SERVICES FOR EDUCATION IN THE METROPOLITAN RESEARCH AND EDUCATION NETWORK

Miroslaw Czyrnek, Filip Koczorowski, Michal Kosiedowski, Cezary Mazurek, Piotr Pawalowski
Wojciech Pieklik, Maciej Stroinski, Jan Weglarz and Marcin Werla
Poznan Supercomputing and Networking Center, ul. Noskowskiego 12/14, Poznan, Poland

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Abstract: Over the recent years Poland has been very successful in deploying advanced ICT infrastructure for use by the public sector. This infrastructure includes fiber-based metropolitan research and education networks interconnected with the backbone optical network PIONIER, and a vast amount of advanced services that provide interesting resources and tools also for the education sector. Today Poland gains a big opportunity of innovating its education system to a novel ICT supported classroom immersed in an integrated education environment. Creating an educational service network based on research and education network links would bring a new, better learning and teaching experience for the education system participants. However, it also sets a big challenge before designers of such an educational service network. In this paper, we discuss the current opportunities and our approach at creating such a network.

1 INTRODUCTION

Poznan Supercomputing and Networking Center has been the operator of the metropolitan research and education network in Poznan since early 1990s. This network (POZMAN) was originally founded to interconnect academic and research centers such as universities and research institutes. It later became the means of interconnecting offices of various public domain services such as municipality offices, hospitals or public schools. Today, this metropolitan network provides fiber to 23 schools in Poznan, thus creating an opportunity to draw a roadmap for integrating them into one educational corporate network also on the service level.

An attempt to create an educational service network is also justified by the existence of various advanced services that may either deliver interesting educational content for use during the educational process or provide a new quality to this process. These services include regional digital libraries that provide access to rare library resources, the public television educational programme offer and archive delivered through an Internet-based system, educational portals that provide a vast ammount of articles, educational resource directories and online tools, e-learning platforms with materials in the form of e-courses, videoconferencing services or virtual laboratories.

Last but not least, also the analysis of the needs of the education community in Poznan shows that the delivery of innovative educational tools based on advanced services available in the metropolitan research and education network is highly required by the education community itself. In October 2008 we conducted a questionnaire among 42 public high schools which showed that various activities in this field were already being undertaken by schools and that there was a high demand for training teachers in ICT utilization in the educational process.

In this paper we present the value that a research and education network with its advanced services may bring to the educational system. In section 2 we shortly present an example metropolitan research and education network (MAN) and the wider context of its interconnection with other such networks in Poland, Europe and beyond. Section 3 describes various services currently deployed in the public optical network and accessible through the MANs. Section 4 draws a roadmap for building a service network for education with the use of available ICT infrastructure. We end with a presentation of related initiatives in section 5 and a summary in section 6.

2 RESEARCH AND EDUCATION NETWORK

The metropolitan research and education network POZMAN has been operated by Poznan Supercomputing and Networking Center since 1993. It started as FDDI-based network linking major universities and research institutes in the city. Later, the base technology was changed to ATM, and other types of institutions such as, for example, municipality offices and hospitals were being connected to the network. Today, the network is based on 10 Gigabit Ethernet technology and connects over 100 institutions, including all academic institutions in Poznan, all municipality offices, most hospitals and 23 public schools.

Figure 1: PIONIER Polish Optical Internet.

Further on, the metropolitan research and education network of our city is interconnected with 20 other similar networks around Poland through a nationwide backbone research and education network called Polish Optical Internet PIONIER as shown in Figure 1. This allows for wide cooperation between institutions connected to metropolitan research and education networks at the national level. Such cooperation takes place in the research and academic community, where common projects are conducted with the vast utilization of the optical networking advantages. Some of the most important initiatives that can be mentioned here include access to remote instrumentation in the form of virtual laboratory (Lawenda at al., 2004), provision of country-wide multimedia content delivery system (Czyrnek at al., 2006) or organization of the national Federation of Digital Libraries (Lewandowska, Mazurek and Werla, 2008).

Moreover, the PIONIER network provides access to the European research and educational services through the optical interconnection to the European academic research network Geant2.

PIONIER also has optical links to all Poland neighboring countries. This international connectivity is also used to facilitate cooperation between fiber-enabled institutions, with a majority of this cooperation taking place within the scientific community. Access to CERN's facilities, integration with the European digital library Europeana, performing high definition videoconference sessions or delivering broadband channels to a vast amount of research projects is not a problem at the international level.

It is also important to mention that local, province-wide initiatives to create broadband province networks connected to PIONIER take place in various parts of Poland. For example, the Swietokrzyskie Province is currently in the process of building a province-wide broadband with the use of wireless technologies. In other regions, such as our province Wielkopolska, the plan is to build local fiber connections to all counties. The existence of broadband links in the counties gives the local governments an opportunity to interconnect institutions they are responsible for, including public schools. This process has already begun. Pila, one of the biggest towns in Wielkopolska, has recently invested in a fiber connection to one of their primary schools. Further investments are planned in the future.

The optical network, operated by a research center as ours, creates a good opportunity for delivering a new type of educational materials and a new type of educational tools to public schools. The optical link provides schools with a new quality in the education process they maintain. It is at the same time received at a reasonable monthly cost of 400 zlotys (about 100 euros) for a 100 Mbps connection. However, this reasonable cost becomes especially attractive when the optical link is delivered in a package including also a set of advanced services that enable real access to the above-mentioned educational materials and tools. Examples of such services already existing today in the PIONIER network and accessible through metropolitan research and education networks are presented in the next section.

3 EDUCATIONAL SERVICES IN THE RESEARCH AND EDUCATION NETWORK

The broadband network link such as the optical connection to a metropolitan research and education

network is a must for the environment aiming at innovating the educational process with the use of ICT tools. While this constitutes the necessary start and a required infrastructure, the core of this environment are services that are capable of delivering vast amounts of new educational materials and tools. In this section we present examples of such services, currently used in other contexts than an integrated educational service network.

Examples of the above-mentioned services that could enrich the options that schools have at hand when maintaining their day-to-day work with students include the following:

- digital libraries;
- multimedia content archives;
- high definition videoconferencing;
- virtual laboratories;
- e-learning platforms;
- and educational web portals.

We discuss the value of each of these services for the education processes conducted at schools in the following subsections.

3.1 Digital Libraries

Over the recent few years many digital libraries holding lots of valuable resources have emerged in Poland. This includes 14 regional digital libraries with such libraries as, for example, Wielkopolska Digital Library (http://www.wbc.poznan.pl/), Lower Silesian Digital Library (http://www.dbc.wroc.pl/) or Kujawsko-Pomorska Digital Library (http://kpbc.umk.pl/) that were built with the use of the standards-based dLibra framework (Dudczak et al 2007). What is more important these libraries are interconnected with each other through OAI-PMH mechanisms thus creating a nation-wide Federation of Digital Libraries, which was already mentioned in section 2. Overall 38 digital libraries are part of this Federation giving access to a total of over 180 thousand digital objects. One should also not forget about efforts aiming at integrating the Polish Federation with the Europeana digital library.

The constantly growing number of digital objects held by Polish and European digital libraries may be already accessed today by teachers and students at schools. These objects constitute a great value especially for such classes as history, literature, arts and culture. Some of the objects that can be found in the Wielkopolska Digital Library, for example, include rare manuscripts dating from the 15th century, a collection of local newspapers from the 19th and early 20th centuries and other

regional artifacts, dating back to 13th century. Example Wielkopolska Digital Library publications of educational value are shown in Figure 2.

Figure 2: Example publications in the Wielkopolska Digital Library bringing educational value for schools.

3.2 Multimedia Content Archives

Another example of digital content with a great educational value to the teachers and students at schools are multimedia found in online archives such as, for example, the digitized archive maintained by the Polish public broadcaster TVP (http://www.itvp.pl/). What is important to note here is that this multimedia content is distributed within the PIONIER network with the use of thoroughly tested, intelligent content delivery system, already mentioned in section 2.

The TVP online archive holds around 1200 educational audio-visual assets. This includes older programmes digitized recently, and the current production which is being digitized and put into the online archive straight away. These programmes hold a great value to a number of classes and courses, including physics, chemistry, nature, science or history. Example resources are shown in Figure 3.

Figure 3: The view at the educational multimedia archive of the Polish public broadcaster TVP.

3.3 High Definition Videoconferencing

Videoconferencing shows a great potential at enriching educational experience of students at school. Different types of videoconferencing techniques are used at schools already today. According to a questionnaire conducted among high schools in our city in October 2008, 8 out of 42 schools own dedicated videoconferencing rooms with equipment and facilities, that are used during classes. These are television quality videoconferencing terminals. However, as the HDViper project (http://www.hdviper.org/) findings show, high definition videoconferencing carries even greater educational potential.

The utilization of HD quality video requires much higher bandwidths, yet it is fully justified by the much better user experience. The latter is especially true for such educational performances as for example chemical experiments where the visibility of details is vital, or e-meetings of students from remote schools where high video quality constitutes a better feeling of presence. A questionnaire conducted within the HDViper project with a number of actual high school teachers showed that there is a widespread agreement that videoconferencing gives new possibilities in education. The teachers pointed to a number of uses of videoconferencing like cooperation on joint projects between schools, interviews with famous people, participation in seminars or scientific experiments and activities with individual students.

3.4 Virtual Laboratories

Virtual laboratory systems provide means of remote access to unique laboratory equipment from the comfort of one's desk. They are mainly used by scientists to access expensive and rare equipment, often in a collaborative manner allowing to perform observations on a scale unknown before. An example of such an infrastructure may be remote radio-telescope access which allows astrophysicists to use over 20 radio-telescopes distributed across 6 continents to achieve a high resolution image of a given fragment of the sky (Okon et al., 2009).

Virtual laboratories in the context of mandatory education will not involve access to expensive equipment and infrastructures such as the above-mentioned radio-telescopes. This concept can be used to access limited laboratory instrumentation at either selected schools in a given geographical jurisdiction or at university laboratories. However, virtual laboratory platforms come with advanced simulation and visualization tools which can be used by school with virtually no limit, thus giving access to results of actual scientific experiments performed with the use of the aforementioned expensive infrastructures such as radio-telescopes. This creates an opportunity for innovative educational scenarios and enrichment of traditional science, physics or chemistry classes.

3.5 e-Learning Platforms

e-Learning platforms such as, for example, the open source Moodle (Rice, 2008) have been known for quite a few years now. The emergence of the SCORM format enabled standardization of e-course creation thus facilitating its exploitation within the education sector. Many universities currently use some form of e-learning. In Poznan also the Teacher's Training Center (ODN – Osrodek Doskonalenia Nauczycieli) uses an e-learning platform to offer various e-courses aimed at upgrading skills of public school teachers.

The above-mentioned questionnaire we conducted in 42 high schools in Poznan showed that 8 of them are maintaining their internal e-learning platforms used to create and utilize educational materials for students in the form of e-courses. Furthermore, 80% of schools cooperate with various universities which provide valuable e-courses on selected subjects. With the emergence of optical

links at schools it is natural to think of enabling their internal e-learning resources together with the materials provided by universities to the totality of schools, thus equalizing access to these resources, reducing costs of their creation and enabling their sharing and reuse.

3.6 Educational Web Portals

A vast number of educational resources can also be found on the web, especially within educational portals such as the Polish Educational Portal "Interkl@sa" (http://www.interklasa.pl/). Such portals contain lots of useful educational materials and provide interesting tools for use within the educational process. For example, the above-mentioned "Interkl@sa" portal provides access to over 5500 articles catalogued within subject subpages. It also delivers various specialized tools such as web educational resource directory, "Virtual Classroom", chat or Frantice, a French language vortal.

Access to the resources of web educational portals does not require an optical link to the metropolitan research and education network. However, it constitutes a value that should be combined with the services mentioned above to deliver an integrated educational environment of resources and tools that enables to provide means for the application of an innovative classroom. We discuss how this should be done in the next section.

4 BUILDING AN EDUCATIONAL SERVICE NETWORK

Having the fiber-based broadband link to the Internet and a critical mass of digital resources and tools available online, schools may begin to organize improved education courses supported vastly by ICT use. To this end, two elements must get integrated into an educational service network. First, one must define an organizational framework for cooperation between schools and other educational institutions within the assumed educational scenarios. Second, an appropriate approach at the integration of ICT infrastructure should be assumed. We discuss both these issues in this section.

4.1 Organization of Educational Scenarios in the Service Network

When designing an organizational structure of the educational service network, one must first of all understand what types of relations may exist between actors participating in scenarios that can be supported with the use of this network. Our analysis and discussion with the education community, represented by the most active high school principals in the city, shows that there are 4 categories of actors delivering and/or utilizing the educational services in such a network. These are students (S), teachers (T), Universities (U) and methodological centers such as the aforementioned ODN (M). The relations between these actors are presented in Figure 4.
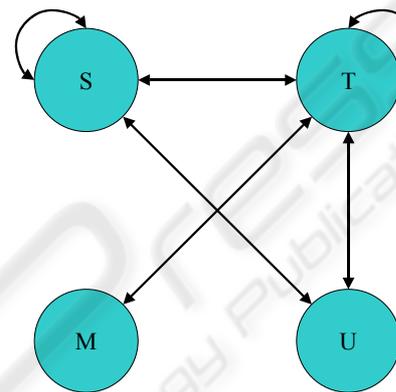

Figure 4: The relations between actors with the educational service net: S – students, T – teachers, U – universities, M – methodological centers.

Further on, these actors as listed above, may take different roles in five educational scenarios we found on the base of our discussions and the questionnaire we conducted in October 2008. These scenarios include:

- supporting traditional classroom with educational services of the network, for example, reaching to online resources as a teaching aid in the classroom;
- complementary education with the use of educational services of the network, for example, students preparing projects based on resources found within the network;
- utilization of university resources in high school education, for example, organization of special laboratory e-presentations;
- utilization of educational services of the network in out-of-classroom education, for example, for the most talented students or students that cannot participate in classroom activities for a given period of time;
- teacher improvement with the use of educational services of the network, for example, utilization of e-learning platforms to provide improvement e-courses.

In each of these scenarios not only passive utilization of services and resources takes place, but the actors may also actively cooperate with each other on the inter-institution level. That imposes important requirement of a careful design of the new processes that take place in this new environment. To this end key participants in the value-chain such as the local governments that administer the local education systems must undertake the role of designing the new process workflow. In the case of our activities aiming at establishing an educational service network, this role has been undertaken by the Department of Education of the Poznan City Hall.

4.2 Integration of ICT Infrastructure for the Delivery of Educational Services

When it comes to the integration of the educational service network at the technical level, three major requirements must be taken into consideration. These requirements are as follows:

- ease of service utilization;
- ease of resources and tools reuse;
- privacy and security.

In relation to the ease of service utilization two important issues are worth considering. First of them is the appropriately designed user gateway to the service network. This not only includes easy-to-use user interface but, more importantly, seamless integration of the underlying systems. The users should be able to access any of the services with the use of a single authentication mechanism in a single sign on manner. That imposes a requirement on the middleware layer of the service network to enable single sign on in the whole environment and to contain necessary interfaces to all heterogeneous underlying systems such as digital libraries, multimedia content delivery systems or virtual laboratories.

Reuse of resources and tools is especially important in this type of environment. This should be first of all addressed in the context of reusing the same resources in various scenarios and applications. It is also important that any new resource that gets created within the network is easily noted by other users. In the context of resource reuse semantic web technologies show a good potential. To this end the middleware layer of the educational service network infrastructure should get equipped with means of semantic description of resources and tools, and in mechanisms enabling automatic search for relations between documents

according to the designed ontologies immersed in the educational service network. Appropriately defined ontologies will certainly help to facilitate reuse and sharing of resources in this network.

Finally, the privacy and security issue is connected with two important issues. First is to protect the personal data of actors involved in the utilization of services in the educational service network. This especially refers to the students various information on whom, such as the level of their skills, possible illnesses and/or disabilities, political and religious beliefs and others, may be found in the network. They should be protected with appropriate privacy protection techniques. The other issue refers to the protection of content provided within the network. This includes the content produced by each school, e.g. provided through their e-learning platforms, and the content enabled for use only within the educational service net, e.g. some specific content of television archives which could be enabled for educational purposes, while at the same time cannot be enabled for general public access. In both cases the existence of a coherent corporate network built on top of the metropolitan research and education network will help to achieve the goal of privacy and security protection.

5 RELATED WORK

One of the brightest examples of educational service networks is Glow (http://www.ltscotland.org.uk/glowscotland/), the Scottish part of the National Education Network (http://www.nen.gov.uk/) in the United Kingdom. Glow is "the world's first national intranet for education." It delivers a trusted and safe environment where one can create personalized programmes, share resources, use a variety of online tools to enhance learning experiences and collaborate with others across the network. The resources come from different sources and can either be accessed from any place after a successful login or are available for access only from schools, e.g. in the case of a music archive. In the United States, the Utah Education Network (http://ww.uen.org/) connects Utah's public schools with high speed links and provides various services such as interactive videoconferencing, e-trainings, e-learning or Internet television.

Important for our work are also advancements in the field of various applications and tools that could be utilized to improve the quality of education at schools. One of such advancements is the subject of

the VccSSe project (http://www.vccsse.ssai.valahia.ro/) which aims to adapt virtual laboratory techniques for utilization within education processes at school. The work of the project focuses mainly on mathematics, physics, chemistry and biology and involves schools from Romania, Poland, Spain, Finland and Greece. The use of high definition videoconferencing in education is the subject of the aforementioned HDViper project.

Finally, an important field of our attention is the use of semantic web techniques for facilitating access to resources and services. A very interesting work in this field is done within the OASIS project (http://www.oasis-project.eu/). This project develops the so called OASIS hyper-ontology, which aims to interconnect heterogeneous ontologies to achieve the sharing of contextual information between different objects and services (Kehagias et al., 2008). While the primary application of this hyper-ontology architectural concept is for seamless service provision to the elderly, it shows a potential for utilization also in other fields, such as, for example, an educational service network.

6 SUMMARY

In this paper we have presented a concept of building an integrated environment for the provision of services for education in a metropolitan research and education network. On the basis of a questionnaire we conducted in October 2008, we were able to draw a list of requirements for the initiative aiming to build such an educational service network. Furthermore, we found what usage scenarios are expected in this network and what is the necessary critical mass to start the work on the establishment of this environment.

An important message coming from the education community was also their need to utilize the resources already existing and available in the metropolitan research and education network that we operate. This becomes available today with the optical link directly reaching schools in our city and with useful technologies such as semantic web at hand. Our goal is to work in this direction with the relevant stakeholders in our region to deliver this sort of integrated environment where ease of use, reuse and sharing of resources, as well as privacy and security are main drivers of the innovative education experience.

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