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ABSTRACT

Lulea University of Technology (Sweden) has, for the last few years, deployed an Internet-based learning environment, mStar, to distribute courses to students independent of time and geographic distance. The mStar environment gives remotely attending students possibilities equal to traditionally attending students to take an active part in a course, as well as enhancing the learning experience for all students. This is made possible through a novel combination of IP-multicast technology and the World Wide Web. This paper describes net-based learning using the mStar Environment, including large scale distributed lectures and the virtual student community consisting of a virtual teachers' room, virtual group room, and virtual billboards. The paper reports on experiences gained over a few years of practice and depicts a vision of the next generation of the mStar environment. (Contains 14 references.) (Author/MES)

Student 2000: Net-based Learning for the Next Millenium

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Abstract: Luleå University of Technology has for the last few years deployed a net-based learning environment, mStar, to distribute courses to students independent of time and geographic distance. The mStar enviroment gives remotely attending students equal possibilities as traditionally attending students to take an active part of a course, as well as enhancing the learning experience for all students. This is made possible through a novel combination of IP-multicast technology and the WWW. This paper reports on experiences gained over a few years of practice and depicts a vision of the next generation of the mStar environment.

1. Introduction

If the Internet is the next industrial revolution, then net-based learning may be the next educational revolution [Synnes et al. 1998]. The evidence of this is clearly present at most major universities and companies, where the WWW is used to distribute information to students. Many environments have been presented at past WWW conferences and we can today see that the technology is maturing as usage is increasing.

Some of the early educational uses of the WWW [Perron 1994][Goldberg et al. 1995][Ibrahim et al. 1995] and virtual classroom environments [Lai et al. 1995] have been a major influence for this educational revolution. The availability of course related information such as lecture notes, extra course material, exercises, and course schedules blended with the WWW's inherent qualities such as hyperlinks and accessibility have added much information to the classical structure of courses.

A common deficiency found in these early environments are the lack of support for spontaneous interaction between students and teachers. Additional functionality like real-time textual chat and video conferencing has enhanced communication, creating environments that are near to complete in functionality. The mStar environment [Parnes 1997a][Parnes et al. 1997b][Synnes et al. 1998] is a fully symmetric and distributed system for net-based learning that include the necessary support for spontanous interaction between students and teachers.

Although the mStar environment is functionally well equipped, the usage of it is still immature. Courses at Luleå University of Technology, LTU, are still given in the traditional way, with lectures and laborations, and students are not using the available possibilities of interaction.

This paper reports on experience gained from a wide use of the mStar environment for over three years and depicts a vision of the development of net-based learning using this environment in the next millenium. The paper consists of a brief background, a presentation of how the mStar environment is used at LTU today, and finally a discussion on how a future environment could be like.

1.1 Background

One of the major driving forces behind the Centre for Distance-spanning Technology, CDT, is to deploy net-based learning in the county of Norrbotten. The reasons for this is quite evident: a sparse population in a large geographical area, a decrease in funding while students increase in number, a higher demand from industry for post graduate studies, and the increasing problem of finding competent teachers.

Thus, many high-schools cannot gather the critical mass, funding and competence to offer the courses and subjects that are possible in the more densely populated areas. By giving multimedia- and WWW-based courses over the networks, a sufficient critical mass is generated, creating a county-wide virtual university with breadth and quality that might otherwise not be possible. This virtual university can also be used to guarantee life-long

learning aspects, where people continously can take net-based courses that does not demand their full workday attention. This is becoming more important as people without a university level degree have increasing problems to find work, at the same time as it has become economically harder to complete a full university level education.

LTU have given a large number of distributed courses using the mStar environment, ranging from graduate-courses to full fledged under-graduate courses. The university has achieved a significant deployment and usage of distributed education over the Internet, not only internally but also to other companies and organisations in the county. Giving joint courses might help bridge the gap between local industry and the university.

This paper therefore presents the concrete results of a wide deployment effort of the mStar environment for distributed education where secondary schools, the university, local companies and communities are all active participants. We are now only starting to see the first social and cultural changes within the schools and companies involved. The paper also depicts the vision of the future use and continuation of the net-based learning efforts at LTU.

2. Net-based Learning Using the mStar Environment

The mStar environment is a collection of tools that span from preparation to presentation. The tools are flexible enough to be useable in many educational scenarios, from large scale lectures to small group activities.

Note that by combining the possibilities offered by available networks, the accessibility and ease of use of the WWW and the benefits of IP-multicast [Deering 1991], we have been able to make these scenarios a part of our everyday, real-life teaching experiences. We would like to stress that this is a working system in real use.

This chapter means to briefly describe the current use of these tools, as well as some lessons learned.

2.1 Large Scale Distributed Lectures

The traditional large scale lecture is currently an important part of the net-based learning efforts at LTU; not because it is the best form of education, but perhaps because it is most similar to ordinary education.

To conduct a distributed lecture the lecturer prepares HTML slides before the lecture, where additional content can be linked into the slides for in-depth information. The slides is then put on the WWW in advance of the lecture which give ambitious students the possiblility to prepare for the lecture. They can also be used after the lecture for repetition or further in-depth study.

The lecture hall is equipped with computers, cameras, microphones and projectors. This enables projection of the HTML slides in the lecture hall as well as distribution of the slides to remote students attending from the net. In addition audio and video are distributed from the lecture hall, which gives the remote students an equal opportunity to take an active part in the lecture. The remote students can also send audio and video, which gives them the possibility to ask voice questions just as if they were in the lecture hall.

All-in-all the learning experience come near to something that is *better-than-being-there*. That is, the remotely attending student has an enhanced learning experience in comparison to the normally attending student. The remote student can in parallell to the lecture follow in-depth material, have side conversations with fellow students, and can even do secondary low attentive. Furthermore, remote students with disabilities have benefits that are not otherwise available, such as control of the slide presentation format (font sizes, colors etc) and a more undisturbed audio environment.

The mStar environment constitutes a set of tools based on IP-multicast. These tools and their respective use have previously been presented in detail [Parnes 1997a][Parnes et al. 1997b][Synnes et al. 1998], but here is a brief summary of the most used tools:

- mMOD - media-on-demand server for recording and playback of sessions
- Marratech Pro – fully symmetric media client, which consists of two parts:
  - mVideo (audio and video)
  - mViewer (slides, chat, whiteboard and session directory)

The lecturer announces a session for the lecture, then both lecturer and students launches Marratech Pro. All media are then presented locally in the lecture hall as well as distributed to the remotely attending students. The student can ask questions by either sending voice (mVideo), text (mViewer chat) or figures (mViewer whiteboard). Note that the students in the lecture hall can hear and see the remote students and the other way around.

The participants are 'submersed' in a fully symmetric environment that takes distance education a step further

from traditional HTML-based courses. The students are no longer passive receivers as they can interact in real-time, which is very important for promoting student participation and debates between class members.

Finally, the lecture can be recorded with mMOD and can then later be played back. A recorded session can for instance be played back into a live lecture, which enable reviewing and debating of related recorded material. The recordings also give students a possibility to rehearse before exams, and – more important – follow courses asynchronously. The latter is a major point for life-long-learning issues, where people that cannot attend during day-time or even follow a course full-time actually can take part of a course.

2.2 Virtual Student Community

The lectures mainly offers a one-to-many channel, since students often are too shy to ask questions – especially if the session is large. We have found that something complementary is needed, where students can cooperate and interact with each other. It is naturally very important, perhaps even vital, for remote students to have a continuous contact with the teachers and fellow students.

Creating such a community, as described in [Lai et al. 1995], can also lessen the workload for both students and teachers. Today students themselves are sources of information, the teachers are no more the sole information source, which means that collaboration and sharing of information is vital to make large distributed courses a success.

However, most of the courses currently given using the mStar environment at LTU are *normal* university courses. This means that the incentive to establish a virtual student community is weak, since there is a physical community to fall back on. It is always possible to knock on the teachers door. The result is also that the current virtual student communities are sparsely populated. This would change if most students were *real* remote students, and the physical community was not available.

2.2.1 Virtual Teachers Room

The virtual teachers room is basically a Marratech Pro session where the teachers of a course are available to answer questions or chair discussions. This could also be a session where a group of teachers are available – thus not necessary linked to a specific group, but as a general resource. The latter case might be important for the feeling of continuity for remote students, since they change courses every tenth week and need a fixed point in their studies.

2.2.2 Virtual Group Room

A Marratech Pro session can be used by a group of students, forming a virtual group room, to discuss course related issues, with or without a teacher attending. The virtual group room can also be used for project status presentations, where a subgroup of a larger class is attending.

This form of meetings may prove invaluable, as remote students need to overcome isolation by forming groups and socialize. It is therefore important that courses emphasize collaborative over individual learning, in order to stimulate use of this media.

2.2.3 Virtual Billboards

The value of asynchronous communication should not be underestimated, as many students choose to follow courses entirely or partly asynchronously. Systems that support asynchronous communication are numerous, ranging from simple mailing lists to advanced WWW-based boardsystems. LTU has recently deployed a system developed internally, W3Cs, which enables students and teachers to communicate via a bulletin board. W3Cs also offer basic support for course management, a task earlier handled by homemade scripts individual to each teacher and course, as well as support for document publication.

One observation made is that usually silent students also contribute to asynchronous communication, maybe because they have more time to formulate their meaning or since the interaction is more abstract. This is more noticeable if a electronic group is maintained over time, creating a virtual community of students where the

students *feel like home*. The virtual community must however have an active leadership (introducing new members and excluding misbehaving members) and clearly defined boundaries (limiting what should be discussed).

2.2.4 Lessons Learned

The statistics from our mMOD server logs show that many students prefer to watch lectures during evenings, or even late at night. The possibility to watch recordings is clearly useful for students having overloaded daytime schedules. Using the playback facilities offers another clear advantage; it enables students to take pauses, to either read additionally related information or to consult the course literature. Unfortunately, these students can not be part of the spontaneous discussions during lectures. Having multiple participants active in the playback environment might remedy this to an extent, but this is clearly an area to be improved.

We have noticed that other social protocols have been established when using the environment for presentations and education. Foremost are the sub-discussions that take place using the chat tool, where a set of the participants either discuss the presenters material or something completely uncorrelated. This kind of discussions and sharing of information enhances the learning experience, since attending a lecture physically normally disallows side conversation in the audience.

By encouraging the use of different means of communicating electronically, such as email or WWW-based discussion media, we have found that students tend to help each other. This form of social clustering, is most interesting. It lessens the traditional burden of a teacher, where students with additional knowledge often share it with the rest of the class and the teacher. The fact that students are able to share this knowledge with the group is an enormous advantage to more traditional teaching, where students seems to rarely form groups with more than five members.

A downside is that lectures distributed with the mStar environment tend to become more static than classical (i.e. non electronic) lectures. Experienced teachers are most often those who can improvise and dynamically alter the course of a lecture. These teachers usually do not need to prepare presentation material, as their lectures often take the shape of a normal conversation. With mStar, teachers are easily *caught* in the flow of their pre-made electronic material. It is therefore very important to still allow the teacher to improvise, perhaps by making use of an electronic whiteboard or a sketchboard.

3. Net-based Learning for the Next Millenium

The experience gained over the last years allows us to draw conclusions about how a future system for net-based learning could look like. This chapter therefore aims to present our vision and to give initial answers to some of the questions we have found important.

3.1 Questions

Who will the future student be? Students will range from persons reading a single course to persons following a complete fixed program, but the typical student will have a individualized program (where they select course themselves). They may also have varying study paces and learning styles, as well as different needs for learning support. A conclusion is that the future students will be a very inhomogenous group, especially if we take life-long learning into consideration. This means that courses must be modularized to a larger content than today, so that it is easy to customize a course for an indivual depending on the knowledge level of that individual. Required background information and in-depth material should therefore be easily accessible to give individuals an optimal learning experience.

Where and when will the student study? The possibility to study independently of time and geographical location is increasingly important. The idea that a university is for everyone is otherwise hard to attain, atleast in Europe. People that are limited to study on evenings or that is resident far from a university are dependending on this possibility.

Will the university offer social training? The student used to be a passive individual that is fed information; this is something we need to change. The industry needs persons that can communicate easily and work effectively in groups, which means that we need to better prepare the student for the professional life after

graduation. The traditional lectures must be complemented by group discussions and projects where students work in groups. Again this might be a European phenomenon, but is generally important. It is naturally extra important for net-based learning scenarios, where the remotely attending students otherwise easily can get socially isolated.

Will there be a local university? The role of the present universities will not change initially, even if much of the competence will reside on the outside. There are however several efforts to create virtual universities, where top competence is gathered to one virtual location. This means that the physical location for studies will be less important in the future, even if it for obvoius reasons always will remain (lab equipment etc). The most extreme is that the university only will be the *quality brand* of an educational program. It might also be so that the currently ongoing competence concentration around cities with universities will slow down, where the less densely populated areas also can take part of higher education and prosper.

3.2 The Vision of the Student Year 2000

Our belief is that students will not be much different than today, but that they will have increased possibilities to take part of university level education. No longer are large geographical distances or time limitations ruling out where and when education can be offered. The student year 2000 can be everything from a full-time student attending lectures physically on the university, to a part-time student following courses from his home at evenings and weekends. It might even be cheap, both from economical and time perspectives. By giving courses for a larger number of students, they will become cheaper per student. Remotely attending students will also need to travel less, which further lowers the cost as well as the time spent. The student in the next millenium will certainly have demands on cost and time efficient education.

By combining large scale distributed lectures with group projects and personal assignments, well balanced distributed courses is attainable. The lectures should contain invited speakers from the industry or other research organisations, to complement the traditional academic content and to better prepare students for what is required after graduation. The group projects leads to early training of social skills, while personal assignments remain important for grading reasons. However, when courses are attended by a large number of students, it will be increasingly important to establish personal tutors or advisors. Personal relations to teachers are important for the overall learning experience, students simply need someone to ask questions.

The future of net-based learning include equal parts of freedom and responsibility. We can clearly see that the old way of spoon-feeding students with information is coming to an end, and a more collaborative shared learning experience is forthgrowing. This however needs students with high self-motivation, discipline and commitment. It also put higher demand on the courses, on content as well as pedagogics. The new net-based courses must apply specially developed content, following the old tracks simply do not work, and new ways of teaching is also required, which emphasize collaborative learning.

4. Summary and Conclusions

This paper describes a novel multimedia environment for net-based learning which tightly integrate the WWW in a close relationship with IP-multicast technologies. The variety of usage experiences and the successful county-wide deployment clearly demonstrates that the mStar environment is scalable from small informal presentations to complete university courses.

We have argued this from a variety of perspectives, all showing that this environment offers extended support for interactivity, better help through the use of a *virtual student community*, as well as on-line availability of all course media. The goal is to create an educational environment that can be qualified as better-than-being-there, bringing everyday situations such as interacting, learning and collaboration to the Internet.

5. Future work

Today the different tools are simple and intuitive to use, and the technology is rapidly becoming stable. There is however a long way to perfection, especially considering the pedagogic aspects. Large scale lectures is still far too common, which in turn are too limited when distributed over the network. Using only HTML slides is too limiting, and using the mouse to draw in the electronic whiteboard is too unprecise. Work is currently proceeding

to install a pen-based electronic whiteboard (synchronised with the mViewer Whiteboard) in the lecture hall, to better support spontanity.

Although the remote students have a very good environment for following lectures, the physically attending students have a less than perfect environment. This is due to bad hardware, where the LCD projector available in LTUs lecture hall is both too noicy and weak. Together with limited spontanity, this creates a *tiredsome* setting for the locally attending students. Hopefully new funding can sponsor a better equipped hall.

As a last issue, the general pedagogic and social issues in our net-based learning environment needs to be studied. How good are distributed courses in comparison to traditional courses, and how does the results of remotely and physically attending students compare? Our belief is that we have a strong technology, but that we are weak on pedagogy. Hopefully, the new Center for Net-based Learning at LTU, CNL, will help us bring clarity to the remaining pedagogical issues.

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