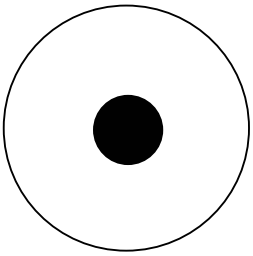

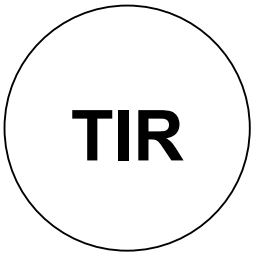

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Compression of On-Site and Video Taped Lesson Efficiency

Saiki, Diana; and McFadden, Joan R.

Abstract—*Communicating knowledge and skills on-land versus electronically was examined. There is variation in how successful e-learning methodologies are with lessons that include complex instructions and intricate hand manipulations. The reported study demonstrates this difficulty. One group viewed instruction of a complex task on-land and a second group viewed the task in a simulated e-learning version of the lesson. Participant completion of the task was examined. The on-land instruction resulted in more accurate completion of the task than when a group viewed a simulated e-learning version of the task. E-learning information apparently needs to be supplemented with clear written guidelines. Continual testing of e-learning methodologies is needed.*

Index Terms—*distance education, e-learning education, digital video instruction*

1. INTRODUCTION

Research into the methodologies that are most effective in communicating intricate details to others is the focus of this article. Such knowledge and skills have traditionally been transferred by on-sight demonstration and student repetition with simultaneous critique to insure accuracy. With new methodologies due to increase in technological abilities, instructors are often faced with additional roles as technical specialists and instructional designer [1].

As the education community explores the avenues of alternative instructional methodologies, the authors were involved in application of best practice education methods in electronic instruction even before convincing research results were available to direct choices. Neuner and Landtsheer [2] [1]describe websites associated with on-line courses, as "an inherently visual medium that enable us to combine text, images, audio and video in an innovative way" (p. 57). Having taught electronic instruction that was already created, the authors know major pitfalls to avoid, but, due to the content, the course under development was to have “hands-on” application of multi-media instruction for intricate details included. Only limited resources were identified to assist with the selection of best practice methodologies. The results of this recent search of the literature were similar to that found by Wright [3] who found that there were mixed reviews of the technological systems available, especially in the field of education, where it was expected that recent research would define best practice methodologies for current use in distance (e-learning) education. Being researchers at heart, the authors decided to conduct a study to supplement the evidence available regarding the use of digital video for the e-learning student as a substitute instructional method compared to the traditional demonstration compared to the on-land student.

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2. PROBLEM STATEMENT

The purpose of this study is to compare effectiveness of a presentation of a complex lesson with hand dexterity in a simulated e-learning situation to effectiveness of the same lesson in an on-land learning situation.

3. LITERATURE REVIEW

Electronic education has been identified as helpful to reach out to students in cases where physical presence is not available. Reisetter and Boris [4] evaluated students about design elements that students believe are needed for successful e-learning experiences. They found that course coherence, clear goals, teacher voice, and extensive teacher feedback were the most important elements for learner success. Student-to student communications were not considered important, a surprise finding according to Reisetter, et al.

Concomitant instruction may be needed to make e-learning instruction successful with, for example, contextual retrieving services for distance learners and different distance learning methodology. Nakayama, Vicari, and Coelho [5] reported that the contextual search process can aid the student who can clearly describe their need, resulting in fewer, but more relevant documents geared toward the solution. Instruction in effective search process may need to be included in a course syllabus if retrieval for special projects is to be a component of a given course.

Gawronska [6] identified the major issue resulting from information searches, called information retrieval (IR). The difficulty in sorting through the results, information extraction (IE)

may be computed. She explored the possibility of a computer program to organize information being studied (compared) from similar texts, but out of two different domains and recommends this program be refined.

Efficiency is one of the hallmarks of distance (e-learning) education in terms of temporal and spatial issues. Shyu [7] studied efficiency in distance learning. Shyu's findings relevant to this project include the fact that "distance learning models do not provide a uniform learning pattern" but that they "depend on the course arrangement and the educator's teaching style." Given that Shyu's study focused on distance education, it reports being surprised at the finding that learning "inefficiency is in fact an intrinsic property of the traditional education model." p. 69 After comparing active learning and passive teaching (this is where the instruction/instructor poses a problem and lets students search to solve it) with active teaching and passive learning (traditional lecture or teacher dominated and student absorbs), Shyu concluded that the latter is more efficient. Eventually, Shyu gave the highest recommendation to a methodology called CD-type learning model, which focuses on high learning efficiency and low learning cost. To accomplish this high efficiency and low cost, the CD-type model enables the integration of the roles of the text, the instructor, and the computer and can capture multi-media materials as well as text. This encouraged the experiment that the authors conducted.

Assessment of effectiveness is also a major component of e-learning instruction. Tietjen [8] reported that e-learning can be measured by key benchmarks as well as alternative assessment procedures which may be used in best instructional practices. Fowler [9] compared on-site with e-learning courses and found several advantages for the online course, contrary to the results often presumed.

4. METHOD

4.1 Conditions

The following experiment was conducted to examine the effectiveness of classroom teaching versus instruction via a digital video recording, which could easily become the mode of delivery for this instruction in a distance learning course. In order to understand the early design elements of clothing, the lesson was complex involving visual acuity and manual dexterity. Students were asked to drape a toga on a doll. This lesson is often completed during a class about historic costume. Although specific to historic costume class, the lesson was to represent other hand manipulation lessons in a wide range of disciplines, such as simulation of surgery in medical school, creating models in architecture, and creating a sculpture in art. To drape a toga on a doll, the following steps must be completed: (1) the fabric must be draped over the left arm, (2) the remaining fabric is pulled over the shoulder, (3) this fabric is then folded in a series of pleats or tucks, (4) this fabric is wrapped under the right arm, (5) it is pulled over the left shoulder; allowing the pleats or tucks to fall creating loose circular shapes at the front called a sinus (6) the initial fabric from step 1 is pulled up under the loose folds to the top to create a knob [10] (see Figures 1 and 2).

Fig. 1. Steps to drape toga [11]

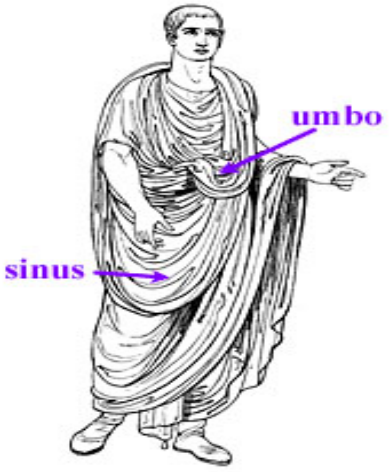

Fig. 2. Toga wrap. Picture courtesy of VRoma project [12]

In the on-land class, an instructor presented the steps to a group of 30 students. Students were chosen randomly from a class that was unrelated to historic costume. The students were college level. The majority of the students had limited sewing experience. Each student was provided with a doll and fabric. They were asked to dress the doll in a toga with the provided fabric. The instructor started the lesson by introducing the toga. It is an outer wrap worn by government officials and citizens during Ancient Rome. After

an introduction, the visuals in figure 1 were shown to the students. In addition, the instructor demonstrated the toga drape by draping a piece of fabric over a student. The instructor also verbally described each step. Another student volunteered to digital videotape the session, a preferred means of information transfer recommended by Mullen, Britten, & McFadden [13]. During this on-land session, students were allowed to ask the instructor questions.

After this on-land model session, the taped session was shown to another 15 students simulating the e-learning student instructional mode. These students were from the same university with comparable skills as the students who participated in the on-land experiment. They were students in a different class also unrelated to historic costume. Fifteen students were available to complete this task. The instructor who conducted the initial session was not present when the students watched the tape. They viewed the tape once and were asked to drape the toga with provided fabric around a doll.

The instructor assessed the drape of the fabric around the dolls. The results were evaluated for each group. The on-land results included 30 students who completed the exercise with the instructor and the e-learning results included 15 students who completed the exercise by watching a taped recording. Dolls were evaluated for the accuracy of the drape.

4.2 Analysis

More students draped the toga accurately following the live presentation than following the viewing of the taped presentation. Twenty-five out of 30 students (83%) draped the toga accurately during the live presentation. The five students who did not drape the toga accurately, completed part of the toga drape correctly. For example, one student draped the toga accurately around the doll, but did not complete the last step. One student was completely incorrect, tying the fabric into a knot around the doll.

Following the taped presentation, only three out of the 15 participants (20%) draped the toga accurately. The students generally understood that the toga was draped over the left shoulder and under the right arm. However, they did not include the sinus and the folds that are found at the front of the toga. Several of those participants tied the fabric in a bow, creating a box shape at the front of the garment. Others gave up by the last step, allowing the fabric to fall loosely around the doll. The three who did tie it accurately tied it too tightly, so that the results for the communication of knowledge and skills by means of contemporary digital video recording does not compare positively with face-to-face (on-land) instruction.

4. CONCLUSION

Best practice methodologies for distance (e-learning) education were investigated. Methods were compared for an intricate knowledge and skills exercise.

Progress has been made in identifying the design elements needed for successful e-learning experiences. These include course coherence, clear goals, teacher voice, and extensive feedback. Student-to-student communication was not considered important [1].

The contextual search process procedures recommended for refining student directed learning is commendable [4]. However, access to computer assisted information extraction is not yet available.

Some of the on-land success or failure of a course attributed to the instruction seemed to be evident in e-learning instruction and is apparently built into the model by the instructor's design of e-learning modules.

The research reported in this article compared on-land student comprehension of intricate detailed knowledge and skills communicated by face-to-face delivery with the same instruction communicated to a simulated e-learning student group by digital video recording. The face-to-face instruction was significantly more effective at the.01 level with 83% success from the e-learning instruction and only 20% from the simulated e-learning instruction.

Simulated e-learning experiences were not as effective. This result may be partly due to the difficulty of clear communication as suggested by Restauri [1]. The students learning by video could not ask teacher questions for feedback. The main steps were present and seen in the video, but students watching the simulated e-learning version had a limited view of the demonstration. Student-to-student interaction during the taped section did not improve results. However, the adult students' reacted to interaction with a live teacher. Students learning on-land may have been motivated to complete the steps accurately because the teacher was present.

Continued research in this area is needed to refine the methods for e-learning instruction. Perhaps, supplementing the recorded instruction with an additional e-learning handbook that includes diagrams and step-by-step instructions would influence the results to be more comparable to face-to-face instruction, such as multiple views of the hand manipulation.

While this research project did not show the success the authors anticipated, it did reveal substantially more differences of on-land and e-learning instruction than anticipated and the results reaffirmed the need to test assumptions.

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Finding a place and a space for online learning environments in an institutional setting: issues of objectification

Habib, Laurence

Abstract*— Online learning environments (OLE) are being increasingly used at all levels of the educational system. Although they are marketed as tools to enhance student learning and improve the efficiency of administrative and academic work, their implementation often meets a considerable amount of resistance. This paper examines the phenomenon of OLE implementation and use from a "domestication of technology" perspective. The original "domestication model" focuses on consumption of domestic technologies, and presents the adoption of technologies as a multi-faceted negotiated process. This paper suggests that it may also be used to shed light on issues of adoption of OLEs, which are used both in the domestic sphere and in an institutional setting. This article suggests that the way OLEs are given a place and a space within an institution of higher education, how compatible they are with other existing systems and how they are customized to fit the needs of their users, may influence their reception both an the individual and at the institutional level.

Index Terms*— appropriation, domestication, e-learning, higher education, implementation.*

1. Introduction: domestication in new settings

THE term 'domestication' has gained some popularity over the last couple of decades in a number of areas in the social sciences, in particular in works concerned with how information and communication technologies affect the lives of individuals or groups of individuals.

The model of domestication of technology was originally developed in order to shed light onto the processes of consumption of home technologies. It is mainly concerned with the integration of new technologies into the domestic sphere and the 'moral economy' of the household [1]. The core idea is that objects and products go through a process of domestication that renders them fit to use in the eyes of their owners or users, and that this process consists of a number of dimensions or moments, such as commodification, appropriation and conversion [2].

It is perhaps not surprising that domestication studies have mostly been concerned with the domestic sphere and, to some extent, with the personal sphere - with areas of focus ranging from the telephone [3] to the television [4,5], the mobile phone [6,7,8,9], the car [10,11] and the home computer [12,13]. All in all, the concept of domestication has been used rather little to describe technology use in an organizational setting. And yet, the ideas of 'taming the wild' and feeling comfortable, 'at home', with a new tool are very relevant to the study of technology in organizations and institutions. In particular, the relationship between organizations, their members and stakeholders and the technologies that they use to fulfill their individual and organizational goals may be conceptualized as a process of domestication.

2. Overview of the study

This paper is based on a study of the use of online learning environments (OLE) at Oslo University College (OUC), a Norwegian institution of higher education. This exploratory phase consisted of examining how two OLEs - called Agape and Satori for confidentiality purposes - came to be used, thought of, understood and negotiated both at an individual and at an institutional level. Agape was adopted in 1999 and was replaced by Satori in 2004[2]. Like other OLEs, Agape and Satori provide access to a personal archive for the storage and organization of files and to a password-protected environment common to a group of users (for example the students and teachers of a particular class). Within this environment, a number of online functions are available to support teaching and learning. Those include tools allowing for the online creation and publication of files and various levels of access to those files, communication tools such as chat, message

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[2] For a comprehensive study of the implementation of the Agape system, see [14]. For a detailed overview of the implementation of the Satori system, see [15].

boards and collaborative writing functions, as well as tools for registering marks and for tracking learner activity and progress.

An interpretive methodological approach and a range of qualitative methods were chosen for this study as they seemed most appropriate to an inquiry where the principal subjects of investigation are human action and human behavior, and where the emphasis is on the social context of a particular type of technology (as suggested in, e.g. [16,17,18,19]). It may also be noted that such interpretive approaches have been successfully used in earlier studies of e-learning systems in higher education such as [20,21]. The exploratory study on which this paper is based was carried out during the period January 2003 - February 2005 using a variety of qualitative methods. I conducted twenty in-depth interviews with users and potential users of OLEs, and gathered data from informal conversations with a large number of staff members. I also analyzed text-based information in the form of e.g. e-mails, exchanges on discussion boards, reports and meeting minutes.

One of the aims of the study is to start reflecting upon the possibility of extending the use of the concept of domestication to situations that go beyond the domestic and personal sphere. In particular, it uses the term 'domestication' as an encapsulation of the processes that come into play when a foreign element (such as an OLE) enters a human system such as an institution of higher education. The domestication of an OLE would then be a gradual process whereby a new computer system and all the changes that it entails slowly become naturalized and established within the organization.

This paper aims to build upon some of the key themes of the domestication approach to explore the use of OLEs in higher education. It does not attempt to study the process of domestication in its entirety, but to focus on one particular set of elements in this process, namely the various aspects of objectification. In the original model of domestication [1,2], the term 'objectification' refers to the process of an object acquiring a place and a space within the domestic landscape. Although OLEs cannot be seen as being 'objectified' in the same way as domestic technologies, they still need to be given a place and a space, both physically and symbolically, within the organization they enter. The implementation of an OLE into an organization involves necessarily its integration into the physical landscape of this organization. In addition, it may be more or less accepted by users depending on whether it is compatible with other systems and with the world-view of the users, and on whether it can be modified to fit their needs. The rest of this paper explores those issues in more details and concludes with a discussion of the limitations of the study and of possible directions for future research.

3. A CLOSER LOOK AT THE DIMENSION OF OBJECTIFICATION

3.1. Physical objectification: the embeddedness of OLEs into the physical world

Although an OLE is not a tangible entity as such, its use relies on a number of physical objects and the way those objects are built and handled may affect the workings of the OLE. An example of such objects is the server that supports the installation. One of the main vulnerabilities of the Agape system was that the installation on the server often ceased to function due to upgrades to the operating system. Because only one member of the technical team had been assigned to working with that server and because he did not always have the time or the competence required for rectifying the problems, the Agape system ended up being unavailable to the users for relatively long periods of times (up to several consecutive weeks).

Such breakdowns and the crises that followed remained engraved into the collective memory at OUC and became a major argument for discarding the Agape system and replacing it with a system that would be run outside the College, presumably by a team of professionals. Server problems were definitely less severe with Satori but they did not completely disappear. In particular, the fact that several institutions were 'catered for' by the same server caused problems in terms of speed of access to online documents and functions. Such problems only came to an end after the installation had been moved to another server.

Another object that seems to have significant consequences on the workings of an OLE is the personal computer used to access the program. Personal computers around the College vary in terms of brand, age, capacity and, most of all, configuration. In particular, different versions and different updates of the Internet Explorer browser caused some confusion among Satori users, as explained by the Head Coordinator at OUC:

"[…] Satori as any web-based/server-based application relies upon the browser, the program to view and interact with the application that resides on the server. As different browsers on different systems with different upgrades, updates and bug-fixes are indeed different, how Satori appears (what you see) and how it acts (what it can/cannot do and how it is done) differs.

The user experience may vary from home to school to work. For some, this is useful. Personally, I use different browsers for different tasks. Many, however, find this frustrating. That, at least, is my assumption from interviews, small-talk, hear-say as well as support-related e-mails." [Excerpt from an e-mail correspondence]

In addition, OLEs are typically used both in institutional environments and within the domestic sphere, where, as suggested in [13], computers are all but personal: they are shared objects that are used for a wide variety of purposes by family members who do not always keep each other informed about what their computer has been used for and what modifications have been done to it. As one of the respondents put it:

"I have teenage children, and you can't really expect teenagers to tell you exactly what they've been doing with the machine when you're away, can you? Like my son… he's playing computer games and stuff and he's always installing things on the machine. I end up having to deal with viruses and stuff that completely mess up my Agape settings, but what can you do?" [Excerpt from an interview]

This shared ownership of the physical platform that supports the OLE participates to making computer-supported work both perplexing and unpredictable to the user, and can thereby make the domestication of the OLE difficult.

3.2. Compatibility

The original model of domestication [1,2] emphasises the need for objects to 'fit in' the existing domestic landscape in order to become integrated into it. Domestic technologies, for example, become part of a domestic media ensemble [22,23,24] where the various objects match and complement each other. If their appearance or their function breaks the esthetical and functional harmony of the space they enter, chances are that their presence in that space will feel disruptive and that they will be relegated to a place that feels more adequate, hidden away or even disposed of.

Issues of compatibility also seem to play a role in the domestication of OLEs in educational institutions. Here, it is less a question of esthetical harmony than a matter of practical congruence. In particular, the introduction of an OLE into an educational institution can be more or less disruptive depending on how smoothly the new system can be incorporated into the technical, organizational and human fabric of the organization.

a. Technical and organizational compatibility

The case studies provide an illustration of the need for an OLE to fit into the rest of the digital environment in order to be suitably integrated into an institution. In particular, data compatibility with other systems already in place within the institution appeared to be a major concern both with Agape and with Satori. At the College, all information regarding students and staff members (ranging from usernames and passwords to courses attended and marks given to each course) is registered and updated in a nation-wide system called Common System. This raises a number of issues regarding the registration of user information into the OLEs.

The situation was particularly problematic in the case of the Agape system due to both technical and organizational issues. Because Agape and Common System had been developed independently of each other, they had a different structure and operated with different data formats, which meant that the transfer of data from one system to another required some additional programming. Although experienced programmers at the College worked on designing a script for data transfer from Common System to Agape, some of the information remained untransferable. For example, Agape was built on a model where users could not have any other username than their email address, while Common System used simple individual identifiers based on the user's name or student-number. In addition, there did not seem to be an easy way to automate the transfer for passwords from Common Systems to Agape, and administrators ended up typing passwords manually on the Agape user registration screen. Another set of problems arose because the registration of student information into Common System was the responsibility of the Study Administration Office whereas registration into Agape was done either at the Department of Learning Resources or by the teachers themselves. As a result, update in one system did not necessarily result in update in the other system, which generated a considerable amount of confusion as to who was registered for which course.

Those transfer problems were one of the reasons many users urged the College to change systems, and one of the arguments in favour of Satori was that it had apparently been successfully 'integrated' with Common System at another Norwegian institution. Indeed, the transfer of data between Common System and Satori turned out to be a lot smoother than it was with Agape, although it was not completely unproblematic, as observed by one of the respondents:

"[…] the lax - or plain scandalous - security of Satori has been a problem. Several entries had to

be removed from the data imported to Satori as the function for hiding the information did not ...function." [Excerpt from e-mail correspondence with an anonymous respondent]

OUC uses a number of other systems such as web-publishing systems, library systems, accounting systems, etc., and those could hypothetically be linked with an OLE. However, this has not happened in practice due to incompatibilities in terms of security.

"Satori has features aimed at project management with cost-calculation - or even cost control - but it is unlikely this will be allowed to provide input data for [our accounting system] as security and control with this is far stricter than anything we can expect from Satori." [Excerpt from an e-mail correspondence with the Head Coordinator at OUC].

b. Compatibility with the Weltanschauung[3] of the users

Another issue that may be raised is that of the compatibility of the OLE with the users' Weltanschauung, i.e. their apprehension, comprehension and appreciation of reality, which is shaped by a multitude of past experiences. One example of such relevant experiences is the user's familiarity with similar systems, which appears to play a major role in the acceptance of an OLE at the individual and organizational level. Indeed, throughout the process of evaluation of the various possible systems that were to replace Agape at OUC, a number of staff members around the College viewed the Satori system as unsuitable because it was "too different" from Agape. One of the respondents noticed that:

"There is no such thing as 'the best system'. Any system is the best system after a while once you've got used to it. No matter how badly designed or counterintuitive it is - it's the best system because it's the system you know." [Excerpt from an informal conversation]

Similarly, the users' understanding of an OLE may also be shaped by their knowledge of other computer applications they use or have used, such as word-processors, spreadsheets, database packages, etc. As the Head Coordinator at OUC noted, the Satori system presents a number of idiosyncrasies that may confuse some of the users.

"Satori resembles many other common applications. But it is also different. As a web-based application, it is less menu-based than most software but relies more on buttons. One consequence is the multi-view. One set of buttons relates to courses (rooms) and another set of buttons are personal - personal e-mail, calendar, archive etc. This multi-view - or switching between different views that are not related - seems to be alien to many users." [Excerpt from e-mail correspondence]

In addition, users may relate more easily to a system if its structure and the metaphors it uses fit with their Weltansschauung, their own intuitive understanding of their work and organization. An outcry from one employee while she was taking the Satori introductory course to illustrates how systems may clash with the Weltansschauung of the users:

"You [the teacher] are asking us to use a system that's miles away from what we actually are doing [at the College]. This system here is hierarchical while we are [our organization is] matrix-based. We can't just take our reality and twist it in order to cram it into your structure here."

The existence of a gap between the needs of the users and the solution offered by a system or software was early recognised in the information systems literature [28,29]. It is often suggested that such problems might be solved through a higher level of user involvement [30,31,32,33]. However this case study illustrates the challenges that arise when an organization chooses to implement a standard product. As one of the respondents commented:

"We've told Agape many times about functions that were obviously missing and bugs that were making existing functions practically unavailable. We always got the same answer: 'your suggestion is registered, but it isn't on our priority list'. That's because they have so many different customers, you see. They can't satisfy them all." [Excerpt from an informal conversation]

3.3. Customization

The problems raised by the use of standard products in a particular organizational setting bring up issues of adaptation and customization. The concept of customization is not formally identified as one of the 'dimensions' of domestication in the early models of domestication [1,2]. This may be due to the fact that those original models mostly dealt with the study of objects that were not easily modifiable, such as the television set, the radio or the traditional telephone. And yet, it is almost

[3] The concept of *Weltanschauung* is one of the pillars of Soft System Methodology, developed by Peter Checkland [25,26,27] refers to a particular view of the world held by an individual or by a group. This worldview involves not only an overview of the situation, but also an interpretation of the roles played by the various actors involved, and a perspective of what modes of action are appropriate to this situation. Checkland held on the German word, which does not have any literal translation in English as it is based on the combination of two concepts: "anschauen" refers to a way of perceiving, of experiencing and "Welt" designates the world, reality.

inevitable that any object will be used, at least by some, for a purpose that was unintended by its designers, and this novel usage will in some cases require some degree of modification of the original product. Hence, it can be argued that the alteration of a product by users so as to make it fit more closely to their needs participates to the process of appropriation, and, more particularly to that of objectification.

Miller [34], in a study of the way tenants on a London Council Estate appropriate the kitchen facilities, provides an illustration of this phenomenon. Some occupants kept all the original features of the kitchen unchanged throughout the tenancy period, mostly in order to make it clear to themselves and others that this apartment was only a temporary solution and that they did not identify with the lifestyle of 'traditional' council estate residents. Other residents made various types of changes to the original kitchen ranging from minor alterations to total redesign of the space, thereby removing what they felt as alien and adding objects and features that made the environment feel more homely.

In the case of OLEs at OUC, a number of attempts have been made to customize the standard products at various levels of the organization. Such bespoke work was meant to best fit the specific needs of the College, but, at least in the case of the Agape system, it ended up creating more problems that it had solved in the long run. The main problem with the tailored features of Agape was that they had been developed by a consulting company independently of the Agape producer itself, and that they disappeared with the next upgrade of the system, which led to much confusion amongst users who had grown used to the customized functions.

Another interesting point with the Agape system is that one of the most usual customization jobs, the making of an OUC "skin" (or customized background layout), had never been done. This could be explained by the fact that the creation of such a skin would have incurred a cost that OUC was not prepared to pay, particularly after the word had started going round that Agape was soon to be replaced by a new system. It could also be argued that there was a certain amount of reluctance from OUC's side to become too closely associated with a system that was largely unpopular among several user groups. In that sense, OUC might have wanted to dissociate itself from the Agape system, in the same way as the council estate tenants were dissociating themselves from a council estate lifestyle in Miller's study [34].

The Satori system has also undergone a number of modifications in order to accommodate particular user needs. However, none of the modifications have required additional programming, which makes them less vulnerable to upgrades from the producer. It can be noted that the customization of Satori happens both at an institutional level, at a Faculty level, at a group level and at an individual level.

At the institutional level, the customization has mainly consisted of the physical installation of plug-ins (Java Runtime Environment and ActiveX) on OUC computers to enhance compatibility with some Satori features and of the writing of additional applications for the import of data from other software to Satori. In addition, a "skin" was created by the Head Coordinator with the standard OUC colours and logos and was made an integrate part of the Satori installation at OUC. Customization has also happened at the faculty level, leaving a certain margin of manoeuvre for groups and individuals, but with one significant limitation: individual changes are allowed, but they will be lost whenever the Faculty default setup will be renewed.

It is also interesting to see that many users have used much energy to give a 'personal touch' to the standard OLE products. For example, one of the popular features of Agape was the 'business card' function whereby users could make available online a picture of themselves as well as a few paragraphs about themselves. This was not unproblematic, as teachers felt they had to check for offensive content and intervene when they came across 'self-descriptions' they judged to be of objectionable character.

The Satori system does not have any feature allowing for users to publish a 'self-description'. It did, however, allow users to change their 'official' picture to a picture of their choice. This was an opportunity for Satori users - in particular among the student body - to put up a picture that they believed to be more aesthetically pleasing or that they felt would be more suitable for the purpose of online publishing. For example, a female student that might have been from a culture where women do not normally uncover their face in a 'public' space, chose to switch her official picture with a picture of herself wearing a head cover, and positioned in a way that made her literally unrecognizable. Others found an opportunity to show humour, switching for example to pictures of cartoon characters (sometimes as a coordinated effort – a group of students chose pictures of characters from the 'bar gang' from the television series *The Simpsons*). The picture-editing function, however,

was removed shortly after the implementation team discovered that a student had replaced his official picture by a picture of a 'smoking Jesus', as the Head OLE Coordinator at OUC explains:

"When you start mixing smoking and the Church, you are dangerously close to even more scary mixes like for example alcohol and the Church, and this, in a country like Norway, is really a no-no, at least for some people. That's why we removed the possibility for users to change their online pictures on Satori." [Excerpt from an informal conversation]

The examples above show that the customization of OLEs may facilitate their process of integration in an institutional environment. However, an excessive amount of flexibility may become a challenge for the organization, first because a lack of standardization may cause some information to be lost, and second because there may be a need to check the suitability of the content published by users.

4. CONCLUSIONS AND FUTURE RESEARCH

This article has concentrated on one particular set of issues, namely those aspects of domestication that relate to objectification - to the idea of an OLE finding a place and a space in an institution of higher education both at a physical level and at an organizational level. It has suggested that a number of elements might play a role in the integration of an OLE in an institutional setting: the embeddedness of the system in the physical landscape of an institution, its compatibility with existing systems and with the users' own understanding of their organization and work duties, and the extent to which it may be customized so as to provide the closest possible 'fit' to the needs of the users. In the case study, all those elements appeared as playing a significant part in the process of acceptance of OLE systems by their users.

It needs to be kept in mind that objectification constitutes only a small part of the process of domestication. More work is required to understand the relation between the processes described here and the other dimensions of domestication, such as for example the mental construction of OLEs by users, their incorporation into individual and organizational routines, and the 'conversion' of potential users by existing users.

Another limitation of this study is that it is based on a personal and, therefore, necessarily situated account of an organization-wide process. As a result, the descriptions provided in this paper can only reflect the interpretations of one individual, who cannot pretend to be the spokesperson of the whole organization. The next phase of this project will involve a team of several researchers from different departments of the College, who will examine the use of a variety of features within the Satori system among various user groups. This will hopefully bringing in more 'voices', and might help provide 'richer' descriptions of the phenomena under investigation.

A last limitation might be that the findings of this study are somewhat system-specific. It would be interesting to explore the relevance of the concepts of objectification and domestication to other areas of information systems. Applying those concepts to other case studies involving other types of systems, other types of organizations and other types of users might provide a more solid basis for the generalization of the findings from this study.

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An overview of trends in personalized content retrieval

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Abstract— ***The topic of this paper is an overview of the state of the art of personalized content retrieval and the analysis of future trends in this domain. The paper first discusses the main problems and issues related to content descriptions, which are important for content identification and selection process. The second part of the paper presents some of the most interesting topics related to personalized content retrieval such as usage of semantics, user interaction mechanisms and standardization of user models. The paper concludes with the presentation of implications that the future development might have on personalized systems.***

Index Terms—*personalization, user modeling, ontology, metadata, user-system interaction, MPEG-7 User Profile*

1. INTRODUCTION

THE amount of available content increases daily, providing us with textual documents, images, videos, music, etc. Corpora of digital(ized) content items, access to virtual museums, research publications, news (Usenet), product and service catalogues and many more have found their way into the public, mostly through the Internet. Additionally, other distribution mechanisms such as peer-to-peer networks and digital television with its distribution channels (Digital Video Broadcasting - DVB) are becoming more and more widespread. With the ascent of peer-to-peer systems, user devices are becoming sources of information, which will increase the number and heterogeneity of available content even further. Today, searching for particular information (document, image…) usually results in a vast number of hits, with a high amount of irrelevant ones. It is unlikely that hundreds of millions of users are so similar in their interests that one approach to information search fits all needs. Information and content retrieval can be more effective if individual users' interests and preferences are taken into account. Such an approach to information and content retrieval is usually called personalized content retrieval, sometimes also referred to as user modeling.

The focus of this paper is the state of the art of personalized content search and the future development trends in this field.

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2. DIFFERENT CONTENT TYPES, THEIR INDEXING AND DESCRIPTIONS

In order to understand the possibilities offered by systems for personalized content search, we should first take a brief look at existing content types and their descriptions. Content descriptions represent a basis for the identification and distinction of content items, therefore their understanding is very important.

2.1 Types of content descriptions

Content descriptions differ significantly and can be categorized based on a number of criteria.

The first categorization of content descriptions is very basic and is based on the properties of different content items. Namely, content descriptions can be either textual or non-textual. The first category is usually referred to as high-level descriptions, the second as low-level descriptions. The difference comes from the fact that images and video differ significantly from conventional data items (textual documents). This is because the extractable features are not high-level concepts like word lists (word vectors) [4], which enable relatively direct matching of search queries against data item representation. This is not the case for low-level descriptions, therefore they will be only briefly mentioned in this paper. Basic image features are the so-called low-level features, which contain information about colors, textures, shapes etc. [15], [16], [17]. Videos contain the same low-level features and have additional features like position, direction and speed of motion [1]. We should stress that, at this moment, no metadata standard seems to be widely used for image descriptions. An exception might be the MPEG-7 standard [1], even though its widespread use is also questionable. Today, text-based search techniques are still the most direct, accurate, and efficient methods for finding images and video. Text annotations can be obtained either by

manual effort, embedded text, or from hyperlinked documents containing images (Google, Yahoo Ditto). The problem is that for truly accurate textual descriptions, manual indexing is required. The classification tree of high-level and low-level descriptors is presented in Figure 1.

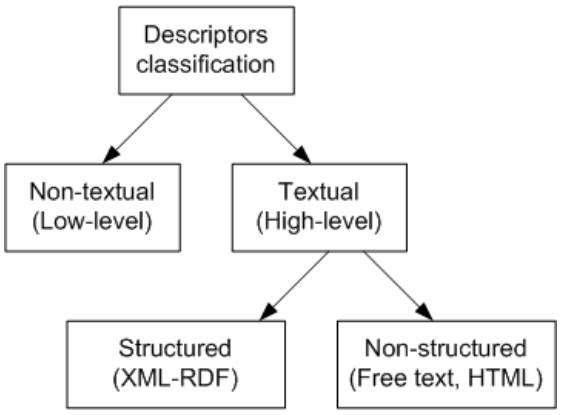

FIGURE 1: CLASSIFICATION TREE OF (MULTIMEDIA) CONTENT DESCRIPTORS

The second important categorization splits the high-level descriptions into two main categories: structured and unstructured content descriptions. The first group represents content descriptions that follow a certain metadata specification, which provides a set of rules for the proper use of metadata elements. Examples of metadata standards are TV Anytime [2] – used for TV program and video descriptions, Dublin Core [3] - a general metadata standard, ID3 – used for describing MP3 audio files, etc. Typical metadata elements used in these standards are title, genre, album, synopsis, author, lists of actors, directors, etc. In the second category are unstructured descriptions, mostly belonging to textual documents. In such cases the descriptions usually do not even exist in an explicit way, but are later generated by automatic indexing methods.

There are a number of ways to index (assign context terms to) textual documents. The automatic methods can be based on either single term or multiple terms indexing [4][5]. With single term indexing, the documents are most often represented with a standardized set of terms, named word vector. Each vector entry belongs to a predefined term and contains a weight value. The weight value is directly proportional to the frequency with which its term appears in a document and inversely proportional to the number of documents in which the term appears [4], [18]. Single terms are not ideal for indexing as their meanings out of context are often ambiguous. Term phrases on the other hand have more discriminative power. These approaches include statistical methods, probabilistic methods and linguistic methods [14]. Statistical methods use term frequency within a document as information about term relevance. Probabilistic methods generate complex index terms based on term dependence information. In practice only certain dependant term-pairs are considered as relevant. Linguistic methods are used to enhance the statistical methods by assigning syntactic class indicators to terms (verb, noun, adjective, etc.). Identification of most relevant syntactic units results in the selection of relevant phrase elements.

Opposed to automatic indexing methods are manual methods. When compared to automatic methods, they are extremely time consuming, but the generated indexes are much more exact. Moreover, some concept terms can be used to describe content even though they do not appear in the content, etc.

It is evident that content descriptions vary in a number of ways and that it is difficult to make a universal content retrieval search engine. This task is even more tedious if it is supposed to provide search results matching user's preferences. Since high-level descriptions contain keywords, concepts and semantic annotations, they are much more appropriate for annotation of a user's preferences. Therefore, the majority of personalization approaches are based on high-level (textual) descriptions.

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3. PERSONALIZED CONTENT RETRIEVAL

3.1 Background

According to [6] the first user modeling approaches appeared in the late 1970's. At the time, they were general and modular in structure, containing explicit assumptions about users' preferences. Over time they became more topic oriented, focusing on commercial applications. The complex reasoning capabilities and assumptions of generic user modeling systems were gradually replaced by simpler approaches. On the other hand, the introduction of the client-server architecture in these systems has enabled the possibility of comparing users among each other [6].

3.2 Basic user modeling elements

The user interaction mechanisms provide basic observation mechanisms, based on which conclusions about user preferences can be made. Usually these mechanisms are implemented in the framework of the graphical user interface (GUI). User interaction mechanisms are related to the question of the type of user feedback. Users can be either asked to explicitly evaluate the suitability of a particular content item, or the system has to make implicit conclusions about the suitability of content, based on content usage (select, ignore, delete,

record etc.). A combination of both approaches is also used. One would normally expect better results from the explicit feedback approach, since implicit feedback systems have to make decisions relying on incomplete and uncertain information. However, some authors [28] report improved results in the domain of television programmes using implicit feedback obtained through the analysis of the Personal Video Recorder (PVR) usage history.

User models store information about user preferences. They can have a special structure (decision trees, hierarchical structure, keyword vectors etc.) or can contain only lists of content items selected/rejected by the user. The first standardized approach to user modeling in the multimedia (MM) domain is presented in Section 4.

Content selection algorithms can be standalone computational procedures (e.g. similarity calculations) or can be a part of the user model structure (e.g. decision trees). Today we can speak about a number of recommendation approaches [9]: collaborative recommenders, content-based recommenders, demographic recommenders, utility-based recommenders, knowledge-based recommenders and also group-oriented recommenders. The main two approaches are content-based filtering (CBF) [18],[19],[20], [21], [22] and collaborative filtering (CF) [23], [24], [25], [28]. The difference between the two is in the process of identification of suitable content for the user. When using the CBF, the suitability of particular content for the user is estimated through direct comparison of content description (meta-data) and the model of the active user. When using the CF, first the similarity between users is estimated, and then content liked by users 'similar' to the active user is recommended. The advantages of collaborative systems are the independence of the representation of content items and the capability of recommending content items from cross-genre niches (music, movies, books...). The drawbacks are problems of new users and new content items. New users have not yet rated enough content items, while new content items have not yet been rated by a sufficient number of users. The content-based approach similarly suffers from the problem of new users and is not capable of cross-genre recommendations. Both approaches also need large historical data sets in order to provide quality recommendations. The mentioned approaches make recommendations to individual users, while another approach, which has come up recently, makes recommendations for groups of users (viewers) [8]. They all have their advantages and drawbacks and are not universally suitable for all fields of usage. Therefore, they are often combined into hybrids (see [9] for an overview).

4. THE TRENDS IN THE DOMAIN OF PERSONALIZED CONTENT RETRIEVAL

It is clear that personalized content recommender systems have a future and that they will soon appear in most of the content retrieval domains. Regardless of the content types, the personalization approaches used today have similar usage scenarios. Users browse content listings, rate content items implicitly or explicitly and get content suggestions. The drawbacks of today's systems are context unaware keyword approaches, relatively primitive means of interaction with systems resulting in poor implicit feedback, unawareness of a user's mood, etc. At this point, the question arises: what improvements can we expect in the future from personalized content recommended systems?

In the following subsections we mostly focus on the issues of user/system interaction and the seamless acquisition of information about user's preferences and moods. Later we address the issue of contextual understanding of content and the existing approaches. The section concludes with a presentation of the MPEG-7 user modeling standard [28]proposed by the MPEG initiative.

4.1 User-system interaction

One of the most important issues related to the development of personalized systems, is the advent of digital devices used for access to content at any time. All of these devices, from handheld Personal Digital Assistants (PDAs) to the Personal Video Recorders have gained in processing power and storage space. In this sense they are becoming very similar to computers and can run Java applications, connect to the Internet, download, store and display content items of any type [13]. This means that the observation of user preferences and a user's content selections is no longer bound to a single device but is possible in almost any situation at any time: At work, at home on a trip, etc. Consequently, personalized systems will be able to get much more information about the user. This approach will of course require more sophisticated user modeling techniques. An especially difficult issue is the acquisition of user preferences from different devices at different times and in different contexts, and their synthesis into a single user model.

Related to this issue is the question of user-system interaction. New types of user interfaces will have to be developed, which will enable seamless communication and interaction. Some authors report that users like to communicate with computers as if they were human; therefore new user interfaces using humanoid avatars and voice processing are being developed [10]. These enhancements may not directly improve the quality of personalized selections, but will nevertheless improve the overall functionality of such systems, as the users will benefit from easier and more 'human-like' interaction.

It is well known that users prefer communication based on interaction that requires as little as possible of explicit feedback. The first step in this direction is the possibility to analyze content usage history in home digital devices, from which some conclusions about user preferences can be made [1]. This approach basically uses the information about a user's actions related to particular content items like movies, videos, etc. Using the information about how many times a particular movie of a certain genre, with a certain cast crew, etc., was watched, or maybe deleted, conclusions about user's preferences can be made (see Section 4). Some nonintrusive methods of getting user feedback are presented in [26], [27]. However, nonintrusive ratings (such as the time spent reading an article) are often inaccurate and cannot fully replace explicit ratings provided by the user.

More straightforward solutions use very simple explicit feedback techniques like "thumbs-up" "thumbs-down" used in the TiVo system, where a (positive or negative) rating of a particular content item requires only a single push of a button.

At the same time much more intriguing and controversial approaches are being developed. In the most mature stage of development seem to be the systems that are able to track a user's focus on the screen of any device [10]. By combining this information with the information about the contents on the screen they can get very reliable information about the user's current interests. This technology seems especially useful for the analysis of interest in textual documents and Web pages. Another step forward from the analysis of a user's (visual) focus seems to be in the capturing of additional information about the user's state of mind, his/her current mood, fatigue, etc. It is well known that the appropriateness of content selection is dependant on these parameters, therefore, the ongoing research projects are investigating the possibilities to identify people's mood based on their biometrical signals (heart rate, temperature, sweating, amount of exhaled gases, etc.) [11]. These systems will be able to identify a user's current mood and will combine this information with the information about his/her general preferences in order to recommend suitable music or movie selection for example. Complementary initiative comes from the authors of the TV Anytime standard [2], which have in the content description schemes foreseen a field describing the type of mood for which some TV programme is suitable.

While being enthusiastic about the progress of the ongoing research, we should be aware of the accompanying issues that these systems might bring. The main issue is undoubtedly the security and privacy of a user's data, which not only includes the preferences but also the information about a user's health condition or reactions to particular content types, captured by the future recommender systems. Even though these issues are beyond the scope of this paper, we should bear in mind that inadequate protection of such information may bring a lot of potential trouble to future users and also affect the wide acceptance of these products.

4.2 Semantic search and understanding of content

The problem of contextual understanding of keywords is mostly present in case of textual documents, especially web pages. The current situation in the web is such that data is generally "hard coded" in HTML files. The concept terms used are semantically ambiguous, so there is no way of telling which of the possible meanings is the right one. For example: a search query "north pole" may provide thousands of result pages with content about the famous geographical location, a company with the same name or even a pub. This ambiguity is transferred into the user profile when information about "preferred" keywords is extracted from web pages and stored. These words are handled using statistical tools, which are mostly based on advanced 'counting' of word occurrences. However, taking into account the wider context of the documents would give much more information about the documents and consequently user preferences. In order to resolve this issue, an initiative called the Semantic web has been started [12]. To put it simply, the idea is to describe specific term meanings, their relationships and context information with the help of schemas and ontologies. Once such information is attached to documents they become much more useful and easily processable, e.g. for categorizing. The descriptions are made using RDF (Resource Description Format). With the development and use of inference logic, this approach may become a very powerful tool for information processing and retrieval.

The situation is similar with multimedia content types. A solution to this problem is being offered by the MPEG-7 standard [1]. Namely, the MPEG-7 standard aims to describe all types of MM content (audio and speech, moving video, still pictures, graphics and 3D models) including information on how objects are combined in scenes and their semantic meanings and relationships (temporal, spatial, etc.). The standard has powerful mechanisms for content description, but is on the other hand very complex, therefore widespread use is still questionable.

The problem of semantic content descriptions unfortunately does not end when content is described using structured, semantically sound metadata standards. Even if every content creator would take enough time to describe each of the created content items according to an appropriate metadata standard, there would still be many similar content items described with different metadata standards. Agreements in

metadata specifications are necessary to achieve semantic interoperability among communities. However, more than one metadata specification exists and it is impossible to achieve a general consensus about the use of one, and only one specification. To minimize the time spent in maintaining content metadata and to maximize the use among a broad range of users, the compatible parts of one metadata specification should be available in other related specifications [7]. Therefore, metadata crosswalks are necessary to facilitate interoperability among heterogeneous, but at the same time related specifications. A crosswalk is an explicit mapping of one metadata specification to another. Creating a crosswalk is a difficult and error-prone task, which requires in-depth knowledge and experience of the metadata specifications being mapped [7]. Developing a crosswalk between two metadata specifications requires steps like harmonization, semantic mapping and additional rules. An example of metadata mapping is presented in Figure 2. In this example, the semantically equivalent metadata elements such as abstract and keywords are both present in two different metadata specifications (on the left and right side of the Figure 2) and are labeled with the same colors.

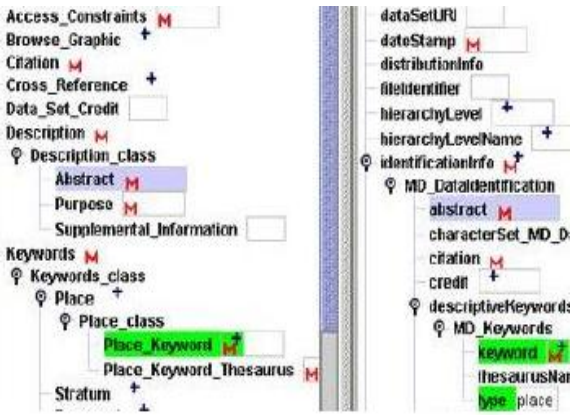

FIGURE 2: AN EXAMPLE OF SEMANTIC METADATA MAPPING BETWEEN TWO METADATA STANDARDS [7].

Even though the identification of semantically matching concepts may seem simple for a human, it is not so for computers, especially when considering the complex structures that the metadata standards may have.

4.3 User modeling standards (MPEG-7 user profile)

Despite the development in the field of personalized content selection, there are surprisingly few standards regarding the descriptions of user preferences. Apart from the widespread use of word vectors, there is actually only one standard in this field: the MPEG-7 user profile. The idea was to standardize the description of user preferences and the means of usage of MM content [1].

In order to enable the exchange of information about user preferences with 3rd party services, they also decided to standardize the information about content usage history. This part of the standard is specifically oriented towards user interaction with the personal digital video recorder or similar devices, but can also be used elsewhere. For this purpose, two description schemes (DS) were designed: The UsageHistoryDS and the UserPreferencesDS.

The UsageHistoryDS (see Figure 3) enables annotation of user's actions (play, record, delete etc.) with respect to a particular content item. These annotations form a detailed record of the interaction history between the user and the content, which represents a basis for meaningful representation of user's preferences. The latter are 'stored' in the UserPreferencesDS.

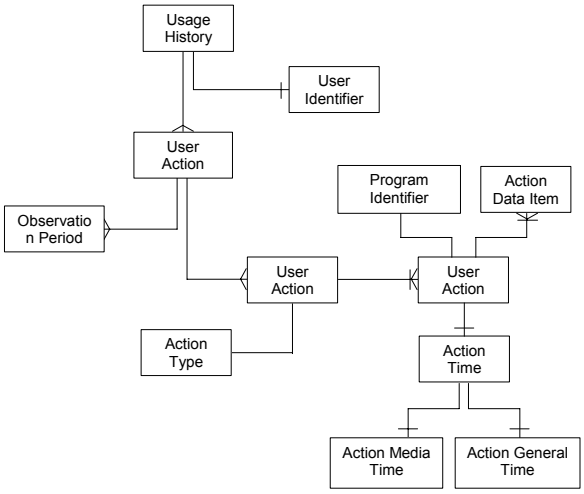

FIGURE 3: THE USAGEHISTORY DESCRIPTION SCHEME, USED FOR DESCRIBING THE INFORMATION ABOUT THE INTERACTION BETWEEN THE USER AND CONTENT.

UserPreferencesDS (see Figure 4) enables annotations of user's preferences regarding content creation (favorite titles, actors, directors, locations of content creation etc.), content classification (favorite genres, subjects, languages, etc.), source preferences (favorite media formats, dissemination mediums etc.) and some others. Although the standard mandates the structure of both description schemes, it does not mandate the algorithms used for mapping of usage history to user preferences. These are left open for the developers.

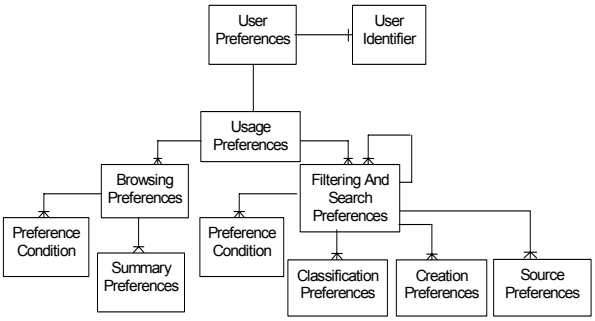

FIGURE 4: THE USERPREFERENCES DESCRIPTION SCHEME, USED FOR DESCRIBING THE INFORMATION ABOUT USER'S PREFERENCES.

A typical data and content flow of a personalized retrieval system, using user preference description and usage history description is presented in Figure 5.

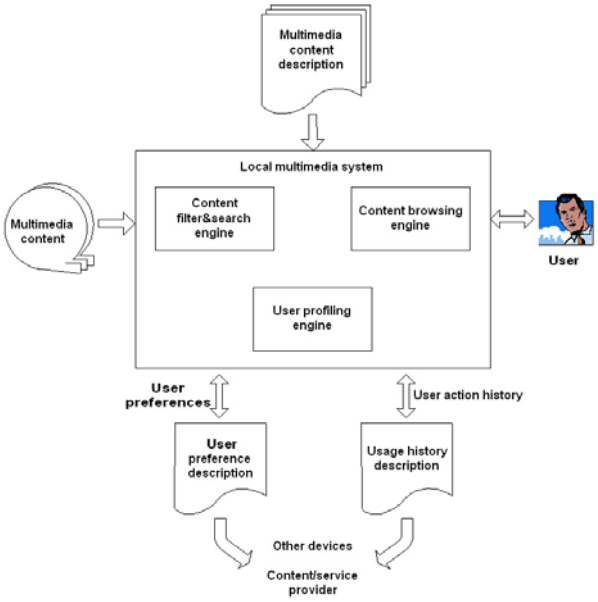

FIGURE 5: MM SYSTEM AND USER INTERACTION [1].

5. CONCLUSION

Personalized content retrieval is becoming a widespread technology, penetrating in different fields of usage. A number of personalization systems exist today, selecting and recommending content to a vast number of users. In the future, users can expect improvements in the field of user interfaces, which will enhance the interaction with systems, contextual understanding of terms and topics, enable exchange of user related information and consequently personalize experience on almost any device. This scenario will come true only if supporting technologies are provided, like unobtrusive biometrical sensors, further advancement of digital devices in terms of processing power and available storage, improved personalization algorithms etc. These approaches may seem very controversial, as they provide an insight into the user's most personal world by analyzing his/her mood and even knowing his/her biometrical data. Therefore, the user should have the final word when deciding which details (if any at all) of his/her user model should be shared or used for other purposes. We should bear in mind that data, gathered by personalized systems are very interesting to many commercial companies, as well as to individuals. We should make sure that this data is not misused and that user privacy is not compromised. In the opposite case, such systems and products will never be accepted by a wide audience.

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A Multi-Expert System for Movie Segmentation

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Abstract— ***In this paper we present a system for movie segmentation based on the automatic detection of dialogue scenes.***

The proposed system processes the video stream directly in the MPEG domain: it starts with the segmentation of the video footage in shots. Then, a characteri-zation of each shot between dialogue and not-dialogue according to a Multi-Expert System (MES) is performed. Finally, the individuated sequences of shots are aggregated in dialogue scenes by means of a suitable algorithm. The MES integrates three experts, which classifies a given shot on the basis of very complementary descriptions; in particular an audio classifier, a face detector and a camera motion estimator have been built up and employed.

The performance of the system have been tested on a huge MPEG movie data-base made up of more than 15000 shots and 200 scenes, giving rise to encouraging results.

Index Terms— ***MPEG, Multi-Expert Systems, multimedia database, video analysis***

1. INTRODUCTION

MORE and more videos are generated every day, mostly produced and stored in analog form. In spite of this, the trend is toward the total digitization of movies and video products given that the effective use of them is hindered by the difficulty of efficiently classifying and managing video data in the traditional analog format.

In the past few years, several algorithms have been presented in the scientific literature to allow an effective filtering, browsing, searching and retrieval of information in video databases [1]. It is generally accepted that the first step toward an effective organization of the information in video databases consists in the segmentation of the video footage in shots that are defined as the set of frames obtained through a continuous camera recording. Anyway, even if the individuation of shots represents a fundamental step, it is clear that this approach does not allow an effective non linear access to the video information. This is evident from at least two points of view: firstly, humans usually remember different events after they watched a movie, and hence they also think in terms of events during the retrieval process; secondly, a modern movie contains more than 2000 shots on average, which means that an intelligent video analysis program needs to process 2000 frames per movie to give a coherent representation.

Consequently, it is necessary to define units for accessing the video footage obtained by grouping semantically correlated shots. Scene is the term most used in the scientific literature to call this semantic unit. First approaches for detecting scenes (see for example [2, 3]) operate by simply clustering the shots according to the visual content of the most representative frames (also called key-frames). Anyway the quoted techniques do not take into account any model for the scene, so the results are not always semantically coherent. In fact, it is worth noting that the way the shots are grouped in a scene generally depends on the type of scene under analysis as well as on the video genre. The scenes of a TV-news program are different from the scenes of a talk-show, of a documentary, of a movie. Hence, it is important to aggregate shots also considering a model for the scene. Several recent papers try to define models for scene detection, mainly in the field of TV-news, where effective and simple models can be defined. For example, in [4] a method based on a Hidden Markov Model to segment TV-news at various semantic levels it is presented, while in [5], Bertini et al. describe the use of multiple features for content based indexing and retrieval of TV-news.

The same problem is much more complex when the movies domain is faced: there are much more different scene types and for each kind of scene different styles can be adopted depending on the Movie Director. Interestingly enough, although scene analysis can be very useful for several purposes (think for example to video abstraction and automatic classification of the video genre) only few papers have been presented on the problem of detection and characterization of scenes in movies [15][16].

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Among those few, an interesting one is [6] where Saraceno et al. define some simple rules to group the shots of a movie according to some semantic types.

In this paper we present a system for video segmentation based on the automatic detection of dialogue scenes within movies. The detection of dialogue scenes is a task of particular interest given the special semantic role played by dialogue based scenes in the most part of movies. The proposed system starts with the segmentation of the video footage in shots. Then, it operates a characterization of each shot as dialogue or not-dialogue according to a multi-expert approach, where each decision system (expert, hereinafter) classifies a given shot on the basis of a particular description while employing the most appropriate decision technique. The final result is obtained by combining the single decisions through suitable rules [7]. In this way, if the utilized experts consider different and complementary aspects of the same decision problem, the combination of the single decisions provides a performance that is better than that of any single expert. Finally, the individuated sequences of shots are aggregated in dialogue scenes by means of an appropriate algorithm.

In order to improve the computational efficiency of the whole process, we analyze the video footage directly in the MPEG coded domain.

While the general approach of multiple experts is not new (see for example [8, 9]), its application to this specific problem is interesting and quite novel, and the obtained results on a huge MPEG movie database are encouraging.

2. THE PROPOSED SYSTEM

As stated in the introduction, the proposed method starts with the segmentation of the video footage in shots. Then, a characterization of each shot between dialogue and not dialogue according to a Multi-Expert System (MES) is performed. Finally, the individuated sequences of shots are aggregated in dialogue scenes by means of a suitable algorithm. This approach can be justified on the basis of the following considerations: i) a scene is a group of semantically correlated shots; ii) almost all the shots belonging to a dialogue scene can be characterized as dialogue shots; and iii) the shots belonging to the same dialogue scene are temporally adjacent.

Therefore, it follows that the proposed system can be structured according to three successive stages, as depicted in Fig.1:

- Stage 1 - shot boundaries detection
- Stage 2 - dialogue / not dialogue shot classification
- Stage 3 - shot grouping

A short description of each of the quoted stages is given in the following.

Shot boundaries detection: the problem of automatic detection of shot boundaries has been widely investigated in recent years; hence, the scientific literature is rich of papers discussing approaches which allow us to reliably segment videos in shots both in the un-compressed and in the MPEG coded domain. For the purposes of this paper, we have implemented the technique described in [10] that is characterized by good performances both in terms of correct detection and of low computational requirements, since it operates directly on the compressed stream.

Dialogue - not dialogue shot characterization: this classification is performed through the use of a multi-expert system. The rationale lies in the assumption that, by suitably combining the results of a set of experts according to a rule (combining rule), the performance obtained can be better than that of any single expert. The successful implementation of a multi-expert system (MES) implies the use of the most complementary experts as possible, and the definition of a combining rule for determining the most likely class a sample should be attributed to, given the class to which it is attributed by each single expert.

Therefore, for the purpose of shot classification as dialogue or not, we introduce the following set of experts:

1. Face detection,
2. Camera motion estimation,
3. Audio classification

which are integrated within the whole system as shown in Fig.1.

Each expert can be viewed as constituted by a sensor and a classifier. Each expert of the system has two inputs: the MPEG video or audio stream and the complete list of the shots boundaries. The latter information is used by the sensor to access and characterize the MPEG data at shot level. The output of the sensor is used by the classifier to perform the dialogue / not dialogue shot classification. In our system we have integrated three experts whose sensors implement the algorithms described in [11] for face detection, in [12] for camera motion estimation and in [13] for audio stream classification, all working directly in the video/audio coded domain. It is worth noting that the output of the first sensor is correlated in a simple way to the output of the corresponding expert; in fact, the presence (absence) of a face implies a dialogue (not dialogue) shot. On the contrary, the sensor for camera motion estimation provides three estimates respectively for the zoom, tilt and pan rate for each P frame. Then, the average and the standard deviation of the zoom, tilt and pan rate over each shot constitute the features vector used by a neural network to perform the shot classification. Finally,

the sensor for audio classification uses the same feature vector defined in [13], but in our case the classification is realized through a neural network trained to recognize only the dialogue and not dialogue shot classes.

Then, the outputs of the single experts are combined according to a suitable combining rule (for a review of the most common used rules see [7]).

Shot grouping: the final stage of our approach provides to group in dialogue scenes the shots classified in the previous stage. The rationale of the algorithm for shot grouping derives from the consideration that the shots belonging to a dialogue scene are temporally adjacent. However, the shot grouping algorithm has to properly handle also the possible classification errors generated at stage 2. In fact:

- **a false alarm** (i.e. a not dialogue shot classified as dialogue) might cause the declaration of an inexistent short dialogue scene, and
- **a missed detection** (i.e. a dialogue shot classified as not dialogue) might cause the partitioning of a dialogue scenes in two scenes.

Thus the shot grouping algorithm implements the following rule: a transition from a dialogue scene to a not dialogue scene (and vice versa) is declared when a sequence of at least N not dialogue (dialogue) shots occurs. In Fig. 2, there are depicted examples of scene transitions in case of N = 3.

3. EXPERIMENTAL RESULTS

In order to assess the performance of the proposed system we used a large and significant database of video footages obtained from 10 movies. It results in about 20 hours, corresponding to more than 15000 shots and 228 dialogue scenes. In the construction of this movie database particular care was taken to include a representative of the major movie genres (action, comedy, drama, science fiction, fantasy, etc) so that to reproduce the high variability of the video characteristics over the different genres. More details on the chosen movies are given in [14].

In order to setup the proposed system and to assess its performance, we extracted two disjoint sets of samples from the database: a training set (henceforth **TRS**) and a test set (**TS**). The **TS** has been built by choosing continuous sequences of *L* shots from each movie, where *L* was obtained as approximately 30% of the total number of shots in that movie. The choice of using temporally adjacent shots is motivated by the fact that such sequences have to be used to test the Stage 3 of the system in the detection of dialogue scenes. The **TRS** were built by randomly choosing among the remaining part of the database a number of samples corresponding to 50% of the whole dataset. Note that the remaining 20% of samples of the database were used for building the validation set (**VS**); this set was required for training the neural classifiers of the 2nd stage, as it will be clarified in the next subsections.

3.1 PERFORMANCE EVALUATION OF THE STAGE 1

This stage provides the segmentation of the video stream in shots, by mean of the technique described in [10]. In order to assess the performance of this algorithm we carried out a comparison between the algorithm output and the ground truth. Such a comparison consists in the evaluation of the numbers of missed detections (MD, i.e. cut frames which were not detected by the algorithm) and false alarms (FA, i.e. non-cut frames which were declared as cuts from the algorithm). Then the overall performance is usually expressed in terms of *Recall* and *Precision*, which represent the fraction of correctly detected cuts with respect to the true cuts and the total number of detected cuts, respectively. They are defined as it follows:

$$Recall = \frac{CD}{CD + MD} \quad \text{and} \quad Precision = \frac{CD}{CD + FA} \tag{1}$$

where *CD* is the number of correctly detected cuts.

The algorithm implemented in this stage of our system required a tuning phase in order to select a suitable threshold that maximized the performance. In order to take into account both *Precision* and the *Recall*, we used a unique performance index defined as the sum of the preceding indexes; in this way we are able to weigh equally both indexes. The tuning phase required us to select the value of the threshold that maximized the performance on the **TRS**. Once completed the tuning phase, we tested the algorithm on the **TS**, obtaining the following performance: *Recall* = 0.96 and *Precision* = 0.94. These results confirm how the selected algorithm is able to perform very accurately, even if it is interesting noting that the performance of the implemented cut detection algorithm is lower with respect to what the authors declare in [10]. In fact, they report no missed detections and only one false alarm on their test set composed of only 27000 frames and 269 cuts.

3.2 PERFORMANCE EVALUATION OF STAGE 2

The camera motion expert and the audio expert are built by using a neural network - namely, a Multi-Layer Perceptron (MLP) - for their classification modules.

The architecture of the neural classifier of the audio and the camera motion experts has been chosen after a preliminary optimization phase on the **TRS**. In particular, the MLP net adopted for the audio expert is made up of 35 hidden neurons, while the net for the camera motion

expert has 25 neurons in the hidden layer.

In Table 1 there are the *confusion matrices* obtained on the **TS** by the best audio, camera motion and face experts.

The face expert required a different experimentation since it employs a naive classifier. It simply associates the presence/absence of a face in the central I-frame of the shot to a dialogue/not-dialogue shot. Anyway, this expert also required a training phase in order to setup some parameters of the face detection algorithm [11], with particular reference to the skin color module. In this case we used the same training, validation and test set defined for the other two experts.

After having assessed the performance of each expert, their results have to be fused together in the combiner. In Table 2, it is represented the *Coverage Table* evaluated on the **TS**, which reports the joint behavior of the three experts with respect to the shot classification task. In particular, the rows of this table represent the percentage of samples in the test set for which respectively three, two, one or zero experts performed the correct classification.

From Table 2 it is readily available the recognition rate achievable by employing a majority voting rule: it is given by the sum of the recognition rates of the first two rows of the quoted table. Hence, by using this simple rule it is possible to achieve a recognition rate of 83.97% (not dialogue shots) and 86.2% (dialogue shots) for the 2nd stage of the system.

It is worth noting that the multi-expert approach allows to obtain a relative overall improvement of about 8% with respect to the best single expert (the Audio one – about 79% correct classification). In Table 3, we have reported the relative improvements obtained by using the MES with respect to each single expert.

3.3 Performance evaluation of Stage 3

In the 3rd stage of the system the shots, classified in the 2nd stage, are aggregated in dialogue and not dialogue scenes. This is realized by the simple shot grouping algorithm described in Section 2.

Before going into the details of the tests that we carried out in order to assess the performances of this stage, it is worthwhile to dwell upon the set of indexes which we are going to estimate. It is important that such set is able to give a correct representation of the actual performances of the system.

We decided to provide a description of the overall performance of our technique in terms of **Correct Detection** (***CD***) and **False Alarms** (***FA***), which respectively account for the actual dialogue scenes which were detected and the dialogue scenes which were detected without being actually present in the movie.

These two parameters are defined as follows:

$$CD = \frac{CDS}{DS}\% \quad FA = \frac{FDS}{NDS}\% \qquad (2)$$

where:

- *CDS* is the number of actual dialogue scenes, which were detected;
- *FDS* is the number of dialogue scenes which were detected, but not actually present in the movie;
- *DS* is the number of actual dialogue scenes;
- *NDS* is the number of actual not dialogue scenes.

To this aim, we declare that an actual dialogue scene has been correctly detected if at least one of its shots is present in a detected dialogue scene. Anyway, it can be simply devised how the indexes introduced before provide only a rough description of the real performances of the system: no information about the "quality" of the detection is given. In fact, such indexes do not account for scenes which are only partially detected and/or split and/or merged. In order to cope with such a problem we introduce two other sets of indexes: *overlap percentages* and *split/merged scenes percentages*.

The first set of indexes has been introduced in order to give a condensed view of how much the detected dialogue scenes coincide with the actual dialogue scenes. Hence, we define the **percentage of correct overlap** (***CO***) and the **percentage of false overlap** (***FO***), given by:

$$CO = \frac{DSF}{ADSF}\% \qquad FO = \frac{NDSF}{ADSF}\% \qquad (3)$$

where:

- *DSF* is the number of frames of the detected dialogue scenes which overlap to the real dialogue scenes;
- *NDSF* is the number of frames of the detected dialogue scenes which do not overlap to the real dialogue scenes;
- *ADSF* is the number of frames of the actual dialogue scenes which have been detected by the system. The rationale inspiring the choice of excluding the undetected actual dialogue scenes relies on the fact that with such set of parameters we want to give a measure only of the quality of the detected scenes.

The set of indexes about split/merged scenes has been introduced in order to take into account the errors occurring when an actual dialogue scene is split into two or more dialogue scenes or vice versa when two or more dialogue scenes are merged together. To this aim we define the **percentage of merged dialogue scenes** (***MS***) and the **percentage of the split dialogue scenes** (***SS***) as it follows:

$$MS = \frac{AS}{DDS}\% \quad SS = \frac{DiS}{DDS}\% \qquad (4)$$

where:

- *AS* is the number of the detected dialogue scenes, which were merged into a single scene;
- *DiS* is the number of the detected dialogue scenes, which were divided into two or more scenes;
- *DDS* is the number of the detected dialogue scenes.

Note that according to the previous definitions it might occur also the situation of a detected dialogue scene that is both merged and divided. In such case this scene is considered for the computation of both *MS* and *SS*.

After the definition of these indexes, we can evaluate the results of the experimental campaign carried out on the video sequences of the **TS**. It is worth recalling that the **TS** has been built by considering a continuous sequence of *L* shots from each movie, where *L* was obtained as approximately the 30% of the total number of shots in that movie.

The experimentation of the 3rd stage of the system required to set only the parameter *N* that was defined in Section 2, representing the minimum number of adjacent shots that allows switching among the two different types of scenes. We tested the system for different values of the parameter *N*. In Table 4, there are reported the experimental results obtained by setting *N* = 3 and 4.

The first conclusion which can be drawn is that the dialogue scene segmentation is significant only in the cases of *N* = 3 and 4. In fact, a higher value gives rise to under-segmentation: many scenes are merged together; conversely with *N* = 2 over-segmentation occurs.

The experimental results are very appealing as in both cases we obtained about 90% in the detection of the dialogue scenes. Furthermore also the results about overlap are quite good with about 80% of correct overlap and only 10% of false overlap. The results about scene overlap are important since they represent an index of the quality of the detection. Low values of *CO* accompanied by high values of *FO* would be misleading, in the sense that they could not allow a user to perceive the true semantic content of the scene.

In order to evaluate the improvement in the overall performance introduced by the use of sensor fusion approach with respect to the case of a single expert, we have tested our system using in the 2nd stage only the best expert (audio). We have reported in Table 5 the experimental results obtained with this expert in case *N* = 3 together with the relative improvement introduced by the use of the MES.

From the experimental results reported in Table 5 it is evident the improvement yielded by the employment of a MES. The advantages are considerable not only in the percentage of correct detection, but also for the other indexes. The use of information about face presence and camera motion allows improving the overall quality of the segmentation.

4. CONCLUSION

In this work we have analyzed the problem of movie segmentation. The proposed approach is based on the detection of dialogue scene by means of a Multi-Expert System (MES). The MES is constituted by three different experts which analyze the video and audio tracks of the movie directly in the MPEG coded domain. Although each expert is not characterized by optimal performances in the classification of the shots (this is due both to the errors of the sensor and of the classifier which constitute each expert), their combined use gives good performances even when a very simple combining rule is used. This confirms our initial hypothesis that the utilized experts consider different and complementary aspects of the same decision problem. Current research is focused on improving the overall performance of the system by implementing the experts as classifiers able to yield also some information about the reliability of the classification, and by using more sophisticated combining rules. Actually, we are also exploring the possibility to extend the proposed approach to detect action scenes within movies.

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TABLES

	Audio		Camera Motion		Face	
	ND	D	ND	D	ND	D
ND	**77.57%**	22.43%	**58.43%**	41.57%	**76.43%**	23.57%
D	20.01%	**79.99%**	23.59%	**76.41%**	30.45%	**69.55%**

Table 1. The confusion matrix obtained on the **TS** by the best audio, camera motion and face expert, where **ND** and **D** stand for *Not-dialogue* and *Dialogue shot*, respectively.

# Correct classification	Not-Dialogue	Dialogue
3	**32.18%**	**45.17%**
2	**51.79%**	**41.03%**
1	12.31%	8.38%
0	3.72%	5.42%

Table 2. The coverage table evaluated on the **TS** by considering the outputs of the three experts.

	Not-Dialogue	Dialogue
Audio	*8.3%*	*7.8%*
Camera motion	*43.7%*	*12.8%*
Face	*9.9%*	*23.9%*

Table 3. The relative improvements obtained by using the MES with respect to each single expert in the dialogue/not-dialogue classification of the shots.

	N = 3	*N* = 4
Correct Detections (*CD*)	**90.83%**	**88.78%**
False Alarms (*FA*)	7.89%	6.88%
Split Scenes (*SS*)	16.32%	13.39%
Merged Scenes (*MS*)	14.68%	17.89%
Correct overlap (*CO*)	82.64%	76.80%
False overlap (*FO*)	11.54%	6.67%

Table 4. There are reported the experimental results obtained by setting N = 3 and 4.

	Audio	*Relative improvement*
Correct Detections (*CD*)	*81.27%*	*11.8%*
False Alarms (*FA*)	*19.38%*	*59.3%*
Split Scenes (*SS*)	*23.31%*	*30.0%*
Merged Scenes (*MS*)	*21.34%*	*31.2%*
Correct overlap (*CO*)	*75.70%*	*9.2%*
False overlap (*FO*)	*17.72%*	*34.9%*

Table 5. The experimental results obtained by using the audio expert in the 2nd stage of the system with *N*=3; the relative improvement introduced by the use of the MES are also reported.

FIGURES

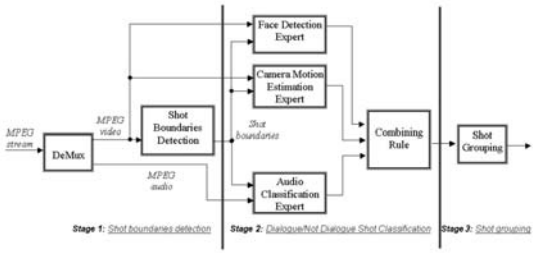

Fig. 1. Block diagram of the system for automatic detection of dialogue scene.

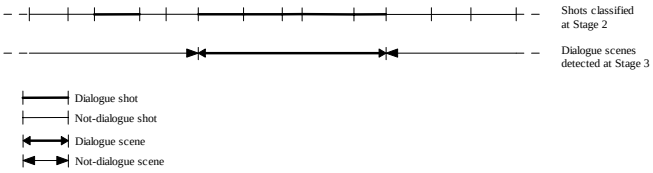

Fig. 2. Examples of scene transitions in case of N = 3 are depicted.

Network Structure and Emergent Collaboration in a Research Network

Molka-Danielsen, Judith; and Søvik, Bernt Louis Berge

Abstract— ***Clusters of associations and even friendships can foster a sharing of ideas that lead to the co-production of scholarly works. This paper studies the emergence of a network of research collaborations within one small academic institution. We study which of these associations are beneficial to research production and what is the relationship to the structural connectivity of the network. The nodes of this social network are 92 researchers at Molde University College in Norway, and the links are their co-author associations that produced 1480 unique scholarly works. The source of data is the ForskDok database of documented research in Norway that contains over 160,000 publications. We examine global network characteristics: the average degree distribution, and the diameter of network collaborations. We study network neighborhood characteristics: a comparison of percentage of collaboration takes place within and between faculties and that which is external to the school. From these findings we discuss the emerging collaboration and conclude whether faculty members that collaborate have higher quantities of publications. Finally, based on our study of this network data, we discuss the meaning of collaborative efforts for researchers and their institutions.***

Index Terms—*Collaborative networks, degree distribution, network diameter, and productivity.*

1. INTRODUCTION

SOCIAL networks are information networks of humans interacting and creating relationships. A link between two persons in the network can be a close friendship, partnership, or working relationship. There are many studies that examine the structural and dynamic network characteristics of such social networks, and in particular of emerging researcher networks.[4][5][12][14] This study also examines a network of researchers, in particular, the collaborative co-authorship network at Molde University College in Norway. We explore the associations between network characteristics, the benefits of collaboration and the quantities of publications. While "the network of researchers" is becoming an important resource also to small educational institutions, a problem for these is they usually to not have the established researcher networks of larger institutions. Other studies support the need for this research. In particular, a study on betweeness centrality correlation in social networks has shown that "each person in surrounded by almost the same influential environments of people no matter how influential the person may be."[10] This indicates that improving the collaborative environment can assist all member of that environment. We are therefore motivated to discover how the connectivity of the network emerges; because it can assist in the network's further evolution and indicate how to improve the potential productivity of the institution.

2. BACKGROUND

2.2 Prior Research of Information Networks

Recent studies have identified a "small world" phenomenon in social networks.[17][18] This phenomenon states that average distances across networks can be very small, that one must traverse only a few links on average to go between any two nodes of the network.[1] That is all of the members of the network are on average close to all other nodes of the network. Why do some networks exhibit this phenomenon? Small world networks have been characterized to have a few members (or nodes) with many connections to other members. The popular members are called "hubs". We see hubs in technology networks also, such as routers on the Internet. The routers (nodes) are connected by transmission lines (links). But, hubs exist also in certain social networks, such as networks of researchers connected by collaborative works. Is the researcher network at Molde University College a "small world" network? The data here will support that MCs network shares some of these characteristics. The characteristics that we study are: the average degree distribution of the nodes, the "betweenness" positioning of nodes, the clustering coefficient of node neighborhoods, and the direction of collaboration. Finally, we will look at what these characteristics mean to the researchers.

3. RESEARCH METHOD

3.1 Data

The Data source for the experiment was the ForskDok database publicly available from the library pages at the Molde University College: (http://www.himolde.no). ForskDok defines itself: "ForskDok consists of two (2) databases, FORSKPRO and FORSKPUB. In addition is a

register of Norwegian research institutions, a register for topic disciplines and a person register. FORSKPRO consist information about more than 5000 ongoing or finished FoU-projects. FORSKPUB consists of information about more than 160,000 publications and other results from FoU-works."

From the ForskDok database we obtained a listing of research works given constraints from input specifications. The listing for this experiment was requested on the 19th of January, 2005. The query response consisted of 1781 publications for college faculty researcher consisting of 1480 unique publications.[4]

Open source Java Universal Network/Graph (JUNG) framework for analyzing networks and graphs was implemented to produce the visualization of the network data results. In particular, JUNG was used in creating the network map and for collecting data about; the diameter of the network, degree distribution and betweeness values.

3.2 Network Structural Characteristics

In the network studied authors (researchers) are defined as nodes and links are created between authors in the network when they collaborate in a publication. Links are not redundant in that there can only exist one link between two (2) unique authors. A "unique co-author" link is defined as the first occurrence of two authors working together on a publication. For example, if author A works with author B on publication-2001 and publication-2002, there is only one unique link established. If new author C also works on publication-2002, then two new unique links are established A-C and B-C.

Since some of the analysis was to be based on authors from the staff at Molde College (MC) it was necessary to be able to identify the nodes as either internal or external. Internal Links (IL) are co-authorships between two persons that are both faculty within one department at MC. Between Links (BL) are between 2 MC faculty from different departments. External Links (EL) are between persons where one person is not on faculty of the college. There were 92 internal researchers. Links are discussed later and listed in Table 5. It was also an objective to be able to study the evolution over different time periods, so identification of the age/date of the publication/collaboration link was collected.

[4] Table 1 has the number of publications or scholarly works that the researchers of the various departments have been a part of. This total of 1781 is different from 1480 because authors A and B can be from two faculties and have worked on the same publication P. The count of publications per researcher is therefore different than the total number of unique publications (1480). The number of co-authorships is also greater than 301 (=1781-1480) because some coauthors are not on faculty within the college.

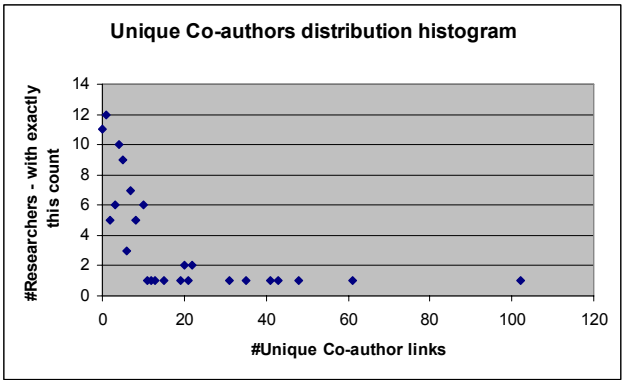

Fig.1. Unique Coauthor distribution histogram

TABLE 1
PUBLICATIONS AND CO-AUTHORSHIP

Faculty	#Pubs for researchers	#Unique Co-Authors	#Total Co-Authors
Health Sc.	194	80	142
Informatics	324	165	420
Social Sc.	271	152	326
Logistics	517	223	660
Economics	475	217	618
Sum	1781	837	2166
Average	19.36	9.10	23.54
Std. Dev.	35.8	14.71	49.33

4. FINDINGS

Table 1 summarizes the data by faculty of the total number of publications per researcher, the number of unique coauthors and the total number of coauthor collaborations. In the dataset the average number of publications per researchers is 19.36. The average number of unique associations per researcher is 9.1. The average total sum of unique coauthors that a researcher would have ever worked with (on all accumulated works) is 23.54. The average number of co-authors on one given scholarly work is 1.21.

One objective of this project was to find out whether the data summarized in Table 1 would in more detail characterize the researcher network at MC as a "small world" network. In summary we find it can be called a "scale free" network with some characteristics of a "small world" network. We demonstrate in more detail in Figure 1 and explain herein.

4.1 Degree Distribution

In Figure 1 the number of unique person-to-person links follows an exponential distribution or power law. In other words, there are a few authors with many different collaborators. This degree distribution follows the shape of a "scale

free network" rather than a "random network." The degree distribution of random networks follows a bell shaped curve. So, if one plotted the number of nodes with links versus the number of unique links there would be a bell shaped distribution. That would mean that most nodes have the same number of links and that nodes with very large number of links do not exist. Random network theory was introduced by Paul Erdős and Alfréd Rényi in 1959. [7]

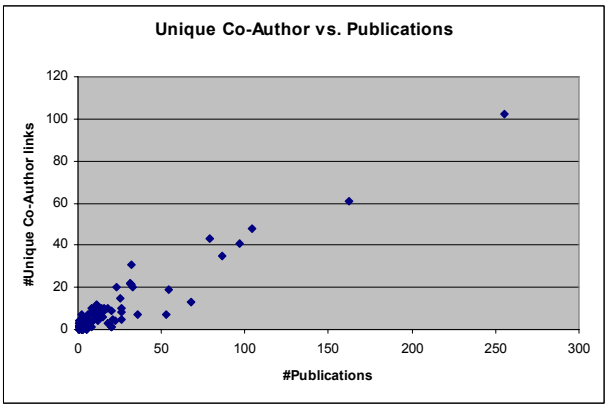

Fig.2. Unique Coauthor vs. Publications Count

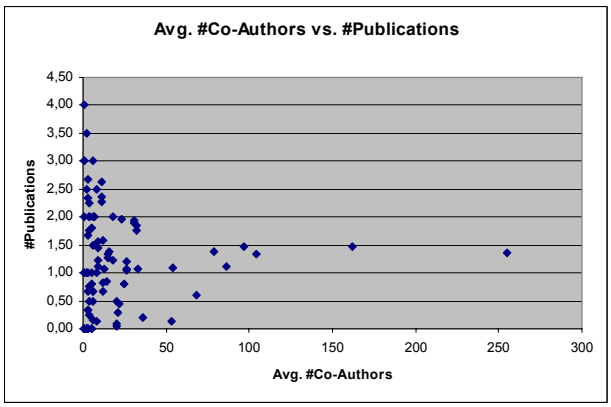

Fig.3. Average #Coauthors vs. Publications Count

Another kind of network, described by Barabási and colleagues, is called a scale free network. [3] This type of network follows a power law distribution such that most nodes have only a few links, while a few nodes have many links. The nodes with many links are called hubs. An example of this is an air traffic system where many small airports are connected by a few hubs. Social networks have also been found to follow a scale free distribution. For example, a study was made by Malcolm Gladwell to measure how social a person is. [9] His conclusion was there are a few people that have a knack for making friends and acquaintances and these are connectors. Similarly, our network of researchers appears to contain a few connectors, as is seen

TABLE 2
BETWEENESS OF NODES

Faculty	Betweeness	
	Rank	Score
Health Sc.	124.88	1643
Informatics	90.41	4032
Social Sc.	71.07	4270
Logistics	36.67	16102
Economics	87.76	3865

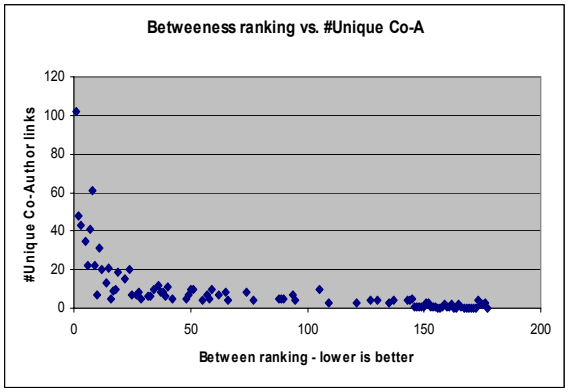

Fig. 4 Betweeness ranking vs. #Unique Co-Authors

in Figure 1 and summarized in Table 1, the standard deviation from the average number of unique coauthors is broad.

Another characterization of networks is that they change or evolve over time. [4] Presently, the Molde College researcher network has some demonstrable "hubs" of researchers with many connections. But, the number and size of hubs can continue to increase over time. Similarly, Albert and Barabási study of the Internet and the www network of web pages showed that though one might expect that there would be only a few hub web pages with very many links in and out, that was not the case. Rather, they found the hubs on the web are not so rare, and that new hubs can come into existence even while other established hubs already exist. Also although the number of hubs increased, that the network still followed a power law and that growing networks often follow a power law distribution.[2]

In our network, we may also have researchers that will change into connectors or hubs over time. That is, they may produce more publications and create more connections (new associations) over time. The creation of hubs usually arises out a differentiating factor. For example, a researcher with a research grant might make that researcher a popular coauthor. This phenomenon has been called "preferential attachment."[3] Preferential attachment explains that any researcher would prefer to work with a more famous, established, or experienced researcher than with an unknown. The tendency, also known as "the rich get richer", explains the growth of hubs in some networks. Others from

1955 until the present confirm that "growing networks are self-organized into scale-free structures because popularity is attractive."[6][16] Causality can be bidirectional, as will be discussed further later.

Is there an association between the amount of collaboration and the number of works produced by researchers of the studied network at Molde College? Figure 2 shows that working with a high number of unique coauthors are associated with a high number of publications. Figure 3 shows that the average number of coauthors per article is not necessarily associated with a high total number of works produced. We may conclude from these data that it helps to have many associations, but it does not help to have many names on one article. The data in these figures are based on the data collected from ForskDok and summarized in Table 1.

TABLE 3
PUBLICATIONS GROWTH

Period	#Publications added	#Publications accumulated
1991-93	35	35
1993-95	80	115
1995-97	164	279
1997-99	374	653
1999-2001	250	903
2001-03	378	1281
2003-01/ 2005	199	1480

TABLE 4
DIAMETER AND CONNECTIVITY

Year From 1991 - to 12/31/yy	Diameter of network	# Connected authors	#Links in network	# Clusters
1997	8	148	333	16
1999	10	286	674	12
2000	10	339	817	14
2001	10	375	889	14
2002	10	416	981	15
2003	10	444	1059	17
2004	12	462	1119	16
2005	12	494	1214	15
2006	12	494	1214	15

TABLE 5
EXTERNAL LINKS TO INTERNAL LINKS RATIO

Faculty (FAC)	#IL within FAC	#BL between FAC	#EL out of MC	B-to-I ratio	E-to-I ratio
Infor.	19	14	113	.74	5.95
Econ.	20	35	139	1.75	6.95
Health	12	17	39	1.42	3.25
Social Sc	19	18	94	.95	4.95
Logistics	6	28	182	4.7	30.33
MC total	132	←	567		4.30

4.2 Betweeness

Table 2 and Figure 4 tell us something about how the collaboration network is connected. It follows the shape of exponential distribution but important to note is the nodes not in the direct path of the shape. These are nodes that most likely connect larger clusters together making them a preferable location to traverse from one cluster to another. [3] This could be perceived as the strength in weak links which relates to the early studies of Mark Granovetter who as a graduate student at Harvard University tried to find out how people "network" to get new jobs. [11] The authors/nodes in the network with the "best" ranking can be called connectors or hubs since they often are connecting clusters together. These connectors or hubs can be observed in the visualization of the complete network in Figure 6.

4.3 Degree Exponent

As stated previously, the link distribution in a scale free network follows a power law.[15] That is the probability of a node being connected to k other nodes can be expressed as $P(k) = C * k^{-Y}$ where Y is the degree exponent. The degree exponent for our network is .8 and is shown in Figure 5. We found this to be lower than expected for social networks in general. Previous research by Barabási found higher degree exponents in social networks of scientific collaboration. They found it was Y=2.1 in a Natural Science collection, and Y=2.4 in a Mathematics collection. Their collections spanned 8 years. Although these exponents are considerably higher than ours, it should be noted that the number of researchers in the prior studies are also considerably larger. The mathematics database contained 70,975 different authors and 70,901 papers. The natural sciences database contained 209,293 different authors and 210,750 published papers. [4]

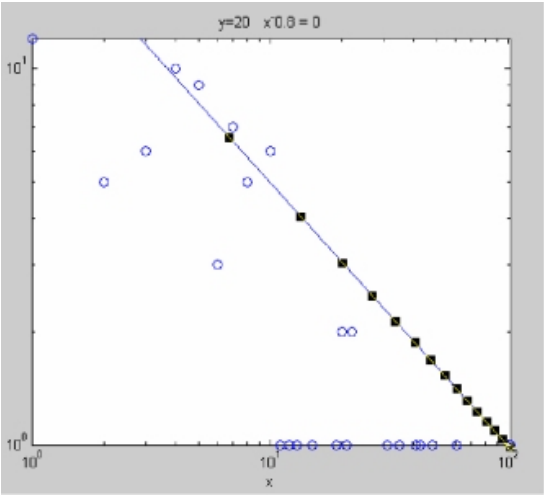

Fig.5. Degree Exponent

In summary, our network had too few participants to represent the end of the scale that is supposed to be rare occurrences. Of the 92 researchers, only 66 researchers were part of the connected network (had coauthors). A network of more researchers is needed to map the degree exponent. Also, and importantly, the former studies concentrated on specific fields of science while our data was cross-disciplinary and there would seemingly be less collaboration across fields. Last, the degree exponent can be different from that of a larger institution because the quantity of research activity or unique collaborative ties established by member (nodes) of one small college may be far less than that of a larger.

4.4 Analysis of network evolution

The growth of the network is depicted in Table 3 and Table 4. The registration of publications in ForskDok started in 1991. As links are added to our network the number of separate clusters reduces and the size (number of nodes) of the largest cluster increases. The diameter of a network is the "longest shortest path" or the largest number of links that must be traversed to get from any node to any other node in the network using the shortest path.[5] Our program computes the diameter and also the average of "longest shortest paths" that is the average distance. Peterman distinguishes between the definition of "small world" and "scale free" networks. He says "small world" implies that the average distance between nodes of the network increases at most logarithmically with the number of nodes.[6]

[5] One estimate for the diameter of the web is D=2log(N) where N is the number of web pages and 2 is an estimate of the inward degree exponent.

[6] Peterman defines: Scale-free refers to the lack of an intrinsic scale in some of the properties of the network. In particular, degree (or connectivity) distribution: the degree k of a node is the number of other nodes it has links to and the degree distribution P(k) is simply the histogram of the number of nodes with a given degree k. Scale-free networks exhibit a power-law behavior of the distribution $P(k) \sim k^{-Y}$, with Y values often between 2 and 3." [15]

TABLE 6
CLUSTER COEFFICIENT OF THE CONNECTED NETWORK

Faculty	# IL	# Nodes	# Possible Links	CC	CC Random
Infor.	19	20	190	.1000	.0475
Econ.	20	14	91	.2198	.1020
Health	12	10	45	.2667	.1200
Social Sc	19	10	45	.4222	.1900
Logistics	6	6	15	.4000	.1667
MC total	76	66	2145	.0615	.0303

In our network the average distance between any two nodes is 4.4 links in 2005 and it was the same in 1999. The growth is too small to draw conclusions. Similarly, if the average distance increases with a logarithmic law, we would also expect the diameter of the network will increase slowly and it does as shown in Table 4.

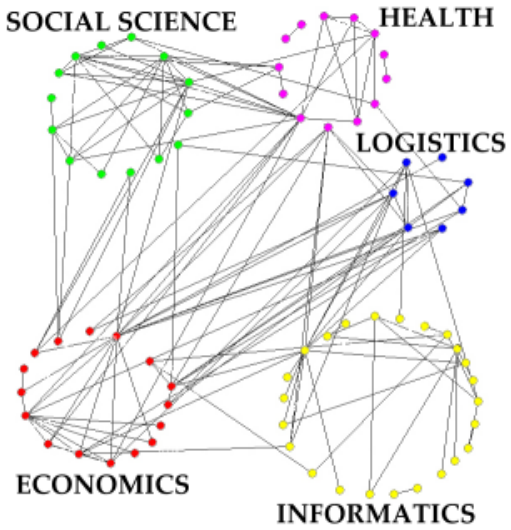

Fig. 6. Molde College Researchers Network Map

4.5 Where the links are established

Some communities are sometimes identified by the number of links within a group. For example, this method was used to identify communities on the web. The study by Flake, Lawrence and Giles, identified "documents belong to the same community if they have more links to each other than to documents outside the community." [8]

But, researchers it is hoped do not work dominantly within their own department. We examined collaboration by department and confirmed a greater establishment of links outside MC. In Table 5 is the ratio of external links to internal links for all faculty departments is greater than 1. To compare the extent of collaboration within departments, we can look at

the clustering coefficient (CC) of the connected network of researchers. The connected network is the group researchers that have collaborated with someone. The "clustering coefficient" is the number of existing links divided by the number of possible links within a grouping. [13][17] In Table 6 we see that the Social Sciences and Logistics departments are the most collaborative among researchers within their department and Informatics is least collaborative. Figure 6 is a network map of the links within and between departments. The node set in the figure includes the group of researchers with at least one coauthor link.

However, even though the Logistics faculty collaborates within, they also have a high ratio for establishing external contacts. We can also ask if a greater ratio of external associations contributes to a higher number of publications. A study by Newman found the probability of acquiring new collaborations increases with the number of past collaborations. [14] We can look at the association of the publication count to past collaborations. Table 5 shows that while all departments are collaborating more often externally, with coauthors in an outward direction rather than within the school, the Logistics department has the greatest ratio and the greatest number of publications in Table 1. This would indicate that external collaboration helps in the production count.

5. CONCLUSIONS

In the first part of this study we analyze the properties of the social network of researchers at Molde University College and recognize that the degree distribution of collaborations is similar to other scale free networks. This is significant because understanding how the members of the network connect to each other and the importance of "connectors" or hubs within this network may encourage the members of this network or other small institutions to come in contact with other researchers and to form new associations or links. The hubs in Figure 6 are apparent and traceable.

Second we analyzed the connection between researcher productivity as measured in the total number of publications and the existence of coauthor collaborations. It was asked if one can boost the total number of publications by increasing the number of coauthors on each paper. The answer seems to be no. The data in Figure 3 supports this conclusion. In short the average number of coauthors per publication across all researchers was 1.21 coauthors per work with a .9 standard deviation. That is, the author with the most publications (data point with count of 261) had an average of 1.36 coauthors per publication. Another researcher with 26 publications had an average of 1.19 coauthors per publication. Although the publication count is an order of magnitude different, the average numbers of coauthor links are almost alike. We conclude that listing many coauthors on research cannot be the only factor in contributing to a high number of publications. Figure 2 however, indicates another factor contributes to a greater number of publications that is the number of unique associations.

The relationship between the unique associations and the number of published works cannot be concluded to be a one way causal relationship. As others found that two factors are present in networks that exhibit the scale free structure that is growth and preferential attachment. [3] This was also observed in the study of a citation database. [14] Our data also supports this point: while more associations can lead to more production, it is also true that more production can lead to more associations. For a young researcher, it is only important how they can join this virtuous cycle. Therefore, we finally looked at the role of the "connectors" or hubs to see the type of connections made. In addition to acting as connector to between research faculties, the connectors appear to have many external contacts. As indicated in the betweeness data points in Figure 4. Also Table 5, establishes that external contacts seems to contribute to the total number of publications for the faculties and the school.

Last the cluster coefficients in Table 6 for the entire MC and for the faculties demonstrate that there is collaboration within faculties, but it may not be as commonplace for faculty between faculties to work together. This is in agreement with other studies that working partners are not chosen randomly, and is also supported by the network's degree distribution and confirms this network as a scale free network.

In summary, the most important factor in network productivity is that faculty should establish "new" contacts. The addition of new unique coauthors seems to contribute most to the growth of publications.

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Joint Capacity and Spare Capacity Placement with *p*-Cycles

Dale R. Thompson and Khalid Al-Snaie

Abstract— ***Preconfigured protection cycles (p-cycles) provide recovery times for mesh networks that are near the recovery times of SONET ring networks while providing lower spare-to-working capacity ratios. In this work, two methods of assigning p-cycles in a wavelength division multiplexing network are compared over a range of topologies with different average node degrees. The joint capacity placement (JCP) method considers the working traffic and spare capacity jointly. The spare capacity placement (SCP) method assigns traffic to the shortest paths and then assigns p-cycles using the spare capacity. The joint capacity placement method provides ~35% lower spare-to-working capacity ratio than the spare capacity method with ~7% increase in working capacity cost. In addition, a topology with higher average node degree provides lower spare-to-working capacity ratios because more straddling links are possible.***

Index Terms—network reliability, *p*-cycles, *wavelength division multiplexing*

1. Introduction

THE Internet and business functions rely on communication networks. Failures of optical connections, even for small periods of time, cause a large waste of resources. Unfortunately network failures are frequent. According to the Federal Communication Commission (FCC), metro networks annually experience 13 cuts for every 1000 miles of fiber, and long-haul networks experience 3 cuts for 1000 miles fiber [1]. A network with 30,000 route miles of fiber is cut every four days on average [1].

There are two well-known approaches for protecting an optical network: ring-based restoration and mesh-based restoration. Ring protection such as the bi-directional line switched ring (BLSR) can achieve low restoration times (50-60 ms). However, in real networks ring protection requires a spare-to-working ratio between 200% and 300% of resources [2].

In mesh restoration the spare-to-working ratio is lower than the ring protection because many working paths can share one unit of spare path. The required spare-to-working ratio can be as low as 50-70% depending upon the network topology [2]. However, the restoration times of mesh-based restoration are generally higher than ring-based recovery because of the more complex distributed signaling.

In 1998 Grover and Stamatelakis introduced the concept of preconfigured protection cycles (*p*-cycles), which can be an attractive method for span protection in wavelength division multiplexing (WDM) optical networks because it combines the benefits of the recovery speed of ring-based restoration and the efficiency of mesh-based networks [2-4].

2. Problem Statement

There are two methods for assigning *p*-cycles in a network. The joint capacity placement (JCP) method considers the working traffic and spare capacity jointly when assigning *p*-cycles. The spare capacity placement (SCP) method assigns traffic to the shortest paths and then assigns *p*-cycles using the remaining spare capacity. In this work, the spare-to-working capacity ratios of JCP and SCP will be compared on several network topologies with varying node degree. In addition, the required working capacity for JCP and SCP will be compared on the same set of topologies. These comparisons will give network designers guidance for which method to use when assigning *p*-cycles.

3. Literature Review

3.1 The p-Cycle Concept

Two basic types of *p*-cycles exist. Link *p*-cycles protect the individual channels within a link. Node encircling *p*-cycles are routed through all neighbor nodes of a specific node and protect all the connections traversing this node. In this work, we focus on link *p*-cycles, assuming the nodes are reliable.

Fig. 1 illustrates using *p*-cycles for a 6-node network topology with 11 spans (average node degree: $\bar{d} = 2S/N = 3.67$). Like BLSR the *p*-cycle is based on cyclic structures having the property that protection switching decisions can be made quickly. Since only the two nodes on either side of the failure need to perform actions, BLSR-like restoration times can be achieved. For example, the single *p*-cycle shown in Fig. 1 can cover 6 on-cycle working fibers as seen in Fig. 2.

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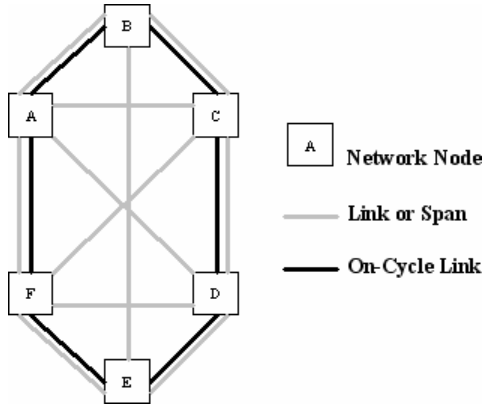

Fig. 1 Network topology with 6 nodes and 11 spans before failure with one *p*-cycle (A-B-C-D-E-F).

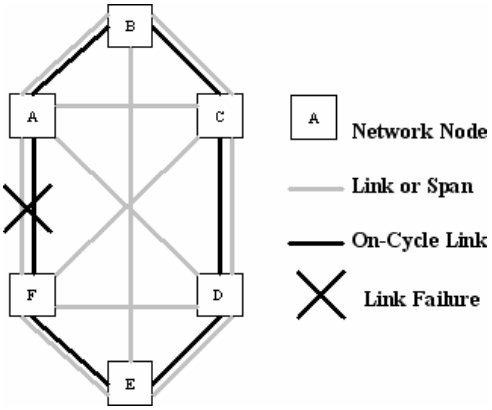

Fig. 2 Network after A-F on-cycle failure with one protection path (A-B-C-D-E-F). Only nodes A and F need to perform real-time action.

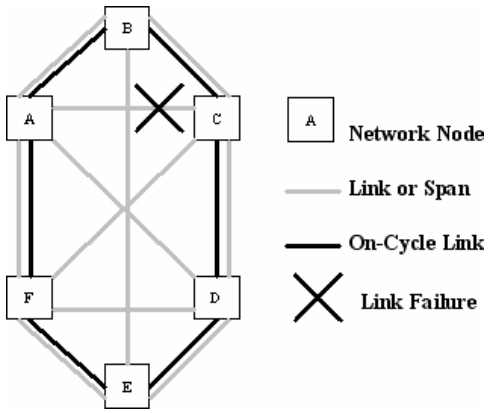

Fig. 3 Network after A-C off-cycle or straddling span failure with two protection paths (A-B-C) and (A-F-E-D-C).

A *p*-cycle can also protect 5 straddling spans providing mesh-like efficiency as seen in Fig. 3. Note that a straddling span can be restored by using capacity from two different paths. We see that a single Hamiltonian *p*-cycle that has 6 spans can protect up to 6+2(5)=16 working fibers with a spare-to-working percentage of 6/(6+2(5))=37.5%, which for this case is a lower bound for a span-restorable mesh network, 1/($\bar{d}$ -1) [1], [5-8].

There are two types of WDM networks: virtual wavelength path (VWP) and wavelength path (WP). The nodes in VWP WDM networks perform full wavelength conversion, i.e., lightpaths can be switched to a fiber output if there is a free wavelength channel. The nodes in WP WDM networks do not have wavelength conversion [4]. In this paper, *p*-cycles are used in VWP WDM networks.

3.2 Mathematical Formulation for the Optimal Combination of p-Cycles

The mathematical formulations for JCP and SCP are shown below [1]. These formulations will be used to find the set of *p*-cycles for a given topology and traffic matrix. The set of elemental distinct simple candidate cycles are limited to a reasonable number to make the problem tractable [1].

Sets:

S set of spans between mesh cross connection points.
P set of elemental distinct simple cycles.
D set of all demand pairs.
WR set of all candidate working routes for each demand pair *r*.

Parameters:

c_j cost of a link (working or spare) assigned to span *j*.
W_j number of working links placed on span *j*.
$x_{i,j}$ number of paths a single copy of *p*-cycle *i* provides for restoration of failure of span *j* (2 if straddling span, 1 if on-cycle span, 0 otherwise).
$p_{i,j}$ number of spare links required on span *j* to build a single copy of *p*-cycle *i* (1 if *p*-cycle *i* passes over span *j*, 0 otherwise).
d_r number of demand units between end-end pair *r*.
$\zeta_j^{r,q}$ Takes on value of 1 if the q^{th} working route for demand pair *r* uses span *j*, 0 otherwise.

Variables:

n_i number of copies of *p*-cycle *i* used.
s_j number of spare links placed on span *j*.
w_j number of working wavelengths placed on span *j*.
$wf^{r,q}$ working capacity required by q^{th} working route for demand between node pair *r*.

3.2.1 Spare Capacity Placement (SCP) in VWP WDM Networks

In spare capacity placement (SCP) the demand is first routed using shortest path, and then the optimal capacity algorithm is applied on the spare links to minimize the spare capacity cost as in (1).

Objective function: *Minimize* $\sum_{j=1}^{|S|} c_j \times s_j$ (1)

Subject to:

$$s_j = \sum_{i=1}^{|P|} p_{i,j} \times n_i \qquad \forall j \in S \tag{2}$$

$$W_j \le \sum_{i=1}^{|P|} x_{i,j} \times n_i \qquad \forall j \in S \tag{3}$$

$$n_i \in \{0,1,2,.....\} \tag{4}$$

3.2.2 *Joint Capacity Placement (JCP) in VWP WDM Networks*

In joint capacity placement (JCP) the working routes are optimized at the same time as restoration routes and spare capacity placement to minimize the total capacity as in (5) [1].

Objective function:

$$\textit{Minimize} \quad \sum_{j=1}^{|S|} c_j \times w_j + \sum_{j=1}^{|S|} c_j \times s_j \tag{5}$$

Subject to:

$$\sum_{q=1}^{|WR|} wf^{r,q} = d_r \qquad \forall q \in D \tag{6}$$

$$w_j = \sum_{r=1}^{|D|} \sum_{q=1}^{|WR|} wf^{r,q} * \zeta_j^{r,q} \qquad \forall j \in S \tag{7}$$

$$s_j = \sum_{i=1}^{|P|} p_{i,j} \times n_i \qquad \forall j \in S \tag{8}$$

$$w_j \le \sum_{i=1}^{|P|} x_{i,j} \times n_i \qquad \forall j \in S \tag{9}$$

$$n_i \in \{0,1,2,.....\} \tag{10}$$

Constraints (2) and (8) determine the protection capacity allocation, constraints (3) and (9) ensure the working capacity to be protected, and (4) and (10) ensure integer *p*-cycle units. Constraint (6) ensures all demands are routed, and constraint (7) ensures the working capacity on span *j* can accommodate all working flows simultaneously routed over it by all demand pairs.

4. METHOD

SCP and JCP were applied to sets of network topologies with 10, 15, 20, and 25 nodes. Each set had 20 random physical topologies that are similar to real networks with varying average node degree and were generated by GT-ITM[7] using the Waxman method [9], [10]. The number of required wavelengths between each source and destination was generated randomly with a uniform distribution in the range from 1 to 15. Then SCP and JCP were applied to each of the topologies with the same demand. The mathematical models of section 3.2 were formulated in AMPL and solved by CPLEX 8.1.0. The spare-to-working capacity ratio was calculated for each case. The spare-to-working capacity ratio is defined as the number of required spare wavelengths required for all *p*-cycles divided by the total number of wavelengths required for the working traffic.

5. RESULTS

The spare-to-working capacity ratio for the twenty random network topologies with 25 nodes and varying average node degree are shown in Fig. 4 with a polynomial trend line. Similar results were obtained on the network topologies with 10, 15, and 20 nodes, but are not shown.

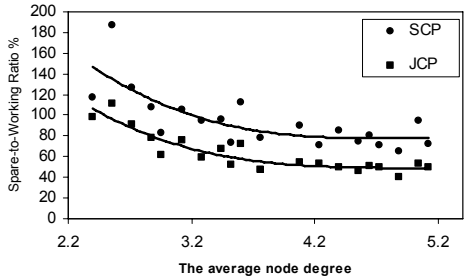

Fig. 4. Spare-to-working ratio vs. average node degree for 20 random topologies with 25 nodes.

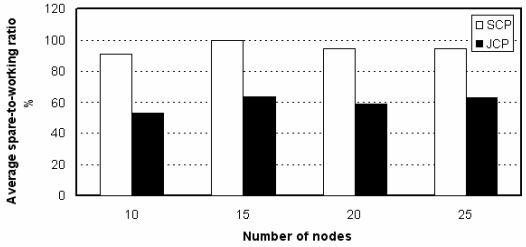

Fig. 5. Average spare-to-working ratio vs. number of nodes for JCP & SCP.

As seen in Fig. 4, jointly considering the working capacity and spare capacity costs provides lower spare-to-working capacity ratios. In addition, a higher average node degree lowers the spare-to-working capacity ratio because there are more straddling links and more possible candidate *p*-cycles. In general, a higher average node degree corresponds to more straddling links that can be efficiently used by *p*-cycles. In addition, *p*-cycles are less suitable for network topologies with average node degree below 3.0.

[7] Georgia Tech Internet Topology Models (GT-ITM) is a package for generating the flat random and hierarchical models. It is publicly available at: http://www.cc.gatech.edu/projects/gtitm/.

For SCP and JCP, the average spare-to-working ratio at a given number of nodes was plotted and is shown in Fig. 5. JCP provides approximately 35% lower spare-to-working capacity ratios than SCP over all tested topologies. However, JCP solutions require an approximate 7% increase in required working capacity.

6. CONCLUSIONS

The joint capacity problem (JCP) and the spare capacity problem (SCP) methods for assigning *p*-cycles were applied to network topologies with 10, 15, 20, and 25 nodes and varying average node degree. JCP provides solutions with lower spare-to-working capacity ratios than SCP. In addition, network topologies with higher average node degrees have lower spare-to-working capacity ratios when using *p*-cycles because more straddling spans are available.

JCP provides solutions with lower spare-to-working capacity ratios than SCP because it jointly considers the working traffic and the spare capacity required by the *p*-cycles during a failure. This provides a solution space with a greater number of possibilities than the more restrictive case of SCP. SCP initially assigns the working traffic to the shortest paths and then uses the remaining capacity for assigning *p*-cycles. A disadvantage of JCP is that the required working capacity is larger than SCP.

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Development of an Integrated System for Education and Administration

Hanakawa, Noriko; Maeda, Toshiyuki; Mori, Akira; and Tsutsui, Shigeyoshi

Abstract—*A web-based integrated education system has been developed for teachers, students and administrators. One of the most important features of the system is seamless usability of educational and administrative systems. Moreover, teachers and students can access seamlessly the system and securely even from outside of our Intranet using SSL. We assert simple usability for the portal site as an entrance of the integrated education system. To achieve short period development, our development concentrated the user interfaces on the portal site because of familiarity to students and teachers. The other parts of the system; servers, databases, networks were developed within usual technique and commercial package software. In addition, because the existing administrative system was not revised, the integrated education system has been developed within 5 months. After working the integrated education system, students tried doing preparations and reviews of their lessons. Teachers were able to decide the final results of the lectures from outside of the university. In addition, we discuss the system's accidents that were caused by administrators, and low performance's problems.*

Index Terms—*Web-based system, portal site, e-learning, large scale network*

1. INTRODUCTION

A feature of typical university's computer systems is existence of two computer system categories; a basic administrative system, an education support system. The both systems are equal-valuable, each system is indispensable and a kernel computer system for universities. Different points between the administrative system and the education support system are target people and aims of the systems. In the administrative system, the target people is clerical staffs, the aims is to execute smoothly the administrative processes. In the educational support system, the targets are students and teachers, the aim is education. In almost universities, these different categories' systems are managed independently. The two systems' budgets are independently, sections of universities for operational management are different. The administrative computer system includes a basic student information system, a management system of lecture registration, a result management system and a job hunting management system. Some administrative sections share the databases for the management. In contrast, the education support system means computer facilities of classrooms and their peripherals, software for education such as automatic attendance software. Moreover, the e-learning contents which have developed by teachers are included to the education computer system.

However, campus life of students means not only education in lectures but also receiving the administrative services such as job hunting and student's loan. For example, after lectures, a student joins a guidance of job hunting, after that, he/she enjoys a student party sponsored by a dean of students. After that, he/she submits his/her report to a teacher through an education support computer system. Students are not interested in which computer system includes the activity such as the student party. Both computer systems which are divided for convenience are equal-valuable to the students.

Therefore, we have developed a web-based integrated education system that merges the two computer systems; the administrative system and the education support system. We call it as HInT (Hannan Internet community Tool for e-education). An aim of HInT is an integrated support to students on both educational service and administrative service. An entrance of HInT is an individual portal site that has been customized to each student and each teacher. There are 300 or more portal sites for teachers who are full-time teachers, part-time teachers, and special teachers for extension programs. HInT prepares 6000 or more portal sites for all kinds of students who are undergraduate school students, graduate school students, and occasional students. The portal sites are generated in real-time based on administrative information that was accumulated in the databases of the administrative system. For example, an individual weekly timetable for lectures is generated automatically to a portal site using information of lecture registration in the

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administrative system. Moreover, information such as cancellation of lectures and change of classrooms indicates automatically to the individual portal site through the administrative system. Events such as job hunting guidance sponsored by administrative departments are inserted automatically to the individual portal site.

In addition, if you click a subject name of the weekly timetable of lectures on the individual portal site, you can go on e-learning sites according to the clicked subject. That is, parts of education computer system such as e-learning contests, original teaching materials, submission of reports, and lecture results' management can be executed through the individual portal site. Students and teachers who use the portal sites of HInT can enjoy university's life without awareness of division between the administrative computer system and the education computer system. Because HInT is web-based, students and teachers can access HInT from outside of our university. For people who do not have a computer at home, HInT has functions that can provide parts of information on HInT through mobile phones.

This paper shows the detail of HInT, and development process within only 5 months. Techniques of merging the existing administrative computer systems with the educational computer systems are described. Under the constraint of only 5 months' development period, a success process of putting students' needs and teachers' needs into HInT is explained. Section 2 shows the related works. In section 3, features of HInT and development process are described. Section 4 explains technical essences of HInT, section 5 discusses the usefulness of HInT after starting HInT from April of 2004. In section 6 we point out problems that occurred under working HInT, and section 7 shows summary and future works.

2. RELATED WORKS

There are many useful web-based education systems. A virtual collaboration space: EVE (Educational Virtual Environment) has been developed including synchronous and asynchronous e-learning services [1]. A laboratory has been built around a web-based digital model railroad platform controlled by a client-server system for education of computer science[2]. Also, a web-based system has been developed for control engineering education[3]. To put communication skills into engineering curriculum, a web-based system to integrate workplace has been developed. The purpose of these web-based systems is to establish efficient education, and to communicate sufficiently among teachers and students. In various education areas, various education problems are solved using the web-based systems. The HInT system is also one of such web-based education systems. The most important feature of HInT is an integrated education system that consists of portal sites and e-learning sites, and connection to administrative computer system. The scoop of HInT is beyond the usual education systems' scoop. HInT is more useful to achieve total education in universities.

Next, e-learning environments are discussed. There are many e-learning tools. For example, software engineering education supported by simulation in computers is popular. Drappa[4], Blake[5], and Oh, E[6]have educated software engineering with simulation methods. In addition, many information literacy education tools have been developed such as electric notice boards[7]. The electric notice boards are useful to share the knowledge of students' questions, and know how to operate. According to specific subjects, many tools and system have been proposed. An organization system for software engineering through group e-learning[8] has been developed. Using the system, the strategies of students have been clarified in some groups. The students' strategy was that leadership and analysis ability are most important in group working. A tool of English writing environment has been developed[9]. The system can access from all over the world through Internet. Students who stay in world wide can communicate with teachers on the system. Although these systems are useful to support students' learning, these systems are limited to only the specified subjects such as software engineering, English writing. HInT has a different view point from these systems' concepts. HInT has supported not only the specific education but also total campus life in the university including the administrative services.

In addition, there are many virtual universities such as California Virtual University and Stanford University[10]. The virtual universities can give full-online educational services and administrative services. Students of the virtual universities are not required to go to the school. The concept of virtual universities is different from the concept of HInT because the concept of HInT is "total support of campus life for students and teachers through the integrated systems". Therefore, we can not compare simply the systems of virtual universities and HInT. A more similar system than the virtual universities is an educational system of Durhan University in England[11]. BlackBoad[12] that is No.1 share of e-learning package software has been implemented to a total e-learning system of Durhan University. Although the total e-learning system has already been working from July of 2000, many requests that the system supported not only e-learning but also total campus life occurred. Therefore, a new package software BlackBoad/Portal introduced to the university, the integrated services between

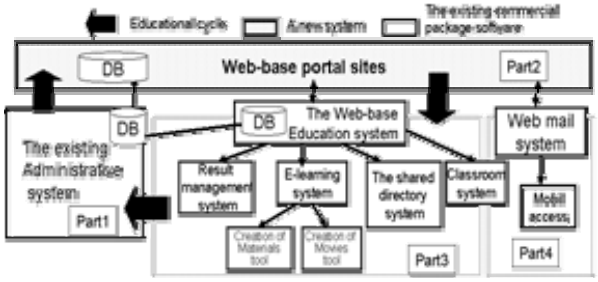

Figure 1 An out line of HInT

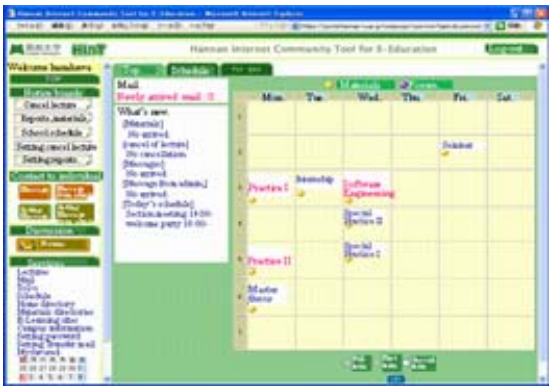

Figure 2 A portal site of HInT

education and administration provided to students, teachers, graduates, candidates for admission. Problems of Durhan University are an improvement of user interfaces, and additional functions to execute the original procedures of the university. The functions and user interfaces of BlackBoad/Portal are not familiar with people of Durhan University, because package software such as BlackBoad and WebCT has been created for general use of general universities. In contrast, an important policy of HInT is “familiar portal sites” on the design phase. HInT is familiar to students and teachers because HInT did not use just original package software such as BlackBoad/Portal.

3. FEATURES AND DEVELOPMENT PROCESS

3.1 A basic concept: Seamless

A basic concept of HInT is “seamless”. The seamless means two kinds. One is seamless data between the administrative computer system and the educational computer system. Another is a seamless environment between inside of the university and outside of the university. In the seamless environment, users can access HInT in the same operations on both Intranet and Internet with keeping security. The basis of the concept is disadvantage that occurs by the divided computer systems and environments. For example, although students’ information such as mobile phone numbers and e-mail addresses was accumulated in the administrative database, teachers have to ask students e-mail addresses and mobile phone numbers in seminars. After that, the teachers have to make original mailing-lists. Of course, the maintenance of the mailing-lists is responsibility of the teachers. Moreover, a function of automatic record of student attendance in classrooms was prepared even in the conventional education system. However, the teachers have to transfer manually the record of student attendance to paper-based student lists that were provided from the educational affairs section. The teachers’ manual maintenance of the mailing-lists and manual transfer of the record of the student attendance lead to mistakes. Indeed, important messages have not been able to send to any students because of invalid e-mail addresses.

In addition, users were able to access the conventional educational system in only Intranet environment. Of course, usage of the share folders on network drives was limited on only Intranet environment. Therefore, when students would like to do home work, the students have to copy the electric files to portable media such as CD. The students have to go to school in order to submit the home work to the share folders. Moreover, because open-time of the computer rooms of the university is limited, the students can not make their reports until midnight. Therefore, we have an aim of solving the disadvantage that causes by the divided computer systems and the divided environments; Intranet and Internet.

3.2 Requests of developing HInT

In the university, significant problems may occur in revising the educational computer systems and the administrative computer systems on the way of the year. Hence, timing of the chance of the large revision of computer systems is only April in Japan. April is start month of a new educational year. Because HInT should be started working at April, the development period has be set to only 5 months. Our important requests of developing HInT are as follows; (1) development period is 5 months, (2) no-revise the existing administrative computer system, (3) because the portal sites is an important linchpin of integrated systems HInT, the functions and user interfaces should be satisfied to teachers and students needs, (4) users can access various data without awareness of distinction between the administrative system and the educational system, (5) basically, users can access various functions in same operations in both Intranet and Internet, (6) a moment access by 200 students should be executable without delayed executions.

4. TECHNICAL FEATURES OF HINT

4.1 An outline of HInT

HInT consists of four parts; the existing administrative computer systems, portal sites,

educational computer systems, and Web-mail (See Figure 1). A feature of HInT is that an educational cycle can be constructed in HInT(See bold arrows of Figure 1). Starting point is the existing administrative system(Part 1). Next, on the portal sites users can refer interactively both the administrative data and the educational data(Part 2). After that, users can proceed to e-learning sites(Part 3) through the portal sites. On the e-learning sites, teachers can communicate sufficiently with students. The e-learning sites are useful in various educational scenes such as lectures, reports, questions and answers, examinations, and home works. After education, the teachers make final results with referring to various records such as reports' results, attendance records, short-tests' results, and final examination results. After the final decision of the results, the teachers renew the data of administrative computer systems(Part 1). The educational cycle can have been achieved by seamless between administrative data and educational data.

4.2 Combination of package software for short development period

To meet our request (1) (See 3.2) "development period is 5 months", it is difficult to develop newly all parts of HInT. Therefore, we planned to concentrate on the development of a specified part of HInT. We thought that the other parts would be achieved by combination of the commercial package software. We targeted the portal sites as the specific part because of our request(3)(See 3.2). Especially, we thought that the satisfaction of users about the user interface is important. By the concentration on the portal sites in the development, HInT has been able to achieve high familiarity with teachers and students. On the portal sites(See Figure 2), there are an individual timetable of lectures, notice boards, administrative news, individual messages, material distribution, submission of reports, ToDo lists, university's event calendar, and forums. The functions of the portal sites can support not only education but also overall campus life.

The commercial package software has been applied to backend parts such as database engines and servers. An engine of the portal functions is Campusmate/Portal, an engine of educational system is Internet Navigware provided by Fujitsu corporation. UBPoint! is a package software for accumulating lecture movies and delivery services. WebCollaboration is for access the share folders on the network drives from Internet. ThroughPass is for single sign-on to multi-package software.

Especially, we had to devise the e-learning sites. There were some not web-based functions in the engine of e-learning system; Internet Navigware. If users access the e-learning sites,

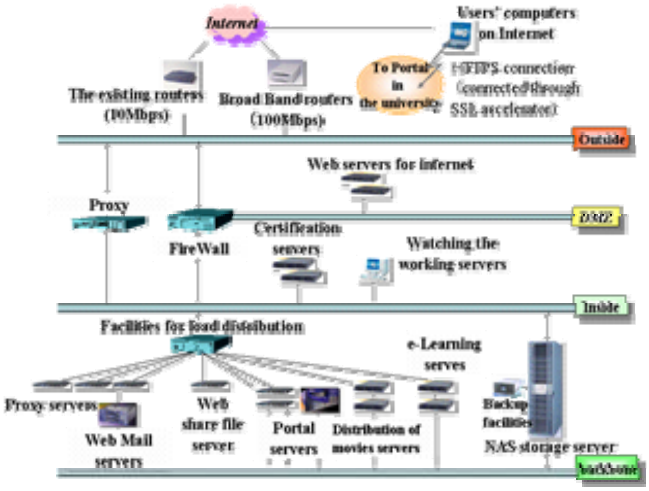

Figure 3 A system design for a large-scale network

the users will have a feeling of wrongness because of the non web-based functions. Our request(4) and request (5) (See 3.2) was not able to be satisfied. Therefore, new package software named "Campusmate/CourseNavig" provided from Fujitsu Corporation at April of 2004 was applied to the e-learning sites. Because the package software was not yet designed and was not yet implemented when HInT was being designed, our design process of HInT was very hard. HInT had to be designed based on the expected design of the new package software. However, we made close meetings with the staffs of the new package design, the e-learning sites of HInT has been achieved well.

4.3 Combination with administrative data

In the administrative computer system, students' basic information, lectures' information, and lecture registration information are accumulated using the package software named as "Campusmate-J". As our request(2) (non revision of the administrative systems), a new database in HInT has been constructed using data that has been extracted from the database of the administrative system. We have understood sufficiently the harmful effects of the dual databases. However, unique information that does not exist in the administrative system is required in HInT. For example, the unique information means occasional students who do not need lectures' results, collaborative researchers of partnership corporations, business men who attend open seminars. Therefore, we dare to have taken the dual databases because of high flexibility of HInT. In addition, we have established a function of real-time change of the data in HInT when the data of the administrative system was revised.

4.4 Large-scale network corresponding to LAN and Internet and load distribution

Figure 3 shows an outline of network

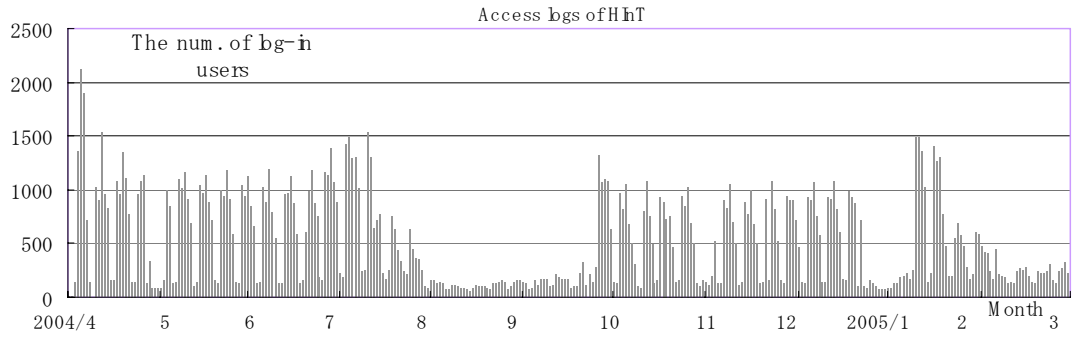

Figure 4 Access logs of HInT for 12 months

architecture of HInT. We have set up a line of 100Mbps/s as an internet gateway from ISP(Internet service provider). Network inside of the university has been constructed as star-type network. A nucleus center switching has been prepared enterprise-version equipments of Giga port. The nucleus center switching has been connected to seven important bases in the university and all servers under lines of 1Gbit/s. We have established 100Mbps/s transmission speed between the floor switching hubs on the seven bases and all 900 client personal computers. In addition, because of accumulating all data of HInT to one place, we have established a storage system. To achieve the requested performance of the storage system, we have prepared the dedicated segments of 1 Gbit/s for only traffics between the storage system and all servers of HInT. Therefore, we were able to have provided real Giga network for users because the backend processes used the dedicated segments.

In addition, facilities of HInT have been defined as not only inside computers of the university but also outside computers of the university such as internet cafes' computers and homes' computers. Hence, to achieve security of HInT, we have decided four policies; (1) enciphering in using SSL(Secure Socket Layer) on web-based, (2) enciphering of communication paths of wireless LAN, (3) using single user ID and single password for multiple package software and HInT, (4) introducing VPN(Virtual Private Network) system. Therefore, we have established high security environments of HInT without hurting convenience of users.

Because all functions of HInT should be web-based, the load of the web servers of HInT became large. We have prepared two load distribution facilities that equip respectively two CPUs in order to process the moment of simultaneous access. At the system test phase for performance of HInT, HInT has been passed the test of the simultaneous access of 200 users' log-in processes, sending and receiving of 960 e-mails. The security request(5) and performance request(6) have been satisfied.

4.5 Access from Internet of attendant functions

Our conventional education system also had share folders on the network drives for distributing materials and reports. Although the share folders were an important communication tool between teachers and students, the access of the share folders was only Intranet in the university. As the share folders have also been revised to web-based, the teachers and the students can access the share folders from both Intranet and Internet. When users access the share folders, HInT judges automatically which the access is from Intranet or Internet. If the access is from Internet, the access information will be enciphered automatically. The operations of the access to the share folders through both Intranet and Internet are almost same. Moreover, by revising e-mail system to web-based, HInT has been achieved to a unified web-based system.

5 EFFECTIVENESS OF HINT

5.1 Working results from April of 2004

HInT has been started working from April of 2004. The number of users is about 6300. In average, about 1000 users use HInT on a weekday, about 200 users use HInT on a weekend(See Figure 4). People who access HInT on one or more per a week are about 60% of all users. Until March of 2005, the number of lectures' notice is 1,829. The number of subjects that use the lecture's notice is 154 per all 1,690 lectures. The message function from teachers to students was executed on 18,734 times, the message from administrative departments to students was repeated on 89 times.

5.2 Achievement of the seamless concept

In this section, we evaluate the achievement of the basic concept(3.1) and our requests(3.2). At first, the seamless achievement is evaluated. HInT can generate automatically the individual portal site using the administrative data in the educational affairs section. Because teachers can refer easily to a list of members of a class on the portal sites, the teachers are free from carrying always paper-based students' lists.

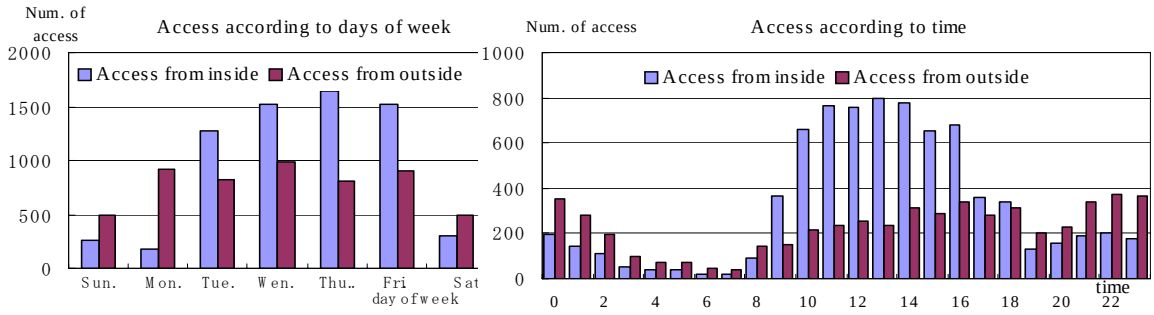

Figure 5 The number of access for the shared folders on January of 2005

Because original materials that have been produced by teachers are inserted automatically into the students' lists of classes, the teachers can refer easily to various reports such as preparation progresses, results of automatic marking short tests, results of reports' evaluation, final results' lists. Moreover, private news such as delay of books' return to a library from the administrative departments are listed to the individual portal site, virtual groups which are performed in forums sites are useful to discuss among students.

In addition, all functions of HInT are web-based. Users can access all functions from outside of the university with the unified operations of HInT. Figure 5 shows the number of access from Intranet and Internet to the share folders, and the number of access to the share folders from Internet are shown. 47% access is through Internet. Access through Internet from outside of the university does not decrease in even nights and on even weekends. Therefore, because all functions of HInT are web-based, we have provided a new campus life environment that students can study in anytime and anywhere.

However, there are some compromises according to the concept of the seamless environment. The compromises are caused by the trade-off between functionalities and data security. Two cases of the compromises are shown below.

First, HInT has been restricted to only reading the data of the administrative databases without writing. Especially, the data of the educational affairs section is important nucleus data in education of the university. Errors of revising the data and the system down are never forgiven. As the educational cycle in Figure 1, we supposed that HInT revised automatically the data of the administrative databases. However, when we thought the danger of the errors of revision of the important data, we have decided that the data should be sent through CSV files to the administrative sections in manually. The staffs of the administrative sections revise the data after the watching confirmation of the errors of the revised data in the CSV files. To protect the important information of the university, parts of the data have not been achieved on the seamless environment.

Next, we show a problem of seamless access between Intranet and Internet. We had different operations between Internet access and Internet access. When users click one file on the share folders through Internet, if the file requires the related files such as Visual Basic.net files, the files with the related files can not open. The error message is "The files are not found". The error is caused by the way of download from the servers of HInT. When the file is clicked, the file is downloaded to a local computer from the file server. However, the related files to the clicked file are not downloaded. The related files are different in various applications. It is difficult to specify the related files in all applications. Moreover, novices can not understand why the related files are in the local computer although the novices do not click the related files. The novices will be falling into confusion because the novices can not judge the latest file on between the server and the local computer. Therefore, we have decided that the related files do not be downloaded automatically to the local computer. We have instructed students "if you access a file of VisualBasic.net trough Internet, you should copy the folder including the file." We judge it is better to separate the operation between Intranet and Internet in considering novices' confusion.

In this way, it is very difficult to cope with both the achievement of the basic concept of HInT and data security in HInT. When the basic concept conflicts with the security, we have arrived at the solutions from the novices' actions. If the novices were falling into confusion, if the novices leaked the important data in HInT, we have judged that the solution is not well. Although a part of functions of HInT conflicts with the seamless concept, we think that our judgment is right in consideration of working of HInT as a whole.

5.3 Examples in lectures

A subject "software engineering" consists of preparation, distributions of electronic materials, regular lectures, electronic short-tests during the lectures, electronic reports' submissions, and a final examination. The materials for the lectures

Figure 6 A report list with evaluations

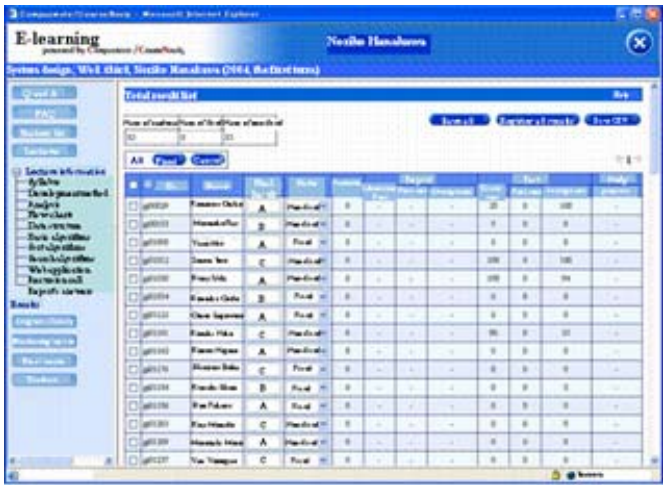

Figure 7 Final judgment on a result page

have uploaded to HInT. Especially, the feature of the materials of the lectures is the simulator for the preparation of the lectures. Students consumed maximum 8 hours to the preparation of the lectures. Such sufficient preparation in the simulator that was uploaded to HInT was available because the students were able to execute the simulation at home through HInT.

Moreover, reports for the exercises were evaluated on HInT. Figure 6 shows a list of the reports' submission and the results. On the web page of the reports, teachers can input the results of the report in the column "Evaluation". Also, teachers can give students comments about the reports on the web page in real-time. The students can re-submit the revised reports after the students refer to the comments from the teachers. Figure 7 shows a web-page for all results that include various results of the preparation's progress, the short-tests, the reports, and the final test. The teachers can judge the final result of the subjects while the teachers refer the individual result because the various results condense into a page. In addition, the teachers can judge the final results at home without carrying a large volume papers such as answer papers, reports, and short-tests' answer papers. After deciding the final results, the teachers save the final results to a CSV file that is provided as a template from HInT. The CSV file is sent to the educational affairs section. In future, because the personal history of individual student can be shown to teachers on HInT, the teachers will be able to make a personalized curriculum corresponding to individual ability.

6 PROBLEMS AFTER WORKING

6.1 Local rules of administrative sections

After working of HInT from April of 2004, we had to change the tables' architecture of HInT database. The change of tables' architecture influenced significantly to practical working in the education of the university. The significant change of the tables' architecture was caused by the data of the educational affairs section. Now, the current curriculum of the education runs in parallel with the former curriculum in the university. One subject between the second-years students and the third-years students has two different names in spite of one lecture because of the two curriculums. The second-years students take the lecture as "Information design" in the current curriculum, the third-years students take the lecture as "System design" in the former curriculum. In real, a teacher instructs a way of design of software in one classroom. There are two subjects' names in the administrative databases. It is not a rare case in universities to run on multi- curriculums because of the renewal of curriculums. In order to run the multi-curriculums, we had prepared two items in the administrative database of the educational affairs section. One is named as "subject", another is named as "lesson". The "subject" means the correct subject's name on each curriculum such as "Information design" and "System design", the "lesson" means the real lecture which a teacher instructs students in a classroom. Although the "subject" names are different between the second-years students and the third-years students, the "lesson" name is only one for the teacher and the students. Therefore, if we had picked up the students based on the "lesson", we were expected to make a list of all students under even multi-curriculums.

However, a local rule of the educational affairs section obstructed the creation of the list of all students in multi-curriculums. The local rule was that staffs of the section dealt with the two items("subject" and "lesson") as one item ("subject"). In short, the staffs were not able to understand the difference between "subject" and "lesson". Therefore, although HInT used the item "lesson"

in making the students' lists, the students' lists were not able to include all students who took the "lesson". Only a part of students was listed to the students' lists. It is wrong to education on HInT in the university. Although HInT was connected to the data of the administrative databases, teachers were not able to see even lists of all students who take the teachers' lectures. So, we have to redesign the tables' architecture of the database of HInT. We decided not to use the item "lesson" to make the students' lists. We have prepared a new function that generates a new unit. The unit is generated by combining the multi-subjects that a teacher takes lessons in a classroom. Using the new unit, the architecture of tables has been changed in May of 2004 at one month later from the start working. According to the change of the architecture, all data of HInT had to have been reset in May.

The local rules should be discovered at the design phase of HInT. We had frequent meetings with administrative staffs. In the meetings with administrative staffs, they did not mention to the local rules because of normal routine tasks under the local rule. In contrast, the design documents of the administrative system had clarified the difference between the two items of "subject" and "lesson". Of course, the designers of HInT had referred to the design documents of the administrative systems. The designers took it for granted that they adopt the item "lesson" in making students' lists. This problem is not a rare case in developing an integrated system including the existing systems. Engineers require investigating sufficiently the existing systems on both design documents and staffs' working. However, the sufficient investigation is difficult in the development of the short period such as HInT. After a new system has started, problems caused by inherent local rules have usually come to the surface. Considering the problems and constraints of the short development period, we think that it was better to phase-in HInT instead of starting HInT all at once. On development of phasing-in, the engineers can develop HInT while the engineers and staffs confirm the correction of each function. If we adopted the evolutional development process such as phasing-in, we will be able to avoid resetting all data of the database of HInT, even if all functions of HInT were not able to start at April of 2004.

6.2 Problems of performance

Performance problems occurred by too heavy load in the moment of simultaneous access. HInT has been passed tests of simultaneous access of 200 users' login processes. However, the performance problem occurred in lectures of Information-literacy for first-year students. The subject of the Information-literacy was designed beforehand in parallel on 6 classrooms for 330 students. The second lecture of the subject has an instruction of HInT operation. In the lecture, at a moment that teachers say "click a button on HInT", maximum 330 users have clicked the button of HInT in simultaneous access. Therefore, the web servers of HInT had the unexpected heavy load. The request of the load distribution exceeded the performance limitation of the load distribution equipments of HInT. As a result, the extreme performance degradation of HInT occurred in the lectures. To take measures of such performance, we thought that the facilities of load distribution should be strengthened, or extra web servers should be added to HInT. However, such simultaneous accesses occur during only a few minutes of the specified lecture per a year. We decided no-change of the system structure; no-additional facility and no-reinforcement of the facilities, because the situation was a rare case. We tuned up the two web servers in which 400 users' requests can be accepted to the web servers. The database strengthening and the additional facilities were not performed. That is, when HInT had heavy load, users' requests can be accepted to the web servers although the responses of the requests are late.

Next, we had another performance problem because of extreme increments of the number of session of database of HInT. A session connected to the database of HInT is established on each log-in by a user. After the log-in, if the user does not operate HInT during 15 minutes, the session is cut automatically because of avoiding leaking information. We have prepared 400 sessions on HInT, HInT had been working in the 400 sessions without sessions' problems. However, students said "our session is cut frequently during listening to teacher's speech". Usually, the teacher's explanation requires frequently more 15minutes. Therefore the session time-out had been extended to 30 minutes. This extension of the automatic session time-out caused the extreme performance degradation. We had experienced a strange situation. The number of the session of the database was short although the number of user was less than 400. After investigating, we had recognized that the users' operation of finishing HInT was wrong. The way of finishing HInT is to click a "log-out" button on HInT. However, almost students had finished by clicking the button "X" that was set on the upper right of the web-browser. When the users click the button "X" on the web-browser, HInT can not recognize the finish of HInT by itself. Therefore, the sessions can not be cut because of non-recognized finish of HInT. 30 minutes later, the session that had remained by the clicking the button "X" is cut automatically by the session time-out. The remained sessions caused the shortage of the number of sessions in spite that the number of users was less than 400. We had taken the

emergency measures to extend the memory area of the database of HInT. Although we had discussed the increment of the session of the database, we have judged that the increment of the memory area and the education of the way of finishing HInT are better than the increment of the sessions.

These performance problems can be solved by additional cost, and by strengthening facilities' hardware and software. Although HInT is an important system for education, HInT is not a most critical system such as a system of the educational affairs section in the university. We need to discuss carefully the trade-off between the additional cost and the educational effects. However, it is very difficult to measure the educational effects on spending the additional cost for strengthening hardware and software. The establishment of the condition of the trade-off between the additional cost and the educational effect is also difficult. Therefore, if we can take some measures without additional cost such as the instruction to users, and the redesign of the system, in this year, we should take the measures without the additional cost. Next year, we will discuss the strengthening the facilities of HInT.

6. CONCLUSION

We have achieved a web-based education system HInT which is integrated a educational system with the existing administrative system. HInT has been established within only 5 months because the existing package software are embedded to HInT. In addition, the usefulness of HInT is presented by the records of the access logs. In future, to use efficiently the educational cycle (See Figure1), functions of automatic generating personal education programs including preparation of lessons, reviewing their lessons. In addition, we will achieve all-around education system including various shared contents while we improve the operation of HInT.

7. ACKNOWLEDGMENT

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Searching and Retrieving Protected Resources using SAML-XACML in a Research-Based Federation

Vullings, E. and Dalziel, J.

Abstract—*Extending IAM (Identity and Access Management) beyond an institution's boundaries to enable SSO (single sign-on) within a federation of trusting institutions currently receives much attention [1]. Within this area, we address the following two problems: how to effectively find protected content and protected metadata in numerous repositories across the federation and how to protect your own published material from unauthorized access.*

Existing solutions for finding resources like federated search assume that all metadata is freely available, but they do not give users an indication of the accessibility of the found results.

The solution we propose extends the SAML-based (Security Assertion Markup Language) federations as currently implemented by the Liberty Alliance and Shibboleth with XACML (eXtended Access Control Markup Language): SAML allows for asserting information about a user, which can be used to determine access privileges. XACML allows for defining rules that enable fine-grained access control to resources. Although this is more limited than digital rights management (DRM), it is sufficient for our user group in Higher Education.

Index Terms—*federated Identity & Access Mgmt, fine-grained access control, SAML, XACML*

1. INTRODUCTION

THE internet makes finding publicly available research material very easy, as can be concluded from the popularity of search engines like Google. However, if the content, or its metadata, is not public, you often have to login to a repository, and do a dedicated search, after which you move on to the next repository. Clearly, this is not very efficient, and it requires many accounts you need to manage. On the other hand, if you publish some information yourself, you would often like to limit the people who can access it.

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Existing solutions for finding resources, like federated search, are limited in that they assume that all metadata is openly accessible. However, for repositories containing, say, sacred artifacts, this might not be the case. For example, a person might need to be a member of an indigenous community, male and initiated, in order to see the sacred artifact. Otherwise, you do not even know about its existence. And even if the metadata is available, it does not contain any information about who can actually access the resource, so you have to actually try to retrieve it in order to find out. And finally, the federated search system's functionality is limited by the fact that search results are based on the trust between the repository and the federated search system, and not on trust in the actual user that is using the system. Continuing our previous example, if the federated search system could inform the repository with sacred artifacts that the current search is by a member of the relevant indigenous community, male and initiated, the search would extend to more resources and potentially be more accurate.

This paper will look at ways to reduce the above-mentioned problems in the current approaches to finding and accessing resources. The layout is as follows. First, we briefly introduce the two core open standards that underlie our work, i.e. SAML and XACML. SAML is illustrated using one of the existing SAML implementations, Shibboleth, which is used to build a federation of higher education identity providers and service providers. XACML is not yet widely implemented, but the basic mechanism is easy to explain.

Next, based on our problem statement, we will describe the key requirements and usage scenarios in Section 3 that we have to address, which will lead to the proposed solution in Section 4, ending with our conclusions.

2. FEDERATED IDENTITY & ACCESS MANAGEMENT

Extending SSO beyond your institution to a federation of trusting institutions in higher education (HE) is a key requirement as determined by the Meta Access Management System (MAMS) project [7]. Currently, there are

two standards that address this issue: SAML v2.0, supported by OASIS [2] and WS-Federation (Web Services). SAML is supported by the Liberty Alliance [5], a consortium of over 130 corporations, and Shibboleth, an open source implementation developed for HE by the Internet2/MACE group in the USA. WS-Federation is currently only supported by Microsoft and IBM, and without existing implementations, and therefore less relevant to our immediate needs, so we will continue our discussion using the SAML approach.

2.1 SAML and Shibboleth

As described in The CoverPages [3], "SAML provides a standard way to represent authentication, attribute, and authorization decision information in XML, and a series of web services-based request/response protocols for exchanging these statements. SAML v2.0 provides support for full federation and mapping of identifiers, session management, greater interoperability for attribute exchange and other features".

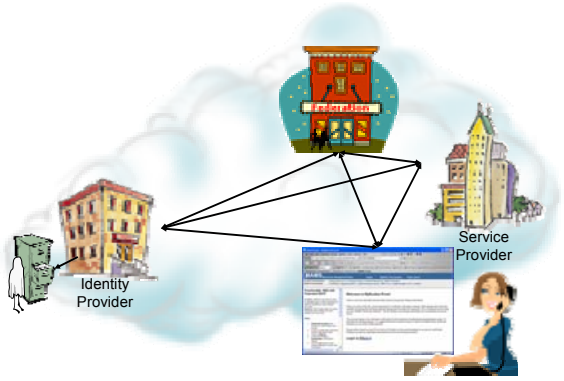

Figure 1. The Shibboleth implementation uses the HTTPS protocol for communication between browser, IdP, SP and Federation.

A high-level Shibboleth implementation is depicted in Figure 1. The main assumption underlying Shibboleth is that service providers (SP) and identity providers (IdP) trust each other within a federation. A typical use case of a user accessing a federated service goes as follows:

1. Using a browser, the user attempts to access a service provider (SP) in the federation. As the SP does not know the user, she is redirected (using a HTTP302 redirect message) to the Federation.
2. The Federation asks the user where she is from, and she selects her preferred IdP (typically her home institution) from the list.
3. She is then redirected to her IdP, which asks her to login if she hasn't already done so. Based on the target SP, which is conveyed to the IdP as part of the redirection, the IdP (after checking whether it can trust this SP) generates a SAML handle (an opaque identifier associated with her identity) for her and redirects her back to the SP with this handle.
4. The SP, after extracting the handle, uses it to query the IdP about the user's attributes.
5. The IdP sends some of the user's attributes (like role, email, affiliation) back to the SP, according to an attribute release policy (ARP), in a signed SAML assertion statement. Note that the ARP is controllable by the user and IdP sysadmin.
6. Based on the attributes, the SP gives certain access rights to the user and commences an authenticated session.

Note that, in order to maintain transport security, all traffic uses SSL/TLS encryption (HTTPS protocol).

The main components have the following responsibilities:

Identity Providers (IdP):

- Allow SSO, within the institution and federation.
- Maintain user attributes while protecting privacy.
- Know the SPs in the federation, so they only send user attributes to trusted SPs; and can format these attributes in a way the SP expects.
- Allow system administrators and individual users to control the attribute release.

Service Providers (SP):

- Control access to service (who can access what) based on the attributes received from an IdP, i.e. they implement attribute-based access control.
- Know the IdP in the federation, so they only accept user assertions from trusted IdP.

Federation:

- Manages the trusted IdP and SP in the federation, and informs member institutions about it.
- Offers additional services, like a Where Are You From service (WAYF), which allows users to select their IdP.

Finally, the user's **browser:**

- Has to enable Cookies for maintaining security contexts with IdP and SP, and enable JavaScript.
- Has to properly deal with HTTP302 redirect messages

2.2 The IdP as Attribute Authority

Essential for our later discussions is the part of Shibboleth's IdP called the Attribute Authority (AA). When a SP requests the attributes in step 5, it is the AA that actually has to perform several actions:

- Determine which attributes the SP needs, which is part of its default Attribute Release Policy (ARP) as configured by the IdP (e.g. 'Email address').

- Check if the user has overruled the ARP (do not send email address due to privacy concerns).
- Retrieve the user's attributes from the directory.
- Format them if necessary (e.g. if the directory contains an "E-mail" attribute, and the SP expects an "email" attribute.
- Put the attributes in a SAML assertion, sign it, and send it across.

Additionally, as already implemented by some Liberty Alliance members, you may need an interaction between IdP and SP to change the ARP 'on-the-fly'. For example, assume that a user visits a publisher, where he receives the "bronze-level" service based on his institution's contract with the publisher. However, the publisher offers the user the "gold-level" service in exchange for his full name and email address for marketing purposes. If the user agrees, he is redirected to his IdP, which asks for a confirmation before actually changing the ARP and releasing the full name and email address to the SP. Another example is a user who wants to download a certain protected document. Although the repository normally only needs to know his affiliation (but not necessarily the user's identity), in order to retrieve this document it also needs the user's full name (or enrolled courses, or any other user attribute). After the user's confirmation, it will receive this information only once, so on the next visit, the original ARP will be used again.

Finally, the ARP should also allow for privacy of information, and the user should be able to change his ARP, potentially hidden from the sys admin. For example, a user who often needs to order items needs to fill out his contact and credit card details for each site manually. Instead, the SP can offer a function to collect this information automatically from the IdP, where the user needs to confirm at the IdP to release this information. Optionally, the IdP could allow the user to choose a different 'persona', i.e. if he makes a personal purchase; take information from his personal description (John Doe, home address and MyPersonal credit card). For business purchases, he can use his business description (John Doe, company address and MyCompany credit card). However, in both of these cases, all information should only be accessible by the user, and not by someone else.

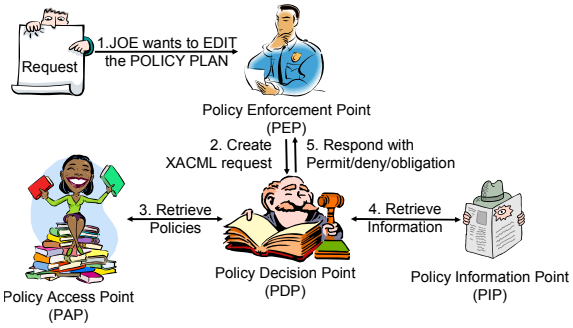

Figure 2. XACML in action: a user's request is translated to XACML, a decision is based using policies and context information, and enforced.

2.3 XACML

According to OASIS [4], XACML was chartered "to define a core schema and corresponding namespace for the expression of authorization policies in XML against objects that are themselves identified in XML. […] XACML enables the use of arbitrary attributes in policies, role-based access control, security labels, time/date-based policies, indexable policies, 'deny' policies, and dynamic policies — all without requiring changes to the applications that use XACML." Although XACML allows fine-grained access control, it does not provide all that DRM does, i.e. after you have accessed an XACML-protected resource, the resource may be no longer protected, and hence you could distribute it. In order to get an overview of XACML, consider Figure 2. A typical use case would be a researcher viewing a paper in a repository:

1. The researcher would use SSO via SAML to access the repository (see Section A).
2. The researcher would search for some keywords, discover the paper and request it.
3. The repository would display the paper's abstract page and each possible further action (e.g. view full paper, rank, download, comment, or edit) would be evaluated using XACML as explained in Figure 2: based on existing policies, the actual resource and the researcher's SAML attributes, these actions would only be displayed if the researcher is permitted to execute them.The researcher selects to view the full paper. The access control is expressed in XML policy documents, written in the XACML namespace. Policies are selected based on generic Target descriptions (see), and each policy consists of multiple specific rules and a way to combine the outcome of different rules (e.g. if any rule permits the action, it's permitted). Additionally, it allows specifying an obligation that must be fulfilled before you can perform the action. Note that access should be considered in its wider sense, as it is not limited to opening documents, but could also mean editing, ranking, or any other type of action.

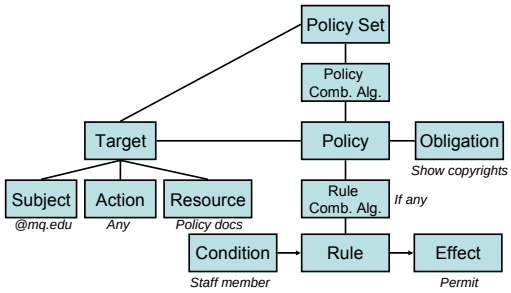

Figure 3. XACML policies are identified using targets, consisting of a SUBJECT doing an ACTION on a RESOURCE. Each policy contains rules and a way to combine them.

3. KEY REQUIREMENTS

Key requirements for federated identity and access management in the Australian Higher Education sector were elicited using two techniques: (1) voting on 14 requirements during several workshops with 148 people, where each had 4 votes, and (2) ranking 45 requirements by 33 people from the 148. The detailed outcomes are published in [7] but the top five is as follows (the #votes it received is added to the end):

(1) SSO with authentication strength (129)
(2) Repository Access & DRM (100)
(3) Federations, federated search & policies (76)
(4) Virtual organizations (59)
(5) Attribute management (57)

SSO can be addressed using SAML as described previously, with the ability to use many authentication methods (like passwords, Public Key Infrastructure (PKI), one-time Short Message Service (SMS) passwords, etc), leading to different authentication strengths. For an overview of the full range of DRM requirements, see [8]. Here, we will describe some key system requirements related to the scope for the MAMS project for repository access (2 – from list above) and federated search (3) from the perspective of the four types of stakeholders: authors; users of content; repositories (e.g. libraries); and publishers. Additionally, we will briefly discuss attribute management (5): who can change or view attributes in the IdP's directory, and what attributes will be sent to each SP.

From an **author's** perspective, a system could:

R1. Disseminate a work to a large audience
R2. Restrict access to a work
R3. Receive feedback from peers
R4. Rank a work based on input from peers
R5. Track the use of a work
R6. Recognize the author as the creator
R7. Enable proper attribution when citing a work
R8. Protect the integrity of a work
R9. Specify whether derivative works can be created
R10. Restrict the way a work can be used and redistributed (non-)commercially

For **researchers**, a system could:

R11. Find relevant content
R12. Provide access to the content
R13. Present the terms of the license
R14. Download content in batches (see 4E).
R15. Provide attribution requirements
R16. Allow anonymous access

For **digital repositories (e.g. libraries)**:

R17. Define the supported access privileges
R18. Provide authors with a method of defining access privileges and terms of use for the content they deposit
R19. Expose the terms of use and access privileges information to repository users, and provide them with a method of accepting or rejecting usage terms
R20. Protect content from unauthorized use
R21. Expose access privileges metadata for harvesting
R22. Define access privileges for the use of metadata (catalog records)

For **publishers**, a system could:

R23. Protect content from unauthorized access
R24. Uniquely identify each instantiation of digital content for licensing and tracking purposes
R25. Define usage rights, e.g. view, print
R26. Identify content users, either to confirm that they have a license or to assign them a license for use

4. PROPOSED SOLUTIONS

In Figure 4, we have drawn the context diagram of the system that should realize the required behavior as described in Section 3. Here, the components that are part of the blue square are under our control, whereas the other components are not or only limited. As a consequence, we are not able to guarantee the realization of all requirements. However, this paper realizes the following requirements: R2, R5, R11, R12, R14, R16, R17, R18, and R26. In two other projects within the MAMS project, we are improving the repository product by using XACML for access control and we are adding functionality and usability to the attribute authority within the IdP, so we can realize more requirements.

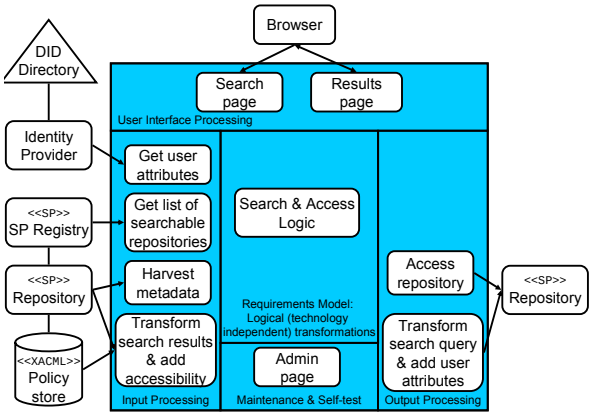

Figure 4. The context diagram shows the dependencies on external systems (DID = Digital Identity).

Our proposed solution to realize these requirements is depicted in **Figure 5**, where the (AFS) authenticated federated search engine extends the capability of the normal (anonymous) federated search engine by receiving attributes of the user that is accessing it. Based on this simple architecture, several scenarios can be implemented, which are discussed in the following subsections.

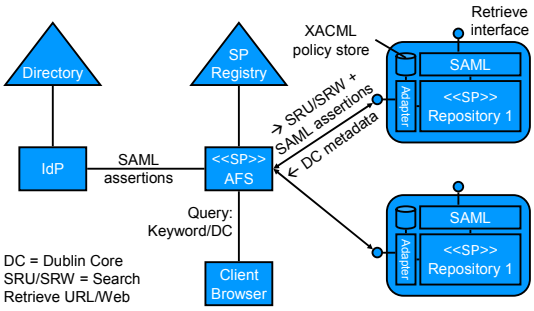

Figure 5. Simplified architecture for our authenticated federated search (AFS) system.

4.1 AFS as yet another SP

In the simplest case, the AFS retrieves the repositories it should search from a registry, either maintained by itself, the federation, or the user's home institution (in the latter case, the AFS could also search and retrieve from repositories with which the home institution might have arrangements, but which are not part of the federation). When the user visits the AFS using SAML/Shibboleth SSO, the AFS will receive the superset of all attributes that each single repository needs. So if repository SP1 needs your affiliation, and SP2 your email address, the AFS will receive both from the user's IdP. Now when it performs the query across the SPs, it will send the SRU/SRW search [9] query together with the SAML assertion containing the user's affiliation to SP1 and the email address to SP2. At the repository site, an adapter (see **Figure 5**) transforms the query to the repository's query language, and determines the user's accessibility to the returned results (metadata and content) using an XACML policy store: these policies are either used directly for authorization by the repository itself (preferred), or the policy store mimics the repository's internal authorization behavior. The search results are in this case returned in Dublin Core [10] metadata format, together with an indication of the user's ability to access the content. If the associated content is accessible, and the user decides to access it, the normal Shibboleth behavior is invoked, i.e. the user will be redirected to his IdP with a request to access the found result in repository X, which will redirect him to repository X with a SAML handle giving him access.

The main limitations of this model are the following:

- The AFS receives much information about the user, because it receives many attributes intended for different SPs, as well as a user's interest (query). This may be a privacy issue.
- The AFS will bypass the IdP's ARP, and schema transformation rules, hence the IdP and all SPs need to use the same schema i.e. attribute names
- The AFS will bypass the user's ARP and provide attributes required by each SP, e.g. if the user does not want SP2 to get his email address, but SP3 may, the AFS does not know this and will send it to both.
- All SPs need to trust the ASF's assertions.

4.2 AFS receives encrypted SAML assertions

A slightly more complicated model that deals with all of the above-mentioned problems is as follows: when the user visits the AFS, the IdP does not send all the attributes that the different repositories need in one SAML assertion to the AFS anymore. Instead of being bypassed, it directly sends signed (using its private key) and encrypted (using the SP's public key) SAML assertion packets, one packet for each SP. So the AFS gets one packet, which is based upon the ARP, for each SP, and it will forward them to the SP when it performs the query. Note that, as these packages are encrypted with the SP's public key, the AFS will not be able to read them. When performing a query, the encrypted and signed SAML assertion is received by the adapter (see **Figure 5**), it decrypts it using its private key and verifies the signature, and treated as discussed previously.

4.3 AFS extending the IdP

An alternative approach is to combine the AFS with the IdP, such that its assertions will receive the same level of trust as was given to the IdP (basically, the assertions would be indistinguishable). Additionally, it would have the advantage that the AFS could respect the user's ARP completely, and that it could be managed by the IdP themselves, i.e. the GUI could be made to fit with the institution's layout, their presentation preferences (do we search using Dublin Core or MARC) can be respected, and you could even query service providers residing outside the federation, as long as they trust you. The main downside to this approach is that now each IdP needs to manage and operate their own AFS, instead of only one site. From a security perspective, this should have no impact, as all trust is based on the IdP's assertion.

4.4 Harvesting and access privileges metadata

Our solution uses a distributed parallel search of repositories to find results as opposed to using harvested metadata. Although performing a distributed search can be more accurate and allows an indication of accessibility, searching local harvested metadata might be faster. If one wishes to combine the advantages of both, there are two approaches: first, you could return the search results using harvested metadata, performing an actual search in parallel, and

update the accessibility (and potentially also the search results) while the user is inspecting the results. This could be achieved using an XMLHttpRequest [9] object, which checks in the background if the updated accessibility information is available.

A second approach is to enrich the harvested metadata with access privileges metadata. This access privileges metadata could be a copy of the applicable XACML policies, but this may introduce other problems ("Why can Sharon from Sandstone University access this document while John from Gum-tree University cannot?"). A better alternative may be to agree on a common but simple semi-hierarchical set of access policies across a federation, for example you could have six classes:

A. Public Domain resources
B. Federation resources:
   (1) All members; (2) Undergraduate students, (3) Postgraduate students, and (4) Staff
C. MyUniversity resources:
   (1) All members; (2) Undergraduate students, (3) Postgraduate students, and (4) Staff
D. MyUniversity+Faculty resources:
   (1) All members; (2) Undergraduate students, (3) Postgraduate students, and (4) Staff
E. MyUniversity+Faculty+Course resources:
   (1) All members; (2) Undergraduate students, (3) Postgraduate students, and (4) Staff
F. Special class using XACML rules & policies

For example, if an author only wants federation staff and post-grads to access (or edit, rank, etc.) his work, he would select "Access protection class: B3" (or "Edit protection class: B3" etc.). Note that C1/2, D1/2 or E1/2 will never be sufficient. If a teacher wants to make content available to his students, he would choose "Access protection class: E2 (Course Physics101)". That is, all enrolled students would be able to access it. Each of these classes could be applied to all content (metadata, resources, and software services) and all actions (access, edit, rank, comment, etc.) although a smart GUI could hide these advanced options if they are not available to a user.

For all other cases, class F can be used, as it allows a user to specify specific rules, similar to a modern-day email program (like MS Outlook) specifies the rules. For example, it could only allow access to a list of specific persons (i.e. an Access Control List). Or the document is only available to members of a certain Virtual Organization (VO). Class F, as it is very specific, will probably not allow you to determine your access rights automatically, unless you are willing to make all necessary attributes part of your ARP. So if your VO uses repository X for storing all documents, which are only available to members of the VO, you should make your VO attribute part of the default ARP, so you can always see and access these documents without any additional SP-IdP redirection to retrieve these attributes.

4.5 Batch downloading

When performing a search across many repositories, the metadata is often not sufficient to actually determine the value of a document and you still need to access it. As described in Subsection 44.1, you can access each document separately, which is quite cumbersome. Instead, you would prefer to have a service, which is part of the IdP, which can do this for you automatically (R14). So you would store potentially interesting search results in your 'shopping list', sent this list to your IdP, which would then retrieve these resources on your behalf, informing you when ready. Using the approach presented in 44.3, where the AFS is already part of the IdP, would be an easer way to implement this functionality.

5. CONCLUSION

'Backing Australia's Ability' is our funding program, which funds many projects sharing the goal of increasing Australia's research effectiveness. Our proposed solutions to the AFS as described in Section 4 achieve this by:

- Making search of protected content more efficient by informing users beforehand which resources are available to them, so they do not try to access something and receive an "Access denied" message.
- By filtering inaccessible results, users can review a shorter list, so it will reduce the time they need to review information.
- Downloading resources in batches, or even by an agent running in the background which retrieves information for you, would save much time as well (imagine accessing 50 documents manually by going to the repositories one-by-one, versus downloading one big file containing all the information).
- If researchers have a more efficient and secure way to share content, they will be more willing to open their work to peers, and material that might have remained hidden on someone's PC otherwise now becomes available.

A minor disadvantage to the proposed AFS solution is that adding SAML assertions to search queries will require extra processing time on the AFS side as well as the repository for each query, although caching the SAML assertions by AFS and repository after the first access should reduce this processing time considerably, as these assertions do not need to be verified again. Additionally, the repository not only needs to find matching results, but also needs to add accessibility conditions. This could only be partly hidden from the user by using an approach as described in Section 44.3.

In all, we feel that the SAML-XACML model as described in this paper will increase research effectiveness considerably, and it only gives a glimpse of the functionality that we might expect in the future.

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Implementation of Probabilistic Packet Marking for IPv6 Traceback

Harayama, Michiko; Kakehi, Naoyuki; and Takeuchi, Daisaku

Abstract - ***Security in computer networks has become an urgent problem. The IP traceback method is expected to prevent most vicious attacks, such as denial of service (DoS) attacks, with false source addresses in IP packets. The probabilistic packet marking (PPM) method has generated a great deal of interest in this regard.***

We herein propose an implementation method of PPM for IPv6 packets. A new hop-by-hop option of IPv6 has been defined as a trace option, whereby the information of the passing node is added. Investigations in an experimental network revealed little affect on routing performance in nodes. The present paper describes the header, the traceback algorithm, the proposed implementation method and experimental results obtained using the proposed method.

Index - ***IP traceback, IPv6, Probabilistic packet marking, Internet security.***

1. INTRODUCTION

As the Internet continues to expand, security in computer networks has become a most urgent problem. Denial of service (DoS) attacks [1] are badly damaging servers and network devices. Furthermore, DDoS (Distributed DoS) and DRDoS (Distributed Reflection DoS) attacks threaten large-scale destruction of Internet sites and services. Currently, no definitive measures exist to deal with such threats because these methods employ normal network services.

In order to prevent network attacks, Intrusion Detection Systems (IDS) [2] are used to monitor packets, and firewalls and routers filter out attacking packets. However, 'spoofing', i.e. the falsification of their source IP addresses, has rendered these systems ineffective.

1.1. Packet Tracing Methods

As effective measures for preventing DoS attacks, several packet tracing methods have been proposed. The link test method [3] traces back the path of a packet using the debugging input function of routers, but this method works only during the course of an attack. After the attack has ended, the link test method can no longer perform traces. In contrast, ITRACE [4,5] can trace the source address with ICMP traceback messages sent by routers to the destination node after an attack has ended.

Similarly, another proposal [9] traces a packet by keeping evidence about every packet in routers. In order to reduce the router load, the traceback messages are sent with very low probability, and packet-unique digested messages are logged instead of IP addresses.

Finally, the probabilistic packet marking method (PPM) [6] includes the node information in a packet as it is passing through a router. This scheme can reduce the load of routers, and has been improved [7~10] and extended to DDoS [11].

1.2. Problem and Purpose

In PPM, the calculation time to reconstruct the path of packets increases rapidly as the number of attackers increases. In addition, most proposals up to now have been for IPv4, and the number of proposals for IPv6 is very small [9,12].

Therefore, we proposed an implementation method of PPM for IPv6 packets.

A new hop-by-hop option of IPv6 is defined as a 'trace option' in order to add information of the passing node. The present paper describes the header, the traceback algorithm, the implementation method and experimental results.

2. PROBABILISTIC PACKET MARKING WITH IPV6

This section presents several definitions and details of probabilistic packet marking methods. In addition, this section describes the newly proposed method for IPv6.

Let a computer network be a directional graph, in which routers or computers are nodes of the graph and connections between two nodes are edges. During communication with the Internet, IP packets pass through a source node to the destination node in the graph. In PPM, every node puts its edge information in each packet to some probability as the packet is passing through.

The edge information consists of the *start* IP address, the *end* IP address, and the *distance*. The *start* IP address is the node from which the packet arrives, and the e*nd* IP address is this marking node. This pair of addresses is called the Edge-ID. *Distance* is incremented by nodes after marking, to be the hop number from the

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marking node to the destination node. When the packet reaches the destination, it contains the edge information. By gathering packets coming from a source node, the destination node constructs the path of the packets and finds its source address.

Although the sampling probability is very small, an adequate number of packets to construct the path will be obtained, because attackers send a sufficient number of packets to a target node during a DoS attack.

There have been a couple of proposals regarding the packet field to save the edge information. One is including the Identification field in the IPv4 header [6], and another is the inclusion of both the Type of Service field and the Identification field. Although, the Type of Service field is designed for Quality of Service (QoS), and the intended purpose of the Identification field is to recombine IPv4 fragments, these fields are not used frequently and the IPv4 header does not have any extra field space to save new types of data. For the same reason, the Flow Label field in the IPv6 header [12] is also a candidate. In fact, these fields are too short to save the edge information, which should therefore be subdivided. Subdivision of the edge information increases the calculation time required to reconstruct the path from packets [8].

By improving upon IPv4, IPv6 has various advanced functions and an effective header format [13~17]. A hop-by-hop option, one of the extended headers of IPv6, is newly defined for processes that are performed at routers. The hop-by-hop option can be used to assign adequate field size, and so it is unnecessary to subdivide the edge information. Therefore, we propose saving the edge dataset in a hop-by-hop option called the *trace option*. In the next section, the header format of the trace option and the packet marking algorithm are described.

3. TRACE OPTION AND PACKET MARKING ALGORITHM

3.1. Header Format of Trace Option

The header format of trace option is defined below and is shown in Figure 1.

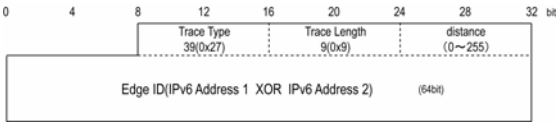

FIGURE 1: **HEADER FORMAT OF TRACE OPTION.**

Alignment Request: 8n□5
Trace Type: Type of Trace Option 39(0x27)
Trace Length: Length of Trace Option 9(0x51)

Data Field
Distance:
Distance from destination node, 0-255, 1 octet
Edge-ID:
XOR of start and end IPv6 addresses, 8 octets

The first pair of bits in Trace Type describes the procedure for routers that can not process the option.

00(0x00) neglect the option and continue processing.
01(0x40) discard the packet.
10(0x80) send an ICMP error (unknown) message.
11(0xc0) for multi-cast communication.
If not, the same as 10.

If it is possible to change the data in the option during forwarding, then the next bit should be 1. Therefore, Trace Type is 39(00100111). In the first octet of the data field, the distance between the start node and the end node, that is the current node, is stored in the next Edge-ID field, XOR of adjacent IPv6 addresses (start node and end node).

3.2. Edge Sampling Algorithm

1. When no data are stored, the router marks its own address in the Edge-ID field at p% probability and clears the Distance field by zero. Here, p=4.

2. If the distance is zero, then the router marks XOR of its own address and the data in the Edge-ID field at p% probability.

3. At step 2, the router increments the distance when an address is marked.

4. The destination node gathers several packets and inserts Edge-IDs into a directional tree in ascending order of distance to find the source address.

4. IMPLEMENTATION

The proposed system is implemented by modifying the KAME patch [18] under the KAME specifications.

KAME is an IPv6 project in JAPAN. The version of the KAME patch used in this system is kame-20031021-freebsd46-snap.tgz. The files in kame:kame/sys/netinet6 are modified.

A packet is sent out by the function ip6_output() at the source node. At relay nodes, the packet is received by ip6_input() and is sent out by ip6_forward(). At the destination node, the packet is received by ip6_input() and is handed over to the upper layer.

At the source node, the trace option is processed by ip6_output() and is inserted at 4% fixed probability by obtaining a pseudo-random

number from microtime() in FreeBSD ver.4.6. In making the trace option, if a packet does not have a hop-by-hop option, a new hop-by-hop option header is made. If a packet already has hop-by-hop options, by obtaining a new mbuf or mbuf cluster, a trace option is inserted under the alignment requirement. Here, mbuf is the memory buffer used for handling IP headers.

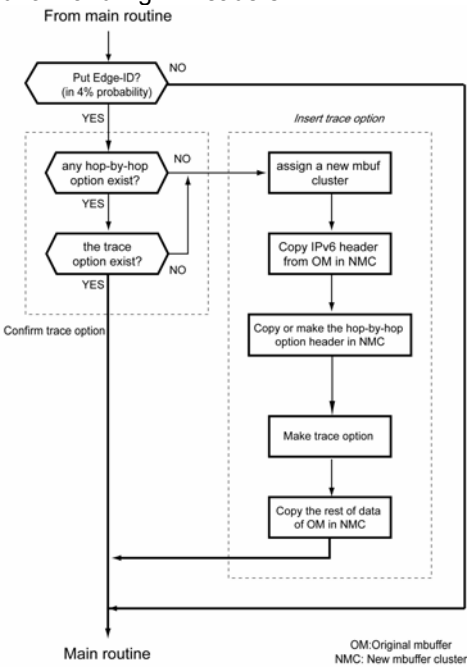

Figure 2: Process flow for inserting the trace option to the IPv6 header.

In contrast, at the destination node and at rely nodes, the trace option is processed by ip6_input(). The edge information of the input-side edge is entered into the trace option. The ip6_input() is used at relay nodes because the input-side edge is nearer to the source than the output-side edge.

Figure 2 shows the process flow at the relay nodes or routers. Similar to the case of the source node, the probability of insertion is determined. If a packet does not have a hop-by-hop option, a new hop-by-hop option header is made. If the packet already has a hop-by-hop option, then the packet is checked as to whether the trace option exists. If no trace option exists, then the trace option is inserted in insert_hopopts(). Here, a new mbuf cluster is assigned, to which the IPv6 header is copied. In addition, a hop-by-hop option and a trace option are inserted, after which the other data are copied.

Figure 3 shows the process for adding the edge information in the trace option. When a trace option is newly assigned, by obtaining the IPv6 address of the network interface, its upper 64 bits are stored in the Edge-ID field. The distance field is cleared by zero. If the trace option already exists, the Distance field is zero, and the probability condition is not satisfied, then the address in the Edge-ID field is replaced by the XOR of the probability condition and the probability condition of new interface. In addition, the Distance field is incremented. If the Distance field is not zero, then the field is simply incremented with no other processing.

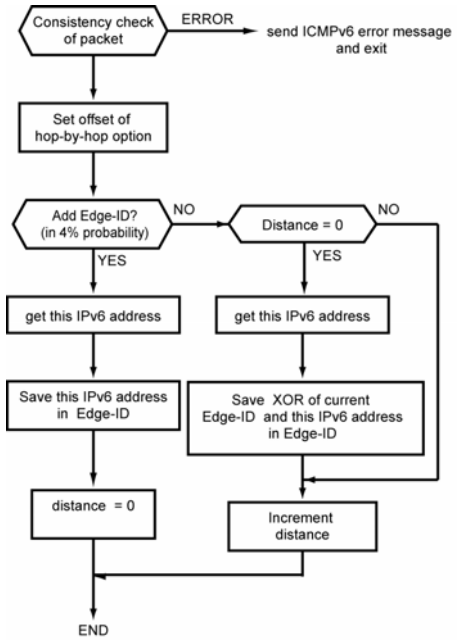

Figure 3: Process flow for adding the edge information to the trace option.

4. EXPERIMENT AND DISCUSSION

In order to investigate the effect of this system on transmission, the response time in an experimental network is measured.
As the experimental environment, five computers were connected in series. The specifications of each computer are as follows: Pentium4 (1.5-2.6 GHz) CPU, 512 MB/MM, and FreeBSD 4.6. Transmissions among the computer were half duplex transmissions at 100 Mbps.

Both edge computers of the network work as source nodes. The other computers work as a relay node (router) and the destination node. The experimental network includes four subnetworks. Each subnetwork consists of the two adjacent computers and the cable linking them. None of the subnetworks have any common network addresses.

The modified KAME patch is installed in all of the experimental computers. The process of the trace option at each network can be skipped by manual operation in the experiment.

Table 1: Experimental Conditions (installed or not installed)

Case	Node1	Node2	Node3	Node4	Node5
No.0	No	No	No	No	No
No.1	Yes	Yes	Yes	Yes	Yes
No.2	No	Yes	Yes	Yes	Yes
No.3	Yes	Yes	No	Yes	Yes

The response time is measured for four conditions, shown in Table 1. Nodes 1-5 are the computers, and cases 1-3 are the installation conditions. The word ‘yes' in the column indicates that this system is installed in the node. Table 2 shows the link number conditions.

Table 2: Experimental Conditions (link number)

link	Node1	Node2	Node3	Node4	Node5
1	Src	Dest	-	-	-
2	Src	Relay	Dest	-	-
3	Src	Relay	Relay	Dest	-
4	Src	Relay	Relay	Relay	Dest

Response time is measured by ICMPv6 echo request. One-thousand packets of five data sizes 64, 128, 256, 512, and 1024 octets, respectively, are sent three times. The experimental results are presented as the mean values of these three measurements.
Table 3 shows the response time for packets of 1024 octets.

Table 3: Response time (ms) vs. Link number

case	1	2	3	4
No.0	0.448	0.879	1.311	1.745
No.1	0.462	0.899	1.338	1.779
No.2	0.445	0.892	1.330	1.772
No.3	0.462	0.892	1.331	1.771

Figure 4 shows that the response time ratio for each case plotted against packet size. The increased response time of the system appears to be caused by increased processing time for the trace option and increased packet size. The effect is less noticeable for larger packet sizes, because of the fixed size of the trace option and the process time.

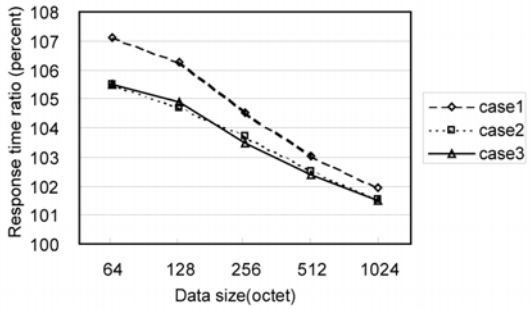

Figure 4: Response time ratio vs. Data size (all cases)

Figure 5 shows the response time ratio with respect to the link number. As the link number increases, the increase in the process time becomes smaller, and approaches a constant for three links.

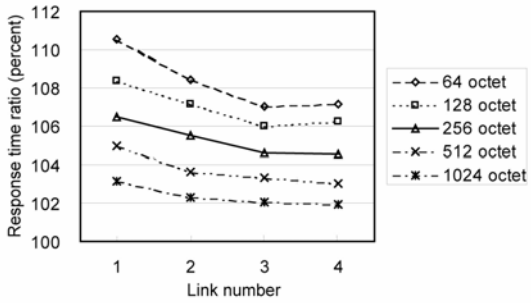

Figure 5: Response time ratio vs. link number (case 1) .

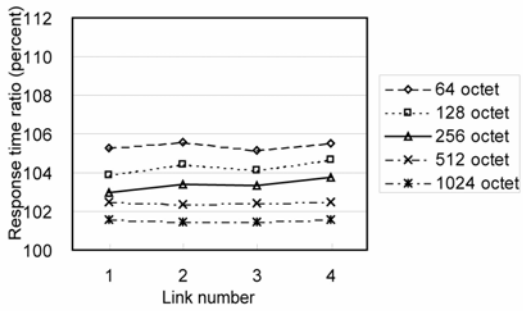

Figure 6: Response time ratio vs. link number (case 2) .

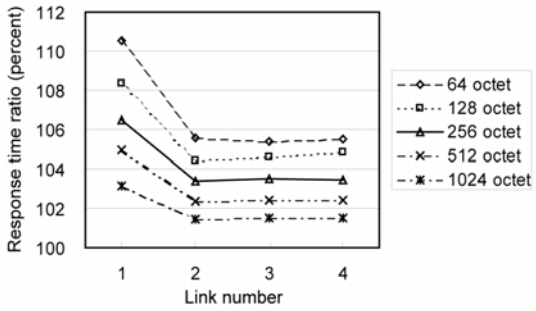

Figure 7: Response time ratio vs. link number (case 3).

Figure 6 shows the response time ratio for the case in which the source node does not assign a trace option. Comparison with Figure 5 indicates that the process of assigning a new trace option accounts for a large percentage of this increase.

Figure 7 shows the response time ratio for the case in which only the second relay node skips the trace option process. Here, the increase in process time approaches a constant with two links. These figures indicate that the response time ratio approaches a constant 2% for a packet size of 1024 octets and is 6-7% for a packet size of 64 octets.

The increase in the response time ratio is very small for large packet sizes and decreases as the link number increases for less than 2%. If packets are large and their path is long, the process time of assigning a new trace option does not seriously affect the total response time. The increased response time appears to be caused by the probability calculation, mainly with respect to the generation of random numbers. Faster random number generation will result in a greater reduction in the response time.

5. CONCLUDING REMARKS

We have proposed an implementation method of PPM for IPv6 packets. A new hop-by-hop option of IPv6 has been defined as a trace option, such that information of the passing node is added. Investigations in an experimental network reveal only a slight effect on the routing performance in nodes.

Although fixed probability is used in the algorithm described herein, the sampling probability should be determined dynamically for more effective and rapid packet trace. This will be discussed in future studies.

IPv6 traceback should be useful not only in preventing DoS/DDoS/DRDoS attacks but also for analyzing packet flow in the next-generation Internet.

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The Obstacles Facing Taiwan's Universities with regard to Internet Courses

Lin, Hui-Chao

Abstract—*The purpose of this paper is to identify the obstacles to Internet education in Taiwan's private technological universities which are introducing e-learning and to analyze statutes from national educational policy concerning Internet courses in higher education. The desires of students and faculty members should be considered as formative for future institutional strategies. The research design combines a literature review with a survey. Survey participants include 567 students whose majors are related to business fields and fifteen leading faculty members who are on the committee for academic strategies in the studied university. The literature review provides an understanding of national higher educational policy and the circumstances that private technological universities are facing. Data from the surveys offer opinions of students and faculty. The results show that Taiwan's society has adequate and convenient configurations to develop e-learning via the Internet. However, language is a big barrier to the development of Internet courses and of interdisciplinary cooperation globally with either higher education institutions or industries. Internet education is prevalent around the world. However, it may be not appropriate for some of Taiwan's higher education institutions.*

Index Terms—*e-learning, faculty governance, higher education, Internet courses*

1. *Introduction*

CONTRASTING with the vibrancy and effectiveness associated with institutional diversity in the market-oriented higher education systems of North America and other western countries, higher education systems in Taiwan are presently emphasizing national quality standards. However, facing global and marketing challenges, Taiwan's higher education institutions must reform their institutional strategies for the sake of survival and development in the future.

From the social side, economic change and an increasing number of universities in Taiwan impact on the university's future survival and development. From the technological side, technology innovations in the workplace influence people to seek training or skills upgrades at universities. Technological advances in communication and transportation bring the growth of foreign trade. Facing global economic competition, more businesses are looking for people with an understanding of international issues. Higher education institutions are looking for a way to deal with these issues in order to attract more potential students.

In recent years, technology diffusion has facilitated globalization in most industries. The higher education industry cannot ignore this trend. Internet courses, for example, are rapidly emerging in the education industry. Although e-learning[8] issues are still in an evolutionary mode, e-learning methodologies seem assured in future education and training [2]. There are some successful, ongoing examples to be found in western countries. The Swedish government currently supports e-learning based higher education [3]. Walden University in the U.S., founded in 1970, provides bachelor's degrees, master's degrees and doctoral degrees through distance learning. It now has nearly 11,000 students and is still growing [4].

Interdisciplinary cooperation between the publishing and education industries has emerged in recent years. For example, Pearson publishers and an American virtual university have formed an e-learning group in the United Kingdom [5]. Another example is the collaboration of Henley Management College with the accounting firm of Ernst & Young, to build a virtual university in the United Kingdom [6]. Internet courses have not only provided interdisciplinary learning between universities and industries, but they have also expanded the financial base of universities. University of Phoenix in the U.S. accounted for 95.5 percent of $1.68 billion in net tuition revenue from online and distance learning courses for the year ending August 31, 2004. University of Phoenix owns 55 campuses, offers associates degrees, bachelor's degrees, master's degrees, and doctoral degrees through distance learning, and had 227,800 students enrolled in 2004 [7]. The Sloan Consortium reports over 1.9 million students enrolled in online courses in the fall of 2003 and the number of online students was projected to

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1. Kekkonen-Moneta and Moneta [1] suggest that e-learning can be defined as using the Internet and Internet-related technologies in instructional development and distribution of educational resources.

grow to over 2.6 million by the fall of 2004 [8]. These examples show us that e-learning education has grown phenomenally in the past years, has expanded the financial base of universities, and is a significant future trend.

2. Problem Statement

For the survival and development of institutional businesses, Taiwan's higher education institutions may add e-learning methodologies to their institutional strategies. However, Taiwan's University Law does not allow for providing degree programs through Internet courses.

E-learning, in this paper, is defined as using the Internet and Internet-related technologies in instructional development and distribution of educational resources [1]. The other problem, therefore, is concerned with the convenience of learning and breadth of educational resources.

3. Background Of Problem

3.1 Higher Education System in Taiwan

Under national educational policy, there are presently two types of higher education institution: academic universities and technological institutions (Table 1). Academic universities provide a broad range of fields of study including arts, agriculture, architecture, commerce, engineering, law, mathematics, medicine, natural sciences, social sciences, and veterinary science that are similar to those provided by universities in the U.S. Technological institutions emphasize applied science and vocational skills for industry, and are different from academic universities that focus on knowledge-teaching and academic research. Currently, there are 70 academic universities/colleges [9]. Technological institutions provide opportunities for vocational school graduates to pursue further study up to and including doctoral work [10], [11], [12]. For the purpose of providing equality of educational opportunity for those students within the vocational system, Taiwan's government established a complete system of vocational education, including vocational high schools, junior colleges, and institutes of technology/technological universities. In other words, Taiwan's students are channeled into one of the following two tracks: general education (the path for those wanting to attend an academic university) and vocational training (for those wishing to continue their education and acquire technical skills) [13], [11]. Currently, there are 89 technological institutions [9]. As of 2004, there were 105 private higher education institutions in Taiwan [9]. Facing an increasing number of higher education institutions and a decline in the number of students, perhaps partially because of a declining birth rate, recruiting more students and expanding the financial base have become critical issues for private technological institutions.

<table>
<tr><td colspan="4">Doctoral Program</td></tr>
<tr><td colspan="4">Master Program</td></tr>
<tr><td rowspan="2">University & College</td><td rowspan="2">Technological University /Institute of Technology (4yrs)</td><td colspan="2">Technical College (2yrs)</td></tr>
<tr><td>Junior College (2yrs)</td><td rowspan="2">Junior College (5yrs)</td></tr>
<tr><td>Senior High School</td><td colspan="2">Senior Vocational School</td></tr>
<tr><td colspan="4">Junior High School</td></tr>
<tr><td colspan="4">Elementary School</td></tr>
<tr><td colspan="4">Kindergarten</td></tr>
</table>

Table 1: The Current School System

3.2 The Present Environment for Internet Courses

Internet User Statistics [14], which were updated on March 23, 2005, show the top seven nations in the world, in terms of numbers of Internet users, are: the United States (200.9 million); China (94.0 million); Japan (67.6 million); Germany (46.3 million); India (39.2 million); the United Kingdom (35.1 million); and South Korea (31.6 million). Although the population of Taiwan is only around 23 million, the number of Internet users had reached over 12.2 million by the end of 2004. Taiwan is ranked number 17 on Internet User Statistics [14]. Taiwan also is able to provide reliable Internet availability for its people.

To start Internet courses, students are required to have minimum hardware and software capability and the ability to use the student system of 'bulletin' messaging, otherwise known as 'BBS' [15]. In Taiwan, high school students sit tests for the use of hardware, software, and issues related Internet access before they graduate [16], [17], [18]. Adults can find computer courses at community colleges, which offer free or low-fee training for citizens [18].

3.3 National Educational Policy

Corporations, dot.coms, and publishing companies are getting more and more involved in the education and training business worldwide. Some are even granting degrees [19]. For example, World Alliance on Distance Education (WADE) is a collaboration between four leading distance universities: Deakin University in Australia, the Hong Kong Open University, the Open University in the United Kingdom, and Canada's Athabasca University to offer a global business school post-MBA International Business Program via the Internet [20]. From fiscal year 2001, a bachelor's degree, requiring 124 credits, could be earned from a correspondence university via the Internet in Japan [21].

According to Taiwan's University Law [12], a student cannot earn more than one third of total required credits via distance learning for a degree program. Under this Law, universities that wish to provide Internet courses to develop new educational ranges must consider alternative ways to implement these strategies for the development of Internet courses and interdisciplinary cooperation.

Chinese Culture University, a private academic university, provides various non-credit courses through distance learning for working adults in its continuing education department [22] [23]. National Taiwan University has launched collaboration with other two public universities, Chian Tung University and Tsing Hua University, in providing ten courses each semester through distance learning [24]. In the 1997 and 1998 school years, Chaoyang University, a private technological university, cooperated with other two public universities, two private universities, and one private technological institute in providing a movie art course through distance learning [25]. Most of these universities offered course materials in Chinese.

3.4 The Issue of E-learning

The latest technological innovations and the Internet present a challenge to traditional lecture-based learning. E-learning is considered the most effective tool for acquisition of knowledge and the most effective part of a systematic approach involving use of classroom with appropriate support [26], [27]. The advantages of e-learning are clear in the area of timely delivery of training materials, increased convenience, and increased learning effectiveness [28], [29]. English is the *de facto* language of the Internet as of September 2003 (Table 10). In other words, web sites written in English are in a large majority on the Internet.

Online Languages As of September 2003	English	35.6%
	Japanese	9.5%
	Chinese	12.2%
	German	7.0%
	Spanish	8.0%
	Korean	4.0%
	French	3.7%
	Italian	3.3%
	Portuguese	2.6%
	Russian	2.5%
	Source: Global Reach http://global-reach.biz/globstats/index.php3	

Table 10: Online Languages

All students in Taiwan must take English courses from seventh grade to twelfth grade at least. For convenience of learning, broadening of educational resources, and development of students with an understanding of international issues, to use the Internet, to conduct Internet searches, and to read online journals and documents in English is the optimum approach to achieve these goals for Taiwanese students.

4. METHOD

A technological institute in Taiwan was chosen for this survey. The institute has nearly 10,000 students and around 300 full-time faculty members. The committee for academic strategies consists of fifteen members, including the Principal, the Dean of Academic Affairs, 11 heads of departments, and the head of the graduate school. This study was confined to surveying these fifteen faculty members and 567 students who had experiences using the Internet in their courses.

Because of the particular suitability of online material for use in business-related studies, the student survey was focused on business-related departments at this institute. First, the investigators carried out the surveys and interviews with senior students in three business-related departments namely International Trade, Tourism Management, and Applied Foreign Languages. These students take computer courses during the first and second years of study. They also take English classes during their whole time at the institute. These students are divided into Group A and B. Group A has 311 students who are full-time students and take all their classes during the day. The members of Group B number 256, who work during the day and take continuing education classes in the evening. Second, the investigators conducted surveys and interviews with those fifteen leading faculty members.

To assure the validity and reliability of the questionnaire, before distributing the surveys to both student groups and the leading faculty members, the author identified possible questions by means of a review of literature in the field as well as firsthand knowledge from the real world concerning issues in applying e-learning. At the first stage, the author collected data by using open-ended questions to ascertain the concerns of most faculty members in applying Internet use in their teaching. Using data produced from this first stage, the author then designed the questionnaire. The items in the questionnaire were rated on a Likert scale of "strongly agree", "agree", "no opinion", "disagree", "strongly disagree."

The final questionnaire was produced after pre-testing a small group from the institute where it was planned to give the survey to and then made some minor changes. Then, the author conducted the survey to the fifteen faculty members and two student groups at this institute.

The mean and standard deviation score for the rating of each item in the questionnaires from faculty members were calculated. The number

and percentage of agreement for the rating of each item in the questionnaires from two student groups were also calculated.

5. *Results And Discussion*

This paper attempts to understand possible obstacles in developing Internet courses through the use of surveys on both faculty member and student sides.

Table 2 shows that most faculty members realized that correct computer configurations are required for developing Internet courses and believed that the institute fulfilled these requirements adequately (M=4.00, SD=1.21 in statement 1). Both Group A and B were unanimous on the computer configuration issue. Most of them agreed that the institute has sufficient equipment to start e-learning programs.

Opinions from faculty members	M	SD
1. Internet requirements, such as software and internal and external hardware components of a computer net system, for students' learning are met adequately in your institute.	4.00	1.21

Opinions from Percent students.	No.	agree
1. Group A	293	94%
2. Group B	211	82%

Table 2: Internet Requirements

Table 3 shows that most faculty members also strongly supported the training programs for teaching Internet courses at their own institute (M>/4.00, SD>/0.93 in statement 2 and 3). Group A and Group B show very high percentage (Group A= 80%; Group B= 75%) in taking Internet courses that are offered by their local faculty members.

Opinions from faculty members	M	SD
2. It is important to have adequate qualified faculty to teach Internet courses in your institute.	4.00	1.11
3. It is important to provide training to faculty to do the Internet courses in your institute.	4.36	0.93

Students prefer to take Internet courses that are offered by their own institutes.	No. agree	Percent
3. Group A	249	80%
4. Group B	193	75%

Table 3: Qualified Faculty

In Table 4, not only did students in both Group A and B believe that English ability is a strong requirement for learning via the Internet, but the faculty members also judged that English ability is a key point for effective e-learning (M=4.50, SD=0.65 in statement 4).

Opinions from faculty members	M	SD
4. It is important in developing e-learning that students have adequate English ability to use resources from the Internet, to conduct Internet searches, and read online journals and documents.	4.50	0.65

Opinions from Percent students.	No.	agree
5. Group A	301	97%
6. Group B	240	94%

Table 4: Students' English Ability

Although learning via the Internet is becoming a worldwide trend, the results from Table 5 show us that Internet courses which use English information do not benefit the students in both Group A and B (M</3.64, SD</1.17 in statement 5 and 6). These results conform to the thoughts of students as shown in the student surveys. Most of them have problems understanding information in English on the Internet. Both Group A and B think translating software does not help in understanding English information.

Opinions from faculty members	M	SD
5. Internet courses that use English information benefit the learning for regular students in your institute.	3.29	1.17
6. Internet courses that use English information benefit the learning of students in continuing education in your institute.	3.64	1.15

Internet courses that use English information benefit your learning in some ways. Percent	No.	agree
7. Group A	31	10%
8. Group B	47	18%
Translating software helps in understanding English information		
9. Group A	25	8%
10.Group B	29	11%

Table 5: The Benefit derived from Using English

Materials

The institute cooperated with other domestic universities on distance learning programs. However, only a few students took them because they lacked self-learning skills and self-control in study. Table 6 shows that most faculty members also consider that providing e-learning programs designed by other universities or online providers is not worth doing because the level of assistance to students is low (M=3.64, SD=1.01 in statement 7).

Opinions from faculty members	M	SD
7. It is important to offer e-learning from other higher education institutions or online providers that will assist current students' learning in your institute.	3.64	1.01

Table 6: Online Courses from Outside Campus

Recently, many foreign universities have recruited new students in Taiwan. The language turns out to be a barrier whether students choose degree programs from either traditional educational modes, or via the Internet. Therefore, most faculty members did not consider that recruitment by foreign universities would threaten the institute's business (M=2.57, SD=1.64 in statement 8; M=3.36, SD=0.84 in statement 9 of Table 7). Considering language barriers, culture background, and job markets, students in both Group A and B are more interested in doing further study in Mainland China than in other foreign countries.

Opinions from faculty members	M	SD
8.It is a matter of concern to your institute that foreign universities offer their degree programs to Taiwan's market via the Internet, thus competing for students.	2.57	1.65
9. It is important to cooperate with other higher education institutions or online providers in order to attract potential students to your institute.	3.36	0.84

Students prefer to study at foreign universities via Internet courses.	No.	agree Percent
11. Group A	0	0%
12. Group B	7	3%

Students prefer to study at foreign universities via traditional courses.	No.	agree Percent
13. Group A	28	9%
14. Group B	13	5%

Students prefer to study in Mainland China via traditional courses.	No.	agree Percent
15. Group A	131	42%
16. Group B	196	76%

Table 7: Competitors from Foreign Universities or Online Providers

In Taiwan, degrees are required for many jobs in both public and private industries. In addition, passing the examinations is the only way to earn a license. In order to qualify to sit those examinations, one must first earn some accredited degree. Thus, the institute considers that finding a solution to the issue of accreditation before developing the Internet courses extremely important, rather than 'importing' non-accredited interdisciplinary degree-granting programs from international institutions or industries via the Internet (M=4.57, SD=0.65 in statement 10 of Table 8).

Opinions from faculty members	M	SD
10.It is important to address the issue of non-accreditation of degrees via the Internet under Taiwan's University Law.	4.57	0.65

Table 8: Non-accreditation of Degrees

Statement 11 (M=4.29, SD=0.83) in Table 9 provides significant information for Taiwan's universities that are highly interested in developing courses via the Internet. Both students and faculty members judged that e-learning materials in their native language/mandarin could assist students in achieving better and more effective learning.

Opinions from faculty members	M	SD
11.It is important to create e-learning materials in your native language/mandarin to assist students' learning in your institute.	4.29	0.83

E-learning materials in mandarin can assist your learning.	No.	agree Percent
17. Group A	201	65%
18. Group B	213	83%

Table 9: E-learning Materials in Native Language

6. Conclusions And Suggestions

Although Internet education is so prevalent around the world and apparently expands the financial base of universities, the views of students and faculty members must be considered when introducing Internet courses for future institutional strategies. Given the lack of Chinese web sites on the Internet and the lack of ability to understand English materials, faculty members, who desire to offer courses through Internet, must provide adequate educational resources in breadth and materials with understanding of international issues for students in Chinese.

Some universities, which recruit students with ability to understand English information, may be adapted for offering and using Internet courses. Others may not be so suitable for the provision and use of Internet courses.

The other obstacle comes from national statutes. Under Taiwan's University Law, non-accredited certificates and degree programs do not attract students from either regular or continuing education. Universities worldwide are consolidating and enhancing their commitments to various models of e-learning. Universities in Taiwan may consider offering non-credit courses for working adults through e-learning or providing degree programs with blended learning, traditional face-to-face teaching plus e-learning.

The surveys were limited by the type of higher education institution, we chose to study, and the corresponding population. Additional studies in other universities are needed in order to extend the research. For further research, if a higher education institution needs Internet education, then what is best way to do it?

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VIGIE: A Learning Tool for Cellular Air Interfaces (GSM, GPRS, UMTS, WiFi)

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Abstract—*One of the difficulties encountered in the teaching of mobile radio networks is to present in a simple way the interaction and the sequencing of various tasks, which must be carried out by the mobile station (MS) and the network over the air interface. The comprehension of these processes is facilitated when they are presented in a visual form that can be understood in real-time, when the common MS-Network tasks such as voice call (MS oriented or MS terminated), short message service (SMS) are going on. This paper describes the architecture of the VIGIE (Visualisation and Interpretation of GSM/GPRS for Institutes & Ecole) software, developed in Java to display the exchanges of these tasks between the MS and the network. The uniqueness in the architecture of this tool is revealed in terms of its modularity. Finally the current work done on the development of the General Packet Radio Service (GPRS) logical screen and the Downlink Signaling Counter (DSC) graphical screen are described*

Index Terms—*Air interface, GPRS, and GSM*

1. INTRODUCTION

BETWEEN 1996 and 2000 a software tool for the teaching and visualization of Global System for Mobile Communications (GSM) protocol over the air interface called GSMShow was developed within the department of Information and Networks of ENST (Ecole National Superieure des Telecommunications). This software is used on a computer connected via a serial link to a *GSM trace mobile*. A trace mobile is similar to an ordinary mobile station in every aspect and can be used on any operational network except that it has the characteristic to send in “rough form” (a succession of bytes) the messages exchanged between the network and its measurements and calculations. The role of this software is to display in a convivial form the exchanges between the network and the trace mobile. The user thus sees the exchange of these frames but from different points of view; each point of view is what led to the development of different windows where the user can monitor specific behavior of the mobile to the network or vice-versa. In 2001, the advent of GPRS led to the development of a new software tool called VIGIE. This software was developed by ENST-Paris and ENST-Bretagne. VIGIE is a teaching aid particularly adapted to render comprehensible, the principle of encapsulation (joint visualization of layers 2 and 3), frequency hopping, management of *timing advance* (TA) and power control, logical channels , activation of GPRS sessions and so on. It also makes it possible to highlight the sequencing of messages for various services. This software is developed in Java, and the the aim is to make it more evolutional than its predecessor (GSMShow). It is able to support the GSM/GPRS protocol and also to be interfaced with, potentially any trace mobile. In the future, it will be able to support other protocols such as *Wireless Local Area Network* (WLAN), *Universal Mobile Telephone Service* (UMTS) or *Enhanced Data rates for GSM Evolution* (EDGE).

2. PRINCIPLE OF OPERATION

2.1 Review Stage

The VIGIE software is intended to be used coupled with a trace mobile, which is connected to the computer via a serial link. The trace mobile theoretically allows the retrieval of all signaling frames as well as frame headers of transmitted data during communication. It also transmits information about the radio environment where it operates and in particular reception measurements levels of signals transmitted by the neighboring cells.

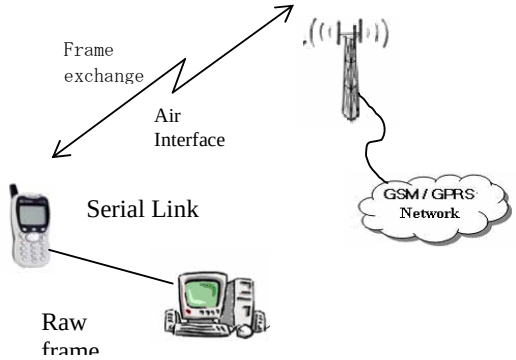

Figure 1: Sequential connection of entities interacting during the use of VIGIE software

The information transmitted by the mobile on the serial link is generally divided into two parts:

the information transmitted by the mobile, which has a format that is actually dependent on the type of trace mobile used[9] and on the other hand the standardized frames which are transmitted or received on the radio link. However the reception of these frames is useful only if the user is able to understand and interpret them. This binary format is not very convivial and does not emphasize on the most significant aspects of the radio resource procedures. VIGIE thus makes it possible to automate this decoding, to interpret the frames contents and most importantly to have the results in such order that will facilitate the user to understand the operation of GSM/GPRS system.

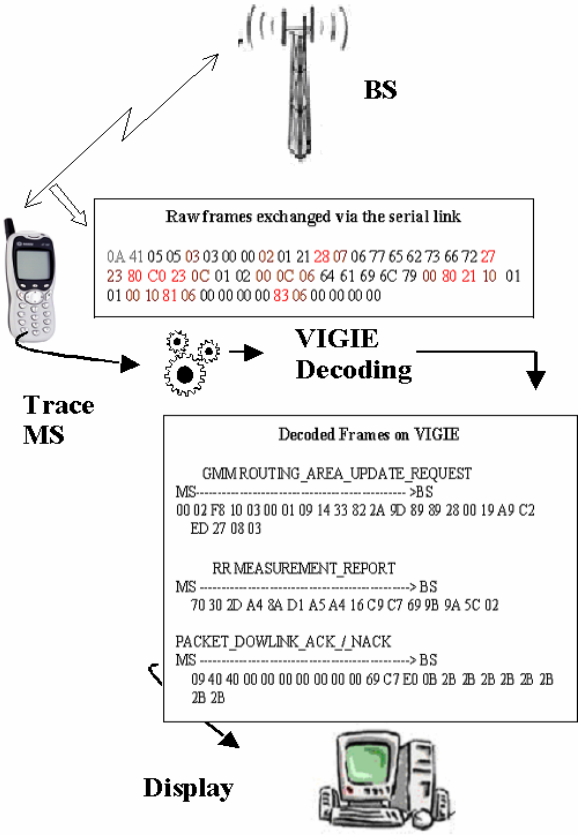

Figure 2: VIGIE principle of operation [5].

2.2 Functionalities

The VIGIE software consists of three modes of operation. The *serial mode* requires the serial connection of the trace mobile to the computer. In this mode, the software stores all the data (frames and reports) delivered by the mobile of trace in real time and records them in a temporary file, this is done to save all the data for possible future storage so as to re-launch the saved data for analysis.

The file mode *step-by-step* allows to run the recorded traces that were saved in the serial mode. Each time the user prompts, the message is read from the trace file; this mode is recommended if sequence of a specific task is to be closely monitored. The *fixed time delay* file mode is similar to the step by step file mode, except that the reading of the file is done automatically at the rate of 1 second.

3. SOFTWARE ARCHITECTURE

GSMShow, which is the predecessor of VIGIE interfaces only with the trace mobiles using *Orbitel* serial link protocol and as a result could not support the GPRS mobile radio protocol. It would have been very difficult to develop and add a new screen that will permit the display of GPRS system information.

Thus the architecture of VIGIE was conceived to be strongly evolutionary. It must be able, via a system of drivers to adapt to the protocol used by the trace mobile to communicate with the computer. It must also be able to present other mobile radio protocols such as the EDGE and UMTS or the operation of WLAN systems.

The data frames are conveyed between the trace mobile and the computer via the *serial link* (see figure 3) which interfaces the trace mobile with the computer. The format of the frames on the serial link depend on the trace mobile used but a system of *drivers* makes it possible to translate the incoming frames into a format we referred to as *generic.* That format can be used by all the remaining modules within the software architecture. The driver primarily makes it possible to group raw frames captured by the mobile into two main groups; the information received from the network such as those transmitted on the logical channels and the results of the measurements the mobile carried out to report back to the network: we referred to these formats as the *Frame* and *Report* respectively. We also further identifies *Report* types (idle mode or dedicated mode) and frame type - layer 3 (L3), GSM layer 2 (L2), GPRS, and GPRS Mobility Management – Session Management (GPRS GMM-SM). As shown in figure 3, it is the generic format that is temporarily saved, which means that it is impossible to view the raw frames coming directly from the trace mobile in the step-by- step mode. Thus the appearance of a new type of trace mobile requires only the creation of the driver that corresponds to such trace mobile. The generic frames are presented in the form of Java serializable objects, which makes it possible to be recorded in a file format (in this case we used *.trc* extension) in order to re-launch the saved trace when data to be observed is not in real time mode.

A module we referred to as the *Interpreter* makes it possible to further carry out decoding of

the frames and report. The interpreter decodes the content of L3 frames and sort them using protocol discriminator into *call control* (CC), *mobility management* (MM), *radio resource* (RR), *session management* (SM) messages, *radio link control / medium access control* (RLC/MAC) messages. The sorting of messages sent on the logical channels, which include *slow associated control Channel* (SACCH) data, *broadcast control Channel* (BCCH) report, page report, channel request report, *access grant control channel* (AGCH) report and synchronization report are done by the interpreter.

The *Dispatcher* makes it possible for the decoded frames and reports in idle and dedicated mode to be progressively distributed as required onto each window upon their arrival. It allows us to group together the frames, reports and to display them in a manner that can be easily understood.

The *Window* module represents viewing of different parameters/information as sorted by the Dispatcher; this is the graphic user interface part of VIGIE, where the users actually interact with the tool. A collection of windows may be considered as a module but they are independent of each other, again the modularity of this tool is being revealed in this aspect as a new window may be developed depending on what is intended to be displayed to the users.

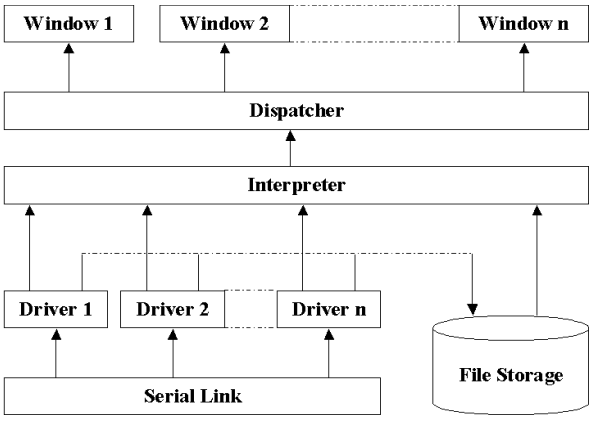

Figure 3: Simplified software architecture for VIGIE.

4. SOFTWARE DESCRIPTION

On the main GUI (Graphical User Interface) window there are eight different menus that can be activated (though more could be activated as we develop new screens). On top of this window, just below the menus, appears a horizontal bar that displays all the activities performed by the mobile (measurements, transmission or reception of frames). At the leftmost base of the main window is the *indicator of state*, which gives the state of connection of the trace mobile to the serial ports; this could be *connected*, *not connected* or *disconnected*. Note that only the connected state is displayed when you are in the serial mode.

Description of the windows: The *Frame serial* window displays all the frames that are exchanged on the serial link in the raw format. This window is only active when you are in the serial mode. *Frames and Reports* window displays the decoded frames in generic format; this window is also active in the serial mode.

Dedicated Layer 2 and SACCH window displays all the layer 2 messages on the dedicated channel or on the SACCH.

GSM Layer 3 Message window displays the messages of layer 3 with or without filtering. Messages that can be filtered include BCCH System Information, Padding Paging, measurement Report, SACCH system Information, Paging (all types) and Empty.

Current BTS (Base transciever station) Configurations window displays various information of the current cell. If one of the neighboring cells is displayed in blue, this means that the BCCH message is being received at this frequency. In the same way display in green indicates the reception of synchronization message. The edge of the box indicates the state of the mobile; if displayed in blue, the mobile is in idle mode while red indicates that the mobile is in active mode. When all the borders of boxes are displayed in red it indicates that the mobile is in dedicated mode. Dx indicate the signaling channel SDCCH (where x is the number of this channel in the slot), TF indicate *full rate traffic* channel and APC is the *adaptive power control* (i.e. dynamic power control).

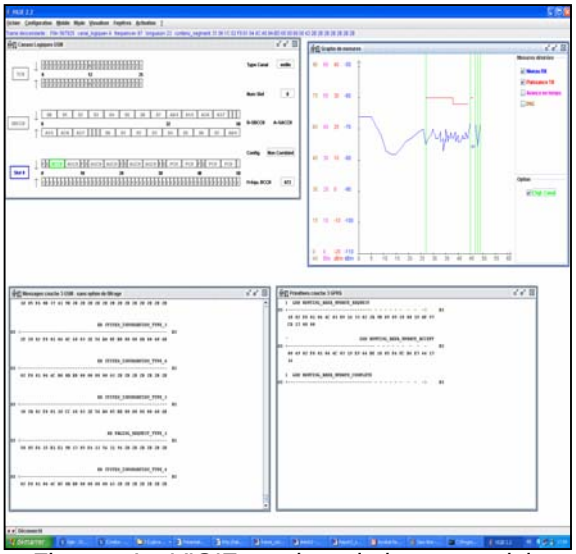

Figure 4: VIGIE main window containing several windows (including the Graph Measure window that contains DSC).

The *Graph Measurement* window shows the graphical plots of various parameters we decided

to group together including the plot of DSC counter we added recently. Four plots are possible when this window is selected, and there is an option to choose the desired plot using a check box on this window. In this window, we plot Rx level (dBm), Tx power (dBm), channel change and DSC (integer) against time, while we plot the timing advance on the x axis.

5. DEVELOPING THE GPRS LOGICAL SCREEN

5.1 Integrating the DSC into the Graph Measurement Screen

The downlink signaling failure is based on the downlink signaling counter (DSC). When an MS camps on a cell, the DSC shall be initialized to a value equal to the nearest integer to 90/N; where N is the BS_PA_MFRMS parameter for that cell (see reference 1). The MS is required to attempt to decode a paging message every time its paging sub channel is active; therefore the network activates the paging sub channel for a given MS every BS_PA_MFRMS multiframes. In case *discontinuous reception* (DRX) split is supported, the mobile listens to its paging sub channel every $1/N_{DRX}$ multiframes [1]. Thereafter, whenever the MS attempts to decode a message in its paging sub channel; if a message is successfully decoded i.e. *bad frame indication* =0 (BFI=0), the DSC is incremented by 1, but never beyond a maximum value (parameter of the radio configuration of the cell) , otherwise DSC is decreased by 4. When DSC$\leq$ 0, a downlink signaling failure shall be declared and this ultimately results in cell reselection [1].

For GPRS, an MS in packet idle mode follows the same procedure. The counter DSC is initialized each time the MS leaves packet transfer mode. In case of DRX period split is supported, DSC shall be initialized to a value equal to the nearest integer to max (10, $90*N_{DRX}$), where NDRX is the average number of monitored blocks per multiframe according to its paging group.

The DSC support has been developed for the trace mobile SAGEM 0T190 and OT290. To retrieve the DSC information from these mobiles, we have developed several functions that ask the mobile to send this information to VIGIE. We have also developed a driver that retrieves the DSC values contained in the proprietary frame format [2] and then translate them into a generic report that is used by the graph measurement screen.

5.2 Specification of the GPRS Window

This specification describes how the window we developed behaves and reacts to the decoding of each type of RLC/MAC PDU (*packet data unit*). This window is made up of labels, text fields as well as graphics. The encoding of RLC/MAC blocks was defined by the means of *concrete syntax notation no 1* (CSN.1). The CSN.1 is a descriptive language for digital message encoding, which enables the description of the structure of message down to the bit level, and is particularly useful to describe bit-efficient encoding [4]. The RLC/MAC specification uses CSN.1 to define the whole of valid blocks which can be exchanged between the MS and the BTS on the logical channels specific to the GPRS [3].

The Temporary block flow (TBF) concept: the TBF is a logical connection between the RR entity at the MS side and the RR entity at the network side to support the unidirectional transfer of *logical link control* (LLC) protocol data units over *packet data channel* (PDCH) [11]. The TBF exists as much as the transmitter has in memory the data to transmit, which can correspond to the broadcast of several LLC packets [11]. There are two types of TBF, the *downlink TBF* is one in which data flow goes from the network to the mobile. The mobile returns acknowledgements and measurement to the network. Here the network sends message of pre-allocation to the MS specifying which blocks to decode in the slots allocated to it; some of these blocks may not be intended for this MS, but can carry data for another MS. The final recipient of the block is designated by the *temporary flow identifier* (TFI) field included in the block and usually the MS will find in one of these blocks an allocation for the uplink that will specify which block to transmit its acknowledgement and measurements.

In the *uplink TBF,* principal data flow goes from the MS to the network and it is the network that manages the allocation of the resources on the uplink (it manages the scheduling between mobiles). The mobile thus listens to “orders” from the network on the downlink to know which of the slots it can transmit on. These “orders” are identified by the TFI, it must also listen on the downlink for the acknowledgement of the packets it transmits. There are two possible allocations on the uplink – dynamic allocation and static allocation.

In dynamic allocation, MS receives an identifier called *uplink state flag* (USF) by slot which it manages and then listens on the downlink. When it locates its identifier in the downlink block, it knows it can transmit starting from the following block. In static allocation, MS receives a message indicating the blocks in which it will be able to transmit for certain period. This allocation is limited to 128 blocks but can be repeated for another period; the mobile only knows if the allocation is renewed during acknowledgement. Thus TBF implies transmission in two directions,

which could be uplink or downlink. It is possible for a mobile to have two TFIs, a TFI uplink and a TFI downlink, which shows that these two aspects are independent, hence there, could be four states: TBF not in progress, UPLINK TBF is in progress, DOWNLINK TBF is in progress and UPLINK TBF and DOWNLINK TBF are in progress.

We propose a graphic interface (see figure 6), which shows how the resource allocation functions on the GPRS radio interface. This logical *screen* comprises of up to 10 representations of the 52 multiframes structures. The first group of four represents the downlink, a representation for each slot on which the mobile may be listening. The next group of four 52 multiframes are those of the uplink. The last two 52 multiframes represent the slot containing the *packet BCCH* (PBCCH) if used[1] and the slot containing the *packet common control channel* (PCCCH[2]). The other label fields shows how we display other important parameters, like the TFI downlink and uplink, the USF of the mobile, and the coding scheme (CS) for the uplink and the downlink.

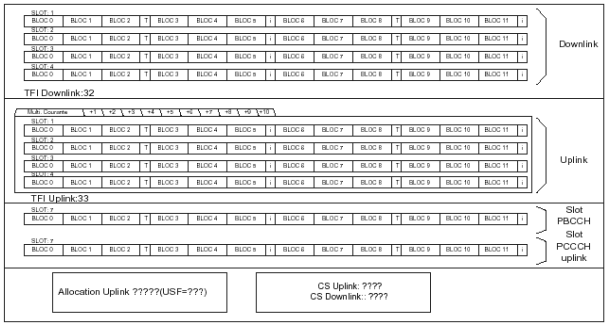

Figure 5: The proposed radio interface for GPRS logical screen

5.3 Decoding of the Blocks

The specification of how the proposed interfaces must react to the reception of RLC/MAC blocks is based on their definition in CSN.1. As we have described above, we wrote the program from the syntax of CSN.1 to create a procedure which is able to determine if the bit strings subjected to it (procedure) belongs to the set of bit strings defined by the syntax and which, if necessary, can isolate each sub string named in this syntax. We thus specify the reactions of our program according to the values of these sub strings; and if these sub strings would not be present, the program should not have any reaction relative to its value except if explicitly indicated.

[1] If the PBCCH is used, only 3 representation of the DOWNLINK multiframe can be used, since PBCCH occupies a DOWNLINK slot, this slot in addition to PBCCH can also transport data for the mobile.

[2] Same remark as for the PBCCH slot, but for the UPLINK multiframe.

CONCLUSION

GSM has evolved over the years, upon which advanced systems such as GPRS, EDGE and UMTS are based. To understand these advanced systems, however, a good understanding of the GSM system is necessary. We have proposed and developed simplified GUIs that will allow the users monitor and understand the sequences of a various tasks between the MS and the network over the air interface. We finally demonstrated the modularity in our software architecture by adding another window - the GPRS radio resources allocation window.

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Power Aware Routing in Ad Hoc Networks

Kush, Ashwani; Gupta, Phalguni; and Chauhan, Ramkumar

Abstract—***A recent trend in ad hoc network routing is the reactive on-demand philosophy where routes are established only when required. Most of the protocols in this category, however, use single route and do not utilize multiple alternate paths. This paper proposes a new scheme called Power Aware Routing Protocol (PARP) to improve existing on-demand routing protocols by introducing the Power efficient scheme in whole scenario. The scheme establishes the multi paths without transmitting any extra control message. It offers quick adaptation to distributed processing, dynamic linking, low processing and memory overhead and loop freedom at all times. This scheme uses the concept of Power awareness among route selection nodes by checking power status of each node in the topology which insures fast selection of routes with minimal efforts and faster recovery. The scheme is incorporated with the Ad-hoc On-Demand Distance Vector (AODV) protocol and the performance has been studied through simulation and scheme performs very well.***

Key words—***Ad Hoc networks, Alternate path, Routing Protocol, Power Consumption, Mobile Computing, Power Factor***

1. INTRODUCTION

An ad hoc network consists of hosts communicating among themselves with portable radios. This network can be deployed without any wired base station or infrastructure support where routes are mainly multi-hop because of the limited radio propagation range. . An Ad hoc network is adaptive in nature and is self organizing. A "mobile ad hoc network" is an autonomous system of mobile hosts which are free to move around randomly and organize themselves arbitrarily. In this wireless topology may change rapidly and unpredictably. A mobile ad hoc network is also called MANET. The main characteristic of MANET strictly depends upon both wireless link nature and node mobility features. Basically this includes dynamic topology, bandwidth, energy constraints, security limitations and lack of infrastructure. MANET is viewed as suitable systems which can support some specific applications as virtual classrooms, military communications, emergency search and rescue operations, data acquisition in hostile environments, communications set up in Exhibitions, conferences and meetings, in battle field among soldiers to coordinate defense or attack, at airport terminals for workers to share files etc. Topology of the network changes frequently and unpredictably since its host moves randomly. Therefore, routing is an integral part of ad hoc communication, and has received interests from many researchers. In traditional "on-demand" routing schemes like Ad Hoc On Demand Distance Vector Routing (AODV) scheme [3], when route disconnects, nodes of the broken route simply drop data packets because no alternate path to the destination is available until a new route is established. When the network traffic requires real time delivery (voice, for instance), dropping data packets at the intermediate nodes can be costly. The Power aware scheme in Ad hoc routing Protocol enables dynamic, self starting, multi hop routing between participating mobile nodes wishing to establish and maintain an ad hoc network. It allows mobile nodes to maintain routes to destinations with more stable route selection. This scheme responds to link breakages and changes in network topology in a timely manner and also takes care of nodes that do not have better power status to participate in route selection. One distinguishing feature of Power aware ad hoc routing scheme is its use of Power status for each route entry. Given the choice between two routes to a destination, a requesting node is required to select one with better power status and more active. The rest of the paper is organized as follows. Section 2 illustrates the routing in ad hoc networks and existing protocols, Section 3 takes a look into the related work which already has been done. New protocol description and system methodology is presented in section 4. Performance evaluation via simulation is presented in Section 5 and conclusions are given in Section 6.

2. ROUTING IN AD HOC NETWORKS

Routing in an ad hoc network is trivial, if all the nodes are within transmission range of each other. All the nodes can be reached with a single hop. The transmission medium works much the same way as in a wired broadcast network. Complexity increases dramatically when distances increase and multi-hop routing is required. Routing in ad hoc networks is usually divided into proactive and reactive routing. The latter is also known as on demand routing.

2.1 Table Driven or Proactive Protocols

In Table Driven routing protocols each node maintains one or more tables containing routing information to every other node in the network. All

nodes keep on updating these tables to maintain latest view of the network. Some of the famous table driven or proactive protocols are: DBF [5], GSR [6], WRP [7], ZRP [8] and STAR [9].

2.2 Demand or Reactive Protocols

In On Demand routing or reactive protocols, routes are created as and when required. When a transmission occurs from source to destination, it invokes the route discovery procedure. The route remains valid till destination is achieved or until the route is no longer needed. Some famous on demand routing protocols are: DSR [10], DDR [11], TORA [12], AODV [3], RDMAR [13]. Study has been concentrated for reactive protocols because they work well in dynamic topology.

Table driven	On demand
Attempt to maintain consistent, up-to-date routing information from each node to every other node in the network.	A route is built only when required.
Constant propagation of routing information periodically even when topology change does not occur.	No periodic updates. Control information is not propagated unless there is a change in the topology.
Incurs substantial traffic and power consumption, which is generally scarce in mobile computers	Does not incur substantial traffic and power consumption compared to Table Driven routing protocols.
First packet latency is less when compared with on-demand protocols	First-packet latency is more when compared with table-driven protocols because a route need to be built
A route to every other node in ad-hoc network is always available	A route to every other node is not always available.

Surveys of routing protocols for ad hoc networks have been discussed in [15, 16, and 17].

3. RELATED WORK

Main emphasis of research on routing protocols in Ad Hoc networks has been delivery of packets and network performance. There has been less amount of work on power aware routing schemes, though it is very important aspect in route selection and performance of protocol. Some study has been done in this context and presented is a brief review of them.

3.1 Minimum Power Routing

Singh, Woo and Raghvendra [1] [2] proposed a routing algorithm based on minimizing the amount of power required to send a packet from source to destination. The equation is:

$$\text{Min} \sum_{i \ni path} P(i, i+1)$$

Where P (i, i+1) denotes the power expended for transmitting packet between node i and node i+1. Link cost is calculated separately for the cases when transmit power is fixed and when transmit power is varied dynamically. Variation is in terms of the distance that changes between receiver and sender. For fixed case energy for each operation is given by [2]

E (packet) = b * packet_size + c

Where b denotes packet size-dependent energy consumption and c is a fixed cost for acquiring channel. For varying transmit power Lin [4] proposed a local routing algorithm. The authors assumed the power needed for transmission is a linear function of d^{α} where d is distance between two neighboring nodes and α is a parameter depending on physical environment. This procedure requires GPS equipped systems, which in turn limits its usage and also it is based on least power cost routes which in many cases lead to problems. In this case nodes die soon and most of the cases those nodes die which are most needed to maintain network connectivity.

3.2 Battery cost aware routing

The previous case gave rise to number of battery cost aware routing algorithms as described below:
(a) Minimum battery cost routing algorithm [14]: It minimizes the total cost of the route. It minimizes the summation of inverse of remaining battery capacity for all nodes on the routing path.
(b) Min-Max battery cost algorithm [1] [14]: It is a modification of minimum battery cost routing. It tries to avoid the route with nodes having the least battery capacity among all nodes in all possible routes. It results in better use of battery of each node.

4. PROTOCOL CONCEPT

In this scheme main aim is to provide an efficient, more stable and long lasting path from source to destination. This routing scheme is designed for mobile ad hoc networks with large number of nodes. It can handle low, moderate, and relatively high mobility rates. It can handle a variety of data traffic levels. In this section, the operation details of this scheme are presented. Since the main aim is to improve the performance of existing on-demand protocols, this protocol description is based on AODV. Modifications to AODV for applying this scheme are also introduced. This scheme has been designed for use in networks in which all the nodes can trust each other, and there are no

malicious intruder nodes. There are three main phases in this protocol: REQ (Route Request) phase, ERR (Route error and recovery) phase and RE (Route Eraser) phase. The messages are received via UDP, and normal IP header processing applies.

4.1 Route Construction (REQ phase)

Route construction scheme can be incorporated with reactive routing protocols. This scheme does not require any modification to the AODV's RREQ route request process. When a source wants to transmit a data to a destination but does not have any route information, it searches a route by broadcasting a ROUTE REQUEST (RREQ) packet. Each RREQ packet has a unique identifier so that nodes can detect and drop duplicate packets. An intermediate node with an *active route* (in terms of power), upon receiving a non-duplicate RREQ, records the previous hop and the source node information in its route table (i.e., backward learning). It then broadcasts the packet or sends back a ROUTE REPLY (RREP) packet to the source if it has an *active route* to the destination. The destination node sends a RREP via the selected route when it receives the first RREQ or subsequent RREQs that traversed a better *active route*.

Nodes monitor the link status of next hops in *active routes*. When a link break in an active route is detected, an ERR message is used to notify that the loss of link has occurred to its one hop neighbor. Here ERR message indicates those destinations which are no longer reachable by way of the broken link. Taking advantage of the broadcast nature of wireless communications, a node promiscuously overhears packets that are transmitted by their neighboring nodes. When a node that is not part of the route overhears a RREP packet not directed to itself transmit by a neighbor (on the primary route), it records that neighbor as the next hop to the destination in its alternate route table. From these packets, a node obtains alternate path information and makes entries of these active nodes in its route table. If route breaks occurs it just start route construction phase from that node. This protocol updates list of neighbors and their power status periodically.

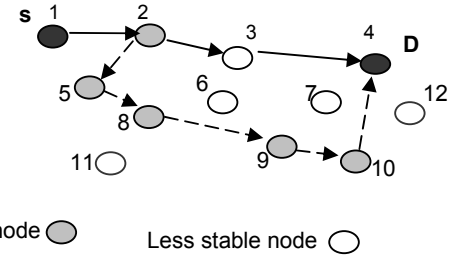

Figure1: Route Selection with stable path

Figure 1 suggests the proposed theory; the route discovered using Power aware ad hoc routing scheme may not necessarily be the shortest route between a source destination pair. If node 3 is having power status in critical or danger zone, then though the shortest path is 1 – 2 -3 – 4 but the more stable path 1- 2 -5 – 8 – 9 -10 - 4 in terms of active power status is chosen. This may lead to slight delay but improves overall efficiency of the protocol by sending more packets without link break than the state when some node is unable to process route due to inadequate battery power

4.2 Route Error & Recovery (ERR)

In this scheme data transmits continuously through the primary route unless there is a route disconnection. When a node detects a link break, it performs a one hop data broadcast to its immediate neighbors. The node specifies in the data header that the link is disconnected and thus the packet is candidate for alternate routing. Upon receiving this packet route maintenance phase starts by selecting alternate path and checking power status. Power factor is calculated using status report based on three states defined as Active, Critical and Danger level.

In this phase when route error message has sent to previous neighbor of any intermediate node it just reinitiates route construction phase by considering power status of all its nodes. All this route maintenance occurs under *local repair* scheme. Local repair scheme tries to get rid off the regeneration of route request phase in the case of route break.

Route Recovery involves Finding active nodes, their Power status, Invalidate route erasures, Listing affected DEST, Valid route update, New route (in worst cases).

(1) Nothing is done if Mobile Host that has moved is not the part of any active route , or power status of that node is below danger level which is not part of active route.

(2) If current host is SRC (Source) and host moved is next_hop then REQ is sent to search VN and Power status is checked.

(3) Local Repair scheme is used if host moved is an active route.

4.2.2 Local Route Repair

When a link break in an active route occurs, the node upstream of that break may choose to repair the link locally if the destination was no farther and there exists neighboring nodes that are in active power state. Node to participate in route selection must be in active state. It can keep on transmission till it is in Critical state and can not participate if it moves in danger state. To efficiently apply power function routines are made to turn nodes not participating in route to sleep mode to conserve energy. A node goes into sleep mode if (a) it is not transmitting any packet (b) If at least one neighbor is transmitting and one neighbor is receiving (c) if at least one neighbor node is transmitting and node is not receiver. All nodes of the topology broadcast these entries

after fixed intervals to all nodes and each node updates its routing table. To repair the link break, the node increments the sequence number for the destination and then broadcasts a REQ for that destination. The Time to live (TTL) of the REQ should initially be set to the following value:

TTL = max (neighboring nodes, 0.5 * #hops) + POW,

Where #hops is the number of hops to the sender (originator) of the currently undeliverable packet and POW is the available power state of any specific node.

From this nodes lifetime is calculated as

F (A) = 1 / TTL

This factor is transmitted as weight factor to all nodes to select best available path with maximum power. The entry is done in route table and transmitted along with hello packet. Thus, local repair attempts will often be invisible to the originating node. The node initiating the repair then waits the discovery period to receive reply message in response to that request REQ. During local repair data packets will be buffered at local originator. If, at the end of the discovery period, the repairing node has not received a reply message REP it proceeds in by transmitting a route error ERR to the originating node.

Local repair of link breaks in routes sometimes results in increased path lengths to those destinations. Repairing the link locally is likely to increase the number of data packets that are able to be delivered to the destinations, since data packets will not be dropped as the ERR travels to the originating node. Sending a ERR to the originating node after locally repairing the link break may allow the originator to find a fresh route to the destination that is better, based on current node positions. However, it does not require the originating node to rebuild the route, as the originator may be done, or nearly done, with the data session.

When a link breaks along an active route, there are often multiple destinations that become unreachable. The node that is upstream of the lost link tries an immediate local repair for only the one destination towards which the data packet was traveling. If an alternate route is not updated during the timeout interval, the node removes the path from the table.

4.3 Route Erasure (RE) phase

When a discovered route is no longer desired, a route erasure broadcast will be initiated by Source, so that all nodes will update their routing table entries. A full broadcast is needed because some nodes may have changed during route reconstruction. RE phase can only be invoked by SRC (source).

5. SIMULATION

To evaluate the performance made by the Power Aware Routing Scheme, the simulation results have been compared with that of the AODV protocol with and without applying this scheme. The network simulator NS-2 version 2.26 is used. The Network Simulator NS-2 is a scalable simulation environment for wireless network systems. Simulation modeled a network of 50 mobile hosts placed randomly within a 1000 meter * 1000 meter area. Radio propagation range for each node was 300 meters and channel capacity was 2 Mb/s. Each run executed for 250 seconds of simulation time. Here we are using random waypoint mobility model. Each node randomly selects a position, and moves toward that location with a speed between the minimum and the maximum speed. Once it reaches that position, it becomes stationary for a predefined pause time. After that pause time, it selects another position and repeats the process. The pause time was varied to simulate different mobility degrees. Longer pause time implies less mobility. The minimum and the maximum speed were zero and 20 m/s, respectively.

The Metrics used for Performance comparison are:

5.1 Packet Delivery Ratio

The fraction of successfully received packets, which survive while finding their destination. This performance measure also determines the completeness and correctness of the routing protocol. If F is fraction of successfully delivered packets, C is total number of flows, f is id, R is packets received from f and T is transmitted from f, then F can be determined by

$$F = \frac{1}{C}\sum_{f=1}^{C}\frac{R_f}{T_f}$$

5.2 End-to-End Delay

Average end-to-end delay is the delay experienced by the successfully delivered packets in reaching their destinations. This is a good metric for comparing protocols. This denotes how efficient the underlying routing algorithm is, because delay primarily depends on optimality of path chosen.

$$\text{Average end-to-end Delay} = \frac{1}{S}\sum_{i=1}^{S}(r_i - s_i)$$

where S is number of packets received successfully, r_i is time at which packet is received and s_i is time at which it is sent, i is unique packet identifier.

Simulations have been conducted for 10, 20 and 50 nodes It has been found that in all cases PARP perform better than AODV in packet delivery ratio. Figure 2 shows the throughput in packet delivery ratio for 50 nodes. As is clear this scheme improves the throughput performance of AODV as well.

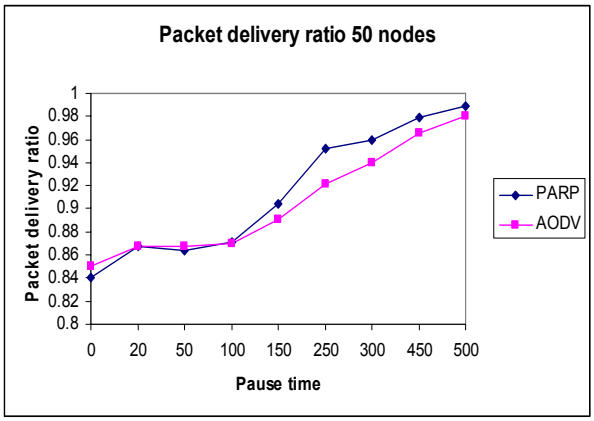

Figure2: Packet Delivery Ratio

As the mobility increases, the performance gain by alternate routes becomes more significant. Due to presence of neighboring nodes which are in active state, nodes attempt to use multiple alternate paths for data delivery in the presence of route breaks, the protocol is able to deliver more packets to the destination than AODV. The proposed scheme has some packet losses. Alternate paths may be broken as well as the primary route because of mobility or power status of nodes, or be unavailable and not discovered during the route reply phase. Moreover, packets can be lost because of collisions and contention problems.

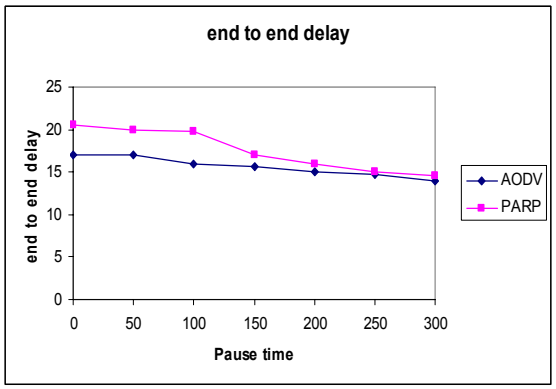

Figure 3: End-to-end delay

End-to-end delay is presented in Figure 3. As expected, New scheme has longer delays than AODV. One can only measure delays for data packets that survived to reach their destination. Proposed scheme delivers more data packets, and those packets that are delivered in Power aware routing but not in AODV, take alternate and possibly longer hop routes. So power aware routing scheme having longer delays than AODV does not represent its ineffectiveness since these protocols use the same primary route.

6. CONCLUSION

A scheme has been proposed that utilizes power status of each mobile node and alternate paths. This scheme can be incorporated into any ad hoc on-demand unicast routing protocol to improve reliable packet delivery in the face of node movements and route breaks. Alternate routes are utilized only when data packets cannot be delivered through the primary route. As a case study, it has been applied to AODV and performance has been studied via simulations.

Simulation results have indicated that new technique provides robustness to mobility and enhances protocol performance. However, this scheme may not perform well under sparse traffic networks. Its performance has been found much better than other existing protocols in dense medium as probability of finding active routes increases. Additionally, plan is to further evaluate this scheme by comparing it with other existing protocols using more detailed and realistic channel models with fading and obstacles in the simulation. The performance of protocol is slightly costlier as compared to AODV and its counterparts and causes slight overhead in route selection initially.

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3. BASIC TEXT

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"Proposed instructions for cache injection support are hand-inserted into synchronization kernels and parallel applications. A detailed simulator of memory subsystem is developed. For each application, we compare the performance of base system and one or more systems that include cache injection. Experiments varied different memory subsystem parameters, in order to explore their influence on cache injection."

4. CONCLUSION

A conclusion section is required. It should concentrate on the price/performance of the proposed/analyzed solution.

APPENDIX

Appendixes, if needed, appear before the acknowledgment. If no space available, use the appendices to indicate the web URLs with all the detailed information.

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http://www.computer.org/tab/tcca/news/sept96/sept96.htm

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