Research paper

Distance Education, Virtual University And Virtual Laboratory: What opportunities for NII in the future?

Henri ANGELINO
National Institute of Informatics

ABSTRACT

The development of Internet and of the news Information and Communication Technology tools have boosted the implementation of distance education, virtual university and virtual laboratory all around the world. Nowadays the only constant in education is change and evolution, long life learning is compulsory, and distance education will be a very powerful answer. In relation with that dictates distance open universities are the front-runners but also many classical universities have developed virtual campus where people can without leaving their work, improve their knowledge and students can tailor their program and obtain a degree. Virtual university offers advantages and has some limits that are presented.

Progresses in research nowadays are increasingly the result of team of scientists who might be spread around different laboratories in the country or in the world. Moreover, they might have to share exclusive, sophisticated, expensive equipment. The development of a virtual laboratory, laboratory without walls, using all the potential of ICT is quite often the appropriate answer. Different considerations, which are presented, have to be taken into account when establishing a virtual laboratory. Finally, as a case study, what CNRS the French National Scientific Research Center has implemented is described. In each case the specific problems of Developing Countries and UNESCO policy is mentioned. Many possibilities exist for NII in each case if…

[Keywords]

Distance learning, Virtual University, Virtual Laboratory, Information communication Technology

1 Introduction

"So where is the agora for the global community? The answer has to be, On the Net."

Brenda LAUREL - quoted in 1993[1]…

The development of Internet is very recent[2], less than thirty years, after the Rand Corporation in USA was commissioned by the U.S Air Force to do a special study… The first email program was created in 1972 and the first use of the term Internet for “Interconnection Network” appears in 1974 but it is only in the nineties after Tim BERNERS LEE from CERN in Geneva invented the World Wide Web (WWW) where all sort of information, documents, sounds, videos, … can be find, that the explosion of Internet uses, not only by scientists, started. This tendency has been accelerated with the recent developments of new tools for the Information Society Technologies that include of course also communication technologies and for instance the facilities to use wireless access to Internet. According to “NUA Internet Surveys”[3] which, since 1998 is offering analysis and comments on global Internet trends, the number of people having Internet access increased from 55 millions in December 1996, 1.34% of the total world population to 195.19 millions in September 1999, 4.64% of the world population to 513.41 millions in August 2001, 8.46% of the world population. In a recent report, eTForecasts[3] predicted that more than one billion people would have access by 2005! Actually the WWW is the fastest growing technology in history[4] achieving in USA 25% market penetration in seven years, compared to 54 years for airplane, 35 years for telephone, and 15 years for personal computers: to be or not to be …in line that is the question!

The National Institute of Informatics (NII), as it is written in its new brochure, “was founded in April 2000 as an Inter-University Research Institute to undertake the comprehensive research on informatics and to developing infrastructure for the distribution of scientific information…" NII research activities include wide domains such as network, software, multimedia … and its different teams are strongly engaged in basic and in applied research activities, not only in computer sciences and information engineering but also in humanities, social sciences and life sciences. It benefits from important computing facilities and operates the Science Information Network (SINET). Furthermore an evolution called Super SINET will provide, in January 2002, an ultra high speed network whose bandwidth is 10Gbps. NII has also some teaching activities mainly seminars and advanced training programs for staff of university, research institutes but it will be very soon engaged a new sort of teaching activities with its own Ph. D program to start after the final approval by the Ministry of Education, Science and Technology (MEXT). At the same time, some researchers at NII are developing research activities on Distance Learning environment and some are already thinking of using all the potential of Information and Communication Technologies (ICT) available intra-muros to participate in Distance Learning (DL) or Distance Education (DE).

My purpose is this paper, taking into consideration the potential existing inside NII, is to give a survey of the possibilities and interests for NII to participate in Distance Education, in Virtual University and/or to establish Virtual Laboratories. This paper does not pretend to cover all the aspects of DE, VU and VL but it introduces some ideas on the different subjects and describes, as a case study what CNRS, the French National Center for Scientific Research, is developing as VL at the European level.

Having in mind Brenda LAUREL's quotation I used the Net to find some information concerning Distance Education (DE), Virtual Universities (VU) and Virtual Laboratories (VL) and the results terrified me: more than 1,250,000 references appear under DE, almost the same number under VU and more than 500,000 references appear under VL!

2 Distance Education

"Distance Education" started in a semi intensive way more than a century ago in Australia[5], but under a different name, "Distance Correspondence" and the International Council for Correspondence Education (ICCE) was established in 1938. It took a long time before the idea of the first University of the Air (Open University) emerged: in 1964 Harold WILSON, at that time the UK Prime Minister, launched the idea in Glasgow … and the Open University started in 1969! Due to the change of technology the name ICCE was changed in 1982 in Vancouver into International Council for Open Distance Education, ICDE, but as James TAYLOR[6] said in 2001 "technology is the answer but what is the question? Today the technology has changed but the question has not". In fact technology is not the issue, content and quality is the issue. ICT is an essential element in flexible, open, distance learning and education but it is not enough. Actually four steps in the development of DE have been identified[6] from the first step -correspondence- to the fourth step -the flexible learning model- based on on-line delivery via Internet and the Computer Mediated Communication (CMC). TAYLOR presented the fifth step -the Intelligent Flexible Learning Model- that is based on the further exploitation of new technologies as basic technologies are exploding. STAUDT[7] for instance mentioned that chips on a mobile phone of today would have controlled the first lunar landing some thirty years ago or that with today desktop we would have controlled the whole Appolo mission.

Access to high quality education is of crucial importance in the development of economic and social systems in all nations. The level of education is becoming more important for the prosperity of countries than access to natural resources and the new raw materials is the access to information and knowledge[7]. As A.W.KHAN[8] pointed out "we lived in a world marked by contrasts: prosperity against poverty, knowledge against ignorance and globalization against marginalization". In that respect the participation of NII to the applications of IT to human resources development seems very important for the benefit of some Developing Countries of Asia. NII could for instance join the Greater Mekong Sub-region Academic and Research Network (GMSARN), recently established by Asian Institute of Technology and different Asian Universities, to foster the development of human resources in that part of Asia using ICT. ICT makes distance disappear and provide an opportunity to share the scarce teaching resources. Today the world is increasingly inundated with communications technologies and the possibilities for interaction in Distance Education appears in many different forms with many different media. According to experts the "IT revolution" could be more significant than any previous revolution. May be Internet and WWW are not a revolution but an "e-volution" nevertheless their impact in all fields, not only teaching, but also on commerce with the development of "e-commerce", is particularly important. We are all faced with the same challenge created by the fast progress of technology and the international economy is increasingly based on knowledge, innovation and skill. We have entered the information economy and education must lay the foundation for the success of the global economy. The networked and interdependent economy is based on the flow of information, ideas, capital, cultural values, goods and services, people and KHAN considers that is the globalization. The earlier area of globalization was built on the falling cost of transportation; the new era is built on falling cost of telecommunication.

IT are becoming an integral part of education and BROAD[4] presented for the USA the development of the use of IT in Higher Education between 1994 and 2000 as a percentage of courses: for email the increase has been from 8% to 59%, for Internet resources from 0% to 42%, for courses WWW pages from 0% to 30.5%, for computer simulation from 9% to 18%. It is obvious this "e-volution" represents an opportunity for NII to use all its competences and means and to play a key role in the diffusion of these technologies. Distance Education is becoming increasingly important due to the knowledge explosion. It is estimated[7] that global knowledge has doubled between 1750 and 1900, then again between 1900 and 1950, nowadays it double every five years and it is forecasted that in 2020 it will double every 72days. Let me remind that predicting the future and the consequences of new technologies is risky and some people in high position have demonstrated their lack of foresight[9] : reaction in 1876 of Western Telegraph to the proposition of Bell for his telephone or more recently in 1977 the CEO of Digital who could not understand why everyone should need a personal computer. Half a century ago a graduate could rely on his/her higher education for his/her 40 years working life, in 1986 75% of the knowledge used in a profession was in the head of the employees, in 1997 only 15-20%. Today it is estimated that every graduate to be competent in his daily work has to accumulate learning equivalent to 30 credit hours every seven years which means that he has to learn in his life two times the amount he has learned during his/her studies. In the present context where change is the only constant, where lifelong education is the rule, the motto for the academics in Higher Education should be "teach how to learn" and for the students "learn to learn", should NII stay aside that real challenge?

3 Virtual University

3.1 The "reality" of Virtual University

Information technology has modified the flow of knowledge in our society and for the University, the primary institution for the creation and dissemination of knowledge, these changes have profound implications. In our society, we generally assume that new is better than old. We know that a new technology is unlikely to preserve all the features of the old one but we expect that the gains to its users will outweigh the losses. Thomas MANN, quoted in 1999[10], said "Assist the new without sacrificing the old" and the best servitors of the news… may be those who know the old and carry it over into the new. In the context of information age the University must adapt its way of teaching taking advantage of the possibilities that are offered by ICT and moving towards Virtual University (VU). In particular the development of the use of Computer Mediated Communication (CMC) -use for human communication of computers-, allows to shift from a teaching environment to a learning ones. One of the advantage of VU is that there is an interaction between teaching and learning and the interactivity between students, teaching staff and others experts could be achieved easily through CMC.

But what do we mean when mentioning VU? First no real campus is needed and a university may be created as a virtual network of different entities involved in higher education. The university concept is radically transformed in a virtual world, and these changes begun some years ago. All university services and functions are simulated on the Internet so no physical interaction is needed any more to complete a study program. Courses programs are put on the Internet and students from all around the world can have access to them. In the case of Universities network lectures are sent from one university to another one to offer them at the same time to students at different places. Several universities offer selected courses for lifelong education on the Net for free choice and combination. Sometimes a central institution acting as a “broker” offers combinations of study programs or courses from different universities to create a personal curriculum: “one size” fits all does not exist any more and on the contrary it is tailored programs that can be organized by the student. In general there are tuition fees but in some case not, as MIT proposed recently for part of its programs.

When the idea of using the IT tools intensively for developing VU appeared the vision of students obtaining certificates or degrees without ever having been in a classroom has challenged the imagination of education entrepreneurs and investors looking for opportunities to offer fast, flexible and fluid higher education. But at the same time some of the academia thought that the entire structure and focus of academic institutions will be undermined by electronic technology. "It threatens to blow away our traditional definition of courses, classes, and students," said Provost Stanley CHODOROW in a seminar held at the University of Pennsylvania[11], which was an appropriate place to deal with the fallout from the information technology revolution as that university let the “genie out of the bottle” more than fifty years ago. In traditional teaching systems courses are defined by credit hours and reading assignments, but what happens when most of the communications for the course occur outside the classroom? In traditional Universities individuals are evaluated on their work, but what happens when a paper is “built by a group of students until it is abandoned to the faculty member? ” At the very start most academia people were afraid of VU and CHODOROW compared the view from academia to “the mix of excitement and terror experienced at the top of a roller coaster”. Will the university we have known be able to exist any more? Will the information superhighway offer an enhancement to the current system of classrooms and books, or will it destroy it as “the automobile did to the horse and buggy industry”?

In fact academia people have soon realized that there are several functions of the university that cannot be duplicated by technology, and these roles ensure the future of the institution. The role of the university as “producer of new ideas” is more important than ever in an age of new economic, social, and political challenges. Academia's role in teaching and training youth is still important. “The electronic environment may enhance, but it cannot replace the intellectual society of the university,” said CHODOROW and “as long as society is healthy enough to need new knowledge and educated citizens, there will be a role for the university”. In the same seminar CLEMENT[11], along with other participants, identified several qualities of university that cannot be fully fulfilled through information technology:

- To lead in learning activities.
- To aid in the maturation process of youth.
- To build a community of scholars.
- To certify learners (by granting degrees).
- To certify knowledge.
- To keep and maintain our national treasures of knowledge.

Part of these conclusion have been re-enforced by RESNICK[12] in his conference in April 2000 in Chicago : “the academic course work of higher education can be replicated online, but what cannot are the organized extra-curricular activities which have been a crucial component of traditional College education. These activities create social capital, prepare students for civic engagement and combat the self-absorbed individualism which undermines democratic society”.

Other opinions exist and in his intervention PERELMAN[11] said that “advances in information technology are not the herald of a transition in higher education, but rather the death knell of the University as we know it. The changes required are so dramatic that, if the University does survive in some form, it will bear about as much resemblance to the current University as a bird does to a dinosaur. Birds may be descendants of dinosaurs, but they are not dinosaurs”. Recently TAYLOR[9] said “given the predilection of universities to either wait & see and do nothing or to add something new to an already overcrowded program of activities they could become a - threatened species -”

Distance Learning specialists Universities are among the front runner for offering their lectures and degrees on their Internet site for instance, in USA the University of Phoenix, the Western Governors University[13] which was formed by the governors of 17 States along with business partners (Microsoft, Sun System, IBM, AT&T), in Canada Athabasca University and the Canadian Virtual University, in UK the Open University or in Switzerland the Swiss Virtual Campus University[14]. In Europe, the concept of Virtual University has developed more recently but interesting information on the concept of a Virtual Institute for Distance Education in the EU (VIDE)[15] can be found in a special report published at the end of 1998. In 2001, Guss WIJNGAARDS[16] confirmed that Europe's Challenge is to accelerate the speed of change in the integration of ICT as a central instrument in teaching, learning and training. Advocates of the Virtual University assume that the Internet can be used to replace the bricks and mortar campus and in 1997 Peter DRUCKER[17], the Management guru, said: "Thirty years from now the big university campuses will be relics. The College won't survive as a residential institution. Today buildings are hopeless, unsuited and totally unneeded". In 2001 Guus WIJNGAARDS[16] said on the contrary "Are we moving very quickly into a scholastic world where buildings and teachers no longer exist: No. Like the appearance of calculators, did not mean the end of the necessity to learn mathematics, computers and Internet do not initiate the abolition of schools and teachers". The question is still open but it is clear that up to now universities have survived the IT and Internet challenges taking advantage of the facilities that are offered by its uses.

Institutions in the area of open and distance learning are heading towards a Virtual University approach but why are the traditional universities going "virtual"[18] despite the serious challenges posed to both teaching and research by information technology? Despite the fact that trying to change traditional university is like "trying to move a graveyard"[9] most of the universities are changing and adapting themselves to the use of IT and Internet, why? First of all more and more academia realize that lifelong learning is a must and that rulers of enterprises prefer to use the IT facilities instead of sending their employees back to universities for training, spending money and not using their competences as long as they are outside the company. At the same time private companies are entering this lucrative business of education, training and human resource development and the competition between universities and private companies will be fierce in this area: Universities must adapt and be prepared for that challenge. Moreover it is obvious that outside the academic area multi-media and electronic networks are rapidly gaining an increasing impact on our every day life and for instance the new generation of students are the e-generation and the "Homo Zappiens" as Wim VEEN[19] call it. All the education system must recognize the "qualities" of Homo Zappiens at work and must adapt and develop entirely new approaches which will be characterized by flexibility in content, in learning model, in time/scheduling, in assessment, and where of course ICT will play an important role. Ounce again NII that has not the "burden" of traditional teaching system and on the contrary has specialists of ICT could play a very active role in this new education. In the context of "information age" and the death of distance more and more institutions are making courses available world wide using Internet why NII, using all his competences in ICT and developing new forms of knowledge access, will not be one of the leading ones?

3.2 Teaching Virtual Laboratory

One very interesting aspect of VU that academia people accepted quite easily is Virtual Laboratory as this aspect is very important for teaching activities: the virtual replace the physical. IT allow us to explore complex systems that for some Higher Education Institutions are "too big, too small, too fast, too slow, too dangerous or too expensive to be explored by traditional means"[4]. Proposals for all sort of "classical" Virtual Laboratory are find on Internet in different fields: Chemistry, Physics, Biochemistry, Medicine, Genetics, etc. Telemedicine is one aspect concerning health and continuing medical education has gained widespread acceptance as a powerful tool: the Virtual Hospital was started at the University of Iowa in 1992 and provides information, including textbooks, images and animation for patients, health care providers and students. In a survey conducted at the beginning of in 1999, 188 worldwide active programs were identified in telemedicine.

The Articulate Virtual Laboratory (AVL)[20] in which science and engineering principles are taught by scaffolding and coaching students in conceptual design tasks has always been of special interest to me due to my chemical engineering background. The AVL is dedicated to enable students "to learn fundamental principles radically better than they would otherwise and to succeed at design tasks that they would otherwise be unable to perform". Design experience is essential to natural sciences and engineering education and provides a powerful motivating context for learning fundamental physical principles: one cannot design an engine, a heat pump, or any industrial plant without knowing and using a broad range of physical principles. Design environments that scaffold students, allowing them to focus on fundamentals, is invaluable for instruction in natural sciences and engineering and could better motivate interest in science learning. It is difficult to provide design experiences in normal classroom because many interesting artifacts are expensive or dangerous to build and to experiment with. Articulate Virtual Laboratories solve these problems enabling students to design, analyze, and test artifacts in a simulated environment, cheaply and safely. They provide coaching for students in order to help them understand fundamental principles, practice the skills needed to model, analyze, and design systems, and they provide the kind of supervision that a good laboratory assistant provides by way of minimizing unenlightening aspects of student explorations.

4 Virtual Laboratory for Research activities

4.1 Introduction to a Virtual Laboratory: What is it?

In the modern scientific environment, especially where increasingly sophisticated and expensive instruments are key elements and where problems must be solved by teams of scientists working in universities, national laboratories, and private laboratories in industry, spread all around the world, the impediments of geographic separation can become dominating factors in trying to accomplish cooperative and/or remote research. Time, cost, and scheduling constraints imposed by travel limit routine and close contacts with remote colleagues and scientific instrumentation. On the other hand, the awkwardness of communicating information and results - not just data - limit the effectiveness of the group intellect. Breaking down the barriers of distance will permit routine and frequent participation by senior academic and research scientists in planning and conducting experiments that would otherwise require scheduling long in advance, flying, housing arrangements, site safety and operations training. The need for a distributed laboratory or for a scientific environment can occur by virtue of research and engineering involving the use of large and/or scarce facilities, e.g. large electron microscopes, synchrotron light sources, various types of particle accelerators, etc. It can also occur by virtue of an equipment being unique due to its scale, e.g. a fusion reactor or because the collaborators and/or industrial partners belong to several different institutions.

The vision of Virtual Laboratory VL is to provide a widely distributed environment in which people, instrumentation, and information can flow and interact as easily as they can when all of the critical resources are local. AVL is different from a classical laboratory (CL) as it is a "laboratory without walls" in which users can perform their research without regard to geographical location, interacting with colleagues, accessing instrumentation, sharing data and computational resources, accessing information in digital libraries. AVL is not a replacement for, or a competitor to, a classical laboratory but instead VL is a possible extension of CL and open new opportunities not realizable entirely within a CL at an affordable cost.

A Virtual Laboratory can be considered as a heterogeneous, distributed problem that enables a group of researchers located around the world to work together on a common set of projects. As with any other laboratory, the tools and techniques are specific to the domain of the research, but the basic infrastructure requirements are shared across disciplines. Virtual Laboratories have been proposed in many disciplines including astronomy, cosmology, weather forecasting, multi-disciplinary design manufacturing (e.g. airplane production), nuclear physics, atomic energy, space, virtual reality, computational biology, drug design, materials science and nano-materials, microscopy, scientific instrumentation, etc.

UNESCO has proposed some VL taking into account the specific missions of UNESCO. The following "definition" of VL was accepted in January 2000 in Paris[21] "an electronic workspace for distance collaboration and experimentation in research or other creative activity, to generate and deliver results using distributed information and communication technologies". In other words, for UNESCO experts, VL is a virtual community in which researchers from developing and industrialized countries can collaborate through telecommunications and telematics on common projects. "Virtual" research groups are becoming increasingly common, and connecting with these groups is a critical task for researchers in Developing Countries (DC) wishing to improve their working conditions, effectively to attack regional and national research problems, and to participate on an equal basis in the international scientific endeavour. To this end, it will be important to provide network access by national scientific institutions, local-level institutions and research stations in developing countries, not only to facilitate operational scientific collaboration, but also to ensure access to relevant information stored in databases in industrialized countries.

4.2 Motivation for a Virtual Laboratory

The motivation for scientists or engineers to establish a VL is quite clear:

- Certain major scientific and technological challenges require a size and scale of effort beyond the capacity of a single laboratory or even a single nation.
- Human resources and expertise required for the scientific and technical goals may be distributed among two or more institutions.
- The subject matter require participation of specialists from different regions due to needs for region-specific data, field tests, or available human resources or training base.
- The research need scientific instruments that are unique, scarce or difficult to access and it is necessary, or cost-effective, to share access via remote means.
- The application of the research results for social and economic benefit may depend on regional participation in the project.

In the case of participation of specialists from Developing Countries, a number of additional considerations should be addressed for the successful formation of VL. These questions include how the Developing Country partners can:

- Get meaningful shares of (and credit for) the research assignments.
- Benefit and perceive their benefits.
- Become integrated into the world-wide research enterprise.
- Acquire the training, experience, and infrastructure support.
- Build up their infrastructures.
- Become acquainted with the standards of the contracting or coordinating body.
- Acquire expertise in technology transfer and management of intellectual property rights.
- Prevent brain drain, which might actually be stimulated by the VL through awareness building of a specialist's "market potential."

4.3 Economic Considerations

Potentially some of the most sensitive issues relate to economic considerations. Key questions include

- Costs and benefits-how to distribute equitably?
- Which market value determines compensation?
- How to manage funds and to transfer funds–local rights and responsibilities in a VL?

As VL will generally operate in the context of classical laboratories (CL) serving as hosts of the local participants, considerable attention should focus on the latters' roles in resolving these issues. It seems reasonable that local salary structures serve as the reference frame while premiums may be added as inducements to generate additional VL activity for host laboratories.

4.4 Legal Considerations

Scientists and engineers often prefer to ignore the complexities of legal issues tied with their activities. However, failure to anticipate these issues leads to major misunderstandings, damaged relationships, and lost opportunities. Several issues must have adequate advance consideration:

- Intellectual property rights-how to balance the distribution of benefits in accordance with the rules of each participating country.
- Multi-institution contracts-responsibilities, sharing in rights and privileges.
- Liability-workers' safety, warrantees on products and services.
- Non-performance clauses-allowance for institutional emergencies.
- Fees, methods of payment-transfer and conversion of funds.
- Duties, taxes, transportation fees-assignment of responsibility.
- Insurance-medical, liability.

The general rule is that the Institution that is providing the salary support for the participant attends to the above issues. When multiple Institutions are involved, they will generally meet to develop agreements, such as memoranda of understanding (MOU's), which cover the Inter-Institutional and international issues.

4.5 Organizational Considerations

VL must have an organizational structure that is both responsible and flexible. Transparency will be essential so that key decisions will be made and accepted in a timely fashion. In some cases, it has been easier for the participating institutions to join in creating a new entity with legal status in the respective countries of the participating institutions. This new entity, held in common by the partners, has its own articles of incorporation and provides the organization under which the major economic and legal issues are addressed. Sometimes the burden exists on VL participants of reporting to more than one administrative unit at the same time.

4.6 Implementation of a Virtual Laboratory

Usually the components of a tentative Virtual Laboratory include:

- Computer servers capable of handling very large-scale simulations and data reductions.
- Data bases that contain application and specific information such as simulation initial and boundary conditions, experimental observations, customer requirements, manufacturing constraints, application specific resources; these data bases are both dynamic and distributed and they can also be very large.
- Scientific instruments that are connected to the network, for example, satellite data, ground motion and air quality sensors, astronomical instruments, Advanced Analytical Electron Microscope, Tokamak Fusion facility, high resolution NMR and spectro-microscopy instruments, etc.
- Collaboration tools.
- Software assets, each virtual laboratory is based on a specialized software for simulation, data analysis, discovery and reduction, and visualization. Most of this software was originally designed for "stand-alone" use on a single machine and these tools have to be used into active, heterogeneous networks of programs that can be scaled to solve the problems.
- Tightly coupled, multi-disciplinary computations place great stress on network bandwidth. Low latency is critical and computer system resource scheduling must be coupled with bandwidth reservation services. Multicast protocols and technologies are critical to the collaborative nature of an experiment in a VL where people, resources, and computations are widely distributed. Information streams in these experiments might combine voice, video, real-time data streams from instruments, and large bursts of data from simulations and visualization sources.

After a survey of different existing projects JOHNSTON and AGARWAL[22] have given an exhaustive list of requirements to establish a Virtual Laboratory:

- Collaboration between multiple researchers at multiple sites.
- Remote experiment monitoring and control.
- Cross-platform compatibility.
- On-line laboratory notebook.
- Interface coherence and usability.
- Maintainability
  * minimal software duplication
- Security for access control, safety, and data confidentially.
- Control coordination
  * automatic transfer of control
- Tele-presence.
- Access from industrial sites.

Many of these points are related directly or indirectly to network capability and infrastructure. The Virtual Laboratory scenario is a nice application for a high speed network test-bed: the data flows are higher than current production networks could sustain, there are real-time requirements in the control system; multiple coordinated data and multimedia streams must be multicast to several users and sites that are widely spread across the world; and a versatile, strong, and widely distributed security infrastructure must be in place…

5 CNRS Case study: Associated European Laboratory- Definition and Procedure

As soon as 1992 the French National Centre for Scientific Research (CNRS) in its European strategy started to launch “laboratories without walls” which were called “Associated European Laboratory” (LEA)[23], in fact a Virtual Laboratory! CNRS gave the “definition” of the LEA and how to implement it. It is a structure which brings together laboratories, teams or groups, belonging to two or more countries, which have decided to pool their human and material resources for a certain number of years in order to carry out a jointly defined, high-quality program. The LEA was opened to other French partners outside the CNRS. The laboratories or teams involved in such projects devote much of their time to carrying out the specific program.

The teams or laboratories that constitute an Associated European Laboratory retain their autonomy, their status, their responsibilities and separate locations, but under common leadership, which can be by rotation when it comes to carrying out the program.

This organization and its corresponding management structure are to be defined in an agreement signed by the Director General of the CNRS and by the head(s) of the other French or foreign authority(ies) involved, and possibly set down as internal regulations.

The duration of an Associated European Laboratory is four years, and is renewable.

These laboratories receive specific means, -for equipment, running costs, missions, appointments of associate researchers, of visitors or grant-holders-, put at their disposal by the direction of the CNRS. They can also ask for funding from the EU or other bodies.

Particular care must be taken to ensure a balance between the human and financial resources provided by the respective regulatory authorities.

The selection is made by the CNRS scientific Departments concerned, but the final decision is taken by the Director General. The CNRS Direction for International Relations (DRI) evaluates applications. It checks that the various foreign partners share the same opinion of the quality of the program and that there is a real balance. The partnership agreement includes a clause governing intellectual and industrial property in case of any applied use of the common program's results. There could also be a clause protecting know-how.

As a rule, the LEA is run by a management committee including scientific personalities external to the teams or laboratories concerned.

Each year, the French and foreign teams involved must produce a short report indicating the results obtained, the use of the means put at their disposal during the previous year, and their requests for the following year. A full assessment is made every four years. This is compulsory before any renewal can be made.

When the different laboratories, teams or groups involved in a LEA are normally evaluated by their competent national authorities which are the signatories of the agreement, the works and results of the LEA must also be evaluated.

The setting-up of a LEA, after selection as described above, will include the following steps:

a) The French team(s) and the foreign team(s) will together define their project and summit it for evaluation and approval,

b) The foreign team(s) will contact its regulatory authorities, the DRI will then negotiate with the foreign authority(ies),

c) Drafting and signing of the agreement between the Director General of the CNRS, the Directors or Presidents of any other French bodies that may be concerned, and the head(s) of the foreign authority(ies). The common scientific program will be appended and a financial appendix detailing each partner's contribution are joined to the agreement.

Under that structure CNRS has created since 1992, 20 LEA, some have been renewed, news have been created and at the present time 15 are still active in such different fields as material sciences, economics, neuroscience, catalysis, genomic, nuclear physics, etc.

6 Conclusion

Nowadays learning is a lifelong process, continuous education is a necessity and Virtual University is well adapted to that necessity. In VU every user is a producer…

Traditional Universities are moving to VU and in that case serious reflection on the changes that Internet will bring to Education and University life MUST confront its long term consequences for Society and the unintended social consequences. NII has many potential and competences in ITC and it seems important that it uses all that for the development of human resources for Developing Countries specially in Asia but not only in Asia as by definition VU is the “death of distance”.

Virtual Laboratories both for teaching activities or research activities have already proven their efficiency. In the case of VL for research activities, which seems the best way to tackle the “Big Science problems to solve” to share the “big expensive and scare equipments”, legal and economical considerations have to be taken into account using MOUs. Moreover VL are well adapted to include the scientists from the Developing Countries into the “Big

Science Problem" and ounce again NII with all its IT facilities and Network could play a leading role in new projects.

In the **case of NII** with its large computing facilities, heavily involved in Internet developments and uses, tackling "Big Science problems", ready to participate in PhD Programs and lifelong education, **participating to a Virtual University** and **establishing Virtual Laboratories will widen its potential and its international reputation!**

With apologies to Charles Dickens and Professor Taylor as NII is quite recent…"Will this millennium be the best of times or the worst of times for NII, it is the age of wisdom, it has everything before him, is it all going to Heaven, is it all going the other way?"

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