Oliver B. Popov

Building a
National Research and Education Network

"But most importantly,
perhaps one needs product champions.
For only these individuals can create all other conditions."

Peter A. J. Tindemans

Introduction

A few recent scientific and technological advancements have had such a profound influence on our lives as networking and the Internet. The Internet (arguably the quintessence of networking) offers the possibility to connect almost everyone using the same set of principles and concepts. The global adherence to open standards are behind the tremendous growth of the technology and its applicability to wide range of domains. Indeed, this Olympian attribute provides the potential to reach every segment of the society. It is a technology that compresses both time and space by giving the individual an access to information, which enriches his knowledge and the freedom of choice.

While this might be a very personal view it nevertheless reflects the notion that an entity such as NREN (National Research and Educational Network) is a very important factor in bringing the Internet connectivity and networking to the research and educational communities both in developed and developing countries. However, the later is even more pertinent to the developing countries where markets are not yet developed and the determination for democracy does not match the reality of practicing it.

The prerequisites for the creation and the existence of research and education networks are not limited to technological proficiency. They also very much depend on policy making, management, legal and financial issues. Exhaustive consideration and detail analysis of all these phenomena are beyond the scope of this article, however we shall try to enumerate some of those issues, as well as present ways to address and eventually resolve them.

There are differences between Europe and United States concerning their respective approach in dealing with many societal phenomena and structures. And that is good, since while the ultimate goals are the same, the means and the venues that differ give wider spectrum of alternatives. This might be very helpful for the developing countries when in the very beginning all options must be under consideration. This line of reasoning also applies to research and educational networking.

In the States the academic communities have always in mind the market and the forces of the private initiative. Consequently, they often use the highly competitive environment to achieve acceptable prices and quality levels, as well as to induce some kind of equity. It is a common knowledge that many research and education networks, and in fact the Internet, have been developed through federally funded research projects. The same more or less is true for the Internet2 initiative.

Traditionally in Europe, there has been much stronger presence of the government especially in the main sectors of the society such as education and health (defense, foreign policy and the legal system are assumed by default). This concept is also evident in the research and education networking where almost all of the national research and academic networks have been established and financed by their governments. Very often the actual implementation and operation of the NREN is assigned to a single organization that originates from the research and education environment (Geoff Huston calls is "the grand experiment"). Each NREN is usually in the rank of national agency or office under the umbrella and supervision either by one or several ministries. This of course should not be confused either by the physical location of the actual network or even its legal status in the beginning.

It is clear, that in some form or another, directly and indirectly, the government plays and should play a vital role in the development an institution/organization responsible for the internal and external connectivity of the national research and education institutions. This is also consistent with the argument that both science and education have a crucial place in creating economic growth, foster national and international understanding and cooperation, and thus create the right climate for political and social stability that improve the well-being and the life of every citizen.

Motivation, Activities and Organization

The ambition to define formally what a NREN is might prove somewhat elusive and will eventually produce ephemeral results. Nevertheless, for the purpose of the argument NREN is defined as an entity whose goal is to establish and to operate a computer communication network that interconnects research and educational institutions within a region (often this region is a country) and provides also external connectivity to other similar networks and to the global Internet. While provision of connectivity is the major goal, the mission is to create the right environment for the science and education communities to facilitate and improve the quality of research and education by unconstrained flow of information, provision of information resources and tools. In addition, the network may be used as a test bed for new network technologies and services. It is fair to say that the test bed feature of the NREN has become slightly sidetracked due to the enormous growth in number of users and diversity and complexity of new services.

To attain its goal and mission, the NREN must perform the following activities:

- Provision of network technology necessary to interconnect research and academic institutions with in the domain of the NREN and to connect to the Internet.
- Identification, development and distribution of network services
- Analyses and implementation of network technology
- User assistance and support
- Education
- Participation in international network organizations
- Transfer of network know-how to other institutions and enterprises
- Contribution to the establishment and implementation of national strategies for the proliferation of the information technology

NREN is much more then a communication and computing infrastructure. However, it must take care that the infrastructure either exist or must be built (the physical lines are usually purchased from telecoms, railway systems, and power distributors, and satellite vendors). While the internal infrastructure is often the responsibility of the participating institutions, the NREN should ensure that there is communication and computing equipment that will provide stable connection and intended services. This might be another venue of activity for the NREN, where it acts as a consultant to other institutions whenever they need to develop and extended the present infrastructure. There are several benefits with this approach: more or less homogenous infrastructure that facilitates maintenance and upgrading, and bulk purchasing and licensing drive down the prices (hence more money for connectivity and services).

Services in the form of access to databases, information systems, archives, on line computation and collaboration, and interactive learning are must for the academic community. Most of the end users do not care about bandwidth, congestion, routers and cables, all they see are their needs framed in services.

NRENs provide connectivity for educational institutions. Therefore they should understand the importance and the technology of education. They have to educate their staff and through them educate their users. Most of the international networking organizations, that the NRENs are either or might become members of such as TERENA, RIPE NCC, CEENet and ISOC organize numerous educational events, conferences, workshops, and seminars on variety of technological, managerial and policy issues. International governmental and non-governmental organizations such as NATO, EC, SIDA, UNESCO, UNDP, and Soros foundation are behind the financial support of these events.

These meetings not only extend the knowledge of the NREN employees, they are also a forum for exchanging experiences and best practices among peers. The partcipants have the opportunity to learn about real life problems describing similar situations in a different settings, get better understanding of the issues they face and the ideas how to resolve those problems. Moreover, the NREN staff will gain the essential pedagogical know-how to train their colleagues and users, by replicating some of the educational events in their respective countries.

That is of course a part of the rationale why the NREN should become a member of TERENA and CEENet. Another reasons are to be in the mainstream of global developments and advances in research and education networking, the opportunity to participate in joint projects and also to become eligible for cross-boarder and multinational funding. This is also a possibility to make the voice of the NREN being heard and the problems shared. The Pan-European and other trans-national organizations give a lot of support to their members and they increase your leverage when you deal with the local authorities. Sometimes membership fees will prove to be cost prohibitive, but many of these organizations have special rates for new members that take into account the state of affairs in their respective countries.

There should be an active promotion of the work and the importance of the NREN through Web sites, periodical bulletins and press reports. It is a good idea to establish a lobby among young and the Internet literate decision makers. Make them users of the network. This will ensure some form of financial stability and resilience to political and economic turbulences. It will also create a position for the NREN to be involved in planning and developing long-term strategies for the IT deployment in the country.

The same criteria as in other academic institutions should be used to select the staff. One should aim for the best and the brightest. Nepotism and favoritism that are so much part of the developing milieu should be avoided. The NREN should aim to be a center of excellence where there is no place for mediocrity.

Courses in networking have become a part of the regular curriculum in almost every university. Therefore, many of the NREN recruits will have a fair amount of knowledge of what they are going to encounter in the course of their daily work. Nevertheless, the profile of the staff should not be limited Computer Science and EE graduates. Networking is not only about technology, it is about people and how they can communicate with each other. The Internet is full with people coming from different backgrounds that have extended the horizon of applications and services.

Young people are not only able to learn, but they are not afraid to. Naturally, a right dosage of experience and maturity must be exercised, especially in the areas of policy making, financial management and collaboration with the authorities. The disadvantages of working for a governmental institutions, where usually there are caps on salaries, is compensated by the enthusiasm that something unique is being created. The combinations of opportunities to be at the cutting edge of the technology and to learn in an international setting are incentives that will make many people to stay. However, some will leave for PNOs, commercial ISPs, or will go abroad. They of course will take with them the time and the knowledge (which at the end translates to money) the NREN has invested in them. Others will come. Eventually, the flow of know-how through the NREN will have a positive fall out on networking in the country. This is one of the pioneering responsibilities of NREN, to overcome the initial frustration with the new technology and to improve the Internet and networking literacy.

The start should be with a very small structure and organization. All the resources that are available and in place are to be used, for example some people from the staff in the computing center. There should be a clear distinction between their previous responsibilities and their new ones. It will help if an additional importance and value is placed on their work. This will inevitably cause some frustrations, but they will disappear as soon as you move out from the umbrella institution and create the actual organization. Growth should be incremental. Let the number of users and services guide, otherwise the NREN might find itself isolated in the ivory tower of self-importance and obsoleteness.

Set up the principles and the rules of the game as early as you can. Some of these include

- Threat all members and users equally. Promote independence of institutional preferences whenever possible. If it sounds like an "impossible mission", it is. Particularly with respect to the founding institutions and the most intensive users. This will increase credibility and appearance of fairness.
- Introduce clear user policies and try not to make any exceptions.
- Avoid flag days and strive for transitional functionality whenever new technology or services are to be deployed.
- Define a small set of services and make them stable. Then proceed with introducing new ones. It is always good to build on a sound and proven ground.

- Stress content orientation and value of the services, not the technological complexity and marvel behind them.
- Avoid regulation that might impose restrictions on the basic human rights such as freedom of speech.
- The need for interconnectivity and interoperability does not imply that security issues should be compromised. Different user communities require different levels of security. Each network on which the national information infrastructure is built must have a number of security procedures implemented that will prevent unauthorized access to the network and the systems that comprise it.
- The issue of network ethics should also include the copyright provisions and intellectual integrity.

Times are certainly different from the early nineties, since the combinatorial growth of the Internet and networking has also lead to exponential growth in the volume of knowledge about them. Key people from the countries that are in the process of establishing NRENs, both on technical and managerial level, have actively participated and contributed to CEENet meetings, conferences and workshops. They have also established working relations with the international organizations and used some of the grants and donations to improve the network infrastructure in their respective countries.

Then again, some of the already enumerated concerns and problems remain the same. In fact they are indispensable part of being NREN and solving them is what is all about. As indicated earlier, it is extremely important to establish an organization and a structure that will formally co-ordinate all dispersed efforts and represent the research and education networking in front of the domestic authorities and international organizations. This organization must be inclusive and should try to accommodate sometimes conflicting interests of prospective member institutions.

The academic community that initially serves as a cradle for the NREN usually comes from some university department or a research unit in the academy of sciences. Previous contacts with colleagues from abroad provide information for funding possibilities, which have been quite few in networking, and then the first connection to the Internet is made. The assistance and the support from outside could be that necessary catalytic funding that makes the Internet connectivity possible for the research and education community. In the mean time some other institution realizes the importance of this activity, and does the same thing with the Internet connectivity based on the approval of another ministry and funding from other institutions. There is no justification for this kind of behavior, except self-centered interests and the abuse of the strategic role of networking.

While it is understandable that when large countries are involved with many academic institutions it is reasonable to have may be a few organizations that cover the area of research and education networking, it is still highly desirable that they work together and coordinate the representation with respect at least foreign institutions and organizations. It is indeed unacceptable, especially in small countries with limited resources that two or more ministries or state agencies based on the information supplied by two or more superficially competing institutions, exercise their rivalry this way. At the end they even try to establish two or more NRENs. Combined with primitive forms of local politics, the final result is a superposition of disconnected efforts and split benefits. And the whole picture does not look very nice in front of the international donor institutions and organizations. It also creates a flaws and strategic weaknesses when dealing with the national authorities who also sometimes have peculiar interests in the PNOs and commercial ISPs.

Fortunately, the international organizations and governments are aware of these excesses. Consequently, they try to remedy the unwarranted situations by mediating between different parties, bringing them together and awarding grants only to either joint projects or projects that apply to a more general situation. This effort occasionally transcends national boarders by trying to bring academic communities between different countries, especially in regions where there is a history of intolerant behavior.

Any institution that is involved in the creation of the NREN must see the new organization as bonding and unifying factor among all the scholars, researchers and students in the country and the institutions they represent. The NREN should not exercise either ignorance or arrogance towards any potential user community. To do so means that the NREN behaves in the same way as some of the PNOs have done in the past and still do until the process of deregulation is over. Here also the national independent regulative body plays an important and stimulative function. One should closely work with this institution and eventually delegate, if possible, one of its members some of its decision making structures. Despite real problems, which are relics of the past, the NREN must work also with the national communication carriers since most of the time they provide the internal infrastructure. No effort should be spared to explain that there is no place for competition, and there is a clear division of the responsibilities and the functions. On Eventually the NREN activity creates larger user community for the PNOs also

The need and the desire to co-operate, associate or become a full member of EU for many countries is a major incentive to undertake regulatory reform of their telecommunication sector. The slow entrance of other carriers that generate alternatives should bring down the prices and make the operation of the NREN financially more feasible.

Financing and funding

There are basically two distinct funding models for services provided by NREN:

- User/service dependent or a user funding model
- User/service independent or central funding model

On many occasions it has been posited that is very hard to identify the optimal model for funding research and education networks, if there is one. It is an ongoing debate for the last ten years or so. It has recently experienced somewhat of a renaissance possibly due to (1) the deregulation of telecommunications in EU and the start up of a similar process in the countries of CEE and FSU, and (2) the process of establishing new NRENs again the CEE and FSU countries, and (3) the NRENs in EU have become almost indispensable entities (as networking is) in the academic communities, so there is a need for stable and efficient model of funding (in the same manner as the rest of education and research have).

The short history of the academic and research networking in Europe indicates the same pattern in the beginning, namely all of the NRENs were funded from a central source or the government. On the opposite end is the so-called user dependent funding. The network recovers the costs from the institutions it connects and provides services for. The funds may come, and they often do, again from the government, but on the surface a particular institutions is free to buy network services from anybody on the market. It is fair to say that especially in developing countries, initially there were very few providers of any connectivity and usually the NREN for a prospective user was the only place to go. The picture is different today and the pool of choices is much larger.

This sometimes creates a superficial argument that there is no need for NREN, and that a research or educational institution should go to the local ISP and ask to purchase services. Indeed, there are many flows in this position. Firstly, it reduces the NREN to an ISP, and there are many more objectives and activities in the realm of the NREN that are beyond the interest and the competence of an ISP. Secondly, the NREN is an extension of the old forms of academic institutions and in Europe, very few have been either replaced or surpassed by private ones, which is partially due to tradition, but more so to it is the reflection of the continuous responsibility of the government, as the primary social moderator to support the best in research and education on a long term basis. Moreover, the intellectual breadth and depth that emanates from the academic institutions represented by the diversity of ideas and concepts, creates a fertile ground for innovative services and modes of usage. Hence, the argument that it can be done by some commercial ISP negates the role of the NREN is a test bad for new technologies and services. Faced with the market risks, an ISP runs only well established and profitable services. Finally, the commercial ISPs have either very little or no experience in educational practices, which are also very important feature of NRENs. Obviously this does not mean that the NREN should enter the state of complacency; on the contrary it should be highly sensitive and responsive to the needs of its users.

Let us explore the pros and cons with respect to the two models of funding. In the case of central funding, the advantages are simplified administrative procedures, more efficient planning and strategy development as well as financial control and reporting, and direct attentiveness of the government to the needs of the academic community with respect to networking. The disadvantages are the notion that the users are out of the loop with respect to both the range of services and their quality, the transparency of the funds transmission, which makes the users think that the operation of the network, the provision of services and the cost are minor issues that also affects their behavior and adherence to the user policies, and finally the susceptibility to political perturbations and instabilities that are so characteristic for many societies in transition. Many times you will have a government official who is a great proponent of the research and education network (the motives are not important and occasionally they are very mundane) that will go beyond his way to support the development and the operation of the network. A few months later, another government is in place, and all of sudden there is a complete lack of interest and ignorance, that puts in peril everything that has been accomplished. Some of them question the existence of the national network. One should not forget that the essential attributes of a civilized society are moderation and recognition of the invariant societal values (which certainly include research and education).

The user oriented model has also its advantages and those are: influence on the types of services that are either running or should be planned for the future, the freedom of the users to use the market as the incentive for the complacent behavior of their network provider, and the opportunity to be aware and control the costs and the expenditures. It might also provide additional immunity from mood swings in the government due to the users who have been used to services and would like to maintain them, in spite of the current mode of reasoning by some government officials. But most of the users, even in the academic communities are self-centered and think only of those services that are important to them and are working well, so very little money for innovations and test-bed activities. It will be very difficult to plan and develop long-term strategies, since their priorities will not always match the needs and the requirements of the users.

Probably the safest (the qualification "best" is deliberately omitted) way is to mix the two models. It is very likely that one will start with a central funding model, with supplementary funds from international governmental organizations (EC, NATO, UNDP) and non-governmental organizations (such as Soros foundation that has played an extremely beneficial role in the CEE and FSU regions, particularly with respect to networking). Even when the funds are directly routed to the NREN from the government or from any other institutions, ask for a breakdown of the funds and costs (for example how much money actually is provided on behalf of some participating instruction). This will make every institutions aware that there is nothing for free an that actually someone pays for the services received, as well as fully conscious about the work and the effort that goes in provision of services. The assistance that comes from the outside will not last forever, and the

intent is to help you help yourself. After a while, if there is no progress, the focus of attention either shifts to another organization or to another country.

As things converge towards stability move some of the services towards full user funding (primarily those that are established). For a long time, if not always, there will be a need of some centrally based funding for implementing innovative services and realization of the long-term strategic plans.

If you are small country, both in size and population, it might help you to diversify you users. Never forget that they are you main asset and reason to exist. Extend the research hat to include research and development units within the industry. They might become the experimental ground for user oriented funding; will most probably enrich the spectrum of services and applications, and bring some financial stability. Extend the education hat to include both primary and secondary education whenever possible, libraries and museums. The NREN should not be necessarily directly involved in all those extended activities. The assistance may be in a form of a technical expertise, user support and education. Hopefully, a few of them will gain sufficient knowledge in some aspects of networking. At a later stage, you might use them to outsource a number of services or operations.

It might prove to be of a mutual benefit to provide connectivity to various NGOs and other non-for-profit organizations. Some of them might have directly contributed in the past, some of them will do so in the future, but NGOs are very important aspect of the civic life and they, with the help of your default – academic users, might be in the first line of defense if sometimes a dubious decision by somebody in the government poses a threat to the NREN.

A well-planed budget and transparent execution of it is essential. NRENs are fairly new type of institutions and not everyone understands either the work they are doing or the need for them to exist (sometimes they are treated as an overhead). The items that comprise a typical NREN budget are: connectivity (national and international), personal, equipment (hardware and software), research and innovation, and education and training. Actually, the former three might be put under a category termed as network operations, where the dominant part of the expenditures goes to the international connectivity (it varies from 50% to almost 80% depending on a country).

At the end, the choice of the appropriate model will depend on the local conditions influenced by the political and social culture, touched by tradition and transformed by the transitional economic realities. The users should be always made aware of the cost, the effort put into running the NREN, and the benefits they get from the services.

The NREN is usually a non-for-profit institution and organization, and as such is subject to assistance from the international governmental and non-governmental organizations. On the other hand, some of the NRENs are trying to commercialize certain segments of their work. This type of behavior should be avoided possibly at all times, but at least in the first five to ten years.

The road is very tempting. First of all, it creates conditions where one could become slightly more financially independent from unreasonable users or myopic administration. Secondly, it will be motivation for the people who work at the NREN to stay (the competition from the PNOs who are suddenly Internet stricken and commercial ISPs is fierce and cruel), since they may supplement their regular income, which might be rather low in a country that goes through economic and social transformations. PNOs and commercial ISPs might accuse you for unfairness since your institution is being subsidized and this induces market imbalance. It will eventually jeopardize the possibilities for international funding, and most of all the institution might loose the moral ground that is unique for academic communities.

So far, we have restricted the discussion about the legal issues to the telecommunication laws, the process of deregulation and the existence of independent regulatory body. Within this framework, the entity of NREN has been addressed as an institution, organization and/or association. There is no doubt that the legal status is one of the key pillars in creating a stable and sustainable network for research and education. While in the very start during the so called "project state" of the NREN, the legal representation is usually confined to university department, university itself or a unit in the academy of sciences, sooner or later as things start to grow the need for financial clarification becomes a pressing argument. Financial clarity that directly influences both the responsibilities and the rights of the entities should be unambiguous and subsequently based on laws.

However, most of the countries that have either entered the process of creating NREN or are about to do so, have rather short history of statehood (their national constitutions are usually not older then ten years). Consequently, in some of those countries the number of so-called system laws that have been adopted by national parliaments is modest. Few of these laws deal with the state of public institutions and organizations (including national offices, agencies, and associations). Eventually these laws will be enacted. The question is how to proceed in the interim period.

If possible then the best solution is to be a national public entity (an agency or an office) with a full legal status. The second choice is to be an association of legal entities that is also a legal entity. A third one is to be association of legal entities, which itself is not a legal entity, but is under an umbrella of a legal entity (two of the most advanced networks in Europe, ACONet from Austria and SUNET from Sweden are not legal entities themselves).

If one wants to introduce a user-based model there are several options for financing. In all of these options, the most important is the mechanism of granularity that will help you set a proper payment scheme that acknowledges different levels of usage. The share-holder model, where the number of shares per organization is for example proportional to the capacity of the access lines or the volume of data in certain period is acceptable, but the term "shares" does not go well with the idea of non-for-profit association. One way to circumscribe possible legal problems is to introduce the notion "categories of users", where again based on some criteria each user is a member of a category and pays accordingly.

Formally, the fees should be declared as a sort of membership. This might help to preserve the non-for-profit status that usually includes preferential treatment by the authorities, namely tax exceptions and duty free/custom benefits.

Whatever option is considered, the final decision will highly depend on the local conditions naturally inspired and guided by similar solutions in other countries. In any case, national laws should be closely monitored for any changes and/or modifications, since the convergence towards sustainability is also a function of the legal status.

Conclusions

Arguably, technology reflects the needs and the interests of the social forces and has never been politically neutral. The NRENs are case in point. There is so much politics involved in their creation that most of the time it is counter productive. The real question is how to make these institutions and their normal operation immune of political perturbations. This will also generate the necessary conditions for self-sustainability and growth.

The steps and the tasks involved in the creation of NREN look sometimes formidable. But as any other innovative things in the history, they very much depend on pioneers, people with vision and courage to work for the public good.

Science and education are the best way to prepare for the future. Today they simply are not possible to do without computer – communication networks. It has been stated that NRENs are new forms and extensions of the academic communities in the past and it is very likely that soon they will become, in some form or another, as indispensable entities as universities and research institutions are.

We have tried to enumerate a few issues that are pertinent to the creation and the establishment of research and education network. They are based on the experience and the knowledge of many networkers involved in the creation and running the NRENs.

Obviously there are no universal procedures that describe the best way to do it. One can only hope that some of the problems argued and solutions illustrated might prevent you for repeating the errors others have made and somehow make your road to sustainability shorter.

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The prerequisites for the creation and the existence of research and education networks are not limited to technological proficiency. They also very much depend on policy making, management, legal and financial issues. Exhaustive consideration and detail analysis of all these phenomena are beyond the scope of this article, however we shall try to enumerate some of those issues, as well as present ways to address and eventually resolve them.

There are differences between Europe and United States concerning their respective approach in dealing with many societal phenomena and structures. And that is good, since while the ultimate goals are the same, the means and the venues that differ give wider spectrum of alternatives. This might be very helpful for the developing countries when in the very beginning all options must be under consideration. This line of reasoning also applies to research and educational networking.

In the States the academic communities have always in mind the market and the forces of the private initiative. Consequently, they often use the highly competitive environment to achieve acceptable prices and quality levels, as well as to induce some kind of equity. It is a common knowledge that many research and education networks, and in fact the Internet, have been developed through federally funded research projects. The same more or less is true for the Internet2 initiative.

Traditionally in Europe, there has been much stronger presence of the government especially in the main sectors of the society such as education and health (defense, foreign policy and the legal system are assumed by default). This concept is also evident in the research and education networking where almost all of the national research and academic networks have been established and financed by their governments. Very often the actual implementation and operation of the NREN is assigned to a single organization that originates from the research and education environment (Geoff Huston calls is "the grand experiment"). Each NREN is usually in the rank of national agency or office under the umbrella and supervision either by one or several ministries. This of course should not be confused either by the physical location of the actual network or even its legal status in the beginning.

It is clear, that in some form or another, directly and indirectly, the government plays and should play a vital role in the development an institution/organization responsible for the internal and external connectivity of the national research and education institutions. This is also consistent with the argument that both science and education have a crucial place in creating economic growth, foster national and international understanding and co-operation, and thus create the right climate for political and social stability that improve the well-being and the life of every citizen.

Motivation, Activities and Organization

The ambition to define formally what a NREN is might prove somewhat elusive and will eventually produce ephemeral results. Nevertheless, for the purpose of the argument NREN is defined as an entity whose goal is to establish and to operate a computer communication network that interconnects research and educational institutions within a region (often this region is a country) and provides also external connectivity to other similar networks and to the global Internet. While provision of connectivity is the major goal, the mission is to create the right environment for the science and education communities to facilitate and improve the quality of research and education by unconstrained flow of information, provision of information resources and tools. In addition, the network may be used as a test bed for new network technologies and services. It is fair to say that the test bed feature of the NREN has become slightly sidetracked due to the enormous growth in number of users and diversity and complexity of new services.

To attain its goal and mission, the NREN must perform the following activities:

- Provision of network technology necessary to interconnect research and academic institutions with in the domain of the NREN and to connect to the Internet.
- Identification, development and distribution of network services
- Analyses and implementation of network technology
- User assistance and support
- Education
- Participation in international network organizations
- Transfer of network know-how to other institutions and enterprises
- Contribution to the establishment and implementation of national strategies for the proliferation of the information technology

NREN is much more then a communication and computing infrastructure. However, it must take care that the infrastructure either exist or must be built (the physical lines are usually purchased from telecoms, railway systems, and power distributors, and satellite vendors). While the internal infrastructure is often the responsibility of the participating institutions, the NREN should ensure that there is communication and computing equipment that will provide stable connection and intended services. This might be another venue of activity for the NREN, where it acts as a consultant to other institutions whenever they need to develop and extended the present infrastructure. There are several benefits with this approach: more or less homogenous infrastructure that facilitates maintenance and upgrading, and bulk purchasing and licensing drive down the prices (hence more money for connectivity and services).

Services in the form of access to databases, information systems, archives, on line computation and collaboration, and interactive learning are must for the academic community. Most of the end users do not care about bandwidth, congestion, routers and cables, all they see are their needs framed in services.

NRENs provide connectivity for educational institutions. Therefore they should understand the importance and the technology of education. They have to educate their staff and through them educate their users. Most of the international networking organizations, that the NRENs are either or might become members of such as TERENA, RIPE NCC, CEENet and ISOC organize numerous educational events, conferences, workshops, and seminars on variety of technological, managerial and policy issues. International governmental and non-governmental organizations such as NATO, EC, SIDA, UNESCO, UNDP, and Soros foundation are behind the financial support of these events.

These meetings not only extend the knowledge of the NREN employees, they are also a forum for exchanging experiences and best practices among peers. The partcipants have the opportunity to learn about real life problems describing similar situations in a different settings, get better understanding of the issues they face and the ideas how to resolve those problems. Moreover, the NREN staff will gain the essential pedagogical know-how to train their colleagues and users, by replicating some of the educational events in their respective countries.

That is of course a part of the rationale why the NREN should become a member of TERENA and CEENet. Another reasons are to be in the mainstream of global developments and advances in research and education networking, the opportunity to participate in joint projects and also to become eligible for cross-boarder and multinational funding. This is also a possibility to make the voice of the NREN being heard and the problems shared. The Pan-European and other trans-national organizations give a lot of support to their members and they increase your leverage when you deal with the local authorities. Sometimes membership fees will prove to be cost prohibitive, but many of these organizations have special rates for new members that take into account the state of affairs in their respective countries.

There should be an active promotion of the work and the importance of the NREN through Web sites, periodical bulletins and press reports. It is a good idea to establish a lobby among young and the Internet literate decision makers. Make them users of the network. This will ensure some form of financial stability and resilience to political and economic turbulences. It will also create a position for the NREN to be involved in planning and developing long-term strategies for the IT deployment in the country.

The same criteria as in other academic institutions should be used to select the staff. One should aim for the best and the brightest. Nepotism and favoritism that are so much part of the developing milieu should be avoided. The NREN should aim to be a center of excellence where there is no place for mediocrity.

Courses in networking have become a part of the regular curriculum in almost every university. Therefore, many of the NREN recruits will have a fair amount of knowledge of what they are going to encounter in the course of their daily work. Nevertheless, the profile of the staff should not be limited Computer Science and EE graduates. Networking is not only about technology, it is about people and how they can communicate with each other. The Internet is full with people coming from different backgrounds that have extended the horizon of applications and services.

Young people are not only able to learn, but they are not afraid to. Naturally, a right dosage of experience and maturity must be exercised, especially in the areas of policy making, financial management and collaboration with the authorities. The disadvantages of working for a governmental institutions, where usually there are caps on salaries, is compensated by the enthusiasm that something unique is being created. The combinations of opportunities to be at the cutting edge of the technology and to learn in an international setting are incentives that will make many people to stay. However, some will leave for PNOs, commercial ISPs, or will go abroad. They of course will take with them the time and the knowledge (which at the end translates to money) the NREN has invested in them. Others will come. Eventually, the flow of know-how through the NREN will have a positive fall out on networking in the country. This is one of the pioneering responsibilities of NREN, to overcome the initial frustration with the new technology and to improve the Internet and networking literacy.

The start should be with a very small structure and organization. All the resources that are available and in place are to be used, for example some people from the staff in the computing center. There should be a clear distinction between their previous responsibilities and their new ones. It will help if an additional importance and value is placed on their work. This will inevitably cause some frustrations, but they will disappear as soon as you move out from the umbrella institution and create the actual organization. Growth should be incremental. Let the number of users and services guide, otherwise the NREN might find itself isolated in the ivory tower of self-importance and obsoleteness.

Set up the principles and the rules of the game as early as you can. Some of these include

- Threat all members and users equally. Promote independence of institutional preferences whenever possible. If it sounds like an "impossible mission", it is. Particularly with respect to the founding institutions and the most intensive users. This will increase credibility and appearance of fairness.
- Introduce clear user policies and try not to make any exceptions.
- Avoid flag days and strive for transitional functionality whenever new technology or services are to be deployed.
- Define a small set of services and make them stable. Then proceed with introducing new ones. It is always good to build on a sound and proven ground.

- Stress content orientation and value of the services, not the technological complexity and marvel behind them.
- Avoid regulation that might impose restrictions on the basic human rights such as freedom of speech.
- The need for interconnectivity and interoperability does not imply that security issues should be compromised. Different user communities require different levels of security. Each network on which the national information infrastructure is built must have a number of security procedures implemented that will prevent unauthorized access to the network and the systems that comprise it.
- The issue of network ethics should also include the copyright provisions and intellectual integrity.

Times are certainly different from the early nineties, since the combinatorial growth of the Internet and networking has also lead to exponential growth in the volume of knowledge about them. Key people from the countries that are in the process of establishing NRENs, both on technical and managerial level, have actively participated and contributed to CEENet meetings, conferences and workshops. They have also established working relations with the international organizations and used some of the grants and donations to improve the network infrastructure in their respective countries.

Then again, some of the already enumerated concerns and problems remain the same. In fact they are indispensable part of being NREN and solving them is what is all about. As indicated earlier, it is extremely important to establish an organization and a structure that will formally co-ordinate all dispersed efforts and represent the research and education networking in front of the domestic authorities and international organizations. This organization must be inclusive and should try to accommodate sometimes conflicting interests of prospective member institutions.

The academic community that initially serves as a cradle for the NREN usually comes from some university department or a research unit in the academy of sciences. Previous contacts with colleagues from abroad provide information for funding possibilities, which have been quite few in networking, and then the first connection to the Internet is made. The assistance and the support from outside could be that necessary catalytic funding that makes the Internet connectivity possible for the research and education community. In the mean time some other institution realizes the importance of this activity, and does the same thing with the Internet connectivity based on the approval of another ministry and funding from other institutions. There is no justification for this kind of behavior, except self-centered interests and the abuse of the strategic role of networking.

While it is understandable that when large countries are involved with many academic institutions it is reasonable to have may be a few organizations that cover the area of research and education networking, it is still highly desirable that they work together and coordinate the representation with respect at least foreign institutions and organizations. It is indeed unacceptable, especially in small countries with limited resources that two or more ministries or state agencies based on the information supplied by two or more superficially competing institutions, exercise their rivalry this way. At the end they even try to establish two or more NRENs. Combined with primitive forms of local politics, the final result is a superposition of disconnected efforts and split benefits. And the whole picture does not look very nice in front of the international donor institutions and organizations. It also creates a flaws and strategic weaknesses when dealing with the national authorities who also sometimes have peculiar interests in the PNOs and commercial ISPs.

Fortunately, the international organizations and governments are aware of these excesses. Consequently, they try to remedy the unwarranted situations by mediating between different parties, bringing them together and awarding grants only to either joint projects or projects that apply to a more general situation. This effort occasionally transcends national boarders by trying to bring academic communities between different countries, especially in regions where there is a history of intolerant behavior.

Any institution that is involved in the creation of the NREN must see the new organization as bonding and unifying factor among all the scholars, researchers and students in the country and the institutions they represent. The NREN should not exercise either ignorance or arrogance towards any potential user community. To do so means that the NREN behaves in the same way as some of the PNOs have done in the past and still do until the process of deregulation is over. Here also the national independent regulative body plays an important and stimulative function. One should closely work with this institution and eventually delegate, if possible, one of its members some of its decision making structures. Despite real problems, which are relics of the past, the NREN must work also with the national communication carriers since most of the time they provide the internal infrastructure. No effort should be spared to explain that there is no place for competition, and there is a clear division of the responsibilities and the functions. On Eventually the NREN activity creates larger user community for the PNOs also

The need and the desire to co-operate, associate or become a full member of EU for many countries is a major incentive to undertake regulatory reform of their telecommunication sector. The slow entrance of other carriers that generate alternatives should bring down the prices and make the operation of the NREN financially more feasible.

Financing and funding

There are basically two distinct funding models for services provided by NREN:

- User/service dependent or a user funding model
- User/service independent or central funding model

On many occasions it has been posited that is very hard to identify the optimal model for funding research and education networks, if there is one. It is an ongoing debate for the last ten years or so. It has recently experienced somewhat of a renaissance possibly due to (1) the deregulation of telecommunications in EU and the start up of a similar process in the countries of CEE and FSU, and (2) the process of establishing new NRENs again the CEE and FSU countries, and (3) the NRENs in EU have become almost indispensable entities (as networking is) in the academic communities, so there is a need for stable and efficient model of funding (in the same manner as the rest of education and research have).

The short history of the academic and research networking in Europe indicates the same pattern in the beginning, namely all of the NRENs were funded from a central source or the government. On the opposite end is the so-called user dependent funding. The network recovers the costs from the institutions it connects and provides services for. The funds may come, and they often do, again from the government, but on the surface a particular institutions is free to buy network services from anybody on the market. It is fair to say that especially in developing countries, initially there were very few providers of any connectivity and usually the NREN for a prospective user was the only place to go. The picture is different today and the pool of choices is much larger.

This sometimes creates a superficial argument that there is no need for NREN, and that a research or educational institution should go to the local ISP and ask to purchase services. Indeed, there are many flows in this position. Firstly, it reduces the NREN to an ISP, and there are many more objectives and activities in the realm of the NREN that are beyond the interest and the competence of an ISP. Secondly, the NREN is an extension of the old forms of academic institutions and in Europe, very few have been either replaced or surpassed by private ones, which is partially due to tradition, but more so to it is the reflection of the continuous responsibility of the government, as the primary social moderator to support the best in research and education on a long term basis. Moreover, the intellectual breadth and depth that emanates from the academic institutions represented by the diversity of ideas and concepts, creates a fertile ground for innovative services and modes of usage. Hence, the argument that it can be done by some commercial ISP negates the role of the NREN is a test bad for new technologies and services. Faced with the market risks, an ISP runs only well established and profitable services. Finally, the commercial ISPs have either very little or no experience in educational practices, which are also very important feature of NRENs. Obviously this does not mean that the NREN should enter the state of complacency; on the contrary it should be highly sensitive and responsive to the needs of its users.

Let us explore the pros and cons with respect to the two models of funding. In the case of central funding, the advantages are simplified administrative procedures, more efficient planning and strategy development as well as financial control and reporting, and direct attentiveness of the government to the needs of the academic community with respect to networking. The disadvantages are the notion that the users are out of the loop with respect to both the range of services and their quality, the transparency of the funds transmission, which makes the users think that the operation of the network, the provision of services and the cost are minor issues that also affects their behavior and adherence to the user policies, and finally the susceptibility to political perturbations and instabilities that are so characteristic for many societies in transition. Many times you will have a government official who is a great proponent of the research and education network (the motives are not important and occasionally they are very mundane) that will go beyond his way to support the development and the operation of the network. A few months later, another government is in place, and all of sudden there is a complete lack of interest and ignorance, that puts in peril everything that has been accomplished. Some of them question the existence of the national network. One should not forget that the essential attributes of a civilized society are moderation and recognition of the invariant societal values (which certainly include research and education).

The user oriented model has also its advantages and those are: influence on the types of services that are either running or should be planned for the future, the freedom of the users to use the market as the incentive for the complacent behavior of their network provider, and the opportunity to be aware and control the costs and the expenditures. It might also provide additional immunity from mood swings in the government due to the users who have been used to services and would like to maintain them, in spite of the current mode of reasoning by some government officials. But most of the users, even in the academic communities are self-centered and think only of those services that are important to them and are working well, so very little money for innovations and test-bed activities. It will be very difficult to plan and develop long-term strategies, since their priorities will not always match the needs and the requirements of the users.

Probably the safest (the qualification "best" is deliberately omitted) way is to mix the two models. It is very likely that one will start with a central funding model, with supplementary funds from international governmental organizations (EC, NATO, UNDP) and non-governmental organizations (such as Soros foundation that has played an extremely beneficial role in the CEE and FSU regions, particularly with respect to networking). Even when the funds are directly routed to the NREN from the government or from any other institutions, ask for a breakdown of the funds and costs (for example how much money actually is provided on behalf of some participating instruction). This will make every institutions aware that there is nothing for free an that actually someone pays for the services received, as well as fully conscious about the work and the effort that goes in provision of services. The assistance that comes from the outside will not last forever, and the

intent is to help you help yourself. After a while, if there is no progress, the focus of attention either shifts to another organization or to another country.

As things converge towards stability move some of the services towards full user funding (primarily those that are established). For a long time, if not always, there will be a need of some centrally based funding for implementing innovative services and realization of the long-term strategic plans.

If you are small country, both in size and population, it might help you to diversify you users. Never forget that they are you main asset and reason to exist. Extend the research hat to include research and development units within the industry. They might become the experimental ground for user oriented funding; will most probably enrich the spectrum of services and applications, and bring some financial stability. Extend the education hat to include both primary and secondary education whenever possible, libraries and museums. The NREN should not be necessarily directly involved in all those extended activities. The assistance may be in a form of a technical expertise, user support and education. Hopefully, a few of them will gain sufficient knowledge in some aspects of networking. At a later stage, you might use them to outsource a number of services or operations.

It might prove to be of a mutual benefit to provide connectivity to various NGOs and other non-for-profit organizations. Some of them might have directly contributed in the past, some of them will do so in the future, but NGOs are very important aspect of the civic life and they, with the help of your default – academic users, might be in the first line of defense if sometimes a dubious decision by somebody in the government poses a threat to the NREN.

A well-planed budget and transparent execution of it is essential. NRENs are fairly new type of institutions and not everyone understands either the work they are doing or the need for them to exist (sometimes they are treated as an overhead). The items that comprise a typical NREN budget are: connectivity (national and international), personal, equipment (hardware and software), research and innovation, and education and training. Actually, the former three might be put under a category termed as network operations, where the dominant part of the expenditures goes to the international connectivity (it varies from 50% to almost 80% depending on a country).

At the end, the choice of the appropriate model will depend on the local conditions influenced by the political and social culture, touched by tradition and transformed by the transitional economic realities. The users should be always made aware of the cost, the effort put into running the NREN, and the benefits they get from the services.

The NREN is usually a non-for-profit institution and organization, and as such is subject to assistance from the international governmental and non-governmental organizations. On the other hand, some of the NRENs are trying to commercialize certain segments of their work. This type of behavior should be avoided possibly at all times, but at least in the first five to ten years.

The road is very tempting. First of all, it creates conditions where one could become slightly more financially independent from unreasonable users or myopic administration. Secondly, it will be motivation for the people who work at the NREN to stay (the competition from the PNOs who are suddenly Internet stricken and commercial ISPs is fierce and cruel), since they may supplement their regular income, which might be rather low in a country that goes through economic and social transformations. PNOs and commercial ISPs might accuse you for unfairness since your institution is being subsidized and this induces market imbalance. It will eventually jeopardize the possibilities for international funding, and most of all the institution might loose the moral ground that is unique for academic communities.

So far, we have restricted the discussion about the legal issues to the telecommunication laws, the process of deregulation and the existence of independent regulatory body. Within this framework, the entity of NREN has been addressed as an institution, organization and/or association. There is no doubt that the legal status is one of the key pillars in creating a stable and sustainable network for research and education. While in the very start during the so called "project state" of the NREN, the legal representation is usually confined to university department, university itself or a unit in the academy of sciences, sooner or later as things start to grow the need for financial clarification becomes a pressing argument. Financial clarity that directly influences both the responsibilities and the rights of the entities should be unambiguous and subsequently based on laws.

However, most of the countries that have either entered the process of creating NREN or are about to do so, have rather short history of statehood (their national constitutions are usually not older then ten years). Consequently, in some of those countries the number of so-called system laws that have been adopted by national parliaments is modest. Few of these laws deal with the state of public institutions and organizations (including national offices, agencies, and associations). Eventually these laws will be enacted. The question is how to proceed in the interim period.

If possible then the best solution is to be a national public entity (an agency or an office) with a full legal status. The second choice is to be an association of legal entities that is also a legal entity. A third one is to be association of legal entities, which itself is not a legal entity, but is under an umbrella of a legal entity (two of the most advanced networks in Europe, ACONet from Austria and SUNET from Sweden are not legal entities themselves).

If one wants to introduce a user-based model there are several options for financing. In all of these options, the most important is the mechanism of granularity that will help you set a proper payment scheme that acknowledges different levels of usage. The share-holder model, where the number of shares per organization is for example proportional to the capacity of the access lines or the volume of data in certain period is acceptable, but the term "shares" does not go well with the idea of non-for-profit association. One way to circumscribe possible legal problems is to introduce the notion "categories of users", where again based on some criteria each user is a member of a category and pays accordingly.

Formally, the fees should be declared as a sort of membership. This might help to preserve the non-for-profit status that usually includes preferential treatment by the authorities, namely tax exceptions and duty free/custom benefits.

Whatever option is considered, the final decision will highly depend on the local conditions naturally inspired and guided by similar solutions in other countries. In any case, national laws should be closely monitored for any changes and/or modifications, since the convergence towards sustainability is also a function of the legal status.

Conclusions

Arguably, technology reflects the needs and the interests of the social forces and has never been politically neutral. The NRENs are case in point. There is so much politics involved in their creation that most of the time it is counter productive. The real question is how to make these institutions and their normal operation immune of political perturbations. This will also generate the necessary conditions for self-sustainability and growth.

The steps and the tasks involved in the creation of NREN look sometimes formidable. But as any other innovative things in the history, they very much depend on pioneers, people with vision and courage to work for the public good.

Science and education are the best way to prepare for the future. Today they simply are not possible to do without computer – communication networks. It has been stated that NRENs are new forms and extensions of the academic communities in the past and it is very likely that soon they will become, in some form or another, as indispensable entities as universities and research institutions are.

We have tried to enumerate a few issues that are pertinent to the creation and the establishment of research and education network. They are based on the experience and the knowledge of many networkers involved in the creation and running the NRENs.

Obviously there are no universal procedures that describe the best way to do it. One can only hope that some of the problems argued and solutions illustrated might prevent you for repeating the errors others have made and somehow make your road to sustainability shorter.

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