distance and neighborhood and how to visualize this structure when observed in an *overview*. A main role of a room is to be a bearer of metadata that describe its function and the kind of context resp. environment it provides. Using that metadata, semantic technologies can be used to describe them and make them available for a more or less cartographic display (mapping, not copying). The outcoming structure of distance and neighborhood includes

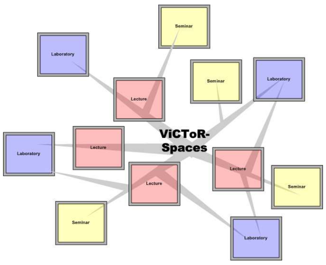

Figure 1: The rhizomatic room structure in ViCToR-Spaces

the semantics of the rooms and can therefore be regarded as more powerful than a simple hierarchical tree structure.

A combination of two possible approaches is discussed.

1. Relation
   The classical approach to structuring, finding, and connecting of rooms is via a graph. Each room is explicitly connected to a set of other rooms. These connections would be represented as doorways within the rooms with the ability to transport a user to the other room marked on the door. This approach resembles a hyperlink in traditional content management systems. Note that not all such doorways are necessarily two-way. Even so, a graph can be built that should, sensibly, connect all rooms to allow a user to walk from any place to any other place.

   Direct doorway connections are in many cases necessary (such as a virtual laboritory being connected with to the virtual data storage chamber), in other cases convenient (such as a shortcut from a private office to the laboratory). Since this is the traditional way of organizing data and its containers, users are also accustomed to *searching* data this way. The analogon would be clicking through a website until one found the relevant subsite, or, in a room view, walking through a building until one found the correct office.

   The connections can also be seen as additional semantic information on the content of the room (and the ones they point to). Search engines such as google mine exactly this information to rank and categorize sites, a prerequisite to searching.

2. Location
   Realizing the concept of relative distance. A novel way of organizing data is by supplying a *coordinate* to each room. Every ViCToR room will be equipped with unique coordinates that give it a position at which it is displayed in a map. Concerning dimensions, so far we don't see obstacles to using three-dimensional coordinates. When needed for a display on a screen, a projection can be calculated. This may be as simple as ignoring the 3rd coordinate or something more sophisticated, depending on implementation and performance.

   A sense of euclidean distance arises naturally from this setup. The idea behind this distance is that rooms that lie nearby each other also have similar or related contents. In the real world, rooms are organized this way, e. g. all laboratories lying in one wing of the court house.

   With this data, it is easy to create a *map* of the entire ViCToR-Space. Users would of course be able to move to any point in the map as they choose, but they would also be able to *search* the map and therefore the ViCToR-Space in an intuitive way. If he has identified a room containing some interesting data, more such data will probably be found in the rooms nearby. In the real world, this would correspond to reading the map-layout of the courtroom to find the office one is really looking for. In virtual space, the most similar thing is currently to refine a google search with keywords from the similar room, but this process is not very intuitive.

   It should be pointed out that these ViCToR-Space coordinates are not directly related with coordinates of objects inside of rooms, which will be described later in chapter 5.

   Of course the display of rooms in a view of the ViCToR-Space map may be done by icons of various design and size according to their character, relevance or actual content. This does not imply that rooms do have an extent or volume, because we do not want logical constraints on how many rooms may exist in a given interval and also we do not want one room to *cover* another. When two rooms lay *close* to each other, e. g. room A at (0,0,0) and room B at (1,0,0) there may still be semantic indications for a third room to be located between at position (1/2,0,0). By using rational numbers as coordinates, we allow ViCToR-Spaces to be spatially scalable. This approach is necessary as rooms typically appear in clusters. In fact, these clusters tend to grow faster than sparsely populated areas of the map, both in size and in density [1].

   The simplest way of actually *finding* the best, most meaningful coordinates for room is to allow the creator of the room to choose it. There are, however, various projects attempting to automate this process [5, 13]. Note, however, that we do not require the positions to conform to strict requirements of a semantic network. As we are mostly interested in orientation and better usability, the map need only represent a cognitive map. Therefore, it is sufficient to typically assume the coordinate offered by an automated tool (see above). The room creator may change this coordinate if he wishes, as he does have further insight into the room's purpose. Finally, an administrator may override these positions in order to correct erraneous or deliberate misplacements of rooms. We believe that because all rooms have *a priori* spatial coordinates, a much clearer spatial structure than in internet information maps will develop, even if the ViCToR-Space becomes very large.

5. INSIDE: LOOK AND FEEL FOR USERS

ROOMS AS ENVIRONMENTS

In recent years remarkable progress has been made in the technology of virtual worlds. Well-running systems such as *World of Warcraft* [14], *Google Earth* [8] or *Second Life* [12] have given rise to high hopes. Though not in all cases backed by particular expectations of high profits they served as proofs of their respective concepts. Seemingly, these technologies - being relatively young - are still at an early stage of their development. On the other hand, from a social and economical point of view these systems lack a certain relevance. Most of them are considered to be games or nice to have. The widely discussed fact that there is a real market for virtual money should not be seen as a proof for an influence of virtual actions on the real world. Rather, one can assume that there is a demand of such influence. In fact profitable markets of the internet economy such as online shops, sale of e-content (e. g. ringtones) or online betting tend not to be linked to virtual money.

So why do non-game applications such as internet economy, knowledge distribution, electronic tax declarations or scientific cooperation fail to adopt virtual world technologies, although there definitely is a demand for visualization, interactivity and atmosphere? Mainly it is because several necessary features such as security, authenticity, accessibility and interoperability impose constraints on the architecture of these systems. Games normally do not (have to) meet these constraints. Unlike other applications games can offer rich-client access to virtual worlds. This, however, requires client software to be installed on the purchaser's computer. This is a viable option for a heavy footprint application such as a commercial game. Moreover, games are still sold as single units to single customers and are usually limited to a single platform for performance reasons.

For true internet applications, none of these three factors is true. Users wish to be mobile between different applications, access to the applications themselves is either free or sold on an organization level, and a variety of platforms has to be supported. Therefore, we argue that a dedicated rich-client is a hindrance to a successful presentation of virtual knowledge spaces. Rather, one should attempt to rely only on web browsers.

Browsers as client software will never outdate, or at least their updating is taken care of by the browser publishers. They are a universal concept, while e. g. a *Google Earth* client is static and may outdate sometimes when the supported services transform incompatibly. Note that plugins *can* be used, and so many extensions are available. Browser technology (including web standards / meta-languages) develops rapidly in supporting interactivity (Javascript, Java, other plugins) and visualization (Flash, SVG, VRML, stylesheets, etc.).

Currently, browsers are often limited in their interactivity, as they normally wait for any user actions before updates are displayed. Web2.0/Ajax extensions are available to avoid this problem, as is shown in CURE or any of the java/javascript chatrooms available on the internet. Another option is to go with a VRML-plugin, which allows a full 3D-immersive virtual environment experience.

Most users have adapted to the somewhat unintuitive requirements and access methods of computer-work. As a result, however, most specialised work still has to be done by computer experts, even though the analogous job exists in the real world. In our example of the court room, a complicated analysis of a forensic evidence would (in the real world) be handled by a forensic expert with experience and intuition with the various analysis methods available, a scientific knowledge of these methods, and finally a sound background in the legal aspects involved. If the evidence is in electronic form, one would have to find a forensic expert who *additionally* has knowledge of databases, electronic authentication and experience with the analysis programs. This imposes an unnecessary complication on the processing of such evidence.

Since we are already proposing a room metaphor, the next straightforward step is to arrange the objects *inside* the rooms in a natural, space-oriented way. This makes it a lot easier for users to orient themselves in the room and has the ability to visualise most working processes in a very simple and intuitive way. In our example, the e-forensic expert would enter the e-forensic laboratory. He would take the evidence deposited in the evidence locker and would bring it to the microscope-shaped analysis tool, put it into the machine, adjust it and finally "print" the result, which would turn into another set of data coming out of the machine. He would then return the evidence and take the virtual printout with him out of the room, which would then allow him to print this out in real life and present to the court. If there were witnesses in the room to attest to the correctness of the procedure, they would clearly see what happens to the evidence and would not require any additional knowledge about whether copies of the data were made or an additional, concurrent process did something else with it. Also, because one may *see* other users if they are present to observe anything, it becomes very easy to tell which users are listening in on a conversation or watching an action.

To achieve a room-internal spatial structure, each object in the room needs to have an appearance (an icon, perhaps), a virtual position and a virtual extent (size), together with the accessors to adjust the position. For more advanced visual applications, objects would also carry an orientation and an exact visual appearance such as shape and textures-maps. The arrangement of the objects in the room is then the job of the room creators/maintainers, who can simply move the objects around in the same way they would furnish a physical room. To achieve such a system, all items/users/tools must be object-oriented, which is the most accepted programming paradigm at this time anyhow, but note that many tools of every day computer work are still not compliant with this, so they may need to be wrapped into object-containers. An example of this are command line instructions, which differ from system to system and are in general not intuitive.

6. CONCLUSION & OUTLOOK

We described how helpfully a room metaphor applies to a scientific e-working environment.

E-forensics is a special working field where scientific investigation is performed with conflicting priorities for protection and distribution. On the one hand, protection is critical because the data, e. g. an illegal movie file or a confidential testimony, *must not* be accessed or manipulated by unauthorized individuals. Distribution, on the other hand, is critical because the data *shall* be accessed and manipulated remotely by multiple collaborating authorized individuals. Having to consider strong security issues, E-forensicians will have difficulties to adopt modern techniques and work flows from less sensitive working contexts unless they integrate stable solutions to questions of virtual presence, permissions and perspicuity.

In the ViCToR-Spaces project, currently under development at Technische Universität Berlin, we try to fulfill the presented ideas. But is there really a demand for another content management system? We see that established learning management systems (LMS) try to pick up and integrate room-like concepts in a more symbolic way. The popular LMS *Moodle* [11] e. g. claims to deposit a document into a course room when adding a link to it on a text page representing the course. Such an approach will not accomplish the above requirements because it is, at best, an imitation. For the enduring vitality and evolution of an environment system it is nessesary, that active users and supporters, and not only programmers and administrators are integrated in the further construction. Therefore the internal data stuctures must match the appearance as authentically as possible. Core aspects of the room metaphor cannot be implemented without the foundation including basics like coordinates from the very beginning. In this paper we have analyzed which room aspects concern the design of a virtual working environment.We have outlined how they could be or are already set into action.

By this we expect to ease human-computer interaction and make access, collaboration and interaction more intuitive and visual for users. Though we cannot hope to reach a similar standard of feeling, atmosphere, action and identification as possible in computer games, we still think, that attractive applications can be attained using games as a role model.

Though coming from the field of eLearning / eResearch we found that the concepts we developed for those fields apply equally to an e-Forensics working environment.

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