Concept

Developing a Lebanese National Research and Education Network

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Proposed by:

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1. Overview

In an era of globalization and modern societal development, the role of technology prevails and digital connectivity has become a key growth element of education, knowledge, and innovation in the new millennium. Today, academic institutions, governments, industries, businesses, and society at large operate and coordinate across borders to meet the demands of globalization and support common socio-economic goals. Information and knowledge represent new globalization phenomena, which pose major connectivity challenges.

More than half of the Arab region's combined population of around 300 Million people is estimated to be younger than 25 years. This fast growing population places limits and creates challenges for the competitive and economic vitality of the region. Unless effective policies are matched with accelerated structural reforms combined with an up-scaling education and training efforts, our countries are unlikely to capture the vital energy of today's youth and meet their ambitions for more opportunities and inspiration. Educational reforms, advancement of research, and integration of ICT infrastructures are critically needed not only to unlock the region's creative potential but also to accelerate the dawning of sustainable economies for meeting the growing regional challenges in education, environment, energy, water, health, security, and governance.

The use of ICTs and, in particular, e-infrastructures, access to computers and the Internet, are innovative resources that have become recognized as vital tools for research, education and lifelong learning. Social inclusion, research & education, and workplace effectiveness are increasingly dependent on access to knowledge, network participation, and the use of ICT. Educational institutions and learning environments play a key role in providing these tools, training, and knowledge that promote meaningful use of ICTs, given that they enable mass access to connectivity and the use of electronic networks, i.e. e-Infrastructure for R&E.

Research and Education networking has become a trend worldwide. The purpose is to establish a leading edge and high-performance network infrastructure that connects universities and research institutes. The development of R&E networking is seen as critical to competitiveness in R&E, scientific and technological advancement, and to the economic development and welfare of people.

There are two key drivers for e-Infrastructure and R&E networking: one is related to the network and the other is related to the type of applications, [1,2,3]. The network drivers are: increased bandwidth requirements on the backbone for some scientific and real-time applications; growing interest in IPv6 protocols; and networking security necessary in some critical applications. The drivers from the applications perspective are generally motivated by the requirements of real-time networking applications and need for reduced interaction time between distributed users and processes. With dedicated R&E networking, features like low network latency; consistent temporal delivery of data; low network jitter; economies of scale in journal subscriptions and software licensing, sharing of resources, and distributed interaction / visualization of large data sets can be guaranteed.

This concept proposal builds on the discussions at the Lebanese Ministry of Higher Education, the National Council for Scientific Research (NCSR), and during the "Grids and

Modeling: Application" workshop held at St-Joseph University/ June 28-29, 2011. The proposal gives a framework for developing a Lebanese R&E Network based on the European best practice NREN model implemented in many Euro-Mediterranean countries. The remaining sections of the proposal present a general perspective of NRENs, NREN model and services, and finally a roadmap for a Lebanese NREN.

2. Perspective of NRENs

During the past decades, the concept of National Research and Education Networks (NRENs) evolved. It comprises dedicated high speed networks that act at the national level to provide connectivity between universities, research institutes, educational hospitals, schools, further education colleges, libraries and other public institutes. These networks can be built using dedicated fibre optic connections or utilizing less flexible and high cost leased capacity from telecommunications providers. The NRENs allow researchers, faculty, staff, and students around the country to communicate with each other and to access a broad range of research tools and information resources.

In addition to physical connectivity, NRENs provide applications and services, including videoconferencing, media streaming, IP telephony, access federations, and wireless roaming. NRENs often establish and coordinate distributed computing resources (grids) and operating experimental test-beds for data-intensive applications. Some NRENs operate national domain registries for the entire Internet community in their countries, and in some cases, provide security services for their own community, government, military as well as commercial sectors.

Research and education networking existed since 1970 and were initially represented by ad hoc facilities, then evolved into a common set of standards of data networking operating over telephone circuitry and managed by dedicated organizations. The development of the first successful network, known as ARPANET which connected government-sponsored research organization, was in 1969. In 1984, NSFNET was developed as a general purpose research network which served as the backbone of the Internet. By the early 1990's, data networking based on X.25 became a common connectivity model between research and education communities, then evolved into high speed dedicated networks that integrate networking interfaces, switches, and routers and facilite running computationally intensive R&E applications and services that are often not found on the Internet.

The following diagram shows the various NRENs and NREN initiatives all over the world. Efforts in the Arab region vary with different successes. According to the TERENA Compendium published in 2010 (www.terena.org/compendium) [5], there is no or little information on NREN efforts in some countries in the Arab region, namely, Libya, Yemen, Oman, Iraq, Mauritania, Bahrain and Saudi Arabia. In Lebanon and Palestine the formation, funding and policy in support of NREN implementation are planned but not yet decided. The remaining Arab countries have working NRENs connecting Universities and research centers, but with different networking topologies and technologies.
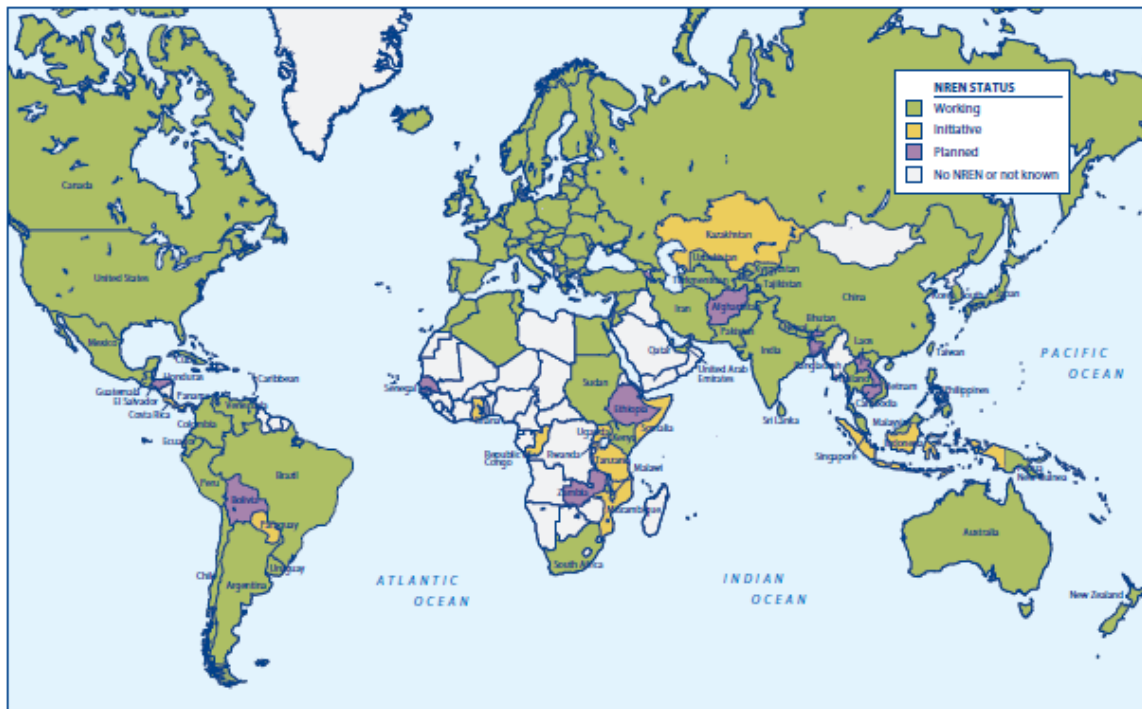
Source: *TERENA Compendium of National Research and Education Networks In Europe 2010*

The main drivers for creating NRENs are based on technological, social, and economic factors, and are identified as follows:

Technological: To satisfy high demand eScience initiatives, including:

- Multimedia Collaboration

- Distributed High Performance Computing (HPC, GRIDs)

- Earth Sciences, High Energy Physics (CERN, LHC…),

- Bioinformatics, Computational Chemistry, Radio-astronomy (eVLBI),

- Engineering (computations, emulations & simulations)

- Cultural (archiving, collaborative digital access & processing) …

Social: To meet societal needs towards:

- Common culture of R&E community

- Virtual Organizations, collaborative research, tele-education

- Smoothing the Digital Divides at the country level and beyond by linkage to the Global R&E community

Economic: To develp capacity for economic prosperity:

- Demand aggregators: University & school staff - students, researchers

- Consolidation & control of diverse public expenditures

- Promotion of Information Society (e-Government, e-Business, e-Health …)

- Stimulation of technological developments & telecom markets

NRENs are usually interconnected with other research and education networks, as well as to the wider Internet. Regional networks exist to interconnect NRENs in certain regions, and to other parts of the world. The European GEANT, US Internet2, Canadian CANARIE, and South American CLARA are examples of regional networks. In the Arab region, the regional network is ASREN (Arab States Research and Education Network), which builds on the previous EUMEDCONNECT projects since 2004. ASREN will continue to serve the 7 southern Arab Mediterranean countries: Algeria, Egypt, Jordan, Morocco, Palestine, Syria and Tunisia and extend to include the remaining Arab countries. The network provides high capacity and high quality Internet connectivity for use by the research and education communities connected to the NRENs in the beneficiary partners, and connected to the European user communities via links to GEANT which is the Pan-European Research and Education network. For most of the beneficiary countries the EUMEDCONNECT network remains the only international connectivity designed for research and education networking.

Due to the continued slow pace of regulatory reform and the related slow emergence of competitive telecommunications markets in most of the Arab countries, the national connections generally still rely on the national incumbent operators. Until recently there had been little investment in new cables in the Mediterranean region. Now, several new Europe/Asia cables are coming on stream and are running through the Mediterranean Sea. There remain hardly any cable connections directly between southern Mediterranean countries which is why the current EUMEDCONNECT2 network consists of bilateral links between beneficiary countries and European destinations which are then linked via the GEANT network.

3. NREN Model

The European NREN model has been identified as "best practice" and was implemented in several countries, worldwide. It is based on a connectivity between Universities, Research Centers, and Educational Institutions with each represented and managed by its own Local Area Network (LAN). The local area networks are then connected at the national level through a high speed dedicated network, managed by an NREN organization. At the international level, connectivity between NRENs is provided by the regional network, in the European case, it is the GEANT network. Some NRENs additionally have their own links to key destinations. The concept of using Cross-Border Fibres, commissioned or operated by the NRENs themselves, is also becoming more prevalent, [4].

Similar to any communication network, NRENs need to be managed, monitored, maintained, upgraded and controlled. There should be a national legal entity to take the responsibility for managing this network and perform the basic network management tasks and to provide network related services. The organizational and ownership model for NRENs varies between countries, and can take one of the following forms:

- **A Consortium**: Universities and research institutions and relevant stakeholders may form a consortium to represent them and take the responsibility for managing the network and may be assigned more tasks and responsibilities. This model is adapted in Italy and Palestine

- **A nonprofit company**: the Universities and research centers or the government establish a nonprofit company to manage the network and do any other tasks and responsibilities. This model is the most flexible model especially in avoiding bureaucracy in procurement and taking decisions and signing contracts. This model is adapted in Jordan and Greece.

- **A Governmental Entity:** the government may create a new governmental entity to take the responsibility of managing the network and provide the necessary services. Such entity can be under the umbrella of the Ministry of ICT or Higher Education or a National Council. This model is adapted in Egypt and Spain

- **National Authority**: an entity may be attached to a National Research Authority as in Morocco and Algeria

NRENs are generally publicly funded by governments for their running costs and/or by their member institutions.

4. NREN general activities

Over the past years, strong research and education communities developed to support network operation and services. Some communities have world class experts and scientists, developed many innovations, and made available cutting edge network services and applications. In some cases, these applications were turned into commercial products. Through the support of these communities and in addition to network management responsibilities, NRENs provide variety of other general services and activities, including:

- Unified connectivity to all research and education institutions to provide country-wide standard communication facilities and capabilities to faculty, researchers, students, and staff, leading to better sharing of resources, information, data, knowledge and expertise.

- Consolidated Internet services, with the NREN acting as an ISP to universities and research institutions. Available statistics in some countries have shown that savings can go up-to 40% on access costs, while enabling common access policies and configurations at the national level.

- Connectivity to regional research networks, providing opportunities for joint research collaboration and online education initiatives.

- Access to content, common repositories, and library resources of all universities with a unified subscription to all journals and periodicals for all Universities and research centers.

- Video conferencing services, media streaming, IP telephony, access federations, and wireless roaming for the purpose of facilitating communications, exchanges of lectures, and coordination of meetings, training and conferences between all users in universities and institutes.

- Consolidated agreements with software vendors on behalf of all Universities for licensing, with savings reaching up-to 50% in some cases.

- Common caching, filtering and anti-spam and anti-virus protection services provided by NRENs to all connected institutions.

Furthermore, an NREN can be eligible to create and manage a national Internet Exchange depending on the regulations of the Country, and provide domain name registry services and networking consultancy.

5. Lebanese NREN - LUN

Lebanon has a diverse research and education system comprised of 41 universities and institutions (12 of them with science and/or technology faculties) and 6 rather small research centres. In the discussions at the Ministry of Higher Education, the National Council for Scientific Research (NCSR), and during the "Grids and Modeling: Application" workshop held at St-Joseph University, it has been reported that the Lebanese University, the St-Joseph University and the American University of Beirut, and the Lebanese Agricultural Research Institute are the prominent institutions in the country. In these institutions, active research communities exist with substantial collaborations with Europe and the US. To better facilitate joint research, data communications, and high performance computing, establishing a dedicated R&E infrastructure has been identified as a priority.

There are some design and operational aspects that need to be taken into account in developing Lebanese NREN. For the purpose of this document the Lebanese NREN is named LUN – Lebanese University Network. ASREN engagement is important to help engage EU and Arab NRENs in these aspects and in technical capacity building and training to ensure the success of implementation. On the basis of earlier discussions, it was recommended that the ownership of LUN – operation, management, and maintenance – is through the Lebanese NCRS.

The formation of LUN, its operational model, and its interconnection with ASREN need to be coordinated with CNRS and relevant stakeholders in Lebanon, namely Universities, Ministry of HE, Ministry of ICT, and Telecom operators. Lebanese engineers and experts need to be indentified to get involved in the operational planning and implementation of LUN. The operational, technical, and funding requirements are outlined as follows:

5.1 Technical requirements

The Lebanese universities, research centers, and institutes to be connected to LUN need to be identified and involved in the process. LUN connectivity can start with a selected number of Lebanese universities then grows as it develops. The network connectivity can be dedicated fibre optic connections between institutes or leased capacity from telecommunications providers. The initial setup in Lebanon is seen through a leased capacity, but ultimately the Lebanese authority will decide on the final setup. The network design of LUN will most likely be dependent on cabling layout implemented by the Telcom operators.

LUN needs to establish its own data center – a network operation center to operate the Network, namely NOC (Network Operation Center). The NOC function will have to set up a number of mechanisms for operating, managing, and communicating with the connected universities, its connectivity providers, and upstream networks (the EUMEDCONNECT/ ASREN). Through ASREN expertise, LUN will be able to setup its own procedures based on the best practice operations used by established NRENs in the Arab region, customized to LUN special requirements. The main operations are mainly linked to operating, maintaining and operating the communication and information flow between LUN NOC and connected University data centers, IP routing, caching and filtering, network security, video streaming, resource sharing and access, fault/ trouble ticketing, technical mailing list, web services and updates, etc.

It should be noted that LUN needs to be provided with a license from the government to provide R&E networking services to avoid any conflict or misconception with national ISPs and operators.

5.2 Operational and skill requirements

Expertise in networking, e-infrastructure and system administration is limited in the Arab region. Therefore, continuing training and capacity building in these domains need to be part of LUN planning to efficiently operate the network. In cooperation with universities and support of ASREN, appropriate courses may be developed and taught to students. In addition, intensive internship programs can be developed in the long-term at LUN and other Arab NRENs. ASREN through its Arab and EU NREN members can also help in developing some kind of a twinning program to allow long-term support and knowledge/ know-how transfer with Arab NRENs. Skills and competencies required at LUN will include areas in:

- LAN and WAN technologies, including areas related to Ethernet, ISDN, ATM, PDH and SONET/SDH

- Internet Protocols – IPv4/ v6 packets, common link-layer, encapsulation schemes, IP addressing, ICMP, TCP, UDP

- IP Network Monitoring - SNMP polling, MIBs and open source-tools like MRTG, Cricket, etc.

- Internet Services - DNS, FTP, telnet, e-mail (SMTP, POP, IMAP)

- Interior Routing Protocols - OSPF and IS-IS.

- Exterior Routing Protocols - BGPv4, Autonomous Systems and the use of Routing Registries

- Multicasting - addressing, IGMP, PIM, multicast extensions to BGP, MSDP, SSM, common multicast-enabled applications

- IP Network Monitoring - Alarms, SNMP traps, syslog, Netflow statistics, network performance monitoring RIPE TTM boxes / AMPlets from NLANR

- Security - CERT, configuring and using IDS & Firewalls, security evaluation techniques, NATs, VPN technologies, etc.

- IP Quality of Service, IPv6, MPLS

5.3   Funding requirements

As in the NREN case elsewhere, LUN will be a non-profit entity and will need to get continuous funding from difference sources, including:

- Membership fees from participating institutions

- Government funds

- Research and project funding through EC, UNDP, World bank, Foundations, etc.

- Donations

- Usage and consultancy service fees

6.   LUN Services

As reported by a number of European NRENs, below is a list of detailed services and activities that an NREN may undertake, [6]. The list has been used as a benchmark by many developing NRENs, and these services are most probably considered for LUN undertaking in the long term.

6.1   Connectivity services

- Basic IP-connectivity services

- Connections to LUN-backbone

- Carrier/telco -service between LUN and intitute

- Bandwidth on demand

- End-to-End connectivity for end users groups

- Access@home - for end users – Student rooms…

- Wireless access (WLAN services: WIMAX- WIFI)

- VPN-services (Lightpaths, MPLS-VPNs, VPN- encryption & IP-tunnels)

- DNS services, NTP-service

- IPv6 (enabled network, experiment & promotion)

- IP-Multicast (enabled network, experiment & promotion)

- Network Support services: Helpdesk, Monitoring, Performance, Detective tools, etc.

- IP & DNS Registration services: IP-address allocation, Domain name registration

- National Internet Exchange

6.2   Security services

- Anti-virus/ Anti- spam control

- Intrusion detection and prevention

- NETFLOW monitoring tool

- Vulnerability testing tool (Network & web services)

- Computer Security Incident/Emergency Response Team

6.3   Authentication services

- Authentication and authorization

- Identity management systems

- PKI certificate service

- Server Certificate Service

6.4   Hosting and content delivery services

- Webhosting /Hot standby

- Mail relay / back up services

- Disaster recovery

- Storage Area Network

- Netnews/Usenet server

- Academic/educational software distribution: frame agreements & clearing

- FTP & Mirroring services

- Hosting R&E services/applications

- Media storage and –streaming facilities

6.5   Communication tools and conferencing

- Video conferencing tools/application

- VoIP / IP-Telephony

- Instant Messaging, and Mailing List services

- E-Mail gateway services

- Search Engines

6.6   Computing resources

- GRID computing

- Virtual Learning Environments

- Digital Repositories

6.7 Dissemination

- Consultancy and advice

- Training: workshops, seminars

- Support &User Portals, user groups /forums/ blogs

- Newsletters, reports, user manuals

7. References

[1] Giuseppe Andronico, *et al,* "e-Infrastructures for e-Science: A Global View", Journal of Grid Computing, in Press, 2011

[2] Giuseppe Andronico, *et al, "*e-Infrastructures for Cultural Heritage Applications", *Handbook of Research on Technologies and Cultural Heritage: Applications and Environments*, Information Science Reference, PP. 341 – 369

[3] Giuseppe Andronico, *et al,* "e-Infrastructures for International Cooperation", Book Chapter, to appear

[4] John Dyer, *The Case for National Research and Education Networks (NRENs)*, TERENA, 2009

[5] *TERENA Compendium of National Research and Education Networks in Europ,* 2010, available at URL: www.terena.org/compendium

[6] *FEAST Feasibility Study for the AU-EU AfricaConnect initiative,* 2009, available at URL: www.feast-project.org/.../FEAST-D2D-2-final-african-workshop-report.pdf

8. Annex I

Notes of Meetings/ June 28-30, 2011

Workshop "Grids and Modeling: Application" and meetings in Lebanon [28-29 June 2011]

- o Opening keynote on behalf of HE Chairman of ASREN Dr. Talal Abu-Ghazaleh
- o Active research communities and evidence of need for high bandwidth connectivity and grid computing
- o Workshop Round Table discussions:
    - Next steps that Lebanon has to make in order to launch NREN
    - Ministry of ICT announced a high bandwidth Fiber physical infrastructure project to be completed by the end of 2012.
    - Possible Direct Gbps links of fibres to the backbone for some entities: Universities, ISPs,..
    - High capacity link to Cyprus via a sub-marine cable
    - JADI cable system - key position, Connectivity to other countries
    - Concept of convergence: applications, devices, networking, services
    - Two layers of e infrastructure: grid, applications
    - Roadmap is important
    - Tools are missing to high performance computing
    - Backbone infrastructure, international capacity, communication at good prices for Universities
    - Ministry of economy, legal update framework, Draft it law for all on the e-activities in Lebanon – regulatory authority
    - Digital community Need, context: each country to operate the research network, true in the Mediterranean eumedconnect National certification authority,
    - Enjoy research, connectivity services, cloud computing
    - Very keen waiting queue Making centers connected, Beirut exchange one space for all ISPs and may be Universities

Meeting with the Minister of Higher Education in Lebanon,
- o Participants: ASREN, TAGOrg, JUNET, EUMEDGrid, Saint Joseph University, ESCWA
- o Main discussions:
    - ASREN, EUMEDGrid, EUMEDCONNECT Overview and need for Lebanese R&E network
    - Minister needs to see evidence of importance of NRENs with examples from the Arab Countries: Key performance indicators, Measures on how good is the investment in improving research
    - Role of ministry
    - Ministry to host a Workshop for all stakeholders for a National consensus – concept papers needs to be submitted ahead with a road map
    - Lebanese NREN to join regional and international R&E networks

Meeting with Delegation of European Union in Lebanon,
- o ASREN, EUMEDGrid, EUMEDConnect overview

- o Results of workshop and opportunities of Lebanon to participate in EU funding projects
- o Importance of Lebanon to enhance/ leapfrog in Research and Education connectivity in the context of the regional R&E network
- o Lebanese Universities are active EU projects: Fp7 and Tempus
- o Lebanese NREN important and funding is not an issue
- o A Ministerial support in the priorities of a bilateral agreement and related funding is needed for any project related to EU. The funding may be used to support the establishment of Lebanese NREN

Meeting with CNRS – National Center of Scientific Research in Lebanon
- o ASREN, EUMEDGrid, EUMEDConnect overview
- o Industry research important
- o Agricultural institute in Lebanon is the main research center
- o University research centers are plenty
- o About 35 universities in Lebanon, 1 public University
- o Only 5-10 universities have research activities – financing has to come through Universities
- o Lebanese NREN is important with the benefits explained but have to be put in a Draft with all details on best practices
- o Brainstorming session - Successful models to be presented: ASREN participation is important
- o Stakeholders and Workshop - national project
    - • Main Universities to be invited: Lebanese Un., AUB, USJ, University of Beirut Arabia, NotreDam Un., Belomond Un.
    - • ASREN to initiate the process for developing the concept paper and invite experts in cooperation with CNRS
    - • CNRS would be the counterpart and the point of contact for a Lebanese NREN

Meeting with ESCWA – United Nations
- o ASREN/EUMEDConnect overview
- o Convening power, and ASREN concept can be as part of the Arab region ICT strategy, policy, Governance, Arab domain names, System approach
- o Arab ICT strategy – published in 2005, available at ESCWA website - ICT sector, broadband, Regional plan of action eper.escwa.org.lb and Wisper
- o ICT strategy: to implement - Dr. Khaled Foda at League of Arab States
- o September meeting, working group, international Promote projects for funding, ecto it forum, under ICT strategy, Goic gulf organization industrial, Policy etc
- o Outcome from workshop in November to help support ASREN
- o ASREN/ NREN needs to involve in services and applications that serve the region: Content, digital library, literacy, etc.