

PROCEEDINGS E REPORT

Video Conference as a tool for Higher Education

The TEMPUS ViCES experience

Edited by
ENRICA CAPORALI
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FOREWORD
THE TEMPUS JOINT PROJECT ViCES -
VIDEOCONFERENCING EDUCATIONAL SERVICES
(2009 - 2012)

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The Videoconferencing Educational Services Project was funded in 2009 by the European Commission as part of the Tempus Program IV, with the University of Florence as Grant-holder and the University Ss. Cyril and Methodius in Skopje (FYR Macedonia) as Grant Coordinator.

The K.U. Leuven (Belgium), the NIIF Institute in Budapest (Hungary), the International Telematic University Uninettuno (Italy), 6 Universities in FYR Macedonia, the University of Belgrade (Serbia) and the Polytechnic of Tirana (Albania) were partners of the project.

The general objective of the project was to use a videoconferencing network with nodes in FYR Macedonia, Serbia and Albania, as a support for higher education experiences in the Balkan region.

Specifically, the project aimed at establishing videoconference services as a part of a distance learning system among several universities in FYR Macedonia, and included the adaptation of educational and organizational methodology to make the most of the videoconference system. A further objective was to increase co-operation in the higher education field among Balkan countries, including by strengthening the Macedonian Academic And Research Network (MARNET) in charge of organizing the academic and research network in FYR Macedonia, both for international co-operation and as part of a permanent modernization process.

This publication is the conclusion of the project as it reports the main outcomes together with the approach adopted by the various partners to achieve their goal.

The book includes a number of contributions focusing on specific topics related to videoconferencing services, such as the enabling of such services in educational contexts, with particular reference to FYR Macedonia and Serbia, and the installation and deployment of videoconferencing systems as part of virtual open campuses.

A specific contribution is dedicated to the pilot videoconferencing sessions which were organized in the framework of the Environmental Engineering three-year courses held at the University of Florence and at the Ss. Cyril and Methodius University. This experience provided an excellent opportunity for testing the videoconference equipment and evaluating possible opportunities for its use within the educational context of the university.

At the final project meeting, held in Belgrade in December 2011, the partners all agreed in considering the ViCES experience very interesting and fruitful, as it had provided an opportunity to improve regional scientific co-operation in the Balkan area and to build an educational network between EU Member States and partner countries. The entire Consortium expressed its belief that further co-operation initiatives should be developed and we sincerely hope to have such an opportunity in the near future.

Acknowledgments

The authors acknowledge with gratitude the contribution by the European Commission, DG Education and Culture, which funded the ViCES Project as part of the TEMPUS IV Program. Very special thanks goes to the legal representative of the project, Prof. C. Borri, the Vice Dean for International Relations of the School of Engineering of the University of Florence and to all the staff of the International Relations Office of the School of Engineering.

Finally, the authors also wish to thank all the colleagues and staff of the Consortium Partners for the support given to the project activities and the organization of meetings and visits. A complete list of ViCES institutional partners is given below:

University of Florence, School of Engineering, Italy;
Ss. Cyril and Methodius University - Skopje, FYR Macedonia;
European University - Skopje, FYR Macedonia;
St Kliment Ohridski University - Bitola, FYR Macedonia;
Goce Delcev University - Stip, FYR Macedonia;
South East European University SEEU - Tetovo, FYR Macedonia;
FON University - Skopje, FYR Macedonia;
Ministry of Education and Science of FYR Macedonia;
University of Belgrade - Academic Network of Serbia, Rep. of Serbia;
Polytechnic University of Tirana, Albania;
Università Telematica Internazionale Uninettuno, Italy;
Katholieke Universiteit Leuven, AVNet, Belgium;
NIIF Institute, the National Information Infrastructure Development Institute, Hungary.

ENABLING VIDEO CONFERENCING EDUCATIONAL SERVICES IN HIGHER EDUCATION

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Abstract. European Higher Education is facing the challenges and opportunities of globalization on the one hand and localization on the other. New technologies, new types of learning content, new providers and new learners have enabled the use of innovative educational solutions. In this paper, the major outcomes achieved by using high end videoconferencing systems within the Western Balkans will be presented. The three-year ViCES (Video Conferencing Educational Services) Project was launched and financed by the European Commission as part of the TEMPUS (Trans-European Mobility Scheme for University Studies) program. The ViCES project provided the Republic of Macedonia, Albania and Serbia with an initial technological infrastructure and learning environment to facilitate student and academic mobility as well as support the harmonization process of different curricula among educational institutions.

1. Introduction

Higher Education refers to the education provided by universities, colleges, institutes of technology and other collegiate level institutions awarding academic degrees or professional certifications. Higher education may take place in a wide range of educational environments which have different educational goals. There is therefore a need for flexibility and the individualization of the educational process. Since the traditional classroom environment cannot effectively provide this flexibility, new educational environments should be exploited.

The mobility of students, early stage researchers and university staff is considered as an added value to the quality of programs and excellence in research and to the academic and cultural internationalization of European higher education. Mobility fosters respect for diversity and the ability to deal with other cultures. It encourages linguistic pluralism, underpinning the multilingual tradition of the European Higher Education Area. Mobility also increases cooperation and competition between higher education institutions. In order to achieve all these benefits, different academic

networks need to be established. Improving communication between the various players in the educational process is crucial to such purpose.

New educational paradigms and innovative education practices stimulated by new information and telecommunication technologies can be used to improve the provision of education by providing instant access to the latest educational materials or educational processes happening in different geographical locations, thereby enabling more effective learning (Jeong *et al.*, 2007).

Students are becoming increasingly familiar with the use of different technologies for their studies and research. This fact provides an opportunity for creating a novel education environment, where high-end, internet-based services are used to implement techniques which cannot be implemented in traditional classrooms. New approaches for providing valuable learning, which allow students to adapt to their learning environment and increase their knowledge and competence, may be seen as indicators of the success of such learning methods. Video conferencing education services, used in combination with other learning paradigms in terms of didactic approaches, help to create such educational environments by lowering the cost and increasing the possibility of access to the educational services provided by various higher education institutions (Bates *et al.*, 2005) (Stephenson *et al.*, 2008).

Video conferencing enabled learning is a new way of acquiring knowledge, which is highly adaptable to different kinds of student profile (Nishinaga *et al.*, 2004). The video conferencing-based learning environment provides a virtual mobility offering benefits to the more general public and enabling the most suitable participants (both from the instructor's and student's perspectives) to attend classes by reducing travel stress and providing availability. The exchange of knowledge and process of consultation between students and available expert authorities (professors/instructors) is a very important aspect of learning alongside the static contents provided in books and various digital learning materials.

In 2008 the University of Florence and the Ss. Cyril and Methodius University launched a three-year TEMPUS Joint Project called ViCES (Videoconferencing Educational Services) financed by the European Commission as part of the TEMPUS IV for the period 2009-2012.

The project, carried out by the University of Florence and the Ss. Cyril and Methodius University in Skopje, together with all the consortium members (three partner universities in the European Union and various universities in Albania (AL), the Republic of Macedonia (MK) and Serbia (RS)), introduced a new approach towards the treatment of Information Communication Technologies at a university level. ViCES provided an environment to support and increases student and academic mobility as well as infrastructures facilitating the harmonization process of different curricula between educational institutions.

This paper explains ViCES' approach to using such educational environment and how it addresses the multiple levels of technology and services which need to be implemented, including the networking infrastructure and video conferencing infrastructures. The service levels include: a web-based portal including services for live video conferencing and video streaming, educational services and their implementation, and the organizational framework needed to support educational services.

The ViCES networking infrastructure and specimen services are elaborated in section 2 of this paper. The didactical approach recommended by the ViCES project is presented in section 3, while the organizational framework needed to support the video conferencing service recommended in the ViCES project is described in section 4. Section 5 concludes the paper.

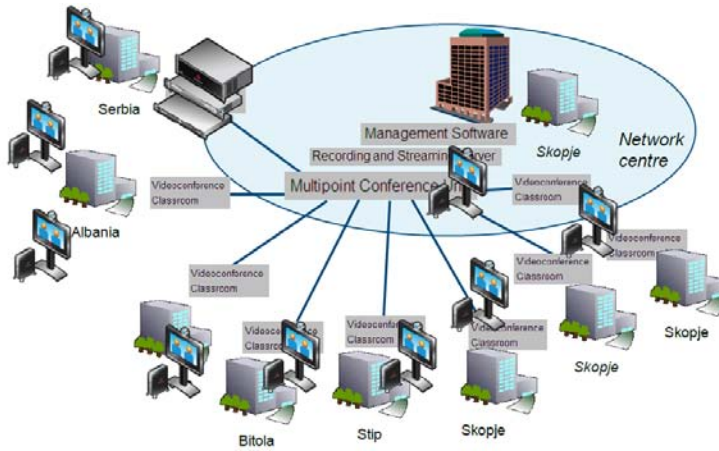
2. *ViCES video conferencing infrastructure and services*

Video conferencing involves two-way video, audio and data communication between two or more parties over a remote connection. Video conferencing is carried out over a variety of media. Due to its low cost, the most popular Video conferencing infrastructure at present uses Internet Protocol (IP) technology (Surendar *et al.*, 2007).

Streaming technology enables the use of video conferencing services. Streaming technology covers the one way transmission of audio, video and possibly other content to an end user. Archiving digital video content and subsequent retrieval methods of archive content must be included. Real-time streaming of videoconferences must consider the achieved quality of service of the real time video streaming since it is directly related to the end user's perception of the content. The second technical issue that needs to be considered when using video conferencing is video format resolution (Huatanu *et al.*, 2007). Large audiences require higher video resolution. Unfortunately, this increased communication bandwidth that should be used for the video conferencing session results in difficulties when providing the required quality of service.

The ViCES educational video conferencing network is based on Polycom's HDX series installed in every major university in Macedonia and the two most important technical universities in Albania and Serbia. It includes multi-conference management centers, video recording and streaming servers. The management software can utilize and optimize the network traffic generated by the video conferencing sessions. The recording and streaming server provides recording capabilities for any video conferencing sessions, thus enabling their later streaming to any web-enabled client (Dickson *et al.*, 2008). The multipoint conference units enable parallel and multicast sessions between different video conferencing classrooms. The general scheme of the ViCES video conferencing infrastructure is shown in figure 1.

Figure 1. ViCES video conferencing infrastructure

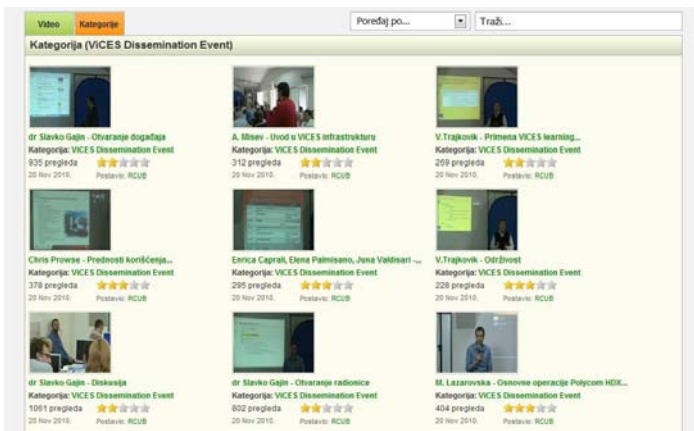


2.1 ViCES video portal

The ViCES video conferencing portal enables students from different universities to attend different lectures on the same or similar subjects. Students are able to exchange ideas and educational findings with wider student communities sharing similar interests (Bolettieri *et al.*, 2007).

The videoconferencing portal has two main functions: to provide access to live videoconferencing and access to pre-recorded videoconferencing sessions by video streaming. The interface of the ViCES video conferencing portal is presented in figure 2.

Figure 2. Interface of the ViCES video conferencing portal



3. *ViCES didactical approach*

The didactical components of any learning environment promoting the usage of video conferencing services can be itemized as follow: the educational methodology used in the learning process and mapping of the video conferencing technology onto the educational methodology (Koumi, 2005).

Videoconferencing sessions should be supported with various educational materials (background reading materials, biographies and possibly the given presentation support materials) before the lectures. After the videoconferencing session the participants should be able to contribute to further discussions (via chat, or forum, and to re-visit the lecture by watching the recorded video conferencing session again).

In the ViCES approach, each videoconferencing session has three main parts:

- interactive preparatory activities which can be supported by various technologies depending on the chosen instructional design models;
- video conferencing session delivery which can be defined as a presentation from a recognized expert using videoconferencing. The videoconferencing sessions should be recorded and made available afterwards to all interested parties;
- interactive follow-up activities that should follow different instructional design models and which may be supported by different technologies.

4. *Organizational support for ViCES services*

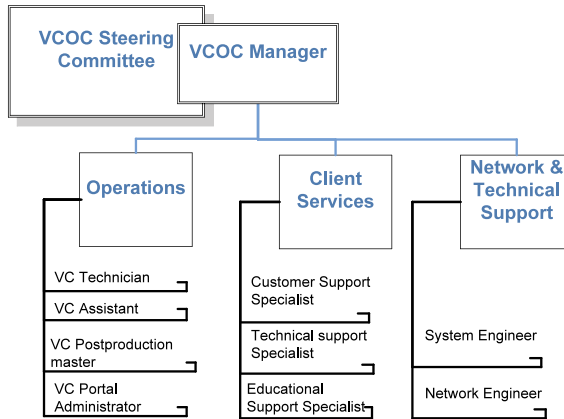
The Video Conferencing Operation Center (VCOC) is designed to support video conferencing activities. It is assumed that relatively small video conferencing operations both in scope and volume will be available at universities in Macedonia at the start of the video conferencing.

The VCOC should be divided into three sections according to the type of activities performed by each. These are: Operations, Client services and Network and technical support.

The complete VCOC organizational structure is shown in figure 3. This organizational structure may initially have one part-time employee per section (initial VCOC organizational structure). It should be noted that the initial VCOC organizational structure is most suited to a very small scale of VC operations (e.g. 20-50 VC Sessions per month), while the complete VCOC structure is suitable for medium to large-scale VCOC operations (e.g. 200 or over VC sessions per month).

The VCOC operations group performs day-to-day activities. The staff in this section maintain the equipment, schedule videoconferences

Figure 3. ViCES organizational approach



and give online support to the clients. The VCOC client services group is responsible for communications with the clients. It prepares and signs the SLA agreements and caters to other client needs. This group is responsible for the proper use of video conferencing services so as to optimize educational benefits, also creating billing reports and taking care of the financial aspects of VCOC. On the technical side this group evaluates and certifies the client's equipment for interoperability. The VCOC network and technical support service maintains the underlying network infrastructure, related servers and applications.

VCOCs should be established at each university offering video conferencing services and a national steering committee should be set up to coordinate the work of various VCOCs. The steering committee consists of three representatives:

- a representative from the University/Faculty where the VC equipment is maintained (the VCOC is usually an organizational part of this institution);
- a representative from the academic infrastructure provider (in the case of R. Macedonia – MARNet);
- a representative elected by major VC users using VCS for educational purposes.

The VCOC will need to establish standard procedures for the processes related to offering VC Services. The initial set of processes which needed to be defined and documented is as follows:

- service ordering;
- certification;
- service handling (implementation);
- maintenance;
- internal reporting;

These processes may be implemented in a different formal manner depending on local university policies. The ViCES project has drafted the workflow for processes with a mind to optimizing them as regards organization (potential lack of staff or lack of staff availability during their part time contracts) and efficiency (the need to set up a flexible organization).

5. Conclusion

In this framework the ViCES (Videoconferencing Educational Services) European-funded TEMPUS Project, carried out by the University of Florence and the Ss. Cyril and Methodius University in Skopje, was launched and financed by the European Commission for the period 2009–2012.

This project has introduced a new approach towards the treatment of Information Communication Technologies at university level, enabling a greater level of harmonization of the different curricula of partner institutions at an international level. Video conferencing is a direct product of the need to adapt education more adequately to the evolutionary development of modern society, with technology as its constituent component. To such purpose different didactical approaches need to be set up for providing education and the relevant organizational support. In this paper we have presented the findings of the ViCES project on this matter.

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THE SIGNIFICANCE OF USING VIDEO CONFERENCING IN HIGHER EDUCATION IN R. MACEDONIA

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Abstract. The ViCES project carried out by the University of Florence and the Ss. Cyril and Methodius University in Skopje, together with all consortium members has introduced a new approach for the use of Video Conferencing Systems at University level in R. Macedonia. The establishment of video conferencing infrastructure and corresponding educational methodology is the basis for further development of an efficient lifelong learning university educational system. The most important benefit of installing video conferencing infrastructure at national level, is allowing the network of institutions to easily share their educational materials, and work together in joint project, not only at national but also at international level.

1. Video Conferencing in Higher Education

Higher Education plays a very important role in the development of people and societies and enhances their cultural and economical development. New educational paradigms and innovative education practices stimulated by new information and telecommunication technologies can be used to improve the quality of education. Conversely, technology-based educational environments need constant upgrading, drawing attention to the need for the economic sustainability of such environment.

The development of a European Higher Education Area was addressed in the Bologna Process (EU Commission 2004) (CRE, 200). This process is aimed at creating more attractive, comparable, compatible and coherent education systems throughout Europe. In order to achieve these objectives and encourage international co-operation, Higher Education institutions are involved in a wide range of programs such as: LLP (Lifelong Learning Program), ERASMUS MUNDUS and TEMPUS (Trans-European Mobility Scheme for University Studies) These programs stimulate European higher education institutions to further internationalize their activities in order to engage in global collaboration for sustainable development.

The European Council has affirmed twice, at Lisbon in 2000 and at Barcelona in 2002, the critical nature of the speed and quality of development of the Information Society in Europe for the future of the continent's economic prosperity. The modernization of higher education has been acknowledged as a core condition for the success of the Lisbon Strategy (EU Commission, 2008) which the European Union launched

in March 2000. The EU modernization agenda for higher education is clearly set out in the European Commission's communications 'Mobilizing the brainpower of Europe: enabling universities to make their full contribution to the Lisbon Strategy' (EU Commission, 2005) and 'Delivering on the modernization agenda for universities: Education, research and innovation' (EU Commission, 2006)

The conclusions and recommendations of the workshop 'Policy Issues for NRENs in South East Europe' (NATO AWN, 2003) provides input for the agenda of decision-makers responsible for policies on research and education, telecommunications and the technical and economic developments of governments in South East Europe. It clearly states that «there is no knowledge-based society without the appropriate information and communication infrastructure. Participation in the development and establishment of the information society is a question of autonomy and competitiveness for each and every nation. The research and education community is the environment where new Information and Communication Technologies (ICTs), and their applications, are conceived, prototyped and brought to life. This community is the place in which the first, real-life, nation-wide tests of many of these techniques are conducted, and further developed».

This approach was also supported by the national IT strategy (MIS-ARM, 2005) recognized by the Parliament of the Republic of Macedonia. New information and communication technologies should be involved in higher education and thereby become a normal working environment for students, resulting in increased use of such technologies in the industry. The use of technologies encouraging active learning within higher education naturally increases the acceptance of lifelong learning policies. These technologies include: computer-assisted instruction, group communications (asynchronous and synchronous), video conferencing systems, web and multimedia materials, collaborative learning, collaborative knowledge systems etc.

Distance Learning Environments reflect the trend of using a mixture of delivery modes for optimal instruction and learning. According to the National Strategy for the Development of Education in the Republic of Macedonia (the organization for carrying out the activities of the Ministry of Education and Science by 2015) (MESRM, 2004), the achievement of these aims is determined directly by the «determination of R. Macedonia to favor education and training, the implementation of advanced technology and its efficient use, raising the efficiency of the public sector and practicing high standards and values».

There is an evident need to offer educational services that will use the existing IP infrastructure so as to provide such services to a wider audience (of national interest) and help the MARNET institutional reform by providing means for organizational and financial self sustainability (institutional interest). To provide such service, all the interested parties

(Ministry of Education, Ministry of Information, society and the public administration, all state-owned universities and most relevant private universities) were consulted as regards use of the MARNET potential infrastructure for offering educational services. One of the services with the most potential is the high end video conferencing system. Such a service is able to: facilitate staff mobility in the case of universities spread out in dispersive locations; promote local student mobility within ECTS at a regional level and encourage inter-university cooperation at a national and international level. The last is increasingly important when there are international curriculums that can offer joint or double degrees between universities in R. Macedonia and universities in the EU since the video conferencing service can further the quality monitoring process.

2. Video Conferencing Services Provided by the ViCES Project for R. Macedonia

The ViCES project (Vi/CES, 2009), implemented by the University of Florence and the Ss. Cyril and Methodius University in Skopje, together with all the consortium members (three partner universities in the European Union and various universities in Albania (AL), the Republic of Macedonia (MK) and Serbia (RS)), has introduced a new approach towards the treatment of Video Conferencing Systems at university level in R. Macedonia.

In October 2007 during the ViCES project, the Government of R. Macedonia reconstructed and transformed the Macedonian Academic and Research Network (MARNET) from being a university-based institution to a National Institution operating within the National Inter-University Conference.

Macedonia has a population of 2 million, a surface area of 25,333 km² (9,781 square miles), six state-owned universities and several private universities. The Macedonian Academic and Research Network (MARNet) provides advanced information and communication infrastructures to academic and research communities in R. Macedonia. The MARNet is connected to the European Academic Network via the GEANT network.

The ViCES project provides one central video conference management system and seven video conference classrooms in R. Macedonia as well as two video conferencing classrooms in Albania and Serbia. This infrastructure has already been updated with more than 8 new video conferencing sites that are willing to participate in the ViCES network. We expect this number to continue to increase. The neighboring academic and research networks of Albania and Serbia have also shown interest in this service. Wider publicization of the project resulted in opportunities to participate in networks offering similar services from an educational or technological point of view.

The primary stakeholders interested in using videoconferencing services are educational institutions (universities, research centers) and students, but on a wider scale, government and non-government organizations, companies and the general public can be also treated as stakeholders.

Establishing a video conferencing service infrastructure means providing an organizational and procedural infrastructure to accompany it. There is an evident need to determine formal and legal procedures that define the terms of use of such service at a regional level. A change in the educational didactical approach should also be encouraged. The ViCES project has succeeded in producing recommendations for all of these issues.

The Macedonian Ministry for Education and Science has actively participated in the project by supporting the transformation process of MAR-NET from a university-based institution to a National Institution, by helping to draft the initial self-sustainable procedures, service level agreements and organization needed to provide video conferencing services, promoting the use of video conferencing systems at all levels of education at local and international meetings, participating in the organization and recognition of local workshops and conferences publicizing such.

3. ViCES Organizational Support provided by the Ministry of Education and Science of R. Macedonia

It is clear that an understanding of the learning process and the way in which technology can best support it, is needed for successful education. However these are not sufficient for success. There are other factors which are also important for the successful implementation of educational processes. These factors relate to the institutional needs of higher education. The main needs addressed by this project are as follows:

- the need for large-scale collaboration in education technology development;
- the need to share resources, especially transferable courseware, on a national scale;
- the need for staff development.

Video conferencing-enhanced distance learning increases the educational opportunities offered by any institution. It reduces the costs of teaching and learning, while giving students greater access to a variety of degree programs. To make video conferencing educational services function effectively, efforts should be made to promote the use of such technologies at a National Level.

The target groups of the project are students and faculty staff. The direct beneficiaries of the project are the students. Higher education institutions also benefit from this initiative by adopting a learning en-

vironment which supports increased student mobility in terms of the learning process.

This project influences the lifelong learning process in the Republic of Macedonia. Establishing the video conferencing infrastructure and corresponding educational methodology will be the basis for further development of an efficient lifelong learning educational system for universities. Both outcomes are measurable by the quantity of video conferencing sessions held and the number of students and academic staff participating in them.

The project meets the needs and interests of the partner country universities and the overall objective of the TEMPUS program since it «contributes to an area of cooperation in the field of higher education involving the European Union and partner countries in the surrounding area» and «promotes convergence with EU developments in the field of higher education deriving from the Lisbon agenda and the Bologna process».

The project outcomes are in the framework of the priorities defined for the Republic of Macedonia by the Joint Project Governments reform since they:

- promote the reform and modernization of higher education in the partner countries;
- build up the capacity of higher education institutions in the partner countries and the EU, in particular their capacity for international cooperation and for a permanent modernization process, assisting them in opening up to civil society and helping to overcome the fragmentation of higher education between countries and between institutions in the same country.

More specifically, the project outcomes have:

- provided new video conferencing services for students;
- supported the institutional reform of MARNET;
- furthered equal and transparent access to higher education;
- promoted the development of international relations.

Special efforts have been focused on dissemination and the sustainability of the project results. Workshops have been organized for each year of the project, involving partner country representatives and a wider, different student and faculty staff audience.

4. ViCES Project Sustainability

Sustainability of the project is potentially guaranteed by the enormous interest of students in the project results. However, the sustainability of the project is also directly related to the cost of video conferencing. It

cannot be reduced to the cost of installing video-conferencing units in classrooms. The costs involve the long-term requirements needed for educational change in conjunction with ICT.

The short term costs of video conferencing can be divided into three main categories:

- infrastructure costs (telecommunication hardware, videoconferencing servers and end-units, adaptation of the classrooms, audio equipment, presentation equipment, software);
- staff costs (experts, local moderators, technical staff, administrative staff);
- ongoing expenses (data and telecommunication volume, external services, equipment maintenance).

Staff cost expenses can be reduced by hiring university staff on a part-time basis (post-graduate students may be especially interested in this kind of position). This way, video conferencing centers can tailor the availability of services according to the availability of staff. Once the demand for services starts to increase, full-time employment should be arranged.

Ongoing expenses are incurred when the videoconferencing infrastructure is utilized, which means there is a party using the equipment, so these cost should be easier to cover. The margin added to the actual cost incurred should cover at least regular maintenance and staff cost expenses.

The following constitute potential revenue sources for the ViCES environment:

- directory services on a national level, or access to the video conferencing servers for optimizing and recording videoconferencing sessions);
- dedicated lectures and seminars offered to specific target groups;
- hosting of recorded video sessions;
- providing streaming options for the interested parties;
- post-production of the recorded video material including translation and sub-titling;
- training of the interested parties explaining the potential for introducing video conferencing services to their institutions.

To increase the number of potential clients, video conferencing centers should offer three categories of fees or discounts for special types of client. The client types are: commercial clients (including private educational institutions), non-governmental institutions, and governmental institutions (including public institutional institutions). This way, video conferencing can be stimulated depending on the expansion strategy of the video conferencing centre. The minimum rate (or maximum discount) should at least cover ongoing expenses.

The use of video conferencing services within institutions should be treated as an internal cost and should therefore be related to: project costs,

educational student service costs, or internal institutional costs. Video conferencing centers should provide legislative means to enable them to provide such kind of internal invoice generation.

5. *ViCES Outcome potential*

The services provided by the ViCES project can increase the visibility of any international research project by optimizing project travel costs and increasing project efficiency. From the point of view of the video conferencing centre, participation in international projects increases the network of potential clients (willing to use the service in the post-project period), and may thus act as a potential infrastructure investment.

The videoconferencing environment reduces travel expenses (which are significantly high in the case of geographically distant universities such as the universities which have joined the ViCES network). It can therefore directly create savings of energy resources (fuel), reduce air pollution and lower the emissions resulting from commuting.

The use of videoconferencing infrastructures also reduces the quantities of materials transported. Lastly it makes for optimal decision-making (meetings can be organized more often at less cost).

The most important benefit of setting up the ViCES video conferencing infrastructure at a national level is that it creates a network of institutions which can easily share their educational materials, and work together on joint projects, at an international as well as national level. The potential this offers is worth the long term investment, whatever it may be.

The variety of locations, combination of students able to participate in the same class from different cultural and educational backgrounds, and the chance to engage foreign lecturers defines a need for carefully structured video conferencing scenarios.

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VIDEO CONFERENCING AS AN EDUCATIONAL SYSTEM: A CASE-STUDY

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Abstract: In the paper some preliminary results of the case-study developed in the ViCES - *Video Conferencing Educational Services* TEMPUS Joint Project through the application of videoconference-based advanced learning methods and techniques are presented. Such case-study was carried out in the framework of the DEREC - *Development of an Environmental and Resource Engineering Curriculum*, TEMPUS Joint European Project experience, and involved students from the Ss. Cyril and Methodius University in Skopje and the University of Florence. A brief presentation of the DEREC Curriculum is given first, followed by a presentation of the didactical approach adopted in the case-study, together with the main results. Finally, some educational benefits of the use of videoconference systems are discussed and some general conclusions are presented.

1. Introduction

The modernization of higher education implies new educational requirements which, stimulated by innovative telecommunication technologies and novel educational materials and methodologies, has led to the development of distance learning environments, where videoconferencing represents a valuable tool for extending educational benefits.

The main advantage of a videoconference-based educational system is that it can overcome the limitations of physical distance, thus enabling teachers and students to be virtually 'present' together in a place that they

cannot reach because of lack of time or expensive methods of transport (Roberts, 2009; Saw *et al.*, 2008). Several configurations can be managed through a videoconferencing system, namely collaborative sessions between two or more parties (end-to-end or multipoint videoconferencing), as well as sessions broadcast to a wider community (live streaming).

Within such learning environment, the system architecture includes various building blocks such as coding/decoding engines, cameras, management centers, gatekeepers etc. In the overall system, another crucial parameter is given by the QoS (Quality of Service) control for providing a quality videoconferencing service, regarding in particular network bandwidth and other technical features of the infrastructure hosting the videoconference platform (Zhu *et al.*, 2007; Yoshimura and Masugi, 2004; Ookuzu and Shibata, 2009). The QoS has a great impact on user's expectations and in the case of failure the whole educational experience may be seriously jeopardized. Furthermore, there must be a defined video transmission process with some application-based control of the actual streaming for overcoming problems that might arise at the application layer (McDonald and Nelson, 2008). The large amount of data within the heterogeneous network may cause bottlenecks in certain parts of the infrastructure, so appropriate measures must be taken in advance, to avoid the problems that may occur and provide stable, efficient and cost-effective solutions (Bijlani *et al.*, 2010; Wei-Ying *et al.*, 2000).

The videoconference infrastructure developed in the ViCES - Video Conferencing Educational Services TEMPUS Joint Project offered valuable opportunities for testing system performance and defining appropriate service quality levels.

In this paper, the preliminary results of a test case-study performed during the project are presented. Such case-study was developed within the curriculum in Environmental and Resources Engineering activated in FYR Macedonia through the TEMPUS-JEP DEREK - *Development of an Environmental and Resource Engineering Curriculum* project (Various Authors, 2009; Caporali *et al.*, 2011) and involved students from the Ss. Cyril and Methodius University in Skopje and from the University of Florence.

A brief description of the main features of the DEREK experience is given so as to describe the framework of the experiment from the educational point of view. The didactic approach pursued in the management of the ViCES case-study is illustrated afterwards. The preliminary results of the case-study are then described and some educational benefits are highlighted. Lastly, the preliminary conclusions of the case study are reported.

2. The TEMPUS DEREK Project

The TEMPUS Project JEP_19028_2004, entitled DEREK - *Development of Environmental and Resources Engineering Curriculum* funded by

the European Commission (DG Education and Culture) in the period 2005/2008 was carried out by the University of Florence (IT) together with Ss. Cyril and Methodius University in Skopje (MK) and involved a consortium of various Higher Education Institutions in the European Union and in the Partner Countries (Austria, Greece, Germany, FYR Macedonia) as well as two individual external experts (Germany, Bulgaria). Through co-operation and the exchange of knowhow and expertise between partners, the following main results were obtained. A new, three-year undergraduate curriculum in Environmental and Resources Engineering was started at the University Ss. Cyril and Methodius in Skopje, FYR Macedonia, based on the European Credit Transfer System and in accordance with the Bologna Declaration. The necessary conditions for offering a Joint Degree Title in Environmental and Resources Engineering on the basis of an agreement between the Ss. Cyril and Methodius University and the University of Florence were also satisfied (Various Authors, 2009).

The methodological approach of the Engineering Curriculum Design included elaborating lists of courses and activities and defining the ECTS ranges for basic knowledge activities, specific activities for civil engineering and for environmental and territory engineering, the elective courses, and training activities, as well as the thesis and final exam (Table 1). In addition, the course content was also developed by the relative professors involved both in Macedonian and in

Table 1. Minimum reference ECTS according to the Italian national rules and ECTS ranges of the undergraduate curricula on Environmental Engineering at the University of Florence and at the Ss. Cyril and Methodius, Skopje

Educational disciplines	Minimum reference ECTS	ECTS range
Basic knowledge activities:		39-72
Mathematics, Informatics and Statistics	36	21-39
Chemistry & Physics		18-33
Characteristic skills:		57-90
Civil Engineering		24-36
Environment and Territory Engineering	45	24-36
Safety; Civil, Environmental and Territory Protection		9-18
Integrative knowledge activities	18	18-42
Autonomous student activities	12	12-12
Foreign language assessment		3-3
Final exam		6-6
Others activities (Training etc.)		1-24

English, with the help and expertise of European Union Consortium Member Institutions.

As a further result of the project, an *ad hoc* agreement for inter-university cooperation and specific agreement for the definition of shared educational paths in study courses in the field of environmental resources and territory engineering and for the mutual recognition of degree titles is now in force between the University of Florence and the Ss. Cyril and Methodius University in Skopje, according to a study program which foresees for the third year a mobility program carried out at the partner university. The two lecture semesters of the third year are spent at the partner university for at least 48 ECTS. The remaining part of the third academic year will be dedicated to the period of training and final exam either in Skopje or in Florence.

The curriculum passed the evaluation process and as an added value to the project, the First Cycle Degree Course in Environment and Resources Engineering was opened to students for enrolment in the academic year 2008/2009.

At the moment the First Cycle Environmental and Resources Engineering Course is offered at the University Ss. Cyril and Methodius in Skopje. On the basis of the existing agreement between the Ss. Cyril and Methodius University and the University of Florence, selected students on the third year of that degree course at the Ss. Cyril and Methodius Universities can spend a twelve month mobility period at the University of Florence. They are able to attend some courses and take some exams included in the curriculum as well as to perform training activities in laboratories at the University of Florence. The certified activities carried out at the University of Florence will be fully recognized by their home institution.

3. *ViCES didactical approach*

The main objective of establishing a video conferencing infrastructure is to increase Quality of Learning (QoL) perception among students by providing factors for increased Quality of Experience (QoE) parameters within the learning process. In our context QoL can be treated as an increased level of computer-mediated, communication-enabled knowledge transfer. This way, we can compare face-to-face seminars with video conferencing.

In order to evaluate whether video conferencing could be used for increased QoL we conducted an experiment including 1st level degree students of 'Environmental Engineering' from Skopje and Florence Universities, in Macedonia and Italy. It should be noted that courses that could be mutually recognized were chosen as the subject of the experi-

ment, namely the 'Geographical Information Systems' (7 ECTS) course in Skopje and the 'Environmental Information Systems' (6 ECTS) course in Florence. The students involved at the moment of the video conferences already had some knowledge of the topics discussed.

When using videoconference systems, different methods of presenting lectures to students can be envisaged, specifically: pre-recorded lecture streaming, live consultation, and live videoconferencing sessions (lecturing).

Pre-recorded lecture streaming is very simple from the educational methodological point of view. The lecturer is asked to record him/herself, and then, this recorded lecture is made available to the students. It is important to emphasize that, in our opinion, this is the most suitable way of introducing new findings to existing educational materials, given the lecturer's freedom to express him/herself, and the very short lapse of time between the recording and making the material available to the students. In addition, this scenario provides the option of making 'the live lectures' given in video conferencing sessions available to students in the years to come. This approach lacks interaction, and thus should be combined with the live consultations on certain topics from the lecturer which can be moderated through videoconferencing in a non-formal way (second scenario).

The third approach, i.e. live videoconferencing sessions, is the most complex bearing in mind the need to establish similar background knowledge among students, and to inform the lecturer on what kind of audience he/she will face. In the ViCES case study, we decided to connect a pre-video conferencing phase and a post-videoconferencing phase to the live video conferencing session. In the pre-video conferencing phase, background reading and information about the lecture was made available to students using different web-enabled channels (web pages, forums, social networks). This way, the lecturer was able to gather valuable information from the students' feedback about issues needing clarification and the approaches to use during the live section. The post-videoconferencing phase provides students with a way of giving valuable feedback on the lesson topics and the technical equipment interfering with the educational methodology.

The live video conferencing session was also divided into three main parts. After the technical check-up of the equipment and introductory notes, the lecture was given, followed by local discussion and a general discussion via the VC system. The structure of the session is shown in table 2.

The first part of video conferencing (lecture) was similar to traditional lecturing and lasted approximately 30 minutes, given the need to hold students' attention. The lectures presented the material emphasizing the issues that had come up in the pre-videoconferencing phase. The second part of the live videoconferencing session did not include vide-

Table 2. Structure of the live video conferencing session

Duration	Activity	By whom
30 min	(before start) Connection of all VC sites and stand-by	Technical staff
10 min	Introduction	Central moderator
30 min	Lecture	Firenze / Skopje teacher
5 min	Pause	
30 min	Local discussion at all participating sites	Local moderator and local expert
30 min	Open discussion via VC	Central moderator
10 min	Concluding remarks	Firenze / Skopje teacher and central moderator

oconferencing equipment at all. In this phase, local moderators discussed the lecture with local students, trying to overcome any problems that might have arisen due to the different language used by the lecturer, or non familiar examples resulting from the different cultural backgrounds of the students and the lecturer. During this phase, the topics for discussion were identified. In the last, third phase of the live videoconferencing session, all the sites were engaged with the lecturer acting as discussion moderator. Students from different sites asked questions and initiated discussions. We found that this was the most valuable part of the videoconferencing session because students tend to be very curious about why different topics are more or less clear to different kinds of students (different universities, faculties, nationalities, mother tongues, ages etc.). This encourages real collaboration between the students when they are trying to explain concepts among themselves. Post-videoconferencing is often used to continue this discussion.

4. Results of the experience and educational benefits

The didactical approach illustrated in the previous section was applied in two different sessions, one held on 25/11/2010 and the other on 13/01/2011. In the first case, the teacher was from the University of Skopje which acted as the local site hosting Macedonian students, while the Centre of Information Services of the University of Florence acted as the remote site, hosting Italian students. In the second case it was the opposite way round: the teacher was from the University of Florence which acted as local site, while the University of Skopje was the remote site.

Figure 1 shows a picture of the two sites with the participant students and teachers, while figure 2 shows the videoconference in progress at the Florence site.

Figure 1. Video conferencing sessions in the ViCES case study, Florence (left), Skopje (right)

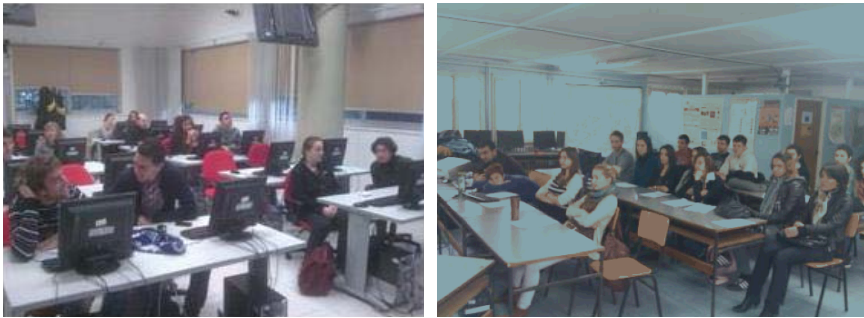


Figure 2. Video conferencing session at the Florence site in the ViCES case study



After the videoconferencing sessions, short questionnaires were given to the students. The questionnaires included questions related to the lesson topic, the technical infrastructure and its influence on the educational methodology, as well as the possibility of co-operation between the students from different sites.

The following tables (Table 3 and Table 4) present the results of the questionnaires from the students in Florence. The students in Skopje gave comparable answers. Table 3 shows the results when Florence was the remote site, while table 4 presents the results when Florence was the local site. It should be noted, that for the second video conferencing session we managed to solve the technical problems of video quality (QoS) providing better QoE resulting in good QoL. On the whole, the technical evaluation of both sessions was good, including organization of the session (which was related to educational methodology). No particular problems affected the sessions, apart from some minor technical adjustments in video and audio during the first video conferencing session.

Table 3. Results of evaluation of the first video conferencing lecture on 25/11/2010: 10 respondents, Florence remote site

Technical Evaluation				Problems	
	Low [%]	Sufficient [%]	Good [%]		%
Audio quality	-	30	70	Attention	20
Video Quality	-	50	50	Concentration	27
Teacher's attitude	-	40	60	Following teacher's explanation	50
Quality of material	-	10	90	Uneasy feeling	-
Technical quality	-	10	90	Asking questions	13
Organization of the session	-	10	90	Interaction with remote site	33
Participation				Advantages of VC	
	Low [%]	Medium [%]	High [%]	Yes [%]	No [%]
Lack of interaction with the teacher	40	30	30	44	56

Table 4. Results of evaluation of the second video conferencing lecture on 13/01/2011: 9 respondents, Florence local site

Technical Evaluation				Problems	
	Low [%]	Sufficient [%]	Good [%]		%
Audio quality	-	22	78	Attention	11
Video Quality	-	22	50	Concentration	11
				Following teacher's explanation	33
Quality of material	-		100	Uneasy feeling	-
Technical quality	-	12	90	Asking questions	67
Organization of the session	-	33	67	Interaction with remote site	11
Participation				Advantages of VC	
	Low [%]	Medium [%]	High [%]	Yes [%]	No [%]
Lack of interaction with the teacher	33	67		69	31

The majority in both remote sites emphasized the loss of interaction with the teacher. The main problems detected were 'following the teacher's explanation' and 'asking questions', with no relevant difference between local and remote sites. This point might be improved by activating a video conferencing consultation between the local teacher and the remote classroom (second methodological scenario). All the students were impressed with the possibility of discussing is-

sues of common interest and seeing how different issues have different priorities depending on the national or study context. They all welcomed the opportunity to collaborate with students from different courses or countries.

From the educational benefits point of view we should consider that stakeholders of the education institutions are constantly interested in incorporating procedures which contribute to student success in learning and the QoE they obtain while learning using different technologies thus creating significant QoL. The educational process involves different pedagogical and methodical approaches to achieve the required QoL.

The survey results presented in this paper have shown that video conferences can be introduced into the learning process while retaining a positive QoE. With the combination of sophisticated video conferencing technology and educational methodology focused on collaboration the educational process met the QoL objective, even when teaching was conducted at a distance.

The survey results presented were also related to the opinions of the teachers involved, showing no relevant differences with students' impressions, as far as the general running of the sessions was concerned.

5. Conclusions

In this paper we have presented some preliminary results of the application of videoconference-based advanced learning methods and techniques, as tested in the framework of the ViCES project.

The approach followed in the proposed case-study made it possible to sustain the positive impact of videoconference systems within educational contexts, with particular reference to the following objectives:

- to increase cooperation between Skopje and Florence Universities, i.e. in general between different education and research institutions;
- to provide opportunities for students and teachers to share their educational expertise and methods with foreign colleagues;
- to share experiences and case studies as well as objectives and results in the framework of both education and research activities.

Such objectives could be pursued further in future educational experiences through the use of the videoconference systems implemented in FYR Macedonia and in the other Balkan and EU countries which cooperated in the ViCES project. The methodologies defined can be applied to different contexts and environments.

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VIDEO SERVICES IN SERBIA'S ACADEMIC NETWORK

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Abstract. Serbia's Academic network (AMRES) has developed a modern high-speed country-wide computer network which connects educational and research institutions. Once the physical infrastructure was no longer a problem, AMRES started to develop and offer new ICT services to its users, especially services to improve the research and education process. Video services are good examples of advanced network use with high impact on the community.

1. Introduction

Modern video services enable the transmission of audio and video signals and data content (presentations) between users. They can be used for various purposes in the research and education community. Distance learning is a commonly used term to express a learning process supported by technology which allows teachers and students to be in different places at the same time. Transferring live bidirectional voice and video is an essential aspect which is performed by video conference technology. There are numerous cases in which teachers and students are geographically separated and distance learning is therefore the most efficient approach: groups of teachers from different cities or countries, joint study programs between several universities, multidisciplinary studies with different professors or student groups especially at master or PhD level etc.

It is common practice in universities to invite respected professors or eminent researchers in the field to give a one-off lecture. Instead of organizing transportation and accommodation and spending several days for a one-hour lecture, they can use video-services instead and spend exactly one hour of time for a one-hour lecture. Seminars and conferences are another example where speakers may not be able or willing to take part in the whole event.

Lifelong education and professional training are examples of a special educational process where the 'students' are professionals in a specific field, with their own full-time jobs and very limited spare time which can be used efficiently by means of video conference.

Remote meetings and remote collaborations are a commonly used approach in many international research projects, such as the projects within the European TEMPUS or Framework Program.

All these scenarios are examples where video services can be used to offer significant savings in time and money to the participants. Howev-

er, participants are very demanding in terms of needs and expectations. First, the service must be of exceptionally good quality, especially for a larger audience, such as students. The video signal must be high resolution, up to the *High Definition* (HD) standard, with a sharp picture, good lighting and contrast, zooming ability and so on. The audio signal is even more important for live or recorded video content. It must be sharp, acceptably loud, with constant volume, and with no echo, background noises and interruptions.

The successful use of video services in education and research depends on the readiness of teachers and researchers to use them. New technology will be accepted by users if it is reliable and easy to use. The service must be available whenever it is needed and work smoothly with no interruptions. It must be easy to use for everyone, regardless of their technical skills and training.

2. Requirements

A number of technical and organizational requirements must be satisfied to meet users' expectations with regard to video services. These elements are described in more detail below.

2.1 Dedicated hardware

Video services are state of the art technology, created using dedicated professional hardware.

2.1.1 Video Conferencing terminal equipment

Video conferencing (VC) is a dedicated service for live two-way audio and video simultaneous communication between participants. The basic component of VC service is the video terminal equipment (end station), combined with an external camera (usually two) and a microphone. Its main role is to:

- initiate a point-to-point call, by dialing an IP address, unique number (GDS) or selecting from the address book;
- establish and maintain the connection using a standard signaling protocol, such as H.323 or SIP;
- encode and decode audio and video signals at different resolutions and rates.

In addition to these basic characteristics, modern video terminal equipment supports many other useful features: remote and web based control, far-end camera control, dual-Monitor Emulation, near and far end picture mode (Picture-in-Picture), audio noise and echo cancelation etc.

Giving lectures in video conferencing service usually means sharing the presentation screen with the audio and video. Therefore, modern VC equipment provides additional video channels, which can get a signal from a computer desktop used to show the slides. This feature is standardized under the name H.239, while some vendors refer it by proprietary names: 'Content sharing', 'DuoVideo' or 'People+Content'. It should be noted that this option must be supported on both sides.

End video terminals can be also software-based, running as regular PC applications, equipped with a personal web camera in lower resolution, desktop microphone and speakers or headset. This is a commercial product usually licensed per user, which provides a basic set of functions compatible with regular VC equipment.

2.1.2 Multipoint Conference Unit - MCU

While the video terminal equipment supports point-to-point communications between two participants, providing VC for multiple users is considerably more complex. There must be one central station which establishes and maintains audio and video communications with all the participants. This central station is a very complex, powerful and expensive dedicated hardware, named *Multipoint Conference Unit - MCU*.

MCU serves multiple users on multiple, simultaneous conferences. It provides different sessions on rates (transrating) and different codecs (transcoding), supports numerous protocols, audio and video standards, in order to be compatible with different vendors.

The gatekeeper function is often integrated with the MCU box. The international numbering plan for H.323 over IP is supported using this function. It allows the translation of the unique GDS number (Global Dialing Scheme) into IP addresses.

Modern MCU also provides several video layouts, a built-in web server for management, built-in streaming server and much more.

2.1.3 Video Streaming server

While the VC service provides bidirectional live audio and video communication between a given number of participants usually limited by licenses, the video streaming service enables unidirectional audio and video transmission from one source only- the streaming server- to end users. The number of users is generally much higher than for the VC service, but users are just passive participants - listeners and viewers, and cannot participate in the session. For this reason, the video streaming service is not an appropriate solution for giving lessons, since interaction with students is of key importance. However, it is sometimes very useful for broadcasting live events to large audiences, such as seminars, workshops, lectures given by keynote speakers and so on.

2.1.4 Content server

Both video conferencing and video streaming services are based on live events. It is extremely useful to record such events for educational purposes and enable playback for a wide user community later on. The content server is a special box of hardware which provides this function. Given its nature, it can easily be integrated with video conferencing and video streaming services. The video and audio material is recorded in raw format, and needs to be manually edited and prepared for playback.

2.2 High-speed network

Video services are very demanding in terms of network conditions. High bandwidth is of the utmost importance. Even low resolution video requires approximately 500 Kbps, while a HD video needs up to 4 Mbps. Another important parameter which reflects on quality are the slight delays, slight jitters, i.e. variation of the delay. Since it is hard to provide a dedicated channel for each video session, QoS techniques (Quality of Service) should offer priority audio and video traffic over other data traffic.

These network conditions are provided by high bandwidth links and high-speed equipment (routers and switches), which are able to process intensive traffic and provide advanced QoS technique features.

2.3 Suitable rooms

Environmental conditions in classrooms or meeting rooms are also an important part of the video conferencing infrastructure. The room must be appropriately adapted in terms of lighting, colors, background panel, acoustics, audio and video coverage, noises, reflections, and other equipment: computers, monitors, projectors, speakers, wireless microphones etc.

2.4 Technical support

Technical support and maintenance is an important issue. Before the video session, the system needs to be properly configured and tested. Technical staff need to configure commonly used features and options, define camera positions, provide local and remote views, allow content sharing, test functionality and interoperability with remote systems, support different scenarios and other features. The stress test before the session and performance monitoring during the session are also important for achieving high service availability and reliability.

2.5 Presentation skills

Technology has to serve the educational process, but the presenters (teachers) also need to improve their presentation skills when using video services. Students and other participants have to be focused on the subject, not be burdened by the technological background. A good teacher is good, regardless of the technology, while a bad teacher is even worse with the technology.

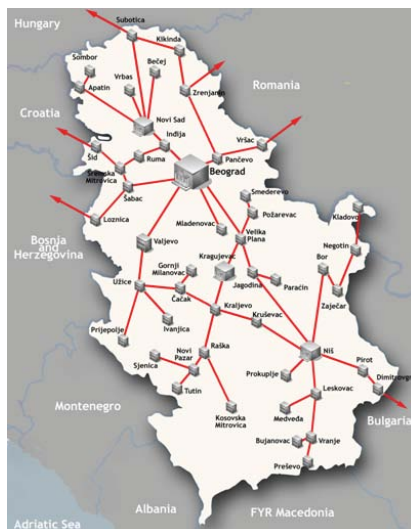
3. Serbia's academic network - AMRES

Serbia's academic network (AMRES) is the national research and education network in Serbia, offering modern information-communication services and internet connection to its users. AMRES is the most significant scientific, research and educational resource in Serbia, contributing to the development of Information Society. It is considered the most advanced network in the country, connecting up to 250 institutions in 50 cities with 4000 km of dark fiber at 1Gbps speed.

A new infrastructure layer is being developed through the SEELight project (South-East European Lambda Network Facility for Research and Education). The SEELight project aims to develop a regional optical network in southeast Europe and provide a long-term solution for regional academic network infrastructures and their integration with the European research and education community. The new network backbone provides a fault tolerance at 10 Gbps speed, with multiple independent connections (lambdas) per one fiber optic pair, which will further expand the capacity, reliability and efficiency of the network. Connections with neighboring academic networks and the European academic network GEANT are now increasing to 10 Gbps speed.

AMRES is therefore one of the most important national research and educational resources and is contributing to the development of Information Society. More than 150,000 country-wide users utilize the network and its services.

Figure 1. Serbia's academic network (AMRES) - dark fiber infrastructure at 1Gbps speed



4. Video services in AMRES

The AMRES infrastructure, based on dark fiber, with 10Gbps at backbone level and 1Gbps at access level, connects institutions with modern QoS-enabled networking equipment and can handle all the requirements for video services perfectly. This chapter presents the video services and infrastructures available in AMRES.

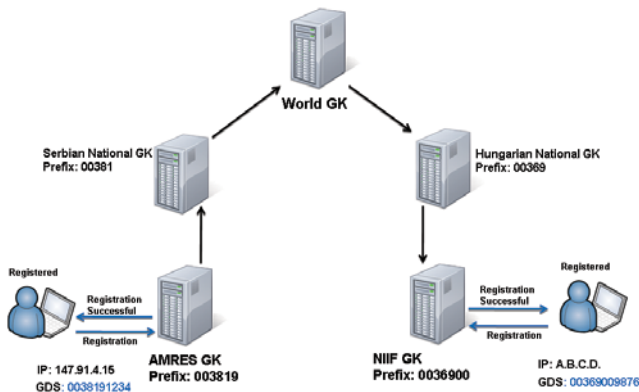
4.1 Video conferencing infrastructure

A large amount of VC terminal equipment is available at universities and other AMRES institutions. These have been provided as part of TEMPUS and other European projects in order to support distance education and enable Serbian researchers to participate in the European research area, overcoming the geographical and technological gap. Most of them use Polycom equipment, while Cisco Tandberg is also present. Further significant support came from a donation by the Republic of China, providing 10 video terminals from the ZTE vendor. Newer equipment is in full HD resolution, and all of it is mutually interoperable.

MCU equipment was recently obtained as part of another TEMPUS project supporting multiple video sessions for educational purposes. The equipment is well balanced with 10 full HD or 20 SD simultaneous licenses, which can serve current needs.

Built-in gatekeeper (GK) functionality is also provided, but AMRES has already established a national gatekeeper infrastructure, based on open source software. There is a central national gatekeeper server, on IP address 147.91.1.126, connected to the world gatekeeper infrastructure. The registered prefix follows the global telephone numbering scheme with the same country code - '00381'. The extension number for the academic community is '9', which means that the AMRES gatekeeper, available

Figure 2. AMRES gatekeeper infrastructure



on IP address 147.91.1.125, is visible as number '003819'. This hierarchy can be further extended for AMRES members, if needed.

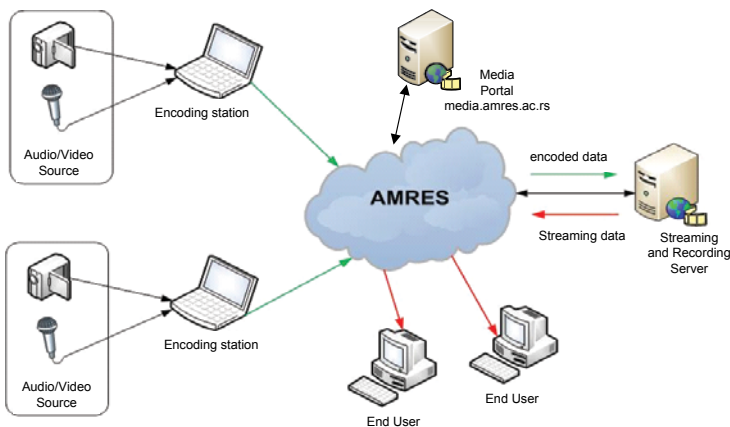
The service works as follows: An AMRES user registers with the AMRES GK and initiates a call to a remote participant, identified by a unique GDS number. The AMRES GK sends the query to the national GK, which forwards it on to the global GK infrastructure to resolve it. The destination GK, which is responsible for the requested number, responds to the query and sends the resolved IP address of the VC terminal back to the AMRES GK, which sends it back to the user who initiated the query. This user is now able to directly contact the remote participant using an IP address. This process is shown in figure 2.

4.2. Video streaming infrastructure

AMRES has developed a video streaming infrastructure available to all network members. The video and audio content source is captured by camera and microphone, connected to a local lap-top which encodes the signal using the *Windows Media Encoder 9* application. The lap top is then connected to the network and the encoded data is continuously transmitted to the central video streaming server using *Windows Media Server 9* software. The same server records the raw video and audio data and stores them in files. Any AMRES or even internet users can access the central streaming server using the *Windows Media Player* application and follow the live event.

However, more appropriate access is achieved via a web browser with *Windows Media Player* plug-in installed. A special web-based portal has been developed for this purpose which allows users to access the streaming events (available on <<http://media.amres.ac.rs>>). The portal has been

Figure 3. AMRES video streaming infrastructure



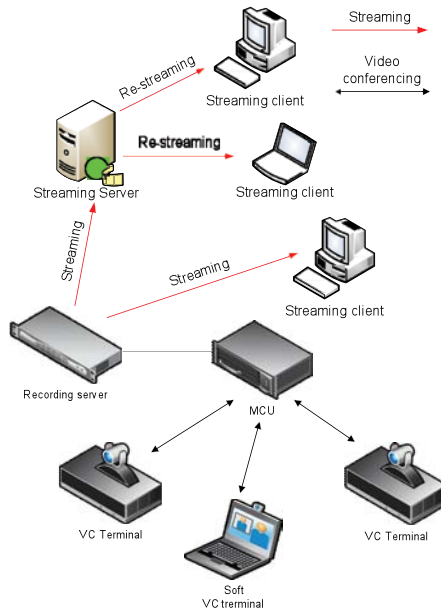
further improved as a repository of stored video files via the TEMPUS project Video Conferencing Educational Services - ViCES. All streamed events are recorded and presented on the portal for later playback. Additionally, users can register and store their own video files, which are locally recorded in institutions. These videos usually refer to lectures, seminars and other events for educational purposes.

4.3 Integrated solution

Video conferencing and video streaming/recording services in AMRES have so far been used separated and independently. The existing MCU can support video streaming, but only for a very limited number of users due to license limitation, which is not feasible for a wider user community. Existing video conferencing equipment in institutions cannot be used therefore for video streaming. Also, there is still no professional recording server which can capture video conferencing sessions and store them in an archive.

Belgrade University Computer Center (RCUB) provides an on-site live video streaming service with a mobile set (camera, wireless microphone and lap top) for members of the University of Belgrade, as well as other AMRES members. All that is needed is network connectivity. As the interest of end users increases however this approach is no longer suitable, so an integrated solution is needed.

Figure 4. Integration of video conferencing and video streaming infrastructures.



An integrated concept can be achieved by connecting the video conferencing and video streaming infrastructure with a recording and streaming server (some vendors name it *Content Server*), shown in figure 4. This server is connected to the MCU as a regular single user. It can record the session, but also stream it to other users. In the case of license limitation, the content server can stream the session onto the existing streaming server, which re-streams the session to a practically unlimited number of users.

5. Conclusion

The initial use of video services in AMRES got very positive feedback from the user community. Video conferencing and video streaming infrastructures are available, but still separate. In case of the University of Belgrade, approximately 50% of faculties have VC equipment.

However, the services are still not used enough, considering the potential benefits they can provide to end users. A common problem is the lack of fully adapted rooms with VC equipment installed. The integration of VC and streaming infrastructures is planned in the near future via a content server. Integration with existing eLearning services is a natural extension, in order to provide a complete distance learning process. In addition to the video services considered in this paper, the web-conferencing service is a desktop solution and an alternative way of enabling audio and video communication and collaboration between users.

Apart from these technical issues, more challenging objectives are found at a policy level. Organized co-ordination of the technical staff is also an important issue which needs to be achieved. RCUB has already provided several workshops and technical training programs. Video services for education must be promoted to end users. Some core groups of teachers and courses need to be identified and targeted to produce initial results and success stories. Later, more users are expected to start using the service until a critical mass is achieved. The final objective is to make the service widely available, and get it accepted and used in the education and research community.

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THE EDUCATIONAL USE OF VIDEOCONFERENCING FOR EXTENDING LEARNING OPPORTUNITIES

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Abstract. Distance learning is a process that connects learners with educational resources separate from them in terms of time and distance. Videoconferencing is a mature technology which can be used in the distance learning process while providing synchronous, interactive communication between the teacher, as a source of information, and the students. This paper focuses on the ongoing project for extending and maintaining learner opportunities for students in universities in Macedonia, through development of a videoconferencing-based educational system. It addresses the necessary system architecture and topology, while defining the basic components, their characteristics and interconnection. However, this study is not just technology-oriented, since the success of such educational systems is greatly influenced by pedagogical methods and students' motivation, expectations and experience of such process. Part of the study therefore relates to determining the constituents of and measuring students' perceived experience.

1. Introduction

Education in its widest sense is action or perceived knowledge aimed at shaping the mind, character or physical capabilities of an individual. As ways of life have become more complex, education has had to develop and adapt its forms and models so as to integrate better with modern society. For thousands of years, learning and teaching always took place in close proximity, and this has become the classic model for education. Learning by its very nature has always been open to technological innovation. Distance education or distance learning, has emerged as a new direction in the educational field, which embraces new technologies, while providing access to learning when the source of information and

the students are separated in terms of time and distance. However, the distance education process should not be always identified with the latest and the most advanced technological solutions; it also encompasses open-ended possibilities and a leveling of differences, a global approach to learning and education and a different organization of resources changing the balance between institutions and individuals so as to create a more effective process.

Videoconferencing technology is a synchronous, real-time media which offers the easiest, most dynamic way for dispersed groups to get together in the same 'virtual' environment. Over the last decade, there has been a tremendous amount of distance education research (Anderson and Rourke 2005; Hanor and Hayden 2008; Saw *et al.* 2008), with a common focus on the use in education of video, videoconferencing, and video streaming systems on demand. This research shows that interactive videoconferencing and video streaming technologies can be extremely effective media for delivering quality education to geographically dispersed student populations.

However, when creating a challenging learning environment which encompasses videoconferencing technology, various aspects have to be considered. Proper system architecture must be developed with suitable point of presence devices in the classrooms (teacher/student video cameras, displays and audio equipment), coding/decoding engines, multipoint conference units, central management site etc. Moreover, the videoconferencing platform needs to be built on a highly scalable, reliable, secure, and surplus transport infrastructure which connects the engaged sites to each other in a close group, enabling the participants to manage and set up single and multi point video calls.

The success of educational systems using videoconferencing is not just technology-dependent; an effective videoconferencing learning session requires adaptation of teaching methods and content, due to the distributed, highly interactive nature of the pedagogical situation. Student motivation, their degree of concentration and satisfaction also play a significant role when distance learning scenarios are compared to conventional lectures.

This study focuses on a joint project involving several universities in Macedonia for introducing videoconferencing to the educational process. These universities have explored different teaching and learning strategies for future development, and have come to the conclusion that videoconferencing rich media can offer excellent learning opportunities for collaboration and improved teaching methods within the region and with universities in other countries. So this paper sets out to contribute to the field of videoconferencing use in the learning environment, elaborating the system architecture, technical behavior and performance evaluation on the one hand and measuring students' perceived experience during the educational process on the other.

2. Objectives and research methodology

Macedonia is a country spread over a small geographical area. Most of the universities (and faculties) are situated in the capital city and several other major cities two–three hours' drive away from each other. The introduction of a distance learning pattern as an integration of face-to-face learning with forms of distance education is therefore a challenging task. Nonetheless, some universities have decided to build a videoconferencing platform which will be used in the learning process and will be involved in a distance learning research project. Most of them already have some form of learning management system for student–content interaction such as Moodle, FEIT Learning Environment etc. This project is recognized as a significant endeavor for inter-university cooperation and a key impact factor on lecturer/student, student/student interaction with an eye to creating efficient, high quality degree programs. This project also has a wider scope of encouraging collaboration and cooperation between various universities in other countries through joint videoconferencing learning sessions. It creates an opportunity for students to participate in the same class, in a 'virtual' environment, despite their different cultural and educational backgrounds.

The introduction of distance learning opportunities within universities providing 'traditional' classroom lectures is a complex task. The technical preparation, proper system development and implementation of the videoconferencing platform on a live transport infrastructure connecting the universities need to be addressed from different aspects.

One aspect involves the technical challenges of designing and practically implementing a videoconferencing platform which covers wider technological areas, with different aspects and approaches to overcome the obstacles to setting up a stable educational system. Different multimedia information including video, audio and data has to be routed through a shared network with optimal performance and predictable behavior. Therefore proper Quality of Service (QoS) provisioning and control mechanisms have to be developed so users can successfully participate in video conference calls where each participant can simultaneously view the video from the other participants and hear the mixed audio from all participants (Liu *et al.* 2009; Spielvogel and Kropf 2010). This videoconferencing platform has to be centrally managed as far as possible, with control of the network activities from a central site.

Video conferencing requires the adaptation of teaching methods since the teacher needs to develop technical skills, learn new teaching strategies and adapt current curricula to the 'new' learning environment.

On the other hand, videoconferencing-based educational systems need to be constantly evaluated in terms of students' perceived experience which should include objective measures of the process, represent-

ed as a subjective rating of usage (Muntean 2008; Brooks and Hestnes 2010). Our focus is therefore also on the perceived quality performance of the system, as a subjective measure of students' experience, referred to as Quality of Experience (QoE). The research evaluates the relationship between the QoS and QoE, which are related but different from one another. The QoS measurement is not directly related to the students (e.g. a student participating in the learning session will not complain that there was not enough bandwidth, or there was too much latency of the packets, delay etc.), while QoE is influenced directly by student participation or observation. The results of research can provide possible technology and application-independent evaluations which may help to define a clear videoconferencing educational system.

The nature of the research in this study is technological and sociological, since it deals with the possible implementation of information-communication technologies and the social impact of the process. It involved various forms of research and categories, such as:

1. case-studies, closely examining specific implementations of the videoconferencing-based learning methodology during the project;
2. evaluation surveys, developed and reviewed by instructional technology experts and researchers, subjected to a wide target student audience within the universities or/and to students participating in specific case-studies;
3. developing models to determine the relations between different variables influencing the success of the learning process (such as objective technical parameters, subjective student experience etc.);
4. analysis of quantitative and qualitative data obtained through the research study.

The study enhances the potential of the relevant institutions by a stronger and smarter adaptation and personalization of educational technologies. It gives the students the opportunity to extend their learning opportunities while participating in a wider range of lectures offered.

3. System architecture and technology description

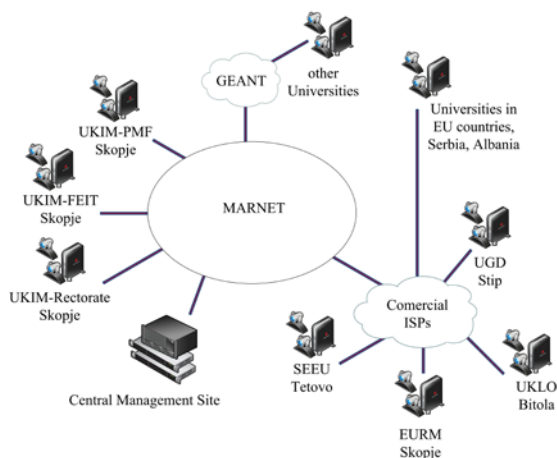
The design of the system architecture of the videoconferencing-based educational platform was influenced by the universities' need to deliver distance learning opportunities to the students, for real time, interactive sessions, with boundaries limited only by the extent of the videoconferencing network.

The project involved state universities in Macedonia located in different cities: Ss. Cyril and Methodius in Skopje (UKIM), St Kliment Ohridski in Bitola (UKLO) and Goce Delcev in Stip (UGD). Sever-

al private Universities, such as the South Eastern University in Tetovo (SEEU), the European University (EURM) and the FON University, both in Skopje, were also part of the project. It also included connections with partner universities in the European Union (University of Florence, Italy; Catholic University of Leuven, Belgium) and Universities in Albania and Serbia.

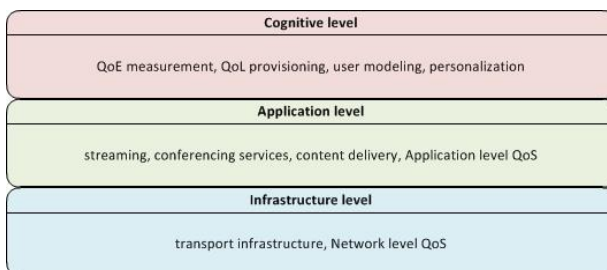
The wider adaptation of the project therefore required complex, robust and reliable system architecture. Figure 1 illustrates the system architecture of the videoconferencing-based education system designed to meet the objectives and provide successful integration of the multiple resources into a closed system.

Figure 1. System architecture and topology of the videoconferencing-based educational system



From an abstract point of view, our videoconferencing-based educational system was designed as a three-layered architecture as shown in figure 2.

Figure 2. The three-layered system architecture



At the bottom, the infrastructure level considers the transport infrastructure over the network connecting the participants in the videoconferencing educational sessions and aiming towards maximization of the Network level QoS. The Application level considers the streaming and conferencing services, content delivery, Application level QoS provisioning etc.

While the first two layers deal primarily with the technical aspects of the system, the cognitive level is the top level, dealing primarily with user perception of the delivered services, Quality of Learning (QoL) provisioning, user modeling, personalization and adaptability of the system.

3.1 *Transport infrastructure*

The transport infrastructure within the system architecture is composed of a modern IP based network designed to connect all the necessary remote locations for point-to-point or multipoint videoconferencing sessions.

The Macedonian Academic and Research Network (MARNET) was used to provide the infrastructure to all the members of the Ss. Cyril and Methodius University in various locations in Skopje. It is connected to the other universities involved via variously sized communication links. It is also connected to GÉANT, a pan-European data network dedicated to the research and education community.

The transport infrastructure is a network which various types of traffic, voice, video and data converge on. The QoS provisioning and controls needed to provide predictable, stable and measurable behavior of the infrastructure in the videoconferencing educational system are then implemented. The infrastructure capacity to recognize specific traffic and application flows was used to provide appropriate treatment so videoconferencing flows (signaling and voice/video media) receive as little delay and jitter as possible, with minimal packet loss.

To maintain end-to-end QoS, recommended differentiated service (DiffServ) values within the network are implemented, which should be the same as the DSCP/ToS values used in GÉANT and other ISPs, to classify the traffic while mitigating and managing congestion. This sets the transport infrastructure as a modern Next Generation Network (NGN), with integrated transport of the multimedia information (Boyoung *et al.* 2008; Du *et al.* 2010).

During the research different scenarios and case studies were developed to generate data on transport infrastructure performance. Real-time feedback from the networking equipment positioned in different parts of the infrastructure was collected through the central site and used to analyze system performance. Further research was undertaken considering students' efforts to interact and experiment with corresponding network bandwidth consumption, packet latency and jitter; while evaluating the QoS/QoE relationship and proper model development.

3.2 Videoconferencing-platform

The videoconferencing platform integrates point of presence devices at each remote location, the interconnecting equipment and the central management site. It is built to standardized protocols (for videoconferencing signaling, audio/video streams etc.) so it can be highly scalable, robust and provide suitable performance during interactive sessions.

The central management site houses the Multipoint Conference Unit (MCU) which provides audio/video and content delivery while managing conference creation, endpoint signaling and in-conferencing controls. It acts as a bridge interconnecting calls from several sources, for point-to-point or multipoint videoconferencing sessions.

The central site has equipment for centralized deployment and provisioning for clients with different sets of features, call speeds, and call quality. It provides device/conference monitoring and management and gatekeeper services with advanced routing for the distribution of audio and video calls across multiple media servers. The videoconferencing platform has firewall management capabilities which enable videoconferencing across firewalls within the complex transport infrastructure.

Videoconferencing sessions and streaming media content are more frequently used as combined technologies to address distance learning needs. Streaming recording and playback equipment is therefore integrated in the videoconferencing platform for recording videoconferences, lectures, and training sessions. These streaming servers can stream events in real-time or archive recordings for on-demand playback from the web or from a video endpoint. It provides platform capabilities to create content that can be immediately distributed to a wider student audience within the Universities.

The complex structure of the platform and automated rich media webcasting from the learning sessions adds the streaming extension to videoconferencing. It added to the value of the research, since it was possible to prepare different scenarios and case studies for proper objective and subjective evaluations.

The videoconferencing platform has possibilities of application enhancement for a higher level QoS which relate to call signaling and terminal handling of rich media flows. These mechanisms include increased signaling reliability and lower latency, dynamic bandwidth allocation and video error concealment. The application enhancement for QoS can work with/without the QoS provisioning controls within the transport infrastructure while providing different levels of system performance. These technologies were used in the research study, so different data could be produced during different scenarios and behavior of the complete system infrastructure. The data was collected from the central management site and was used for analysis and correlation with the students' perceived QoE during the learning sessions. It provided valuable

results which confirmed our hypothesis that technological and subjective factors should be considered as a whole, when videoconferencing is used in the learning environment for extended educational opportunities.

4. Measurement of students' perceived experience

Every system is subject to continuous evaluation in terms of performance and delivery. Educational systems using videoconferencing in the learning process therefore need constant monitoring and improvement. However, technical evaluations do not provide information about students' direct personal participation or observation.

Students' perceived experience is mostly subjective, context-dependent and even dynamic in different situations. Test experiments may provide information on certain aspects, but the measurement of overall Quality of Experience is optimally studied over a longer period of time in a real environment. Quality of Experience (QoE) refers to the overall acceptability of an application or service, as perceived subjectively by the end-user (according to the ITU-T Focus Group on IPTV).

Bearing in mind the subjective character of QoE, its perception for each individual user differs. We assumed that users with similar preferences and expectations will experience similar QoE as well. Therefore, in our system we categorized users into several predefined stereotypes according to their preferences, and enabled presentation of the services for each stereotype to be adapted so as to meet the expectations of each user.

Some approaches attempt to quantify and measure QoE, considering both measurable parameters related to the technological aspect of the services, and non-measurable parameters related to the user's perception of the service, expectations and behavior. The measurable parameters related to Quality of Service can be grouped under Application-level Quality of Service and Network-level Quality of Service. The QoS parameters offer an objective measurement of the service delivered, but considering the subjective nature of the QoE, a high QoS does not necessarily mean a high QoE and vice versa. The most appropriate approach therefore for measuring the subjective aspect of the QoE, is to test and provide questionnaires to actual users, which is a demanding process in terms of both time and processing resources.

The parameters affecting overall QoE can be classified into three groups (Kuipers *et al.* 2010):

1. the quality of the video/audio content at the source;
2. quality of Service (QoS), referring to the delivery of content over the network;
3. human perception, which includes expectations, ambiance etc.

While the first two categories are easy to quantify, for the third subjective category a Mean Opinion Score (MOS) scale was introduced to indicate user opinions in a five point scale (ITU-T P.800): 5 = excellent, 4 = good, 3 = fair, 2 = poor, 1 = bad (Kuipers *et al.* 2010). The minimum threshold for acceptable quality corresponded to a MOS of 3.5.

In our research we focused on developing a mathematical model for QoE that would take into consideration the aforementioned three groups of parameters. Our method set out to combine the technical parameters of the QoS with the subjective parameters so as to produce an estimate of overall user satisfaction with the videoconferencing-based educational service. Optimization of the QoE and QoS leads to the ultimate goal of improving the Quality of Learning (QoL).

We used ANFIS (Adaptive Neuro Fuzzy Inference System) to predict the QoE of users in an educational videoconferencing session. ANFIS is a neuro-fuzzy hybrid inference system able to represent human knowledge and the ability to learn from samples.

The inputs in our ANFIS-based model are variables describing the objective parameters of visual quality, audio-video synchronization, network QoS, user synchronization as well as the subjective parameters of user perception and quality of the material.

The single output variable of the model is QoE. QoE is subjective in nature and is measured using the MOS scale giving values of 1 to 5. Our objective was to maintain an MOS of over 3.5

The values for the objective input variables were obtained from real time readings of the educational sessions of the established videoconferencing system and transformed for each parameter using appropriate metric so as to obtain representative input parameter values.

The data values for subjective input variables were obtained from evaluation surveys conducted among the students participating in the videoconferencing-based learning sessions. The main assumption regarding subjective input parameters was that users with affinities belonged to the same stereotype of users and thus experienced similar QoE within the system. Therefore, after initial surveying of several educational videoconferencing sessions we calculated a mean value for user perception and quality of material parameters representing each stereotype. For each subsequent session involving the same lecturer and material on the same educational subject, we assumed the pre-calculated subjective parameter values for each user in the stereotype.

With the data values for the input and output parameters, the ANFIS model is able to construct a fuzzy inference system the membership function parameters of which are adjusted using the back propagation algorithm combined with the least square error method. The membership functions are bell-shaped. The adjustment process enables the system to learn from the modeling data.

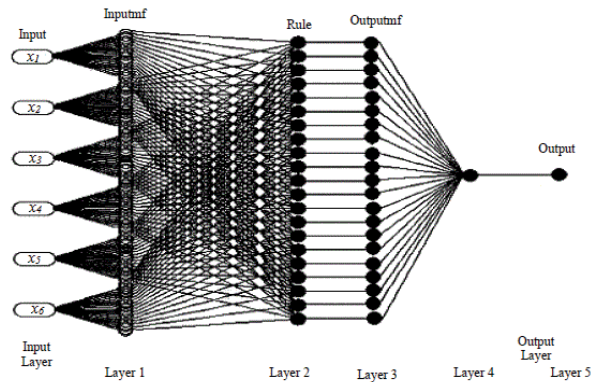
The ANFIS-based model consists of five layers, each layer containing nodes of different structures and connections. The input signals for each node come from the output signals of the previous level. The output from the i -th node in k -th layer is noted as $O_{k,i}$. The graphical representation of the system is given in figure 3.

The ANFIS model works in two phases: training and validation. In the training phase, training data is presented to the system in order to learn and adjust the parameters of the system variables membership functions. In the validation phase, another input data set is given to the trained system in order to validate the capability of the system to predict QoE.

In the present state, the model for QoE prediction is a prototype set up on a network simulation platform OmNet++. We expected a high rate of QoE predictability when we fed the data set values with data readings from the real system.

Evaluation surveys were also developed to interview students on different topics so as to investigate the relations of several variables which may affect the degree of student satisfaction. Information from answers to the surveys during the research study was entered in a central database. Reporting and analysis of the evaluation data was performed so research findings can be proposed for a better understanding of the factors predicting student satisfaction within similar learning environments.

Figure 3. A graphical representation of the five layer ANFIS system



5. Experimental case-studies

To conduct deeper analysis and confirm what was already known from previous research throughout the project, various case-studies were performed. Several learning sessions were organized which used the videoconferencing platform. These sessions provided opportunities

for the researchers to perform detailed contextual analysis of different variables, such as the performance of the videoconferencing platform, the behavior of the transport infrastructure, the methodological approach etc. Even more, students' motivation, readiness to accept the new technology and students' experience could be evaluated through these case studies.

Several learning sessions were organized among the universities in Macedonia. These sessions included point-to-point videoconferencing involvement throughout the process, or multipoint videoconferencing between different sites. They provided an opportunity to gather data through the central management site for system performance at different levels and observe students' experience of the learning process. These case-studies had an even deeper significance; they introduced a new type of lecture design for the distance learning approach in the region.

One of the case-studies included 1st level degree students from the Ss. Cyril and Methodius in Skopje (UKIM) and the University of Florence, Italy. Within this case-study, two videoconferencing learning sessions were established between these remote sites to subject students to different types of lecture and promote collaboration among them. Promoting distance education beyond national borders involves teaching students of different nationalities who usually have different cultural and educational backgrounds so appropriate ways for teaching and learning have to be considered (Sorensen *et al.* 1999; Altbach *et al.* 2007).

The first learning session delivered a videoconferencing lecture from Skopje (as local site) to Florence (as remote site), and the second one (a few weeks later) was dedicated to giving a lecture from Florence (as local site) to two different campuses in Skopje (as remote sites). The courses for these learning sessions were appropriately chosen so the context was familiar to both students groups (local and remote sites), even though both sessions involved different curricula. After the lecturer's presentation, students from both sites were involved in discussion for more in-depth collaboration. The lecturer acted as moderator and the students were able to ask questions on the relative topic. It was a valuable part of the learning session, since it increased student curiosity in both sites and involvement in the learning process.

This case-study provided valuable research data. Real time feedback on the performance of the videoconferencing platform and the transport infrastructure was gathered through the central site, which could be subjected to further research. Even more, for the purpose of the study, different QoS provisioning and controls were prepared for each of the learning sessions. The whole system provided a higher level of QoS, in terms of measured packet loss, jitter and delay for the second learning session. The scenario was very useful for research purposes, since this data could be compared to the students' perceived experience.

The students' comments and experience of these learning sessions was measured through several survey-based questions. Since subjective measurements are not so easy to achieve, these questions focused on two aspects: the general impression of the 'new' methodology and the use of videoconferencing in the specific learning session; and students' impression of the technical quality of the learning sessions (quality of audio/video, instructional information etc.).

The research results showed that the students who had a higher level of QoS within the system achieved higher levels of QoE during the learning session. Even though students were not aware of the actual technical performance in the background (they had no information about the application's performance parameters, actual packet loss, jitter, delay etc.), the survey results showed a strong link with performance of the system. This valuable information was further investigated in the project for proper model development and the QoS-to-QoE mapping algorithm and QoE estimations. Research results could therefore contribute considerably to improving the development, management and governance of e-learning systems in the region.

The evaluation results from the case study, from both learning sessions, gave preliminary results for utilization of the videoconferencing technology in learning sessions across national boundaries. Even though there was a slight difference in numbers (depending on the QoS performance), they showed a positive trend for the 'new' technology and positive student experience.

Table 1 summarizes the results from both learning sessions, as regards students' general impressions and experience of the learning sessions.

Table 1. Summarized results from both learning sessions regarding students' general experience

Survey question	%
Students experienced lowering of attention level	15
Difficulties in concentration	19
Difficulties in following teacher's explanation	41
Difficulties in asking questions	40
Difficulties in interacting with the remote site	22
Advantages in the use of videoconferencing	57

Table 2. Summarized results from both learning sessions related to technical performance

	Low (%)	Sufficient (%)	Good (%)
Audio quality	/	26	74
Video quality	/	36	64
Quality of material	/	5	95
Technical quality	/	11	89

Table 2 gives summarized information on the level of students' experience of technical performance, during both learning sessions.

The case-study showed positive student QoE when videoconferencing was introduced to the learning process. Students had a good impression of the performance of the system, and expressed a very low level of discomfort during such learning sessions. It provided valuable research data for developing models and determining the factors of successful educational practices.

The success of the case-studies performed for local and international videoconferencing-based learning sessions has shown that this technology can be utilized in the educational process in the region. The universities involved can use the implemented infrastructure to develop their learning curricula, plan wider ranges of lectures including videoconferencing and seek out best practices to take advantages of such environment and avoid its weaknesses.

6. Future trends

The project has shown that videoconferencing and distance learning in Macedonian universities has a high potential for development while offering various ideas for refreshing academic practice. As the results have shown, most students quickly recognize its capacity for interactive learning, welcome the chance to collaborate with different students group and generally express a strong preference for the new methodologies.

Furthermore, when videoconferencing is used in conjunction with other collaborative technologies, such as whiteboards, shared screen and shared control, these videoconferencing educational systems can deliver high quality education at a distance. It can be easily integrated with the use of smart mobile devices (tablets, smart phones) for increased student mobility and agility.

The introduction of videoconferencing sessions to the learning and teaching environment has set a new trend for 'blended' lectures that combine the traditional face-to-face approach and distance learning methods. As Osguthorpe *et al.* 2003 define 'blended' learning; it should find a harmonious balance between online access to knowledge and face-to-face human interaction. Garrison and Kanuka 2004, have emphasized the importance of a strong integration between the two environments.

The development of a wide videoconferencing platform in Macedonia has put the universities in this region in a position to join the educational practice which might be an integral part of virtually every lesson in the very near future.

The ongoing continuous research that has followed project implementation will provide results for the proper planning, positioning and

development of future learning programs. Its student-oriented approach will provide results that will be mostly beneficial to the student populations in the universities involved.

7. Conclusion

New methodologies for technology aided learning are becoming increasingly accepted in the educational field as their use contributes to the pedagogical experience. Videoconferencing supports a high level of interaction among the participants and flexibility which can be successfully integrated in the learning and teaching process.

This study researches the educational use of videoconferencing for extending learning opportunities in several universities in Macedonia. The research project was successful in establishing a flexible platform which enhanced students' possibilities and demonstrated an approach which offered benefits to both students and educators.

The videoconferencing system established even closer connections among universities in the region and connections with other universities. It is a system that can be built on, for future expansion of the learning curricula and the delivery of more interesting learning sessions with a wider range of lecturers.

The student-oriented approach will deliver proper quality control focusing on the significant relationship between technology implementation and student learning and satisfaction. It will provide proper measurement of students perceived QoE, determined by the sensitivity of the various factors in relation to the architectural and functional properties of the videoconferencing system.

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QOS IN VIDEO CONFERENCING APPLICATIONS

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Abstract. In recent years there has been a tremendous increase in the capacity of networks and an accompanying increase in the consumption of that capacity. Some applications, such as interactive multimedia applications, not only require large amounts of bandwidth, but also require specialized services from the network with respect to latency and loss. The network must accommodate such traffic without unduly degrading the performance of other applications in the network, some of which may be mission critical. IP videoconferencing is one such application that requires special services from the network. This paper describes the possibilities of providing network Quality of Service (QoS) to videoconferencing applications.

1. Introduction

Most networks today support one or more video traffic types as shown in Table 1. Video traffic is problematic because it has a very high and extremely variable packet rate with a high average maximum transmission unit - MTU (Karam & Tobagi, 2000).

Table 1. Traffic characteristics of different video types

Video type	Traffic characteristics
Video conference	Live, two-way, small groups bandwidth: One or more streams per user
Video on demand	one-way, point-to-point (pull model) bandwidth: One stream per user
Broadcast video (scheduled)	One-way, one-to-many (push model) bandwidth: One stream to unlimited users (IP multicast)

Video conferencing technology enables two or more individuals, or mainly groups of individuals, in different locations to see and hear each other simultaneously while sharing collaboration applications. Videoconferencing can leverage the existing public telephone network, a private

IP network or the internet. Using proprietary technologies or H.323 standard-compliant endpoints, an IP network designed for data only can be modified to support business-quality videoconferencing services. Where bandwidth is available, adding and adjusting a few components is sufficient to provide a complete solution.

All video conferencing traffic is real-time traffic, and needs to be given proper Quality of Service (QoS) support both in the local area network (LAN) as well as the Wide Area Network (WAN). Many enterprises examine the existing and often separate data, voice, and video network infrastructures to determine the most efficient ways of bringing these networks together across an IP infrastructure. In these converged networks, QoS is mandatory at any potential congestion point in the network. QoS ensures that delay- and drop-sensitive traffic, real-time video, and voice pass through unimpeded, as opposed to the drop-tolerant data applications.

In this paper we give an overview of the possibilities for ensuring QoS for videoconferencing traffic based on H.323 in an IP network. We also discuss some additional factors that influence the overall performance of the network as well as some design and implementation issues that are common when using videoconferencing in an existing IP network.

1.1 Video conferencing using H.323

H.323 is a standard (ITU-T, 2009) that specifies the components, protocols and procedures enabling multimedia communication services (real time audio, video and data communication) across packet switching networks. It is widely used in VoIP, video conferencing and data communication across the internet.

H.323 can offer different mechanisms: audio only (IP telephony), audio and video (video telephony or video conferencing), audio and data, audio, video and data. H.323 specifies the following components which connected together on the network provide point-to-point and point-to-multipoint multimedia communication services:

- routers/exit points, used for enabling network IP based video conferencing access outside the local network. They enable protocol translation (ex., H.323 to H.320) and information exchange between different network devices;
- gatekeeper, used to determine whether to establish or ignore the request for video conferencing call. It is the main point for H.323 calls. It is responsible for decisions on the amount of resources for establishing calls and decides whether the devices that ask for the call have the ability and resources to establish the call. It also provides addressing for H.323 internet-based video conferencing clients;
- MCU, the center for video conferencing communications and infrastructure. It serves as a unique point for establishing, connecting and

ending the video broadcast. MCU is needed when three or more users need to establish a real time video conferencing call. It is a bridge that connects the calls from different sources. It can also control multiple video conferencing calls simultaneously. Its characteristics define the number of simultaneous calls;

- video terminal adapter, enables connection to the inherited video conferencing systems. It thus provides protocol translation between the inherited H.320 video conferencing specification across ISDN and the H.323 IP telephony protocol;
- H.323 components, H.323 zone is a collection of all terminals, gateways and MCU managed by one Gatekeeper. One zone includes at least one terminal and can include gateways or MCU. The zone has only one Gatekeeper. The zone can be network topology independent and can include several network segments connected to a router or other devices;
- end devices, the end user devices that join to and receive services from the video conference. Although the systems are different from one manufacturer to another, they all have the same components: video camera, screen and audio components.

H.323 builds on existing IP data networks, scaling to larger deployments and providing greater features. The data sharing capability, remote camera control and enhanced high resolution and high fidelity codec provide much better video conferencing experience with the endpoints available today.

2. Capacity Planning and Bandwidth Management for Videoconferencing Networks

Video conferencing sessions can consume significant amounts of bandwidth. The most significant difference between traditional H.323 video conferencing and High Definition (HD) video conferencing is the increased bandwidth demand. Whereas a traditional video conferencing connection might use 384Kbps or 512Kbps of transport bandwidth, the HD systems can use as much as 4 Mbps of audio and video transport (Polycom, 2007). The H.323 protocol does not require that two or more endpoints in a session send the same data rate they receive. A low-powered endpoint may only be able to encode at a rate of 100K bps, but, because decoding is less processor-intensive, it could decode a 300K bps video stream.

In videoconferencing, bandwidth is assumed to be symmetrical. In full-duplex networks such as ISDN, Ethernet, ATM and TDM networks, capacity is expressed as bandwidth in one direction, though equal bandwidth is available for traffic in the opposite direction. The network designer must first determine the bandwidth of each video call by comparing the different resolution and frame rates available and determining

which settings are best for the business application. When preparing for video conferencing traffic in the network, an estimation of the number of simultaneous sessions the network needs to support and of the network end-to-end bandwidth is needed.

Table 2. Video conferencing bandwidth rates

	Rate	Ethernet	ATM
Video Conferencing	192 K	230 K	240 K
	384 K	460 K	480 K
	512 K	614 K	640 K
	768 K	920K	960K
	1024 K	1.2 M	1.3 M
High Definition Video Conferencing	1472 K	1.8 M	1.9 M
	1920 K	2.3 M	2.4 M
	3840 K	4.6 M	4.8 M
	4096 K	4.9 M	5.1 M

Note: the values shown include the overhead introduced by the IP protocol (for Ethernet) and the ATM cells (for ATM)

Multipoint conference bandwidth is calculated separately from point-to-point sessions. The network designer must determine the number of concurrent calls from each WAN-connected location. The call rate multiplied by the number of concurrent calls will determine the bandwidth requirement on each network access link. It is essential to add the IP overhead. Traditional video conferencing bandwidths are given as the transport bandwidth (e.g., 512 Kbps) where what the network actually experiences is about 20% higher (e.g., 615 Kbps), see table 2. The total count of HD video conferencing calls needs to be multiplied by 1920 Kbps plus 20% overhead in order to obtain the video conferencing demand. This is because video conferencing bandwidth values date from the days when it was all being carried on ISDN, which does not have any overhead. Signaling is out of band, but in an IP network overhead is used to create the packet headers that get the data from one computer to the next. The optimal delay for video applications is similar to voice: 125–150msec round-trip time for optimal results (Cisco, 2005).

If the IP network can't handle the additional traffic associated with live video sessions in a merged or converged network deployment, other options are to rely on circuit switched networks or to deploy additional IP bandwidth capacity.

2.1 Location of the Video Conferencing Bridge (MCU)

Multipoint conferencing products may be software-based or accelerated with special hardware, and their configuration can produce different

bandwidth consumption patterns as well as different user experiences. For example, when an endpoint is used to host a multipoint conference, the maximum bandwidth for any single participant is the bandwidth allocated to that host divided by the number of locations participating. For more than four locations on a call at the same time, network-based products are recommended.

The video conferencing bridge is a bandwidth hotspot because all video conferencing calls participating in multipoint conferences must directly connect to the bridge. Thus, the bandwidth demand of the bridge connection can be significant. The best location for the bridge is in a collocation facility directly connected to the WAN core. This location provides inexpensive high-bandwidth connectivity and ensures that the design will scale as additional video conferencing endpoints are added to the enterprise. Furthermore, the bridge should be placed in the facility where the highest percentage of conference call users reside to minimize the WAN traffic required to support these conference calls.

Each client that connects to the bridge will have a traffic stream flowing from the client to the bridge at the bandwidth negotiated for that video conference. If each client has negotiated a 1.9 Mbps bandwidth call, and there are 6 clients, the bridge will be supporting $1.9 \text{ Mbps} \times 6$ or 11.5 Mbps of traffic. With the 20% additional bandwidth required for IP packet overhead, this becomes 13.8 Mbps.

Some video conferencing endpoints also support a built-in multipoint conferencing mode. If a video conferencing endpoint is acting as a bridge for a small conference, there will be a proportionate increase in the bandwidth to that client. A 4-person conference using one of the 4 clients as a bridge will generate three full duplex streams to the client acting as a bridge. The other three clients will see a single full-duplex stream.

2.2 Bandwidth management

Once the bandwidth demand has been calculated, an evaluation of existing network bandwidth and utilization is required to determine if there are sufficient resources to support the new real-time load. Each link of the network needs to have sufficient bandwidth to support the voice and video traffic expected, plus the existing data applications that use those same connections. In practice it means evaluating the WAN links, the backbone connections of the bridge, and client connections where there may be 10Mbps Ethernet or shared Ethernet connections.

Client connections should all be 100 Mbps full duplex. If the video conferencing endpoint does not support full-duplex operation, it is preferable to run at 100Mbps half-duplex. If the endpoint supports full duplex, but does not support 100 Mbps, it is preferable to run at 10 Mbps full duplex. Some of the most common video problems, such as freezing, come from Ethernet duplex and/or speed mismatch. If the Ethernet

counters indicate large number of CRC/frame/deferred packets, video quality will degrade considerably, so the first checkpoint is making sure all LAN interfaces run error-free.

Converged network links are those where both data traffic and real-time (voice or video) traffic are being supported concurrently. There are two parameters to consider when evaluating the WAN links. First, the expected voice and video (real-time) load should never exceed 33% of the link capacity. Priority-based QoS mechanisms begin to lose their effectiveness at this level. Running with more than 33% high-priority traffic means that the traffic starts to compete with itself, and reliable delivery is compromised (Cisco, 2008).

The second parameter is the total bandwidth utilization of the link, including the real-time components and the data components. It is straight forward to determine the bandwidth demand of the real-time applications, but determining the needs of data applications is much more difficult. Data applications are very bursty, and when many of those applications are aggregated on a link their profile is still very bursty. Data applications depend on bandwidth overhead to get good performance. If the bandwidth of a link is limited to the average consumption of the data applications, the applications themselves slow down, creating user frustration and reduced productivity (Bartlett, Sevcik & Moore, 2004).

Dedicated network links carry only real-time traffic. With these links, the 33% real-time traffic limit does not apply because all the traffic is well-behaved real-time traffic. For links dedicated to voice traffic only, very high utilizations are possible. For traffic that includes video conferencing, which is burstier than voice, a limit of 70% utilization should be observed. High speed links (100 Mbps and higher) can be utilized up to 80%, since the number of streams is much higher and the burstiness of an individual stream has less impact on the link (Cisco, 2008).

This increased utilization does not apply to the classes of service provided by an MPLS provider, unless a separate access link is used. The access link is usually the critical link for QoS, because it represents the lowest speed link in the end-to-end path of the video conferencing. If a single access link is used to support both real-time and data traffic, the 33% limitation must be applied.

2.3 Demand Management

Once the bandwidths for the network have been calculated and put in place, the video conferencing application must stay within the design constraints. As additional systems are deployed, it becomes possible for video to overdrive the network, which will create packet loss and thus poor-quality video. If the network analysis shows that there is insufficient bandwidth on critical links, there are a few options to resolve the conflict:

- bandwidth upgrade, introduces additional bandwidth by upgrading the network links and devices;
- reduce voice or video conferencing demand;
 - The bandwidth used by video conferencing calls can be limited. Better HD video quality can be obtained at 4 Mbps but quite good quality can be obtained at 2 Mbps, and even at 1 Mbps.
 - Manage call volume so that a limited number of calls can occur simultaneously across each link. If a remote office has three video conferencing units, but the bandwidth of the link can only support two simultaneous calls, a scheduling policy can be put in place to insure that only two systems are being used concurrently.
 - The video conferencing infrastructure must have a call admission control (CAC) mechanism in place so that when the bandwidth for a specific network link is fully utilized, subsequent call requests which use that link will be denied.
- Compression/Application Acceleration Appliances.
 - The existing data traffic can be reduced by using a new class of data appliances that use compression, caching, TCP termination, transparent turns reduction and other techniques to accomplish their goals. These appliances can often make room on the link so that video conferencing or voice traffic can be introduced without requiring a bandwidth upgrade (Sevcik & Wetzel, 2006).

3. Quality of Service in Video Conferencing

In particular, quality of service (QoS) is crucial at the WAN edge router. HD videoconferencing traffic has the same needs as standard video conferencing traffic in this respect, just with higher bandwidths. It is critical that the specifications for the wide area network connection meet the requirements of the expected HD video conferencing demand both for real-time support (low loss, low latency, low jitter) as well as for the bandwidth required. Implementing QoS helps to protect the integrity of service-sensitive applications without forklift upgrades. Most of the leading network equipment vendors already support common QoS standards, such as RSVP; they only need to be enabled by the network administrator.

However, care must be taken as to what the backbone provider uses for its QoS. If the protocol or scheme chosen for QoS in the local loop is not the same as that implemented in the backbone, there is a need to put QoS translation software in place for QoS requests to operate end-to-end.

Many service providers today support the demands using Multi Protocol Label Switching (MPLS) technology. MPLS allows the service provider to configure the appropriate bandwidth and to offer classes of service to support the needs of high bandwidth real-time flows and

is recommended by the videoconferencing equipment manufacturers (Polycom, 2007).

3.1 QoS mechanisms

The voice and video streams from a video conferencing endpoint must be given priority treatment in the network (overlay and converged) to maintain audio and video quality. A network class should be dedicated to video, and this class should be of a higher priority than all other application traffic except VoIP. The correct marking for this class will be provided by the WAN vendor. This marking should be put on the IP packets by the endpoint itself through proper configuration of the video endpoint. The network should be designed to trust the endpoint based on its IP address, subnet or port range.

QoS mechanisms can be used on Layer 3 or Layer 2 in the network with the following possibilities:

- Layer 3.
 - Type of Service (TOS) byte, can contain IP precedence value or DSCP value.
 - Resource Reservation Protocol (RSVP), end-to-end QoS signal protocol that allows the end points to ask for a specific QoS they need.
 - Differentiated Services (DiffServ), a complete QoS construction that enables all of the basic QoS operations. The primary enabler is DSField that uses the TOS byte in IPv4.
- Layer 2.
 - 802.1p and 802.1Q, both are extensions of the IEEE 802.1d standard for MAC Bridging (Switching). 802.1p allows for Class of Service Field in the Ethernet frame, while 802.1Q allows tagging and VLANs.
 - Ethernet Class of Service (COS), 3 COS bits in the 802.1p field which is part of the 802.1Q tag (Polycom, 2006).
- Layer 2 and 3.
 - Mapping, done by a router or a L3 switch. Its main function is translation between Layer 2 COS (802.1Q, 802.1p or ISL) values to Layer 3 TOS (IP precedence or DSCP) values.

To provide the appropriate QoS guarantees to video traffic, network devices need to be able to identify such traffic. The differentiated services (DiffServ) model of QoS uses DiffServ code point (DSCP) values to separate traffic into classes. DiffServ defines these two sets of DSCP values:

- Expedited Forwarding (EF), provides a single DSCP value (101110) that gives marked packets the highest level of service from the network. Cisco implements EF service via low latency queuing (LLQ). Generally, EF keeps the high priority queue very small to control delay and

to prevent starvation of lower-priority traffic. As a result, packets can drop, if the queue is full. Usually, EF is most appropriate for VoIP;

- Assured Forwarding (AF), provides four classes, each with three drop precedence levels.

In this context, AF41 (DSCP value 100010) is recommended for video by Cisco. There is no advantage when treating the audio portion of the video streams better than the video packets in an IP video conference application (Cisco, 2008).

By comparison, Polycom recommends that video conferencing traffic should be carried on either MPLS or Layer 2 technologies at a class 4 priority. This translates into an AF41 marking as the DSCP value for DiffServ environments (e.g. MPLS) both voice and video media in a video conference or an IEEE 802.1p marking of 4 for layer 2 environments (Babiarz, Chan, Baker, 2006). Cisco, at Layer 2, recommends using the 3 class of service (CoS) bits in the IEEE 802.1p field, which is part of the IEEE 802.1Q tag (Cisco, 2008).

The predominant technology in use today for providing QoS at layer 2 is IEEE 802.1p while its functionality is often coupled with IEEE 802.1Q, which is the VLAN function. However, it is a common misconception that assigning traffic to VLANs completely separates it in the network, and that this is a viable solution for voice and video traffic. VLAN assignment ensures that traffic will not be forwarded to portions of the network where those VLANs are not allowed, so traffic separation occurs from a permission point of view. On the other hand, priority is assigned separately. Often VLAN assignment and priority assignment are coupled, e.g. any traffic assigned to the Red VLAN gets high priority. If this is true, then traffic in the high priority VLAN will get precedence at the switches, but the two assignments (VLAN and priority) are not necessarily coupled. If there is more than one 'high priority' VLAN passing through the same switch, they will contend for the same output queue resources.

Currently, there are no standards that describe which value is most appropriate for IP video conference. However, Cisco normally recommends the marking scheme shown in table 3 for multiservice networks (Cisco, 2008).

Table 3. Marking scheme for multiservice networks.

Traffic type	Layer 2 CoS	Layer 3 IP Precedence	Layer 3 DSCP
Voice Real-Time Protocol	5	5	EF
Voice control	3	3	AF31
Video conference	4	4	AF41
Streaming video (IP/TV)	1	1	AF13
Data	0-2	0-2	0-AF23

Table 3 assigns streaming video and video conference separate classification and marking values. Streaming video is better able to buffer streams and deal with delay and jitter. Therefore, streaming video requires different QoS levels. In addition, a separation of the control and data portions of the video conference streams may be performed. To separate these two portions of the streams, control should be marked with AF31 and data with AF41. However, this is not the best design since not all endpoints allow you to mark bearer and control traffic differently while control traffic bit rates are negligible, relative to the video call bit rates.

Classification should be performed as close to the source as possible. Third-party video partners VCON, PictureTel, and Polycom can set the IP precedence bits (O'Neil, 2002). The IP precedence field in an IP packet's header indicates the priority with which a packet should be handled. If the H.323 terminal does not set any header values, the packets can be marked at the following points in the network: a Layer 3 switch port, a router that uses class-based marking or MCM feature, an H.323 gatekeeper/proxy that runs on a remote WAN router.

3.2 Video conferencing QoS verification

Network monitoring is a critical component of maintaining a high-quality video conferencing service. A path-based measurement tool should be used to measure the behavior of the network. The statistics gathered by traditional data network tools are not sufficient for monitoring the behavior of networks for voice and video conferencing. The voice and video monitoring tool should be an operational tool that collects information on a 24/7 basis and stores this information in a database. The tool should allow forensic analysis, trending, triggers based on thresholds, and real-time views of the behavior of the network in support of video conferencing.

4. Conclusion

The quality of video and audio transmission plays a key part in videoconferencing. Achieving the necessary QoS by managing latency, jitter, bandwidth and packet loss is the secret for successful IP videoconferencing with great performance. Using QoS the network administrator can control the resources and enable the required network service for the end users.

Because of the different network topologies and conditions and the wide choice of different QoS protocols, the implementation of QoS in a videoconferencing environment can be done in various ways. However, when comparing all multimedia communication traffic QoS alternatives their main goal is based on keeping the main network parameters constant. The most widely accepted model at present is the Differentiated

services. In a corporative environment, a combination of QoS mechanisms proved to be very effective. By combining the advantages of each QoS mechanism an end-to-end QoS for videoconferencing users can be achieved. The network administrator must perform regular network monitoring to maintain high-quality user experience.

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VIDEO CONFERENCING AND THE VIRTUAL CLASSROOM AS TOOLS FOR ONLINE TUTORING

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Abstract. In this paper we describe how videoconferencing can be effectively used as a tool for tutoring online in an environment where teaching and learning are performed at a distance through an internet-based portal.

1. Introduction

The International Telematic University Uninettuno originated from the experience of Consorzio Nettuno and benefited from its know-how, acquired in over 20 years of experience in the field of distance education and e-Learning.

The main didactic tool is the internet-based learning environment <<http://www.uninettunouniversity.net>>, the first portal in the world where teaching and learning are carried out in many languages including Italian, English, French and Arabic.

Communication tools are a core component of the Uninettuno psycho-pedagogical didactic model of Prof. Maria Amata Garito, implemented in the Uninettunoportal; together with Support tools and Didactic content delivery services, it constitutes the structure through which higher education or vocational training courses are provided. In particular, the communication tools allow contact with the tutor and other students in the class, exchange of experiences, the co-construction of knowledge and practical implementation of collaborative learning as a fundamental part of the online teaching and learning process.

2. Tutoring online

Tutoring online, a sub-section of functionalities provided in the Tutor's, Teacher's and Course pages, is the real interactive portal section of the Uninettuno learning environment. In this section real tutors/teachers assist students in the virtual classrooms using chat, forum and virtual classroom environments, correcting their papers, helping them to overcome the learning and motivational difficulties related to studying at a distance. Tutoring is structured into classes of 20 or 30 students, 20 for the Engineering Faculties and 30 for the other Faculties. In general, the telematic tutor will give students cognitive support:

- giving information on the structure of the course and its aims;
- giving user-students an evaluation and feed-back on the work done and the skills acquired both during the learning process and at the end of the course;
- developing study skills such as critical skills and meta-cognitive learning strategies;
- encouraging the anchoring of the new skills and knowledge to other knowledge and contexts;
- facilitating access to technologies and materials that the user-students will use during the course.

The tutor will have to:

1. encourage the structuring of knowledge exchange networks, in a complex system comprising telematic tutors, students and technologies, which is capable of working better than the sum of the single parts;
2. select the didactic material in order to guarantee access to information in an adequate format and level for the skills and knowledge of the various students. The resources will have to be grouped, perhaps in databases organized according to level of complexity, in order to guide people who are not used to navigating (Garito 2000c).

The telematic tutor's role is performed in different didactic scenarios: 'one-to-one' and 'one-to-many'.

2.1 'One to one' scenario (*learning in a single mode*)

In this scenario, by means of video chats, chats, e-mail, the telematic tutor assists the student during his/her exploration of the different environments, giving a constant evaluation of his/her didactic progress, whenever the student wishes. The telematic tutor, by means of interactive dialogues of the Socratic style, will help the student to analyze his/her own thinking and to discover and correct not only his/her mistakes, but also their causes. The telematic tutor will have certain special

functions, borrowed from specific experiences in the field of distance tutoring, such as:

1. Supporting student motivation:
 - mobilizing and maintaining motivation;
 - creating an open and positive atmosphere;
 - compensating the social requirements of the user-student.
2. Helping in relation to course contents:
 - relating the contents to previous knowledge;
 - solving problems in course contents;
 - stimulating the application of these contents in professional life.
3. Development of study skills:
 - promoting a critical sense;
 - developing learning styles and cognitive strategies;
 - helping to auto-regulate study and training;
 - promoting awareness of contextual learning factors;
 - introducing the student to the use of new technologies (e-mail, chat, videoconference, the internet).
4. Evaluation/feedback:
 - informing the user-student of his/her progress;
 - preparing the user-student for his/her exams;
 - helping the user-student to develop realistic self-evaluation skills (Garito 2000c).

2.2 'One to many' scenario (*collaborative learning mode*)

In this scenario, by means of real time videoconferences and diachronic forums, the telematic tutor organizes and structures collaborative learning sessions to promote interaction among the different players in the educational process. The telematic tutor will actively direct the work of the groups. The telematic tutor must:

- organize group objectives clearly and precisely in order to prevent participants from wasting their energy on insignificant interactions and activities;
- define specialized tasks and assign them to the various members;
- clearly define the personal responsibilities of each member.

Particular attention must be paid to the group objectives which have various specific functions. Tasks will be selected so as to offer a stimulating but not impossible challenge in order to encourage motivation and stimulate the sensation of self-effectiveness. In particular, the tasks must be complicated enough to:

- allow each participant to make his/her own contribution to the achievement of the objective;
- ensure the participants realize that the group has greater skills and resources than its individual members.

The tutor must support student motivation by encouraging the creation of an open and positive social environment. The type of environment that is planned must stimulate reciprocal cooperation and help between students, allowing each to express him/herself and participate. In particular, he/she must pay attention to the social processes taking place in the group in order to ensure that these are directed towards:

- social aims in order to stimulate social activities and behavior;
- the adaptation of individual needs;
- ensuring equal opportunities for all the participants to achieve the objective.

The establishment of learning communities will encourage participation in the various groups to combine their skills and attempt to reach a common and shared objective. This way various cognitive processes will be activated:

1. User-students will have to explain their reasoning and understand that of others. This will 'force' them to formulate their thoughts clearly and highlight any shortcomings in communication. They will therefore have to carry out a specular task of decoding other people's thoughts in order to achieve a further process of communication clarification.
2. During social interaction, it is very probable that a 'cognitive conflict' will arise. This will oblige user-students to explain and review their basic concepts when they come into contact with information they didn't know beforehand, perhaps contradictory, proposed by the other group members.
3. There is a cognitive challenge in cooperation where user-students attempt to defend and argue their points of view with the other learning partners. These challenges stimulate them to look for new arguments to support their view, and promote acceptance of other people's ideas when their arguments are recognized as being valid.
4. With cooperation, people also learn that criticisms are aimed at ideas and not at people and this fact stimulates a feeling of respect towards the others and confrontation training which is seen as a moment of growth.

Learning therefore becomes a social process that promotes affective and motivational dynamics:

- Group study supports the motivation of its members, helping them to overcome difficulties. Various research projects have shown how the level of self-esteem in groups is greater than in individuals because it is stimulated by the other members.
- When a learning group realizes that collective success depends on the success and work of everyone, the willingness to provide emotive and didactic support grows, as does self-esteem.

- Thanks to shared efforts and different contributions, the activities of the group encourage students to demonstrate that the subject and the objective they are pursuing is of great intrinsic importance, thereby increasing enthusiasm and self-esteem.

As regards his/her relationship with the organization, the telematic tutor must have the following skills:

1. A thorough knowledge of the characteristics of telematic environments, especially those encouraging collaboration and learning, i.e.:
 - offering a welcoming social environment;
 - concentrating the attention of students on the problems of shared understanding;
 - encouraging exploration;
 - encouraging connectivity to ensure that students follow the logic of their reasoning;
 - giving pride of place to group rather than individual work.
2. Providing the organization with feedback on the students' opinions of the course so as to enable the organization to make improvements to courses and interaction methods.
3. Collaborating with the other institutional roles in order to redefine the role of teachers who will have to introduce specific elements for distance collaborative environments into their activities:
 - preferring to reply to student questions rather than asking them and encouraging communication between students during the search for solutions;
 - the teachers will act as guides and tutors, providing as much personalized feed-back as possible and becoming real and proper promoters of knowledge.

In short, the telematic tutor in his/her new function should:

- play the role of teacher-director designing learning scenarios and who, later on, cooperates with his/her 'students' to create an educational path that should take into account different styles of learning;
- supply the students not only with theoretical and conceptual tools, but also tools that allow them to transform knowledge into practical abilities, then into professional skills;
- promote, through 'virtual laboratories', the integration between knowing and being able to do;
- develop models of sharing knowledge with the other users of the Network promoting collaborative learning processes;
- play the role of somebody who orientates and facilitates and give everybody the necessary tools to help the student find the information he/she needs on the Net without getting lost in the Web Hyperspace;

- promote socialization models on the Net between distance students and teachers communities.

3. *Virtual Classroom*

Through the UTIU Virtual Classroom system students can interactively develop collaborative and cooperative learning processes and socialize on the web through the internet.

The UTIU Virtual Classrooms are a system based on interactive classrooms, via IP, web and Second Life enabling students to connect with Tutors and Teachers by videoconferencing from anywhere in the world.

3.1 *Web Virtual Classroom*

The Web Virtual Classroom system enables students to interact with Tutors and Teachers remotely in two modes.

If the student has access to a videoconferencing/tele-presence system and a public IP, he/she will be able to get wired to the dedicated IP address at the arranged time in order to be able to attend the conference; this system assures the greatest degree of interactivity since it operates directly in an audio-video mode.

If the student cannot access a videoconference system, the UTIU Virtual Classroom enables all students to attend a live videoconference session by putting at their disposal a web-based video-streaming service connected to real-time chat to assure interaction. No additional software components are required to get connected to the UTIU Virtual Classroom via web, nor any additional setting-up compared to what is required to benefit from the normal training activities available on the UTIU portal.

Teachers and Tutors can organize Virtual Classroom sessions for students and classes of students and schedule them by means of the Agenda; the tutoring session or lesson will be automatically communicated to all the involved students on the Student's Agenda. In addition, the Teachers and Tutors will be able to deliver a Virtual Classroom session in the UTIU specially equipped centers as well as by remote using a further 'peer' videoconference linked to the UTIU dedicated IP address by means of a public IP; in this last case, the audio-video signal will be re-transmitted from remote automatically via the web on the UTIU technological platform.

In addition, students can access the records of the Virtual Classrooms sessions already held, available from the dedicated section of the UTIU portal in video format.

3.2 *Virtual Classrooms on the UTIU Island of Knowledge on Second Life*

Events, lessons, tutoring sessions and seminars are also organized in the Virtual Classrooms of the UTIU Island of Knowledge on Second Life.

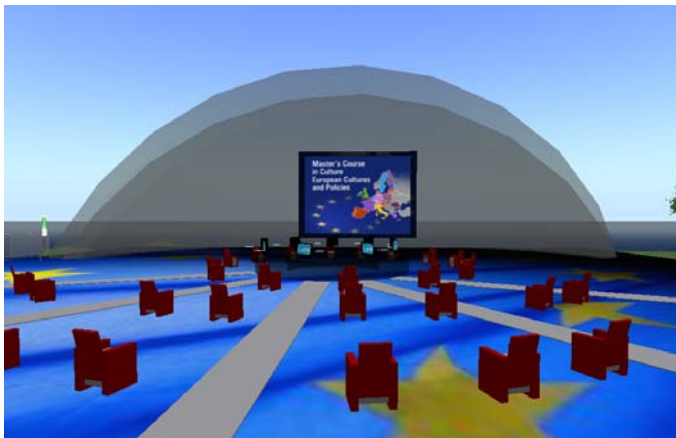
Professors, Tutors and students mutually interact through their respective Avatars in the 3D environment specifically designed for their educational experiences and which enables textual, audio and 3D interaction.

On the UTIU Island of Knowledge, beside a Secretariat, Faculties, an Exhibition Room, a Cinema/Theatre Hall and other facilities which are typical of a campus, there are also two Classrooms providing specific functions.

The Virtual Classroom on the UTIU Island of Knowledge enables textual and audio 3D interaction in multi-conferencing. A set of computers, reproduced in 3D, gives direct access to the UTIU portal.



The Conference Hall on the UTIU Island of Knowledge enables the organization of seminars and conferences in a 3D and interactive environment. It is possible to show videos and presentations and interact in text and on audio multi-conferencing.



At the entrance to the Classrooms of the UTIU Island of Knowledge on Second Life the students find a poster with a guide for accessing the UTIU Island of Knowledge and for creating their own Avatars; this guide is also available online.

In order to access the UTIU Island of Knowledge on Second Life you need to have set up the Second Life software package which can be downloaded at: <<http://secondlife.com/support/downloads.php>>.

To find out about the system requirements needed to access it a page with detailed information is available at: <<http://secondlife.com/support/sysreqs.php>>.

Professors and Tutors can organize Virtual Classroom sessions for students and classes of students and schedule them by means of the Agenda; the tutoring session or lesson will be automatically communicated to all students involved on the Student's Agenda.

3.3 Virtual classroom in formal learning

In practice, the use of virtual classrooms follows a special procedure that is meant to assure students and tutors the highest efficiency and the best possible results that can be achieved with this tool.

Actually, web-based virtual classrooms allow for a much more advanced service level for students and give tutors and teachers many tools to be used in an hour of interactive lesson that they are asked to deliver; at the same time, it is useful to identify a set of rules that could serve as guidelines for teachers and tutors in using this tool.

The need to plan the duration of each single session of virtual classroom arises for two reasons: the former is an essentially cognitive one, linked to the attention level of the group of students who are wired for too long a period of time; the latter is an organizational one: UTIU virtual classrooms, because of their nature, take place in a specially-equipped video production studio; therefore, it is necessary to identify a standard format to be able to schedule the sessions of different tutors; the session duration was fixed at 50 minutes.

Another factor that was formalized is the set of tools put at the teacher/tutor's disposal during the session. The session, as said above, takes place on video live-streaming on the web; the wired students can interact with him/her asking questions or participating via textual chats. However, the teacher/tutor can also check what the students see on their screens going beyond mere broadcasting of his/her own picture. Actually, in the production studio, the tutor, can access a Pc on his/her desk whose video signal is sent to a mixer; the tutor can use files, presentations, specific software packages prepared on purpose for each single subject that the student could not access and, by so doing, can see them working at their own Pc from the teacher/tutor's Pc. Finally, an area on the desk from which the tutor is filmed, corresponding to an A4 for-

mat page is delimited; in this area the tutor can do or show anything: using a felt-tip pen he/she can write down a mathematical formula or a charter (operations that would otherwise be impossible in normal textual chat), or show a book or an object: actually, this area is shot with an azimuth camera which is placed perpendicular to the desk. This set of tools is used by the tutors in an absolutely natural way; since, during the live-streaming session, they are supported by a director and by a cameraman, the tutor performs these different operations in a natural manner and the director sends the students the most suitable picture: the half-length picture of the teacher/tutor while looking at the camera, the signal of the Pc screen when the tutor uses the Pc, the signal of the azimuth camera when the tutor carries on 'physical' operations in the delimited area of his/her desktop.

Finally, given the large number of tools available, required to make the teacher/tutor look as 'prepared' as possible for the videoconferencing session, if the issue being discussed were fully improvised the teacher/tutor would not be able – for instance – to fully exploit the possibilities offered by being able to share the screen of his/her own Pc with the connected students. In scheduling virtual classrooms we organized the opening of a discussion on the subject forum according to the standard procedure – a week before the scheduled session – where students are asked to indicate which issues they wish to study in more depth. By so doing, the three main communication tools supplied by the UTIU portal are used in an integrated way: the forum in preparing the live session, to assure the preparation of the materials needed to carry on the videoconference, maximize times and make the interaction of mere 'request of explanation on a given issue' less frequent to devote more time possible to constructive interactions with the students on a negotiated set of issues which they agreed on; the videoconference and, in fact, the chat enables the tutor to monitor students' attendance and the students themselves to not limit themselves to participating in a mere one-way transmission of knowledge – condition that could make the use of a 'live' means a nonsense – thus becoming co-constructors of knowledge.

Possible evolutions are being studied and soon they will be implemented for the purpose of enriching the study experience offered to the student by the UTIU learning environment; the multiple web-based videoconference, already possible in technical terms, but in practice up to now limited by bandwidth requirements that are too high for the students, who could not be always accredited during the instructional design phase for bandwidth connection, to tools aimed at the co-construction of educational contents in real time (wikis, collaborative maps etc.) that will soon be integrated on the UTIU portal.

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A STEP TOWARDS THE VIRTUAL (OPEN) CAMPUS, THE ROLE OF MULTIMEDIA COMMUNICATION SERVICES

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Abstract. South East European University has developed eLearning and distance learning systems so as to fall in line with current trends in multimedia communication services and apply effective utilization of distance learning education to enhance the teaching and learning process. In this context, it is of immense interest to the South East European University to apply state of the art communication tools for the purpose of improving communication and collaboration between students and teachers in the virtual world. This kind of communication must offer the same experience for teachers and students as that experienced in traditional teaching environments. South East European University has had a vast experience in using LMS tools as well as organizing lectures and conferences via video-conferencing.

1. Introduction

South East European University (SEEU) is the only private-public non-profit Higher Education Institution in the Republic of Macedonia, founded in 2000 and located in Tetovo and Skopje, R. Macedonia. It is a new model of university for the region, initially seen in EU countries and the USA.

SEEU has more than 7000 students and more than 5000 graduates. Since opening its campus in Tetovo in October 2001 it has succeeded in establishing itself as a quality-led, financially sustainable university now regarded as a model for multi-ethnic, multi-lingual higher education in South East Europe. The SEEU has established long-term bilateral co-operation with a number of international, regional and national universities.

Universities in the western Balkans inherited a post-communist education system which over the past 20 years has seen many reforms, mostly by trying to copy the higher education systems of Western countries.

Under the new initiative of the Ministry of Education and Science (MES) for massovization, open access and lower tuition fees in higher education, the public universities in the Republic of Macedonia (RM) have diffused studies in small towns thought the country. In order to be

competitive, private universities have followed this trend, starting to offer study programs in some cities in Macedonia. As a result, higher education is becoming popular. More people are educated in universities. But the rapid increase in the number of students has raised issues of quality since this diffusion has not been supported by an increase in university resources: limited as regards the number of teachers, equipment and laboratories. Lack of infrastructures for higher education institutions has affected the quality of education.

The 21st century is a knowledge-based economy and society. In the meantime, international competition has become fierce.

With the development of science and technology new knowledge is emerging rapidly. Today, internet offers different kinds of services: so-called multimedia communication services like VoIP, videoconference and others. On the other hand the European Credit Transfer System (ECTS) has made co-operation between universities in Europe much easier. Therefore, a growing global perspective and competitive environment have boosted the need for new solutions related to the distribution of the knowledge and experience through a different type of media from the traditional ones. This, coupled with the increasing need to continue education or to improve knowledge and the demands of the growing number of geographically distributed universities, staff training, teaching quality and academic research, emphasizes the importance, acting as a driving force, to ensure the future of a more sophisticated, cost competitive, distance learning approach as a major component of higher education.

2. Multimedia communication services at SEEU

People's lifestyle, especially in this time of global financial crisis, has increased the need to improve their education and knowledge through multimedia communication services.

From the start the South East European University has aimed to developed e-learning and distance learning systems in order to fall in line with current trends in multimedia communication services and effectively use distance learning to enhance the teaching and learning process.

At the beginning of 2001-2002, a South East European University campus intranet network was set up, with open access for all campus inhabitants, 5 MB per student and 70MB per staff member. Part of the intranet memory was for public use, the public domain contained folders for each course and housed electronic copies of the learning materials for each course.

The use of multimedia communication services in the majority of higher education institutions can be seen by the use of Learning Management Systems (LMS), systems that are focused on the delivery and sup-

port of learning opportunities. South East European University's LMS experience started in the academic year 2005–2006, when SEEU began to implement the commercial LCMS 'Angel'. Although there is usually an adjustment period for most students and professors, as they learn the patterns of online communication, the interest in using ANGEL has grown from year to year. There were around 1100 course sites in ANGEL with more than 7700 users.

Additionally, the university has developed a number of electronic services for the student learning process with strong emphasis on staff development through its Research Center. As part of our research effort, a project was founded by SEEU with the purpose of developing a new custom-based LMS later known as Libri. Libri has been in use as an LMS system from 2008 to the present day. Being a custom-developed tool Libri has the advantage of fully supporting the teaching process offered by SEEU and has proven to be adaptive in supporting additional needs as required by its users.

Architecturally, Libri was designed with a modular approach in mind. This way, as requirements change, the system can be adapted and extended to support new requirements. During its lifetime, this system has been actively developed, and today it offers all the tools that are supported by modern commercial LMS tools. Recently, Libri has been upgraded to meet the demands of special eLearning courses taught at a distance, with the introduction of advanced testing tools, offline video lecture streaming and tools aiming to enhance online collaboration among students.

Also, the university has offered thorough training sessions to students and teaching staff with the aim of encouraging their use of the system as well as facilitating their transition towards this new LMS. This has improved the usage of the system, and as of this moment all students and staff members have used the system.

In order to produce a workforce suited to the local labor market demands and to support university-business partnerships, SEE University has established a Business Development Centre. This center aims to promote and identify specific cooperation areas between universities at a national and international level, as well as with industry in general.

SEE University has enjoyed a positive experience in the use of multimedia communication services. Since 2004 South East European University has offered distance-learning courses in collaboration with Indiana University, USA. The objective was to offer graduate level classes in computer science via Polycom. Furthermore, due to the success of these programs, the university extended the scope of these types of courses to undergraduate level, as well as its cooperation with other universities.

Today, SEE University has three classrooms (Figure 1) fitted with the equipment needed for distance learning (Figure 2) and one Polycom RSS 2000 recording and streaming server (Figure 3). These classrooms

are also used to offer video-conferencing lectures and presentations to other universities in the region and abroad.

Figure 1. Classroom (Distance education)



Figure 1 shows a dedicated classroom for the organization of video-conference powered meetings often used in various projects organized by SEEU.

Figure 2. Polycom VSX 7000



Figure 3. Polycom RSS 2000 recording and streaming server



Since 2009 South East European University has been part of the Video Conferencing Educational Services (VICES) Tempus project.

Figure 3 shows the streaming and recording server, which was part of the VICES project. This server was successfully used in many occasions to record video-conferencing lectures and also to stream video lectures.

2.1 Video Conferencing Activity

SEEU has organized many lectures as videoconferencing activities, mainly with Indiana University. Among such courses were computer science related courses, such as Computer Graphics, Data Mining, Distributed Systems etc.

The following table shows the activities (total for the summer semester of 2011) held over the last year, with both streaming and recording sessions:

Table 1. Activities (total for summer semester of 2011) held over the last year at SEEU

	Length	Bandwidth	Protocol	Size
<i>SEEU</i>	95:04:57	1920	H.261	10082184

3. Course preparation

For the effective preparation and organization of distance and e-learning courses the professors involved in providing multimedia communication courses (video conferencing, e-learning and distance learning) have worked together to develop syllabuses and to develop a model for improving teaching and learning multimedia programs in two faculties of the SEE University, the Faculty of Contemporary Science and Technologies and the Faculty for foreign languages. For effective multimedia communication courses (videoconferencing, distance learning, e-learning) the parameters suggested by researchers in this area are as follows:

- design and development of learning materials;
- use of advanced technology;
- teaching/tutoring system;
- student-support system;
- purposeful;
- structured;
- engaging;
- paced.

Considering these parameters, professors have developed a multimedia package as study material which fulfills all the above requirements.

Since the South East European University provides distance learning through videoconferencing and eLearning, these two systems are different and will have different models.

eLearning is a system where learners are separate from the teachers or educational institution in terms of both time and space, while videoconferencing is a system where learners are separate from the teacher or educational institution in terms of space, but not in time. For this reason, materials which are dedicated to eLearning should have clear rules for structure of the syllabus, reading materials and self-assessment while the syllabus and materials dedicated to videoconferencing should be more interactive in order to enable students to question the professor, as in real life. Videoconferencing methods for education require more technical and environmental equipment, such as the videoconferencing infrastructure, dedicated rooms for such purpose.

For the year 2011/12 South East European University is offering the following courses through the videoconferencing network:

- XML Technologies;
- Computer Graphics;
- Business Application Development.

It is important to note that in both strategies and methods the professor should be sure that the student has understood the syllabus of the subject. For this reason professors on videoconferencing and e-learning courses give students tests on issues related to the syllabus. For example:

- How many hours are devoted to this subject?
- How many quizzes have there been during the semester on this subject?
- Do you know the method of assessment in this subject?
- How many content categories is this subject divided into?

The answers given by students assure teachers that they know about the materials and assessment procedure.

What is new however is that different strategies and methods of instructional delivery for meaningful learning keep evolving. Concepts such as blended learning, flexible learning, and virtual learning, among others, abound.

This is a method of using the conventional means, which is largely face-to-face, to deliver educational content through the use of classrooms and study centers to learners. The method entails the physical presence of students in the class for learning to take place. The assessment and evaluation of students is done using the same method. Traditional classroom teaching has long favored didactic and often spontaneous, oral instruction rather than guided independent study (Guiton 1992). Besides conveying knowledge to the students, traditional learning has a cultural aspect.

Videoconferencing will enhance the quality and variety of education in Macedonia in the area of Business Information Technology and promote specific cooperation areas between universities, as well as with the industry in general.

According to the 21st century slogan «education for everyone everywhere», this access became possible with the virtual campus. The virtual campus in fact is a special case of the real university (campus). In a real university, tools and facilities are physical while in the virtual university (campus), computer and internet are the communication lines between the teacher, student and class.

This scenario is of huge interest to universities applying state of the art communication tools so as to improve communication and collaboration between students and teachers in the virtual world. This kind of communication must offer the same experience for teachers and students as they experience in traditional teaching environments.

To successfully enable this kind of communication, universities must be able to integrate Learning Management Systems with online and offline video-conferencing tools. This integration will not only enable seamless virtual communication using eClassrooms but allows students to flexibly organize their time and focus during their studies. With the advent of new social networking tools, universities must be able to extend online communication tools in order to embrace these new trends.

South East European University has had a vast experience both in using LMS tools, and in organizing lectures and conferences via videoconferencing. A valuable asset for this university is its capacity to build and extend in-house developed tools, among which the most important is Libri LMS. As previously mentioned, this tool is designed to be extendable using various modules. In the future, this LMS can be extended not only to support multi-site videoconferencing, but also state of the art collaboration tools, which would vastly improve the learning experience for students.

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VIDEOCONFERENCING SYSTEMS FOR SYNCHRONOUS MULTI-CAMPUS DISTANCE EDUCATION

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Abstract. The purpose of this paper is to describe the current implementation of the videoconferencing system at the University 'Goce Delcev' - Stip, as a case-study, to present some non-functional requirements related to the technology and infrastructure resulting from the implementation process. The paper also presents students' perspectives of videoconferencing in distance education. These findings emerged during the process of preliminary assessment of the videoconferencing system at the university.

1. Introduction

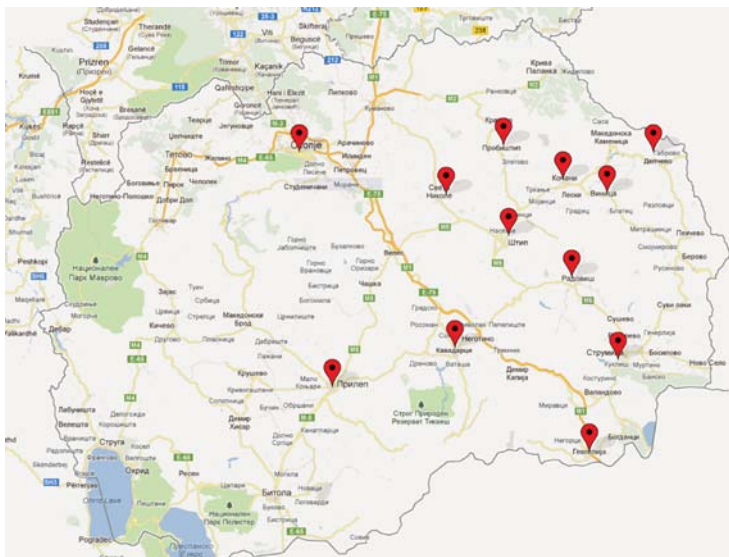
Until the 90's, higher education studies in Republic of Macedonia, were provided by two state universities (Ss. Cyril and Methodious and St. Kliment Ohridski - respectively in Skopje and Bitola). Over the following years, other private and public universities (mainly located in Skopje and the north-west of the country) were established. The location of these institutions did, however, raise a question about ease of access for people living in other parts of the country, notably the east. Additionally, social and economic circumstances prevented people from moving freely from rural areas to cities, therefore limiting their access to academic institutions.

Pursuant to the long-term national strategies for economic development at a national and regional level, the state decided to extend educational opportunities by founding the 'Goce Delcev' University in 2007. The university is located in Stip, R. Macedonia. Nowadays it has four campuses, comprising 13 faculties - covering almost all disciplines, 10 university centers and three institutes. As well as first cycle study courses, the university organizes education for many second and third cycle study programs as well. Currently around 17,000 students are enrolled at the university.

'Goce Delcev' University courses are provided in 12 remote sites scattered over 12 different cities (almost all cities in Eastern Macedonia:

Stip, Kocani, Strumica, Radovish, Vinica, Sveti Nikole, Gevgelija, as well as Kavadarci, Prilep and Skopje)(Figure1). The institution has also established agreements with various universities and experts worldwide to enable and support a growing number of student and staff exchanges between campuses.

Figure 1. Locations of the ‘Goce Delcev’ University remote units



The current structure and growing trends of the university have thus challenged the ‘Goce Delcev’ university to organize and support its education provision focusing on communication and collaboration between the various campuses. Today this is mainly achieved through the physical mobility of staff and/or students between different locations. But the university is progressively supporting initiatives that replace or enhance physical with virtual mobility. Considering the new challenges in higher education and understanding the importance of innovation in education through new educational technologies, the University ‘Goce Delcev’ – Stip is making permanent efforts to integrate various forms of distance learning with traditional education. According to a primary evaluation, among other distance learning methodologies, videoconferencing is considered the most relevant and proven to stimulate collaboration between the various sites, to support and enhance student and/or staff communication, to enable flexible quality learning and accessibility, as well as to rationalize various costs.

The purpose of this paper is to describe the current implementation of the videoconferencing system at the university as a case-study and to

remark on some non-functional requirements related to the technology and infrastructure and emerging during the process of implementation. The paper also presents students' perspectives of videoconferencing in distance education. These findings resulted from a preliminary evaluation process of the videoconferencing system at the university.

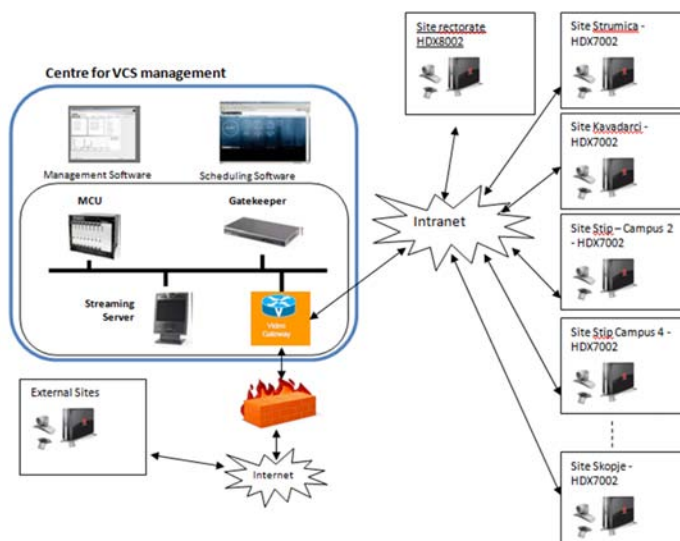
2. Technical infrastructure for videoconferencing

2.1 General system architecture

The architecture of the videoconferencing system implemented at the 'Goce Delcev' university - Stip is presented in figure 2. As can be seen from the figure, the core of the system is the videoconferencing management system, to which many end-points are connected. It consists of two segments: a) software for scheduling and management b) hardware components. The main hardware components in the system are:

- *Multipoint Control Unit (MCU)*, composed of a mandatory Multipoint Controller (MC) used for call signaling and conference control and an optional Multipoint Processor (MP) used for switching/mixing media streams, and sometimes real-time transcoding of the received audio/video streams. Although the MCU is a separate logical unit, it may be combined into a terminal gateway or gatekeeper. The MCU is required in a centralized multipoint conference where each terminal establishes a point to point connection with the MCU. The MCU

Figure 2. 'Goce Delcev' university - Stip ,videoconferencing system architecture



determines the capabilities of each terminal and sends each a mixed media stream. In the decentralized model of multipoint conferencing, an MC ensures communication compatibility but the media streams are multicast and the mixing is performed at each terminal.

- *Gateway*, provides data format translation, control signaling translation, audio and video codec translation, call setup and termination functionality on both sides of the network.
- *Gatekeeper*, provides address translation, admission and access control of endpoints, bandwidth management, and routing of all calls originating or terminating in its zone. Endpoints register themselves at a gatekeeper.

With all the security concerns in today's digital world, nearly every network is protected by a firewall. Firewalls are great for security of the network but they must be properly configured when working with multimedia applications. Video conferencing is no different. When installing firewalls some things have to be considered. Typically this involves the IP-addressing scheme of the network and what ports need to be opened on the firewall for the services to be accessed when needed.

Besides the videoconferencing network infrastructure, for quality distance education room configuration plays a very important role; some related experiences and guidelines will therefore be presented below.

2.2 Classroom configuration - technical settings

While one particular university classroom configuration and solution may differ from another, the basic requirements and capability for a particular classroom will be similar. The typical classroom application will have a central location for a lecturer or facilitator with multiple rows of seating, possibly in a tiered configuration in the larger rooms. There is a requirement for the instructor to be heard well locally, for students to be able to interact with remote participants, and for data collaboration tools.

The classroom requires an audio and video conferencing system capable of multi-point conferences. Often there is a requirement for data collaboration, whiteboards, a telephone line allowing remote participants to dial into the system, program audio and video (such as DVD or VCR) for audio and video playback and often also a web server to make it easier to build content and create a paperless classroom environment.

Students' microphones can either be table mounted, with push to talk buttons, or ceiling mounted to get them away from student clutter. The camera system for the video conferencing environment may be driven by the microphone audio so that the camera follows the audio. The classroom may typically have between 6 and 64 microphones depending on the size of the room and number of participants, ceiling loudspeakers for each 100-200 sq ft of room, and in the larger rooms, program audio

loudspeakers that enable stereo (or even surround sound) reproduction of CD, VCR, and DVD audio.

A typical classroom application, as shown in figure 3 and figure 4, includes tabletop microphones for the instructor and students, and an optional podium microphone for the instructor. There may be one or two loudspeaker zones for the students and several options for program audio and video such as from VCRs, CD players, and DVD player.

Figure 3. Typical classroom layout with teacher and student microphones at 'Goce Delcev' university.

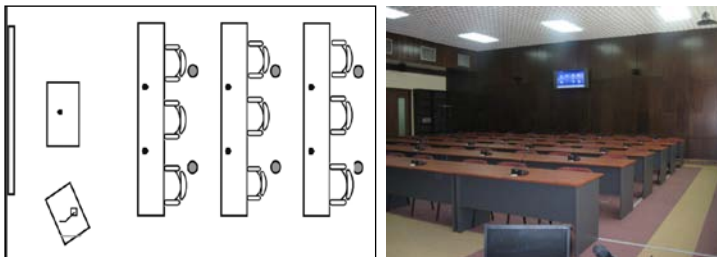
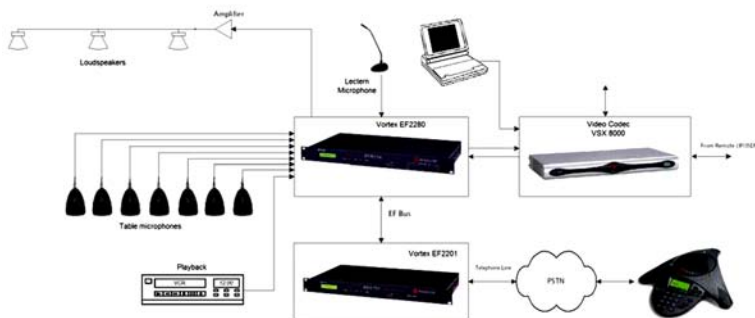


Figure 4. System design for a typical classroom application



2.3 Lecture hall configuration - technical settings

A lecture hall, set up for distance learning applications, is similar to a distance learning classroom but provides seating for up to several hundred people. It has a central location for presenters with multiple rows of seating in a tiered configuration. There is a requirement for the instructor to be heard well locally (in sound reinforcement), for students to be able to interact with remote participants, and for data collaboration tools.

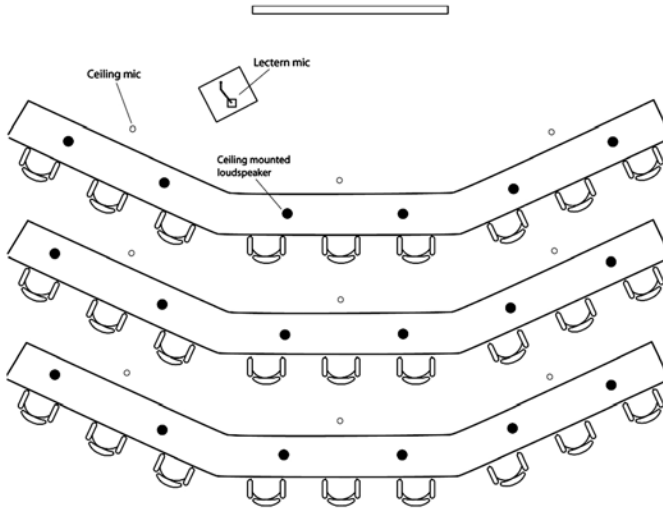
The lecture hall requires an audio and video conferencing system capable of multi-point conferences from two to twelve locations. The students' microphones are normally ceiling mounted as desks tend to be the fold-up type attached to individual chairs. The camera system for

the video conferencing environment may be driven by the microphone audio so that the camera follows the audio.

The lecture hall may typically have between 16 and 64 microphones depending on the size of the room and number of participants, ceiling loudspeakers for each 100–200 sq ft of room, and program audio loudspeakers that enable stereo (or even surround sound) reproduction of CD, VCR, and DVD audio.

A typical lecture hall application, as shown in figure 5, includes a wireless microphone for the instructor, with an optional podium or lectern microphone, and ceiling mounted microphones for the students. There will be multiple loudspeaker zones for the students. There may be several options for program audio and video such as from VCRs, CD players, and DVD players.

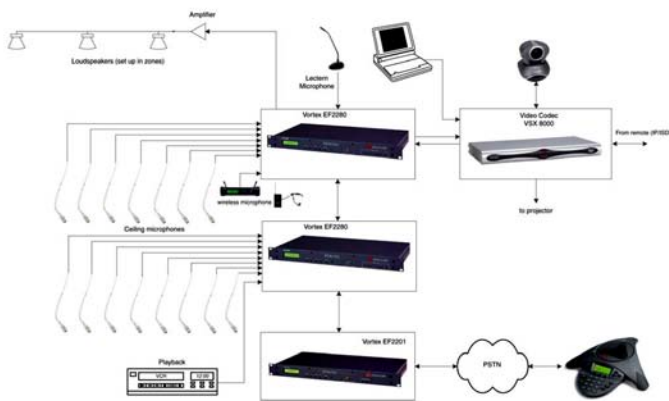
Figure 5. Typical lecture hall layout with teacher and student microphones



3. Videoconferencing as a form of collaborative synchronous distance education

The traditional education delivery system in universities and colleges has for a relatively long period of time been a classroom with a professor giving lectures to students and the students listening and taking notes. Interaction between the professor and students has been perceived to be a crucial learning ingredient in this delivery platform. Innovations in educational delivery mechanisms such as interactive and reflective schools of thought (Schon, 1987 and Clegg *et al.*, 2002) have, however, challenged

Figure 6. System design for a typical lecture hall application



the traditional approaches to education. Progress in information technology has enabled new educational delivery methods such as distance learning and e-learning.

Distance learning is a relatively new educational field that focuses on delivering classroom content/instruction to students who are not physically on site. Various technologies have been used to overcome barriers of place and time between the teacher and the learner. Using these technologies, the teacher prepares the lesson and sends it to the learner, and the learner then interacts with the lesson and sends feedback (questions, assignments, tests) to the teacher. As technologies have improved, so has the quality of this interaction.

An important concept to understand is the difference between two distinct forms of communication: synchronous and asynchronous. «Synchronous communication is communication in which all parties participate at the same time. Synchronous communication in distance learning emphasizes a simultaneous group learning experience. Teachers and students communicate in “real time”» (Connick, 1999). An example of synchronous (happening at the same time) communication is a conversation. Whether face-to-face or on the telephone, to have a conversation both parties in the conversation must participate at the same time.

«Asynchronous communication is communication in which the parties participate at different times. Asynchronous communication offers a choice of where and, above all when, you will access learning... you may read or view these materials at your own convenience» (Connick, 1999). Examples of asynchronous (not at the same time) communication include letters and e-mails. To communicate by letter does not require both parties to communicate at the same time. One person composes a letter and mails it. The other reads the letter upon receiving it and then responds.

Most teachers and learners are much more familiar with synchronous communication in education. All teachers and learners come to the classroom at the same time, make presentations, and hold discussions. As communication technologies have developed, distance-learning teachers have experimented with them to find ways to improve teacher-learner and learner-learner interaction.

Learners may live in isolated, rural areas and have no access to education. Other learners may have ready access to a college, but that college might not offer the course of study needed by that learner. Distance learning also enables those who are not able to physically attend courses on a campus to access education. Furthermore, as learners attempt to balance family, work, and education, time becomes a precious commodity. Driving to the campus, parking, and spending time in class at an appointed (and probably inconvenient) time may not fit into the learner's overall schedule. Distance learning courses increasingly allow learners to participate at a time that is most suitable for their schedule.

Web-based classes are the most common method of delivering distance classes today. These classes utilize various internet applications (instant messaging, email, file upload/download, message boards etc.) to distribute classroom materials and help students and teachers interact with one another. Commonly, specialized software packages that provide easy access to these functions are used to facilitate these classes. In some cases, students may connect to a live video feed of a live classroom streamed over the internet. In these cases, a technology assistant is usually present to provide interaction between the distant students and the instructor and on-site students.

The advent of Web 2.0 introduced dynamic content, easy syndication of content and rich interactive experiences, along with raised expectations of distance learning classes. Both educators and students are asking for more interaction. The classroom is an active place, and live, real-time communications are needed to augment or replace the current standard of text-based, non-interactive classes.

With the explosion of bandwidth after the Dot Com era, the resources are now available to provide more interaction in distance learning education via video conferencing. Using the various technologies available for video conferencing, educators can provide a more interactive distance learning experience by delivering real-time, bidirectional video, voice, and data communications to their distant students, rather than just the standard electronic media.

In one case, remote participants may be additional students that the instructor must now accommodate in terms of instruction and integrate with any participants physically present, into one student group. Remote participants should not feel that they are getting less out of the class than their physically present counterparts and physically present students should

not feel that the presence of remote students is detracting from their instruction. In another case, remote participant(s) may be additions to the instruction itself, such as expert speakers or co-instructors. As with any team-teaching, a cooperative balance of instructional duties is required but this can be made more complicated if video presence cannot compete with physical presence. For instance, instructor accessibility in the physical classroom can easily overtake the presence and command of the remote instructor, encouraging side conversations and inattention to remote instruction.

Yet another aspect of videoconferencing in the classroom is that the 'participants' being shared via the videoconference connection might not always be human. An instructor may want to incorporate an alternative video source (e.g., a document camera, a VCR) for sending to remote locations, or may want to receive video from an alternative video source at the remote site. The potential for combining video inputs and outputs may be endless.

Most importantly, the use of videoconferencing in the classroom requires special attention to the comfort level, teaching style, and instructional techniques of the instructor. In the ideal world, preparation for the use of videoconferencing in the classroom would be minimal. However, today's reality dictates that there will have to be some adaptation and learning on the part of instructors to use videoconferencing successfully for instruction. Practice time outside of actual class time must be available and utilized to effectively integrate the technology with their own instructional style and methods, thereby ensuring a natural flow of classroom activities by the time the technologies are experienced by the students. So, keeping in mind the virtual presence at the remote site(s), classroom time should be planned to include interactive activities that call on remote participants to respond and become actively engaged in the learning process.

Many conferencing systems allow the camera to be set up in a number of different positions (e.g., wide shot of an entire class, close up shot of students in the lower right quadrant) and store them as 'camera presets'. The presets are usually assigned to a button on the remote control. This allows the lecturer to easily focus on a group of participants during the interactive portion of a session or just get a good overview of the level of engagement of varying groups at the remote site. Manual or frequent adjustments to the camera during a session is distracting, resulting in a few seconds of choppy video and has the flavor of a 'home movie' you've been forced to watch. Investing in a few moments of pre-planning or multiple cameras is well worth the effort.

4. Evaluation of the videoconferencing system

The evaluation process determines the effectiveness of a videoconferencing session. Lecturers need an evaluation program to determine

how successful the lesson was by determining the quality of their teaching and learning.

There are a number of ways course instructors/local site coordinators can carry out an appraisal of the system, both from a technical and a pedagogical point of view. Evaluation can be formative (ongoing/continuous process used for course improvement throughout the delivery) or summative (overall assessment conducted upon completion of the course/overall sessions).

In the same way both types of evaluation process can also be carried out using two different techniques, by means of quantitative or qualitative methods.

With the introduction of more technologically advanced resources during classes, there is the increased danger of losing focus of the most important aspect of teaching-learning. Planning curricular objectives and concentrating on students as the major stakeholders leads to a continuum in the life cycle of a technology-based course. Evaluation also paves the way for improvements which can be implemented not only at a personal level throughout the course but also at a curricular level to better suit the needs of the students.

Three important factors to consider when designing and planning a course are:

- effectiveness (achieving the objectives);
- relevance (achieving satisfaction);
- efficiency (the administrative part of the learning process).

There are various types of evaluation instruments designed to suit the different methodologies used. The most common include questionnaires, surveys, structured interviews and observation logs. Other feedback may be provided by different layouts of pre and post-tests like multiple choice and essay questions. The standard Likert 5 point scale makes data collection easier, while keeping questionnaires anonymous makes for a freer response. However one must ensure that questionnaires are not overused and time consuming as this will lead to a substantial decrease in cooperation by participants. Another evaluation exercise which may be particularly useful in the instructor's self-appraisal is the observation log where the instructor can note down observations in relation to interactivity and technology manipulation. To evaluate the system and pedagogy we conducted 30 multi-point videoconferencing sessions during the spring semester of the 2010/2011 academic year. The sessions were scheduled each Monday and Thursday. 50-60 participants (students on first cycle of studies) were involved in each session. They were enrolled at 7 different faculties in four geographic locations. The duration of each session was 30 minutes with 15 minutes for discussion. Besides the lecturer and the students, in each of the sessions a local facilitator was also involved. During

the lecture the number of local and remote interactions between students, as well as between students and teacher were counted. At the end of each session a simple questionnaire was given to all participants (students, local facilitators and lecturer). The structure of the questionnaire was as follows:

Table 1. Questionnaire for videoconferencing evaluation

Instructor(s):		Date:				
Title:		Duration:				
Venue where the videoconference was held:						
Your role: (tick one): participant <input type="checkbox"/> student <input type="checkbox"/> facilitator <input type="checkbox"/>						
Institution/organization:						
Circle the number which best matches your opinions: 1-strongly disagree 5-strongly agree						
Question N.	General comments	1	2	3	4	5
1	The expectations were outlined very clearly before the start of the session.					
2	The content of the videoconferencing session was delivered effectively.					
3	I had no problems in understanding what the participants and members were saying.					
4	The course/session was very well organized.					
5	The videoconference was very effective technically.					
6	The participating site/s had equal opportunities for discussion and interaction.					
7	The learning environment (classroom setting) was adequate.					
8	Different teaching strategies/methodologies were used during class.					
9	Adequate support was given before, during and after the session.					

The average score of each of the questions was calculated for each of the sessions. The results of students' answers are presented in figure 7. The number of interactions is presented in figure 8. As may be observed from the figures, the average scores are on the increase, which means that the effectiveness of the system, as well as the synchronous communication, is improving over time.

5. Conclusion

Videoconferencing is a system which is designed with huge potential for education and communication systems in general. However being innovative and dynamic, it requires a degree of commitment from whoever makes use of it. It needs systematic design and preparation to be fully successful; otherwise it will yet again be another useful techno-

Figure 7. Average results of session evaluation

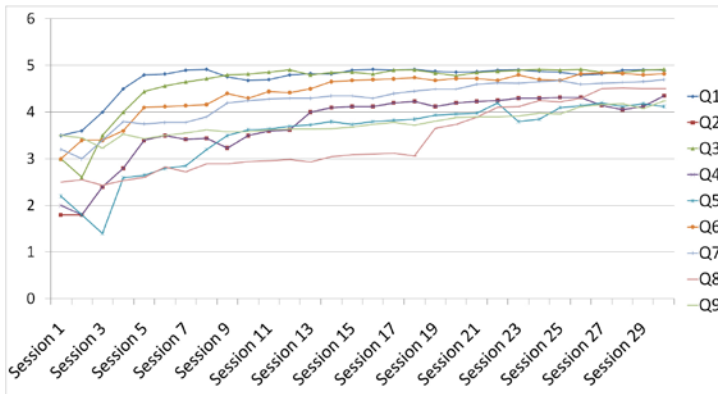
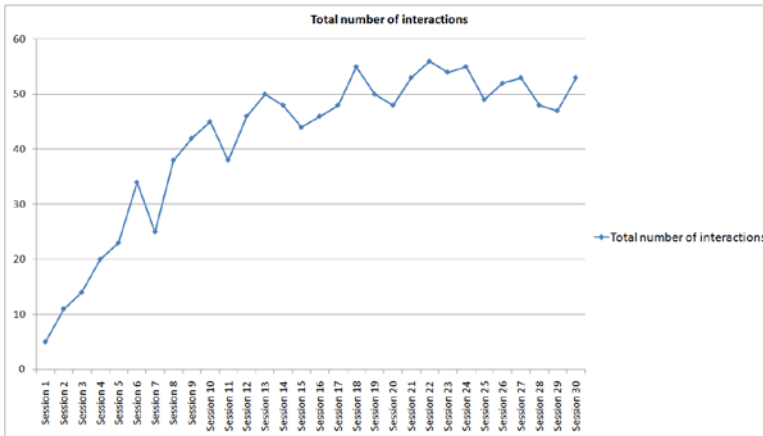


Figure 8. Total number of interactions during videoconferencing sessions



logical resource which represents nothing more than a piece of equipment. Accurate planning needs to happen not only at the design level but preparation also needs to be done at a technical and pedagogic level. One needs to know about the system, and not just get familiarized with it. Knowing the system gives the user more freedom to juggle resources so as to achieve the best possible solution for the audience’s needs.

Keeping the primary stakeholders targeted for each individual videoconferencing session helps establish clear aims and objectives which are the root of the success of such a system, in whatever way and set up it is used. Making the system as transparent as possible to the participants helps not only increase their confidence in the system but also helps them attain the level of skills and satisfaction which learners can only achieve through actively participating in their own learning process.

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ViCES VIDEO CONFERENCING EQUIPMENT, DEPLOYMENT AND USE

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Abstract. The problem of long distances and the need to bring people together with the help of video conferencing has led to a constant improvement of video conferencing equipment. The ViCES project involved video conferencing equipment that is both professional and easy to use. This paper explains the Polycom equipment used in ViCES project. Here we describe the components of the video conferencing infrastructure and give a deployment scenario in Macedonia. We also point out possible usage scenarios – starting from classic video conferencing, to advanced use as recording and streaming multipoint sessions.

1. Introduction

Video conferencing is a technology that brings remote parties together by means of audio and video equipment. The problem of long distances and the need to bring people together for any kind of conferencing has led to constant improvements to this kind of equipment. There are numerous studies that show usage of video conferencing in many fields. The medical field is probably the most popular for this research (Allen *et al.* 2003, Blignault and Clin 2004). There are studies on providing health care services through video conferencing (Hubble *et al.* 1993, Pesämaa *et al.* 2004 and Capner *et al.* 2000). These papers show that in some cases health care can be given by distant health care providers (Hubble *et al.* 1993). The research by Pesämaa *et al.* 2004 gathers data from many papers from over thirty years of studies of adolescent telepsychiatry. This research shows data where the video conferencing is cost-effective, offering savings in travel costs. LeRouge *et al.* 2002 gives a model of quality attributes for telemedicine.

Besides the medical field, there is research about utilization of video conferencing equipment in distance learning and education. Hampel and Baber give results about utilizing video conferencing over the internet for teaching languages. The high cost of delivering subjects to students

is presented in Freeman 2002, talking about video conferencing for providing courses to large numbers of students. We can see that video conferencing is given much thought in scientific literature. There are many studies in the Human Computer Interactions (HCI) field covering use of and interaction with video conferencing equipment. For instance, Daily-Jones *et al.* 1998 show scientific data on high quality video conferencing by measuring fluency and attention focus between parties. The study of interface dimensions in HCI by Gowan and Downs 1994 shows that «the effectiveness of a VCS interface may be task-dependent».

Another extensive field that finds video conferencing a helpful tool is the business sector. Meetings are conducted on a regular basis but businesses working in large markets often cannot afford the time and money for face-to-face meetings. Kidd and Ferry 1994 show how to choose appropriate types of video conferencing tools for greater productivity.

2. Infrastructure establishment

Sophisticated video conferencing equipment consists of many different types of technology. One end point of video conferencing has one or more displays, one or more cameras and a microphone array. End points are connected to each other ‘point to point’ or by other pieces of equipment for ‘multipoint connection’. There are special devices for scheduling video conferences or for recording video conferencing sessions.

The ViCES project created a video conferencing network in Macedonia connecting five faculties from four different universities in four cities. The video conferencing equipment consisted of Polycom devices as end points, recorders or scheduling devices.

The end points are Polycom HDX 8000 devices (Figure 1). These devices have advanced HD video technology offering 720p or 1080p video resolutions and can be managed and provisioned by Polycom CMA servers, supporting Polycom StereoSurround technology using 22kHz audio and delivering a crisp, natural voice even when multiple parties are speaking. Epson Full HD LCD projectors are used for the display. Besides these projectors other means of display can be attached – computer monitors, TV devices or ordinary VGA projectors.

The cameras used with Polycom HDX are EagleEye HD cameras. These cameras are designed to work with advanced HD video conference rooms, offering 720p or 1080p resolutions up to 60 frames per second. EagleEye cameras have 12x zoom control and 180-degree panning radius. The zoom and panning control can be operated through the local HDX or remotely by other parties in the video conferencing session.

The multipoint device used in the ViCES project is also a Polycom product – RMX 1000 (Figure 2). This device is the core of the infra-

Figure 1. Polycom HDX 8000 end point with remote controller, Polycom EagleEye camera and Polycom microphone



Figure 2. On the left the Polycom RMX 1000 and Polycom RSS 200 server, on the right the Polycom CMA 4000 server



structure. It supports multipoint calls for video, audio and content data. RMX 1000 can connect H.323 or SIP protocol devices. The RMX 1000 server provides high quality audio, video and content sharing. This server provides a proprietary function to ensure optimal experience even on sub-optimal networks. It supports an internal reservation system, as well as external reservation with Polycom CMA server.

RMX 1000 is closely connected to the recording device Polycom RSS 2000 (Figure 2). This device is a recording and streaming server. When connected with other participants in a call it records the video conferencing sessions. It offers integration with Polycom HDX with op-

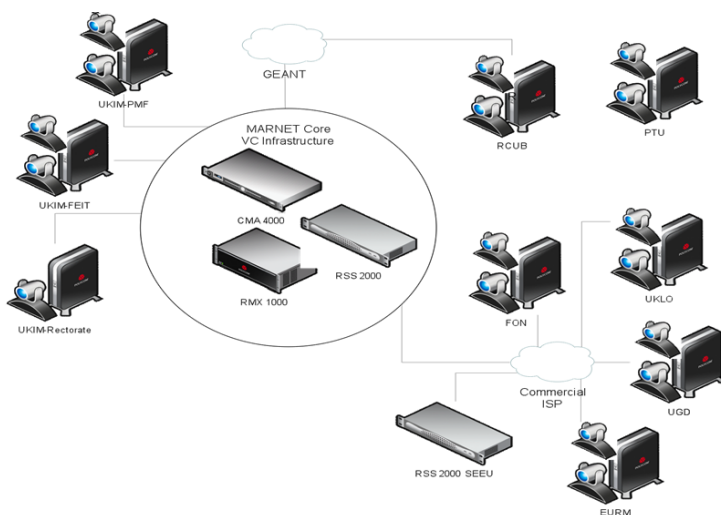
erations such as pause, stop and continue recording. The RSS server also integrates with the Polycom CMA server in order to record multipoint sessions. RSS 2000 offers 720p or 1080p video resolutions and stereo sound recording. For streaming purposes it offers unicast video on-demand or multicast streaming to large numbers of visitors.

The management device used in ViCES is the Polycom CMA 4000 device (Figure 2). The full name of this device is Converged Management Application and it is used as a management platform in the infrastructure. The CMA 4000 can be used for external scheduling purposes when connected to an RMX device. It can schedule point to point or multipoint video conferences. The schedules are made through the integrated web interface, or by using advanced connectivity with Outlook or Lotus Notes. The CMA acts as an advanced center for provisioning Polycom HDX systems and Polycom CMA Desktop clients. It supports automatic device provisioning and scheduled device provisioning for standardly-managed and legacy devices.

Polycom CMA Desktop is a software that integrates video conferencing on your personal computer. It uses camera and microphone from the computer and connects to the infrastructure through the Polycom CMA system. While using CMA Desktop for video conferencing, it can send content from the computer screen – whatever the presenter has on the screen.

All the devices mentioned are connected as shown in figure 3. They use GEANT communication channels for the parties belonging to the GEANT project, or commercial internet service providers where necessary.

Figure 3. Video conferencing network in Macedonia



3. Using the equipment

The video conferencing equipment is meant to be used as a tool in meetings between distant parties. The Polycom equipment installed in Macedonia is mainly used for distance learning when the teaching professor is at one campus with Polycom equipment, and the students are at another campus in a video conferencing classroom. There are cases when the professor is not near a video conferencing room, and then they can use the Polycom CMA Desktop software to give a lecture from their laptop.

There have been a couple of international video conferences between the Environmental Engineering faculties of Firenze and Skopje. On the two distant learning meetings on 25.11.2011 and 13.01.2011 there was a professor from each faculty giving lectures. At the end the students were engaged in mutual discussion sharing experiences from their home faculties.

We used the Polycom video conferencing equipment for more than actual video conferencing. We connected one Polycom HDX to the Polycom RSS recording server and recorded the actual lecture given by the professor to the students present. This way we managed to record the 'Data Structures and High Performance Computing' course from Tempus-SEE taught from 07.11.2011 to 2.12.2011 (see Tempus PhD courses in 2011). The video material can be further edited and given as course material to other students who couldn't follow the course.

4. Conclusion

Good-quality video conferencing equipment is needed for any academic organization. The ability to invite guest lecturers to a distance learning course is far more promising than opting for the expense of moving the lecturers or students to distant locations. The video conferencing equipment installed as part of the ViCES project is fulfilling its objective of facilitating cooperation between distant faculties and bringing professors and students a bit closer. The experience with this video conferencing equipment was very satisfying. Owning this equipment and giving students the opportunity to meet students and professors from other countries has been of great help. We will continue to explore the use of video conferencing in the teaching process.

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A COMPARISON OF STUDENTS' PERFORMANCE AND SATISFACTION WITH A VISUAL PROGRAMMING COURSE DELIVERED LIVE AND BY INTERACTIVE VIDEOCONFERENCING

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Abstract. The purpose of this study was to compare students' performance and satisfaction with a visual programming course taught both live in traditional classroom settings and by interactive videoconferencing in separate, asynchronous sessions. The research study was conducted at the Faculty of Computer Science, 'Goce Delcev' University in Stip, using the campus located in the city of Stip for traditional teaching and the remote campus located in the city of Strumica. Results show that students in both the classroom setting and interactive videoconferencing setting performed well and had a high overall perception of the course.

1. Guidelines

Over the years there have been significant changes in the policies, organization, staffing and funding of universities. One consequence of these changes is that students who now attend university are no longer drawn from an elite or privileged group but are representative of the general population. Moreover, to offer equal opportunities for higher education studies, some universities have opened remote campuses and units at geographically remote locations in the same country or internationally. The Macedonian 'Goce Delcev' university fits in with these global trends perfectly. The university, located in Stip, has four campuses, and 13 faculties – covering almost all disciplines, 10 university centers and three institutes. The studies at this university are performed in 12 units, distributed over 12 different cities. The institution has also established agreements with various universities and experts worldwide

to enable and support a growing number of student and staff exchanges between campuses.

Because of this increase in demand, then need arose to introduce and foster innovative approaches and structures and to make the most effective use of new technology in higher education. Morgan (1996) analyzed the report by the Joint Funding Councils' Libraries Review Group, and states that it: «Identifies long-term changes in the make-up of the student population, with more part-time and mature students; modularization of courses; changes in teaching and learning methods; and a great stress on student-centered learning...».

Additionally, due to the increasing demand for information and communication technologies (ICT), many new faculties of computer science are being established and numerous existing schools of computer science are increasing their class size and opening satellite campuses in an attempt to meet this demand.

With the transformation of higher education into a system that has to cope with much larger numbers comes the need to develop greater flexibility to suit student needs. Distance learning methods free students from the constraints of time and place and allow for more personal feedback than could be achieved from the traditional university teaching system. New tools in higher education can help meet the ever-increasing demands.

Distance education has been defined as «a separation in time and/or space between the learner and the instructor. More than a geographic separation of learners and teachers, it is a distance of understanding and perceptions that must be overcome by teachers and learners» (Hunter *et al.*, 2008). There are many types of distance-education models including online courses, interactive videoconferencing, videotaped lectures, and audio-taped lectures.

The purpose of this study was to compare students' performance and satisfaction with a visual programming course taught both live in a classroom and by interactive videoconferencing in separate, asynchronous sessions.

2. About videoconferencing

Video conferencing is defined as interactive and synchronous voice, video and data transfer conducted between two or more points via communication lines (Gough, 2006). This system reduces the cost of education by connecting students and teachers who are in different locations. In addition, it offers a connected environment where students can relate their experiences to each other and a feeling of togetherness is created, along with the benefit of expert instruction.

As discussed by Hackman and Walker (1990), rapid comprehension in this environment where students are able to express themselves com-

fortably, enables better teacher-student communication. Video conferencing has developed more than other methods of distance education, in terms of real-time interaction, relationship, motivation and collaborative learning (Brown & Liedholm, 2002; Wheeler & Amiotte, 2004; Bates, 2005; Wheeler, 2005). The quality of video conferencing systems varies according to the technology used, and the bandwidth, and it impacts the quality of education and student-teacher interaction level (Martin, 2005). Besides, fostering active student participation in the process is very important for ensuring an effective education and training environment. However, these earlier studies determined that students were not sufficiently encouraged to learn during video conference practices (Motamedi, 2001; Watkins, 2002; Newman, 2008).

A frequent error in assessing video conferencing practices is to equate the environment visually with the face-to-face traditional class environment and use it in this way (Hearnshaw, 1998; Anastasiades, *et al.*, 2010). While video conferencing practices do provide opportunities for synchronous watching, listening and communication with other participants, human interaction is not as effective as in the traditional education process (Bonk, *et al.*, 1998; Schweizer, *et al.*, 2003). Studies that have been conducted in order to evaluate the efficiency of video conferencing in education indicate that the expectations of the participants still cannot be met adequately (Motamedi, 2001; Knipe & Lee, 2002; Delaney, *et al.*, 2004). This situation affects student perception and their learning depends on perception. Perception is accepted as one of the determinants of the development of knowledge (Şimşek, 2008). Students stated that the applied technologies, the locations of the devices, technical problems such as sound, image and connection problems, interaction inside and outside the class, the teachers' use of body language and duration of the courses were factors affecting their opinion of distance education (Martin, 2005; Koppelman & Vranken, 2008; Gillies, 2008; Marsh, *et al.*, 2010).

In the study, *The Quality of Teaching and Learning via Videoconferencing*, Knipe and Lee (2002) examined the quality of teaching and learning activities performed via video conferencing. The study was conducted with 66 students. 45 students participated in traditional, face-to-face courses and 21 students participated in distance education. After the study, the students participating in the course via distance education felt alone and as if they were not a part of class where they could not make eye contact with other students and the teacher. This situation impaired the concentration of these students and had a negative impact on their learning.

The study conducted by Umphrey *et al.* (2008) studied the impact of interaction, the class communication experience and relational features displayed by an instructor when engaging directly with students, compared to student perception in relation to video conferencing education. According to the research results, students believe that face-to-

face education is more positive than video conferencing, in terms of the teacher's proximity, understanding the teacher, mutual communication in the classroom, success and quality. From these results, it seems that the most effective video-conference courses should include interaction and in-class involvement.

A study carried out by Marsh *et al.* (2010) and entitled *Interactive Video Technology: Enhancing Professional Learning in Initial Teacher Education* investigated the benefits of live implementation of theoretical information learned via video conference. The research took place between 2005–2007 with the cooperation of Sussex University and 6 schools. The video conference technologies provided a way of overcoming the limitations of the learning center's physical site. Teacher trainees could access various class applications and practice with the instructor. Course records aided the trainees by refreshing their memories on subjects they had forgotten about.

Martin's article *Seeing is Believing: The Role of Videoconferencing in Distance Learning* (2005) examined Northern Irish students' study of the Constitution of the United States of America as explained by an American congress member. The students from Northern Ireland stated that the opportunity to interact with famous American politicians and to see them without traveling long distances from the places they lived enabled them to evaluate distance education via video conference in a positive way.

Gillies published a paper in 2008 entitled *Student Perspectives on Videoconferencing in Teacher Education at a Distance*. It focused on the experiences of students who took courses via video conference for one year within the scope of initial teacher training. At the interviews students stated that the technical problems that occurred in the sound, image and connection caused them to feel as if they were not real students. Moreover, interviewing with the teacher at fixed time is regarded as a deficiency. Live interaction with the teacher, the creation of a feeling of affinity and receiving simultaneous answers to questions were situations frequently mentioned by the students.

In the study entitled *Experiences with a Synchronous Virtual Classroom in Distance Education*, Koppelman and Vranken (2008) aimed to determine the viewpoints of the teachers and 10 students in synchronous computer technologies education. Students stated that they liked the courses given at short and frequent intervals and had no problems with concentration. In addition, they noted that the technologies applied prevented wasting time traveling to lessons with a distant technician. While students evaluated sound quality as quite good, some students said that they did not like the delays.

3. Methodology

This research was conducted for a 6-credit hour visual programming course delivered during the winter semester of 2010. One course was

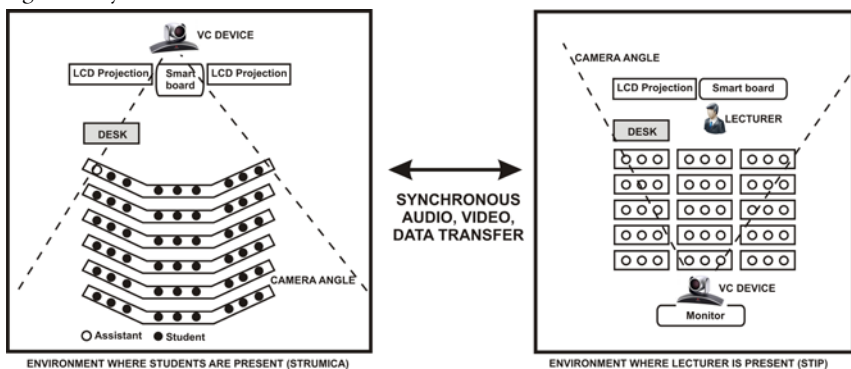
taught in a traditional classroom setting to 90 students at the Faculty of Computer Science, 'Goce Delcev' university in Stip, and the same course was taught in asynchronous sessions via interactive videoconferencing to 48 students at one of the remote campuses of the Faculty of Computer Science, 'Goce Delcev' university. In the latter course, the instructor was physically located in the city of Stip and the students were approximately 70 kilometers away, in the city of Strumica.

Both courses covered the same topics and were given by the same instructor except for 2 lecture hours presented in the classroom to Strumica campus (distance-education) students by external experts.

The distance-education lectures were delivered from a classroom equipped with Polycom HDX 8000 end-point, 36 computers, document camera, interactive whiteboard, two LCD projectors and monitor. The lecturer was able to combine and switch among 3 views delivered to the distant classroom: video image (e.g., the lecturer); computer screen (e.g., PowerPoint presentations); and the document camera (e.g., used to show hardcopies of figures and demonstrate calculations worked out by hand). One LCD projector projected the image being transmitted to the distant classroom, and the image of the students in the distant classroom was presented on the monitor. The distant classroom was equipped with Polycom HDX 7000 end-point, two LCD projectors and whiteboard. These projected a picture big enough to be seen clearly by all students. During transmission, the distant site also had a faculty facilitator present at least at the beginning of each class, and 2 technicians monitored the entire transmission.

The traditional classroom lectures were delivered in a classroom equipped with a computer, a document camera, two video projectors and one interactive whiteboard. The synchronous distance education environment is shown in figure 1.

Figure 1. Synchronous distance education environment



Course and instructor evaluations were completed by each group at the conclusion of the courses. The questions rated students' perception of the course and the instructor using a 5-point Likert scale anchored at 5 = strongly agree and 1 = strongly disagree. The variances of the results were first analyzed using Levene's test for equality of variances. The evaluations were then analyzed using independent sample t tests based on the assumption of equal variances or unequal variances where appropriate in SPSS v19.0. The final course grades were analyzed using the same method. This study was approved by the Human Subjects Review Board.

Researchers and participants were in the same environment for a term. Researchers were able to observe all the courses by being with the participants from the beginning of the term. As a result of this, a warm relationship was established between the researchers and participants.

A 'Participant Permit', indicating the aim of the research, was prepared after the research objective was determined. Participants were given details of the research to be conducted. Participation was on a voluntary basis. Participants were guaranteed confidentiality and anonymity, and assured that the data would not be used for any purpose other than the stated purpose. In addition, the researcher remained objective during the collection and evaluation of data.

Validity and reliability indicators are used for quantitative research. In qualitative research, indicators are credibility, transferability, consistency and verifiability. Credibility is crucial in qualitative studies. In this study, credibility was ensured through continuous participation, source triangulation and participant control. The researchers' constant presence in the environment and the inclusion of participants with different characteristics was also important in order to determine multiple realities by revealing different perceptions and experiences. In addition, the researcher's presence provided opportunities to engage with the subjects outside the interviews, and to discuss and examine the subject matters in question. This way, the researcher was able to examine the participants' view of the process and subject matter in more depth. The data obtained from interviews was given to the participants after the interviews, in order to confirm and verify their responses.

First, data was cleared of bias as much as possible to ensure consistency, and deductions were supported with both quotations and raw data. Moreover, data in the study was coded from beginning to end by two different researchers and the consistency of these two data sets was examined. To ensure consistency, triangulation was used, with the addition of a third researcher examining the data.

A focused sampling method was chosen to ensure transferability of the research and the research process was explained to the reader in as much detail as possible. During data analysis, raw data, findings, conclu-

sions and suggestions were recorded and checked several times in order to ensure verifiability criterion of other researchers.

4. Results

Student demographic data is presented in table 1. Traditional classroom students had a higher computer science grade point average (GPA) ($P = 0.013$) at the outset of the 2 courses, and the distance-education students had a higher mean grade in the prerequisite Programming Basics and Object-Oriented programming courses ($P = 0.221$ and $P = 0.303$ respectively) preceding the visual programming course. No other significant differences were found.

Table 1. Student demographics

	Traditional classroom settings [Mean(SD)]	Videoconferencing distance education settings [Mean(SD)]	Significance (P value)
Age(years)	14.0640	18.5620	22.0817
Overall CS GPA (on the scale 5-10)	61.6728	44.7844	44.5884
Grade in Programming basics	88.1380	118.1564	101.2240
Grade in Object-Oriented Programming	246.7889	255.9483	284.6633

Students who completed the course in the traditional classroom setting had an average final course grade of 8.80 compared to an average final course grade of 8.67 among students in the interactive videoconferencing group ($P = 0.034$).

The response rate for the course and instructor evaluation was 97.92% (47 out of 48 students) for the distance-education students and 97.78% (88 out of 90 students) for the traditional classroom students. The mean evaluation score (Table 2) for the distance-education students was higher than for the live students (4.7 ± 0.6 and 4.4 ± 0.7 , respectively; $P < 0.001$).

Table 2. Domain Analysis of Student Responses

	Traditional classroom settings [Mean(SD)]	Videoconferencing distance education settings [Mean(SD)]	Significance (P value)
General	4.4 (0.7)	4.7 (0.6)	< 0.001
Lecture content	4.4 (0.5)	4.6 (0.8)	0.452
Presentation/style	4.6 (0.5)	4.8 (0.4)	0.204
Student contact	4.3 (0.8)	4.7 (0.6)	0.412

5. Conclusion

Students completing a visual programming course in a traditional classroom setting or by videoconferencing performed well and had a high overall perception of the instructor and courses. The distance-education course was rated higher by students than the same course delivered live. Several techniques were used by the instructor to facilitate instruction via videoconferencing that may have influenced the distant students' perception of the course. Based on the results of this study, at least one technique, the use of recitations, was highly valued by the distant students. The incorporation of regularly scheduled recitation-type sessions should therefore be considered when developing a distance-education course.

So, what we can draw as a general finding from this research is the need for instructors to understand and acknowledge that using video conferencing as a delivery mode will have an impact on teaching styles and methods. Even though the term 'interactive video-conferencing' is often used when discussing this type of technology-based teaching, successful interaction does not take place unless instructors plan and understand how the medium will alter their teaching approaches.

Other findings also indicate that whether the course delivery mode is traditional or technology-based, effective teachers establish and maintain a highly interactive classroom community. They come to class prepared, have checked that equipment is working prior to it and ensure that students have the necessary materials when the class begins. Any discussion on 'how to be successful' when using a video-conferencing course delivery mode should therefore be based on sound teaching practices-successful teachers are knowledgeable about their subject, about their learners, and about pedagogy.

However, to assure the quality of instruction as the use of distance education increases in computer science education, more studies in this area are needed to evaluate the implications of delivering computer science courses and entire curricula via interactive videoconferencing and other distance-education methods.

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VIDEOCONFERENCING IN HIGHER EDUCATION

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Abstract. This paper provides a brief introduction to videoconferencing technology, the types of systems available and the various forms of videoconferencing in educational contexts. An outline of the advantages and disadvantages of videoconferencing as an educational service compared to traditional face-to-face communication, as well of the advantages and disadvantages of the existing types of system, is given. In addition, the paper tackles the categorization of different scenarios of using videoconferencing systems in education. Lastly, it presents our findings and makes recommendations based on our experience so far in using videoconferencing in education. The points made in this report result from the experience in using videoconferencing as an educational service over the past three years at the European University – Republic of Macedonia.

1. Introduction

One way of broadening university boundaries and bringing higher education to even more students is by starting up distant campuses. In the past few years, this strategy has become widely accepted both by private and state-run Macedonian universities. As a result, teaching staff have been coping with the problem of constant travelling to the distant campuses. In addition, studying is not only about attending classes; it encompasses many other activities conditioned by communication between the professor and the student, such as: consultations, partial exams, exams, research, writing papers, assignments, graduation theses etc.

There are a vast number of web services that support this communication, such as: telephony, email and instant messaging which have a limited degree of interaction, since they are limited to audio or message-based communication. One of the latest communication services offering a greater degree of interaction is videoconferencing. It has a lot of the benefits of traditional face-to-face communication such as real-time discussion and collaboration, crucial to the educational process today.

2. Benefits of using videoconference

As a relatively new technology, (about twenty years old) videoconferencing enables interactive meetings between individuals or groups

of people located in two or more different sites. Participants in each site of a video-conferencing session are able to see and hear each other and to share different types of content such as Power Point presentations, other types of applications or even the whole desktop. In the educational process videoconferencing has been used to connect remote students and teachers.

Educational institutions worldwide have acknowledged the advantages of this technology, such as cost effectiveness, reliability and ease of use, and have integrated it in the educational process. The main benefits of introducing videoconferencing to education for:

- The institution are:
 - lower travel costs;
 - the possibility of broadcasting lectures to multiple points at the same time thereby reaching a greater student population in different regions;
 - the potential increase in the number of students.
- The professors are:
 - a greater increase in productivity in not having to spend time and energy in travelling, so they have extra preparation time;
 - a greater opportunity for professional development and collaboration;
 - elimination of the stress associated with travelling.
- The students are:
 - they will not miss out on any lectures due to the geographical distance of the lecturer;
 - they will be able to attend lectures by visiting lecturers, lecturers from abroad and guest speakers from the industry;
 - improved interaction with professors from distant campuses;
 - they will be able to attend previously unavailable courses and observe real-time practical processes (in medicine, dentistry).

Apart from the aforementioned benefits of introducing videoconferencing to education there are certain drawbacks especially with respect to the traditional face-to-face communication, such as:

- the initial investment required for a videoconferencing system;
- the fact that many people are uncomfortable with new technologies;
- the fact that if the guest lecturer is in a different part of the world, the time zones may be different [05];
- the quality of the videoconference established depends greatly on the videoconferencing system and other hardware resources.

Still, the benefits listed above outweigh the drawbacks, as shown by the large number of educational institutions that have already integrated videoconferencing into their educational process.

3. *Types of videoconferencing system*

Prior to implementing videoconferencing in education, it is crucial that the most appropriate type of system is chosen. For this reason it is essential to review the various options available. The choice will inevitably depend on the specific needs, requirements and circumstances at play.

In general, videoconferencing systems can be divided into the following two categories:

- **Hardware-based systems.** This basic category of videoconferencing systems groups together various sub-categories differing in terms of the price and quality of the videoconferencing services provided. This category includes the following types of system:
 - **Telepresence Videoconferencing Systems.** These systems give an impression of physical presence at the meeting regardless of the fact that the participants are located in geographically distant sites. This type of system usually consists of high definition codec coupled with several flat panel displays with a full high definition audio and video signal. Students are under the impression that the professor is in the classroom. Compared to other types of systems, this is the most expensive.
 - **Integrated Videoconferencing Rooms.** Generally, these systems are centralized and the entire equipment is fully integrated in the room. They are usually made up of a main and an additional camera, and one or more displays. Compared to the systems described above these systems have inferior performance, thereby a lower price, and are widely accepted.
 - **Portable videoconferencing systems.** These are mostly used in small or medium size classrooms or meeting rooms. They are used more frequently than the other videoconferencing systems in this category. The price of these systems is lower than the previous two types.
- **License-based systems.** This category of systems falls within non-professional videoconferencing systems. They enable videoconferencing on any computer, given that the necessary software has been installed and there is a basic audio and video hardware, such as microphone, speakers, and camera. Connecting to the videoconferencing system via pc is enabled by a client application. Nowadays these systems provide good quality for a very low price. The price of such systems is undoubtedly lower than the systems discussed above. They come in very useful when students cannot attend lectures on campus and enable them to do the same thing from any location, such as their home or work place. Clearly, these systems do not offer the same quality as hardware alternatives, but they still provide satisfactory quality of service, a good audio and video signal and an opportunity to share various contents as well as the presenter's whole desktop.

To make the right choice when considering the aforementioned videoconferencing systems for educational purposes, the specific requirements in question must be analyzed. The key factors that should be considered are: the number of simultaneous active sessions, the number of sites participating in the session, the number of students taking part in each site, the number of active participants in each site, as well as the size of the classroom.

Table 1 shows the main advantages and disadvantages of both categories of videoconferencing system.

Table 1. Advantages vs. disadvantages of both categories of videoconferencing system

Software-based systems	Hardware-based systems
<p>Advantages:</p> <ul style="list-style-type: none"> • a number of simultaneous sessions can be established at a time; • low cost; • available anywhere on and off campus, students can also join in the videoconference from their home or office; • there is no need for additional hardware other than a computer. <p>Disadvantages:</p> <ul style="list-style-type: none"> • lower quality of service; • the quality of the hardware in use (camera, microphone) affects the quality of the transmitted video and audio signal; • intermediate degree of interaction; • the lecturer cannot move around the room while lecturing – he/she is seated in front of the computer; • an additional server is needed to enable the videoconference. 	<p>Advantages:</p> <ul style="list-style-type: none"> • higher quality of service; • students at the far end site of the session feel more involved in the lectures; • enables higher degrees of interaction. <p>Disadvantages:</p> <ul style="list-style-type: none"> • all participants in the videoconference must have appropriate hardware; • somewhat expensive solution; • some units are not very mobile.

3.1 Types of videoconferencing

There are two types of videoconferencing:

- Point to Point (or P2P) videoconferencing which can connect any number of students located in two different locations (usually two campuses). This type of videoconferencing is suitable in the following cases:
 - when students are in a different location from the professor;
 - when there are students at two different locations and the professor is at one of the two.
- Multipoint videoconferencing which can connect any number of students located at three or more different locations. This type of videoconferencing is suitable in the following cases:
 - when there are students at two or more different locations and the professor is at another one;

- when there are students at three or more different locations and the professor is at one of them;
- when there are students that wish to attend the lecture outside the university campus, such as their home or work place.

4. *Videoconferencing at the European University*

The European University has two campuses: one in Skopje and one in Ohrid. The initial idea of introducing videoconferencing came from the need for more extensive communication and additional consultation with the undergraduate students from the Ohrid campus as well as the need to provide long distance lectures for postgraduate students. The fact that only the Skopje campus offers postgraduate studies to students who are generally employed and cannot always attend the lectures on campus was an additional reason in favor of the idea to introduce videoconferencing. As a result, in 2008 the University made a strategic decision to invest in a videoconferencing system. In order to make this system available off campus, and given the need for more than one simultaneous session at a time, a per-license based system – Microsoft Live Meeting 2007 was procured [02]. The following year as part of the Video Conferencing Educational Services Tempus Project [01,03] one hardware-based system – Polycom HDX 8000 [04, 06] series was also purchased for the Skopje campus.

Over this period, these two videoconferencing systems were used in different scenarios which can be divided into the following categories:

1. Teaching activities and collaboration meetings regarding the teaching process:
 - postgraduate students who cannot attend the lectures on the campus in Skopje can now join in the lecture via videoconference;
 - professors have additional consultations with the students from the Ohrid campus;
 - students from different campuses work together more easily;
 - visiting lecturers from other universities or from abroad give lectures via videoconference;
 - sharing educational resources with other universities.
2. Professional staff development
 - The system is used for scientific meetings between university staff, holding scientific and research seminars, and general cooperation.
3. Scientific conferences:
 - CYTUR 2011 was broadcast via videoconference at the Ohrid campus too.
4. Professional meetings with partner institutions:
 - the system is used for holding professional meetings with the University's partner institutions, as an alternative to real meetings;

- the system is used for meetings regarding the VICES project between all partner institutions in the project;
- the system is used for inter-university meetings related to teaching.

Which of the two available videoconferencing solutions is the most convenient for a specific scenario will depend on:

- whether the other participants in the session have a hardware-based videoconferencing system;
- the number of different locations to be included in the session;
- the number of active participants at the lecturer's end site of the session ;

Table 2. Best suitable system for a given scenario

number of different locations included in the session?	number of active participants at the lecturer's end site of the session	
	One	Two or more
Two	Live Meeting or Polycom Both solutions are possible, the decision depends on the type of lecture	Polycom system + CMA Desktop client
More than two different locations	Live Meeting	Polycom equipment is recommended for each session site, although CMA Desktop client can be used in any site which lacks the compatible hardware equipment

Use of the hardware-based Polycom system is recommended if other participants in the session also have a hardware-based videoconferencing system so as to achieve better quality.

In all other cases the most appropriate system may be chosen according to table 2. Should both solutions be viable, the choice then depends on what material will be presented during the videoconference. We have therefore divided the contents that can be presented during a videoconference into the following three categories:

- contents suitable for videoconferencing;
- contents with special needs;
- experimental and practical contents taking place in specific circumstances which do not allow the physical presence of the viewer. These usually include example classes intended for demonstrating a case study. For instance, complex surgeries take place in specific circumstances which do not allow a larger group of students to observe the process. In traditional lectures the student can only hear what the

professor who carried out the surgery tells them, this makes it very difficult for the student to get an idea of the real state of things. With videoconferencing systems students have an opportunity to monitor the entire surgical process.

The last two groups of content are more suitable for the hardware-based videoconferencing system.

5. Recommendations based on our experience so far

The main problem that emerged when integrating videoconferencing into education at the European University was the fact that most of the professors were reluctant when it came to changing their method and style of lecturing. Out of 110 people constituting the teaching staff, only 15 (approximately 14%) welcomed the idea of videoconferencing.

«More than twenty years ago, one of the hardest things to do was not to develop the initial version of HTTP, or to create a browser that was also an editor, or even to get approval for the purchase of the equipment. The difficult thing was to convince people that the web was something they should adopt», Teem Berners Lee said about internet adoption.

As people needed time to adopt the internet as media, teachers too need time to realize the benefits of videoconferencing and sponsor its use as a teaching and learning service. Over time the number of teaching staff who used videoconferencing as an educational tool gradually increased. Over a period of three years this number reached 60, more than 50%.

To shorten this period of acceptance, induction seminars and presentations for teaching staff should be organized, clearly pointing out all the benefits of using videoconferencing in education.

Diversely, how students accept this educational service depends largely on their first impression, one should therefore be very careful when selecting subjects and professors for initial videoconferencing sessions with students.

Other recommendations concerning the learning process via the videoconferencing service are stated below:

- Learning via videoconference requires a high degree of visual concentration, so preparing good visual content for a videoconference class is crucial to its success.
- Sessions should be highly interactive, thereby encouraging students to become active participants in their own learning. This becomes a problem when both the host and the remote sites are expected to interact (the main issue is the limitation to involving and facilitating interaction between students in both host and remote sites).
- Each site in the videoconference should connect up a few minutes early to allow for any adjustments. This is especially important for the

presenter who should ensure that everything is functioning properly and prepare the content.

- Participants in sessions should not speak too quickly, they should speak clearly.

6. Conclusion

As an educational service videoconferencing plays a key role in reaching and supporting remote students, improving communication between professors and students, and bringing together staff and students across different campuses or different institutions. In order to successfully implement videoconferencing as an educational service, it is vital to select the most suitable type of videoconferencing system based on specific needs. Special attention should be paid to the system adopted by both teachers and students.

Over the past three years using videoconferencing has significantly improved professor- student communication at the European University. By acquiring the Polycom equipment as part of the VICES Tempus project, the European University became part of the inter-university videoconferencing network which connects five universities from Macedonia and two universities from Albania and Serbia. This network, based on high-definition video conferencing equipment, opens up new opportunities for future co-operation in the field of science and education between universities, staff, and students.

As for the future, we are confident that the quality of videoconferencing services and communication with students and staff from the Ohrid campus will improve, given that a hardware-based videoconferencing system has been procured for the Ohrid campus.

Apart from the scenarios discussed in Section 5, we have recently discovered another way of using the existing Polycom hardware-based system. Namely, within the Faculty of Dentistry a number of operations take place on a regular basis, such as inserting implants using the latest methods and other complex operations which are not easily accessible for students. Procuring a special camera for this system will help to bring such practical experiences, otherwise inaccessible, closer to the students of this faculty.

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