

## National Research and Education Networks

- *how universities and researchers connect to each other and to the Internet*

Much of the early development of the Internet<sup>1</sup> was carried out by university based researchers in the US and Europe. However, as the Internet went mainstream in the early nineties, the research and education community found that the commercial, or “commodity” Internet was not serving its purpose for large data transfer and collaboration in scientific and medical research. Its response was to build its own private networks, at much higher bandwidth and with more direct communication between nodes, using dedicated fiber optic cables, a kind of private Internet. These networks and the organizations that operate them are called National Research and Education Networks or NRENs, with names like Internet2 in the US, SURFnet in the Netherlands, and CERNET in China. The national networks are connected to regional backbones, such as GÉANT in Europe, or more recently UbuntuNet in East and Southern Africa, and each NREN offers peering arrangements with its partners to support each other’s traffic at no charge. This has resulted in a global Research and Education community that universities can connect to through their local NREN.

Virtually every advanced, and many emerging, economies now organize their education and research connectivity through NRENs, and there are many lessons to be learned from them by those countries that are beginning to address the issue of Internet access and ICT generally in education.

### 1. What is an NREN?

A National Research and Education Network is both; 1) a high performance communications network owned and operated for and by the education and research community of a country and; 2) the organization that operates that network, constituted as a consortium of members, a dedicated agency, a company, NGO, or other type of body. In World Bank partner countries an NREN may simply be a consortium of universities that organize themselves as a “buying club” in order to get a better price from Internet Service providers (ISPs), or it may be more sophisticated and be offering connectivity services to its members.

### 2. What does an NREN do?

The primary role of an NREN is to operate the national backbone that connects a country’s university campus networks to each other and to other R&E networks globally, and it may offer commodity Internet services too. It runs its own Network Operations Center to manage all traffic on the network, and it provides technical support services to all of its members.

The extent of actual technical management of a network varies among NRENs, but advanced NRENs are now typically leasing “dark fiber” capacity on the fiber optic networks of owners such as telcos, power companies, or railways, and doing everything else that an operator would do, with their own terminal equipment, routers, switches, servers etc. Dark fiber refers to the individual strands or cores of fiber optic cable that are unterminated and unlit; ready for an operator to do so. A number of cores can be bought or leased on a single

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<sup>1</sup> Besides the work of the US Defense Department that set up DARPA-net

contract for the life of the fiber, generally about 20 years, on the basis of what is called an Indefeasible Right of Use (IRU). An initial down payment would be followed by annual maintenance charges to the owner of the cable and the NREN would be responsible for managing the traffic on its part of the cable. If the fiber network is owned by or originally funded by a government or public agency like a power grid company then it may be possible to get “free” fiber and to pay just for the recurrent maintenance cost. There are examples of this practice globally.

### **3. What other services does an NREN offer?**

An NREN can offer a whole range of other services depending on its remit and the needs of members. These services can be; E-mail for all members’ constituents, faculty and students; videoconferencing bridging; a HEMIS; a learning management systems (LMS); access to Digital Library sources and electronic journals; and web hosting if required. NRENs are also providing services to other entities such as hospitals, libraries, museums, and schools.

### **4. What are the benefits of a NREN?**

At its most basic an NREN can offer more bandwidth at less cost but it offers much more than that. It is critical for access to digital resources and databases, costly instrumentation (super computers, telescopes, electron microscopes etc), high definition video, etc. It is essential for participation in international collaborative research and to connect faculty and students to the global academic community. It also provides a springboard for innovation in a country. These are benefits that cannot be gained by using commercial Internet Service Providers (ISPs).

### **5. Threats to NRENs**

Opposition to NRENs’ existence often comes from private operators of Internet services, the ISPs. They regularly try to poach the NRENs’ customer base by offering cheaper deals on the cost of bandwidth, expressed as the price of megabits per month. This is a false price war as the bandwidth offered by NRENs is dedicated to each user institution and links directly into the global R&E networks, whereas the bandwidth offered by ISPs is “oversold”. i.e., the same capacity is sold to many customers on the basis that not all of them will be using it at the same time. This is termed the “contention ratio”, where 50:1 means that 50 users share the same bandwidth and where 1:1 means that the bandwidth is dedicated. NRENs offer 1:1 contention, and ISPs do not have direct access to other NRENs. Anyway, the benefits outlined above should be the driver in supporting NRENs, not the price of megabits per month. This conflict with the private sector could be dampened by pointing out that the existence of an NREN cultivates a future user base for the ISPs – every student at university will be accustomed to high speed Internet access and will be seeking a similar service on graduation. Besides, there are opportunities for partnerships between NRENs and the telcos and ISPs, e.g., for mobile services to students (discounts etc).

Another danger is anything that threatens the NREN’s sustainability. An NREN will only be successful if there is a large take-up of its services by the academic community. There is a critical mass of members that is essential if the NREN is to succeed and be financially sustainable. Therefore, on the one hand, an NREN needs to be efficient and responsive to user needs and, on the other, it needs official government support, protection and promotion, even if that support is “hands –off” (see governance below).

## **6. How is an NREN funded?**

There are various funding models for NRENs, but generally it is a combination of government subvention, membership fees and user service fees. There can be special deals for NRENs where they get discounted bandwidth from infrastructure providers, or spare capacity of fiber is given for a low price. A case can generally be made for the “public good” nature of an NREN and it should not have to compete with private sector Internet providers for its basic infrastructure.

Start-up funding would be for the initial acquisition of network infrastructure and allied equipment, capacity building of staff in the NREN and at the campus level, and awareness raising activities among the academic community. Network capacity does not necessarily have to be acquired at commercial rates, as there are avenues to explore in getting subsidized infrastructure through universal access funds or some such arrangements. Donors also fund some training programs for network operators.

Ongoing sustainability generally requires funding from a combination of sources - government, membership and services fees. In some regions the transition from satellite based bandwidth to terrestrial fiber results in a significant reduction in cost per megabit and therefore university budgets for bandwidth can remain relatively neutral by a switch from paying the high cost of satellite connectivity to paying the equivalent amount to the NREN for enhanced services (e.g., from \$4,000 per megabit per month with satellite to \$150 per megabit per month with NREN).

## **7. How is an NREN governed?**

Again, there are many models of NREN governance around the world. While a government ministry, be it Education, Higher Education, or Science and Technology, may have a major say in how an NREN operates and is funded, it is essential that it is driven by users and their needs. It is important that the NREN is seen as independent from both the ministries and from any one university, and that the academic community is strongly represented on the governing board. Without that bottom up ownership by the user community an NREN can founder.

## **8. How can the World Bank support NRENs?**

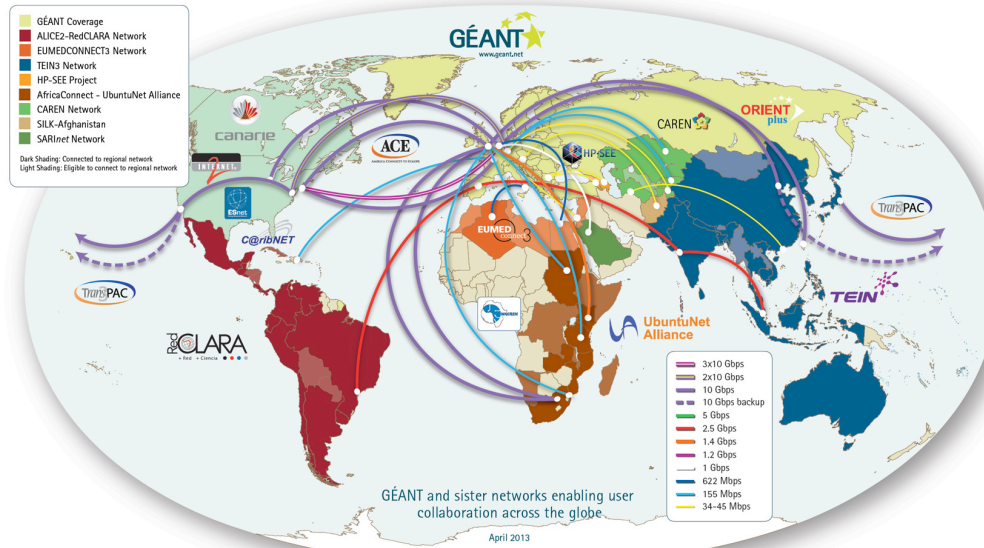
In its knowledge role the World Bank can advise governments about good practice by convening global experience on the establishment and management of NRENs (see below). In its policy advisory role it can champion with regulatory authorities the public good nature of NRENs and advocate for special deals for infrastructure. Finally, it can fund the establishment of NRENs especially through funding for long-term IRUs for telecom infrastructure, for start-up costs, and for capacity building of IT and management staff.

## **9. Where can you learn more about NRENs?**

As part of the South-South Experience Exchange program the SERENE project (South-South Exchange of Research and Education Network Experience) has a web resource hosted by the Sri Lankan NREN, LEARN. It gives slide and video presentations (under “events”) of NRENs from Vietnam, Pakistan and Ireland, with other presentations on “What is an NREN?”, “Digital Libraries”, “Costing an NREN” : <http://serene.learn.ac.lk>

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# GÉANT At the Heart of Global Research Networking



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GÉANT is co-funded by the European Union within its 7th R&D Framework Programme.  
This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of DANTE and can under no circumstances be regarded as reflecting the position of the European Union.



## Connections of GÉANT, the European regional R&E network, to other regions



**Asia Pacific Advanced Network (APAN) – the interconnected NRENs of Asia with connections to the US and Europe.**