Tomas Kozik, Peter Kuna, Marek Simon, Peter Arras

Remote Experiments, from Internet to Intranet

MUZEUM HISTORII POLSKI

Tomáš KOZÍK, Peter KUNA
Constantine the Philosopher University in Nitra, Slovak Republic

Marek ŠIMON
University of SS. Cyril and Methodius in Trnava, Slovak Republic

Peter ARRAS
Catholic University of Leuven, Belgium

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The success of the university institution to establish a remote experiment laboratory, depends on two mutually independent tasks that need to be addressed. The first task is to find a technical solution for the selected experiment and the second task is a proposal for the arrangement of the Web site and its content. The success of the use of remote experiments depends not only on the technical solution, but also from the fulfilment of the teaching requirements of the experiment itself [Kozík, Šimon 2012].

The actual preparation of remote experiments consists of several interrelated points:
– Thought, idea, topic,
– Technical solution for the experiment and its control,
– The creation of the educational content and its visualization,
– Innovation (upgrading) of technical solutions and educational content,
– Long-term operational sustainability.

After putting the remote experiments into practice, in terms of its long-term operation, the last two bullet points are particularly important. The activities carried out in these two points require personal commitment and initiative of the teacher or lab-manager: an active approach in providing technical service for the operation of the remote experiment, ongoing technical control and testing, upgrading the technical equipment and continuous control of the network connection. This also applies to the innovation of the actual content of the remote experiment.

Remote experiments on public Internet

According to the authors' experience, unplanned technical, economic and content demands on long-term operational sustainability of remote experiments is the cause of the declining numbers of active remote experiments freely available on the Internet. Authors investigated the availability of remote experiments on the Internet, in the period 2012–2014. At the beginning of 2015, the numbers of freely available remote experiments declined to 1/6 of the original number.

There is also another reason, in addition to the above reasons for the observed reduction in the numbers of remote experiments freely available on the Internet. This reason is in the operation of remote experiments in the university's Intranet network, separated from the internet. The reason for the use of an intranet can be found in the security issues. Three of the main tasks for security issues on a remote lab need to be considered [Kozík *et al.* 2015].

The first one is to prevent unauthorised access to the laboratory. A suitable authentication mechanism is the first step in achieving access control. The authentication is usually forced out by the creation of user accounts for the users who after their authentication via username and password may access the experiments. This method represents the most widespread way of authentication. A password is easily transferable and its use is relatively simple and comfortable. At the same time, there is a number of disadvantages and risks connected with its use. Nowadays passwords are considered to be a weak device in providing access. There are many reasons for that. Users mostly choose as a password various forms of their names, initials as well as names from their surroundings, dates of birth, and so on. Various studies have proved that almost a third of passwords may be stolen at the tenth attempt. A password may also be detected during when it is being entered. Or a user simply forgets it. The basic contradiction then lies in the fact that it has to be long and complicated, difficult to guess, and, at the same time, the user must be able to remember it. Moreover, people let themselves be easily fooled and persuaded to reveal their passwords.

Secondly, since the remote laboratory is connected to the Internet, it is necessary to protect it via firewall. In general, a firewall is a device which separates the protected network from the unprotected one, and, in many cases, one protected part of the network from another unprotected part of the same network. It is thus a kind of constricting place through which all communication from and into the protected network passes. By means of a firewall it is possible to force a certain level of connection security. The sources of protected network which will be made accessible from the external network must be defined, as well as which users from which computers of the protected network may access the sources of the external network.

Thirdly, current sophisticated computer attacks require that the remote laboratory must be protected by another element – an intrusion detection system. The task of the security violation detection system is to identify, possibly in real time, an abuse, non-authorised or incorrect use of the computer system. The intrusion detection issue is becoming very important with regard to the increase in the number of Internet based systems. More systems means more potential attackers and more difficult identification. The Intrusion Detection Systems, IDS, thus should be included into the security policy as further devices of computer security. The security policy should identify what type of IDS is necessary, where to place it, what type of attacks it should detect, and how to respond to a given attack type.

Remote experiments on Intranet and community networks

Addressing control and management of the experiment and the content of the website determines the target group of future potential users and authors of the experiment have to decide to make it available either via the public Internet net, either the community network on the Internet or the intranet.

Community Networks on the Internet are made up by educational associations (of several separate institutes), in which they share their laboratories and remote experiments for members of the association only.

G.R. Alves *et al.* [2007] reported the idea of networking remote experiments laboratories. P. Orduña *et al.* [2012] developed the basic idea of further developing and designed an international „Federation of remote laboratories". The student submits the application only once in for his own account in a federal LMS and has access to remote experiments at universities, that are members of the Federation. Their thoughts were verified in the WebLab-Deusto.

WebLab-Deusto is a remote laboratory is used since 2002 by over 1,000 students in 12 different courses in the University of Deusto (Spain). WebLab-Deusto supports the federation with other instances of WebLab-Deusto in a transitive way, and this federation protocol is indeed being used with local secondary schools.

T. Kostulski and S. Murray [2011] summarises experience from national Australian Labshare Project (funded by Australian Government) in which 6 universities participated. Labshare's goal is to create a nationally shared network (community) of remote laboratories to address the issues of laboratory under utilisation, accessibility, flexibility and foster the availability of high-quality experiments. These experiments, so-called as rigs, are accessible 24/7 from anywhere over the Internet and provide a diverse set of laboratory-based educational experiences to staff and students at Australian universities and high schools.

The primary aim of the Labshare project is to develop the technical, pedagogical and operational means to enable shared remote laboratory access. The requested access periods varied considerably between classes, from a two-week period to semester-long access on one rig type and to several four-week blocks on different rig types. In conjunction with the order of magnitude difference in student numbers, this resulted in a complex model of expected load of the rigs. Consequently, in order to avoid overloading at certain times and under-usage at other periods, intricate negotiation and coordination or these access periods had to take place between Labshare and the participating academics.

Universities represent educational institutions, whose idea is to mediate results and findings from their own research work and knowledge of contemporary science to their students. From the above, it is a strong likelihood, that remote experiments produced and used in the university will be increasingly innovative. Under „innovation" we do not understand only technical innovation, but also innovation in educational use in subjects, in which a teacher experiment applied.

From this perspective, it appears more favourable to apply experiments on intranet. This solution and the use of remote experiment at the university allows the teacher when he innovates contents (syllabus) of an lecturing subject to immediately adapt and innovate it in the remote experiment educational objectives. And so the teacher can fully concentrate on the best use of the remote experiment in education and to achieve successful outcomes from its use in education.

Remote lab managers should not worry about network security but should be able to devote their attention to the operation of the remote lab and to the possible reduction of operating and maintenance costs of remote experiments.

Using an intranet diminishes the visibility of the university to the public. These problems can possibly be eliminated using other appropriate media means.

Conclusion

A correct functioning of remote real experiments is critically important for their application. As A. Kara *et al.* [2011] state, it includes not only pedagogical problems, but technical problems and challenges as well. The maintenance and internet security of the laboratory of remote experiments may require unexpectedly great human resources and equipment. Security cost can drop if the remote lab is operated over an intranet environment, instead of opening it up to the complete www-world.

Examples of established community networks – remote laboratory experiments in Spain and Australia show one of the methods for the direction of the development and application of remote experiments in the future. Creating a community network will provide a wider base for users of remote experiments. We can also assume that the community network will offer a forum for the permanent innovation of the technical layout of the remote experiment and its didactic applications.

At the same time the internet provides authors with remote experiments and gives university teachers the necessary space for their innovative modifications in technical and content adjustment of their topics to match the present state of the scientific disciplines and their didactic intents.

Preparing remote experiments for an intranet does not preclude, that the authors decide to provide remote experiment on an existing or a newly to be formed community network of educational associations.

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Abstract

Remote experiments for teaching purposes are mediated by users, especially on the Internet. To access a remote experiment from within the universities, the intranet is also used. In terms of extending the application of remote experiments, an interesting method is the creation of community networks on the Internet with associations of educational institutions. In this article authors focused their attention on the formulation and application of remote experiments in education, in terms of their availability on the Internet and Intranet.

Keywords: remote experiments, internet, technical education, science.