

Jordan Research and Education Network **Readiness Assessment Report**



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Forward

It gives me pleasure to introduce this readiness report on the Jordanian e-Infrastructures, as we move into an era of change towards investing to advance the pan-Arab research and education high-speed communication networks as part of the funding schemes provided by the European Commission in the context of EUMEDCONNECT3 and AfricaConnect2 projects. These networks provide powerful means for team collaboration, sharing of resources, and exchange of real-time simulation and data transfer at the national, regional and global levels. With the support of the European Commission and Talal Abu-Ghazaleh Organization, ASREN has been developing means to connect all Arab research and education institutions in a unified network that provides scientists, academics, students, and researchers with state-of-the-art connectivity. An open exchange point is now established in London to peer with research and education networks at the global level and will be linked to regional open exchange points to emerge in Fujairah – United Arab Emirates and Al Maadi - Egypt.

ASREN will continue to join efforts with its European counterparts to bring new technology means and services to the Arab research and education communities and to provide enhanced educational environments equipped with better tools, connectivity, and services.

Dr. Talal Abu-Ghazaleh
Chairman of ASREN

Summary: This report is intended to provide background information on the status of the Jordanian e-Infrastructure landscape and detailed propositions on why Research and Education Networks are important for the advancement of the Jordanian research profile. It also provides a list of communities and beneficiaries of research and education networks and international linkages as well as the potential for international cooperation. The report proposes key development areas for the Jordanian national e-Infrastructure and recommendations to continue sustainable development of international dedicated capacity, funding sources, and service portfolio.

I. INTRODUCTION

With a booming population growth, Jordan is at the forefront of economic expansion and human development. Despite this expansion, the current education of students in Jordan is still limited and provides minimal opportunities for an internationally competitive technical education and business innovations.

The need for highly trained researchers in technical fields will continue to grow to support innovation capabilities and business start-ups in applied sciences, engineering, energy, environment, ICT, and medical applications. Research and education networks represent a great opportunity for Jordanian young researchers to join research communities abroad, access resources, facilities, and repositories, and excel in developing their innovation capabilities. They represent leading edge and high-performance network infrastructures that connect universities and research institutes. The development of R&E networks is seen critical to the competitiveness of research and education, to the scientific and technological advancement, and to the economic development and the welfare of people.

National Research and Education Networks (NRENs) connect to a national backbone, often based on complex interconnection agreements, which discourage provincial/state networks from interconnecting directly. Economies of scale and service of eScience have been the main drivers for interconnection among NRENs.

Research and education networks played a major role in the evolution of the Internet based on a distributed peer-to-peer interconnection. But still many of today's research and education networks operate in a hierarchical structure that lacks transparency and flexibility, with leased links or through subsidy to existing links with remote institutions.

Science and research without computation is not possible any more. Highly computational intensive tools and applications became necessary to analyse, model, and visualize diverse datasets. The new applications demand high bandwidth links that are not supported by the conventional IP service networks, where such networks would be constrained by non-deterministic and burst traffic loading. In fact, such applications may degrade the performance of the conventional networks by occupying the full bandwidth. E-Infrastructure and interconnected dedicated R&E networks emerge as potential platforms to support research, education, knowledge, and innovation in the new millennium. The development of these networks is seen critical to the advancement of science and technology, worldwide.

Jordan has been a pioneer in developing its National Broadband Network (NBN), inline with His Majesty's vision towards "Connecting Jordanians". The NBN is a comprehensive Learning and Public Access Network that connects public universities, public schools, colleges and public access sites. The Ministry of ICT has been investing in the development of the NBN across Jordan. The Jordanian Universities Network – JuNET was established to setup an advanced TCP/IP network for Jordan's research institutions and public universities as the initial stage of the NBN. JUNet linked to the European research and education network as part of EUMEDCONNECT project until 2010. Currently it has no direct connectivity to the international R&E network.

This study is meant to reassess the needs and requirements for re-linking JUNet to serve its university members and Jordan's research communities. JUNet will be eligible for EC funding to cover costs of international R&E circuit up to ...%. This circuit will be directly linked to European, US, and other regional RENs. This circuit capacity can grow up to 10 Gigabits per second to meet future demands for a larger bandwidth.

II. STATUS OF HIGHER EDUCATION

Higher education in Jordan began with a community college in 1950 and a university in 1960. Today it comprises of 10 public universities, 23 private universities, and 51 community colleges with a total enrolment of 223,604 students in public universities, 80,876 students in private universities, and 29,368 students in community colleges. The total number of faculty members is 7,320 in public universities, 3,461 in private universities, and 2,157 in community colleges, mostly are involved in both teaching and research.

University education in Jordan has always been strong, providing quality education to Jordanian and Arab students and supporting substantial research on issues of national and regional interest. Recently there has been a significant decline in the quality of teaching and research, mainly due to the increasing enrolment of students at universities and lack of potential funding resources. According to a recent report, publish by Thompson Reuters, Jordan's research publications remained constant during the past decade compared to that of Turkey and Iran, which has grown 10 times. In contrast, Jordan ranks high with 2000 researchers per millions of population compared to a 500 ratio in other advanced countries.

A. Knowledge economy trends

The argument that a knowledge-driven economy demands a larger proportion of the workforce with a university education and with access to lifelong learning opportunities has had a major impact on participation rates in technical education. Reform of technical education and development of innovation capabilities enabled by broadband networks provide a new perspective on conceptual human development and youth development supporting a need-driven universally compatible educational system.

B. Reform to strengthen higher education structures

Achieving sustained growth, reducing unemployment and poverty, increasing research and innovation capabilities are the main development challenges in Jordan. Numerous efforts are underway for a comprehensive reform in order to improve educational quality and innovation capabilities at all levels. Services and resources need to develop as well to justify the investment necessary for a dedicated high-speed international connectivity. Providing Jordanian young scientists with seamless access to the European advanced computing resources and facilities through high-speed dedicated networks to allow them to integrate with their peers, worldwide is a strong justification. Therefore, introducing viable tools for seamless access is an important step.....

III. RESEARCH AND INNOVATION

Jordan has recently developed a National Science and Technology Innovation Policy and Strategy 2012-2016, with priority areas identified as: water, energy, food security and health, and 6 innovation clusters identified as medical and pharmaceutical, ICT, clean technologies, architecture and construction, education and career development and banking and finance.

Jordan has been noted as the 4th most active partner in the EC funded FP7 program in the Mediterranean region, directly after Egypt, Morocco and Tunisia, involved in 25 projects. The highest level of cooperation in terms of proposals received is in environment, food, agriculture and biotechnologies and ICT.

Jordan is also a partner in ERA-Wide projects for capacity-building benefits and the ICT project JOIN-MED for unite actors in the area of ICT during a period of political difficulties in the Mediterranean region. It is also a partner in the ENPi funded project SRTD that aims to increase the contribution of Jordan's Research and Technological Development and Innovation sectors to Jordan's economic growth and employment.

In a recent discussion with DG Research and Innovation, Jordan was encouraged to play an important role in the Euro-Mediterranean Monitoring Committee on Research Development and Innovation (MoCo) and the INCO-NET project MIRA. It was also encouraged to improve synergies with the external policy of the EU, mainly between FP7 and the ENP in the area of research and innovation. The ENP Action Plan integrates research and innovation capacity building.

Despite the extensive involvement of Jordanian research with EU partners, access to research and educational resources is still limited. The current access is made via the Internet, which is highly congested with commercial traffic and cannot be a reliable channel of communication between researchers. Universities subscribe to a limited capacity of Internet via the Jordan University Network and/or the ISP operators, mainly for communication and access of a general-purpose information and data. Access to research-intensive data and computational resources is not possible through the Internet. The Internet is congested and provides no dedicated high-speed capacity for the access of terra bits of research data and/or sophisticated tools and computational facilities that exist elsewhere in Europe and other industrialized countries.

Research and education networks emerge as high-speed enabling environments for research and education communities at the national, regional and global levels. Institutions, worldwide, are interconnected by these specialized networks and provide access to their voluminous research and data repositories and highly complex computational facilities via a well-defined authentication mechanism. Beneficiaries are scientists, physicists, librarians, and researchers involved in variety of research communities. Communities of interest and practice health, energy, environment, and ICT began to emerge as new means to collaborate at the global level to address problems and issues of global concern.

A brief description is provided on:

- Research tools, and applications at Universities
- Innovation profile and patenting: Jordan ranked 64 in the 2014 global innovation index with a score of 36.2% and the number of patents granted to Jordan by the US patent office during 1977 – 2009 is 24.
- Research Funding and capabilities
- Interconnection and networking
- Computational resources and facilities
- eScience repositories

IV. JORDAN UNIVERSITY NETWORK

JuNet is the official National Research and Education Network in Jordan. It links the public universities with high-speed connectivity via a 1 Gbps backbone using its own optical dark fiber, with a Multi-Protocol Label Switching (MPLS) at the core of its network for Flexibility, Scalability, Security and Management. It provides network services and the Internet and facilitates communications, collaboration, experimentation, and learning to all public universities. JuNET is meant to provide students, faculty members, and researchers to use a high-speed network to increase productivity and foster a culture of innovation. The network is currently used for Internet with 1.7 Gb capacity, which is mainly congested and does not provide a dedicated access to scientific, research, and educational resources and facilities.

A. Organizational and governance structure

As a legal and independent organization, JuNET is officially registered at Ministry of Trade and Industry in Jordan. It is owned by Public Universities as shareholders and their presidents represent JuNET General Assembly (GA). The GA elects the Board of Directors (BoD), formed by 3 university presidents for duration of 3 years. The BoD decides on a Chair and a Vice Chair and appoints the Executive Director. JUNet has a technical advisory committee comprised from the ICT Directors of the public Universities.

For an NREN to operate properly and to fulfill its mission, a governance structure should be in place. This structure should cover the main elements of the functions performed by NRENs which include 1) Finance 2) Operations 3) Technology 4) Services and 5) Outreach, Visibility, and Communications. More elements may be considered according to the specifics of each NREN.

B. Connection policy towards public and private institutions

JUNet was founded and created by the Public Universities as instructed by the Ministerial Cabinet in 2003. The GA and BoD have decided that the membership is limited only to Public Universities and that only public universities are eligible for getting services from JUNet. At that time, the services included connectivity to Internet and GEANT access, licenses, access to EUMEDGRID, digital certificate services, capacity building, and video conferencing. Today, JuNET services are limited to Internet access and Microsoft licensing.

Later in 2012, JuNET BoD decided to provide services to Private Universities including access to Internet and Microsoft Licensing. The offerings of JUNet were not attractive for the private universities in terms of cost and services; especially that JUNet does not offer access to global research and education networks nor access to research and education resources and services.

C. JuNet funding sources and role of ministry

The initial investment for establishing the network including cables, equipment, design, leasing optical fiber, training and commissioning was made by the Ministry of ICT in 2003 under the social and economic reform program. The Ministry of Higher Education and Scientific Research implemented a video conferencing system including a state of the art video conferencing room in each university and upgraded some network equipment for some universities. The Ministry paid the annual subscription for the connectivity of JUNet to the EUMEDCONNECT Project for 18 months. The payment was made under the Higher Education Development Project with the World Bank.

JUNet charges the Universities with annual member subscription fees as well as connectivity and licensing service costs, a total of which represent a sustainable source of funding.

D. JuNet international connection and relations with ASREN

JUNet was the leading NREN in the Arab Region with a wide range of services. JUNet was among the Arab Mediterranean NRENs connected to the GEANT network under the EUMEDCONENCT project. JUNet was an active member in the EUMEDGRID and EUMEDGRID-Support Projects 2005-2011. Together with TAG-Consult GmbH and the Moroccan NREN (MARWAN), JUNet established and founded the Arab States Research and Education Network (ASREN).

Currently, JUNet is not connected directly to any regional or global Research and Education Network, which adds more limitation to the developments of research in Jordan. It is very crucial that JUNet relinks to the regional and global RENs. ASREN offers high quality link to connect JUNet to the regional and global RENs through its main PoP in London at prices lower than what JUNet pays to the Internet access. More opportunities are now open through the EUMEDCONENCT3 Program so that JUNet can benefit from EC co-financing up to 60%.

E. Options for co-financing international R&E connectivity in the future

Being connected to the global R&E networks under the EUMEDCONENCT Program, JUNet participated in other EC funded projects like the EUMEDGRID, LinSCEEM and EPIKH. JUNet depended on government co-funding for the R&E international connectivity until 2008. JUNet has been disconnected since 2010 due to lack of funding.

In contrast, the international links of Arab Mediterranean NRENs in Morocco, Algeria, Tunisia, Egypt and Palestine, have been mainly funded by the government, namely the Ministries of ICT and Higher Education. International connectivity to the global REN is considered a national high priority and asset.

F. Participating in EUMEDCONNECT3 and longer term EC support

Linking JuNET to research and education networks is seen critical at this stage to provide young researchers with a vast accessibility options to scientific resources and facilities available at the research and education networks elsewhere.

V. BENEFICIARIES OF RESEARCH AND EDUCATION NETWORKS AND INTERNATIONAL LINKAGE

The beneficiaries of REN linkage will not only be restricted to public universities as it is the case for Jordan, but rather would be extended to private universities, colleges, vocational institutions, schools, libraries, and research centers.

A. Universities, colleges, and vocational institutions, both Public and Private

The Universities, colleges, and vocational institutions in Jordan represent the largest set of users for the R&E networks. It has been noticed that there are several cooperation projects in research and education and common programs with worldwide universities, mainly in Europe, USA, Canada and Japan. By using a dedicated connection circuit to R&E networks, scientists and academics can seamlessly access e-Science resources, services, and facilities elsewhere available in the developing countries.

B. Schools, both Public and Private

Most of the schools in Jordan are now connected through the NBN, representing a high speed communication network that is only connected locally, and externally through the Internet. Though a dedicated linkage, schools will be able to seamlessly access variety of educational resources, media repositories, and content available elsewhere in the developing countries.

C. Libraries

Public Universities have been pioneer to establish the Library Consortium to serve students, researchers and faculty members in member universities. In addition to advanced library services provided, there are numerous benefits through a provision of common platform, cost savings and common access to resources. Some Arab Countries started the implementation of similar projects, connecting Arab library consortia for an integrated library service platform to better integrate library services and sharing of common resources at the regional level.

D. El Hassan Science City

Building on the Higher Council for Science and Technology (HCST), Royal Scientific Society (RSS) and Princess Sumaya University for Technology (PSUT), El Hassan Science City (EHSC) is considered one of the pioneering initiatives in the Arab region to create a conducive environment in which Arab scientists, researchers, academics, entrepreneurs and students are given the opportunity to promote a knowledge-based economy by innovating and disseminating their intellectual wealth.

Through connectivity and dedicated link, EHSC will be connected to national, regional, and worldwide R&E networks to help achieve their objective “To support applied research stemming from the national, regional and global priorities, which include energy, environment, water resources, and biotechnology”.

E. SESAME

Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) is a regional research center in Amman which will serve its members in Jordan, Turkey, Qatar, Pakistan, Iran, Egypt as well as researchers in Europe and USA. The users of SESAME will need access to Laboratories and instruments in the center from their countries. Users at SESAME will also require access to worldwide High Performance Computing (HPC) resources, mainly the LinkSCEEM HPC at Cyprus Institute in Cyprus, CERN laboratories at Switzerland and other LHC around Europe.

F. King Hussein Cancer Center

The mission of King Hussein Cancer Center (KHCC) is to provide state-of-the-art comprehensive cancer care to the people of Jordan and the Middle Eastern region and is also working to improve access to education, training, public awareness and research in order to decrease mortality and alleviate suffering from cancer in accordance with the highest standards and quality of care. Starting its activities and collaboration in early 80's of the last century, KHCC was the first to connect with Mayo Clinic in the USA through a dedicated link. It is noted that the KHCC is very active in research and education at national, regional and international levels. Connecting KHCC to the national and global research and education networks will provide it with access to worldwide resources, resources and applications and will enable the collaboration with similar organizations.

G. The National Center for Diabetes, Endocrinology and Genetics

The National Center for Diabetes, Endocrinology and Genetics (NCDEG) is an independent non-profit organization. NCDEG was established in 1996 as one of the centers affiliated by the Higher Council for Science and Technology. The main goal of NCDEG is providing quality health care, education and training in the fields of diabetes, endocrinology and genetics. One major mission of NCDEG is conducting scientific research & studies to identify the causes of the diseases included under the provisions of this By-law, their treatment and exploration of the means of their spread in the kingdom with a view to controlling their effects and reducing their complications within the framework of a comprehensive national program.

NCDEG is very active in research and requires connectivity to specialized R&E resources, applications and services in the areas of diabetes endocrinology and genetics. Furthermore, NCDEG will be the center of excellence in the Arab region in research in diabetes.

There are many other important beneficiaries of the dedicated linkage to world research and education communities, including King Abdullah II for Design and Development Bureau, University of Columbia Global Center in Amman, and other organizations and research centers.

VI. EU JORDAN COOPERATION

The present strategy in higher education is relevant in part to a group of reforms in the education sectors. It is in line with the National Strategy 2015-2025, and the National Plan for Human Development, and is based on the 10-year economic development plan being developed....

“EU Sector Reform Contract” (EU-SRC) - recently produced with a budget support of EUR 43m providing support - to the Government of Jordan “Skills for Employment and Social Inclusion”. A strategy is in the development process to assist the government to enhance social inclusion through increased employability and human resource development, which is an important ingredient towards poverty reduction & inclusive and sustainable growth. Its aim is to make a significant contribution towards building better alignment and cohesive governance in higher education systems.

As part of the European Neighborhood Program (ENP) instrument, EU has been funding the establishment of the EUMEDCONNECT research network since 2004. The network has maintained a dedicated high-speed network to the Mediterranean research and education communities serving over 2 million researchers, academics and students in seven southern Mediterranean countries, namely Algeria, Egypt, Jordan, Morocco, Palestine, Syria and Tunisia. With its direct links to its pan-European counterpart GÉANT, the network facilitates the participation of the Mediterranean community in world-class research and education initiatives. The network has points of presence (PoPs) in Sicily, at Catania and Nicosia, Cyprus, and recently established in London linking to the GÉANT network with capacities that ranged from 45 to 622 Mbps.

The EUMEDGRID was initiated in 2006 as an e-Science development project targeting communities in different domains, including physics, hydrology, bioinformatics, engineering, and archaeology. It aimed at fostering e-Science and promoting e-Infrastructures in the Mediterranean region. Several grid sites have been established to support research communities in accessing grid computing facilities and resources. Now, there exists 36 Sites in 11 countries including JUNet in Jordan, providing Grid services based on the gLite Grid middleware, for a total of around 4000 CPUs and 600 Terabytes of Storage Capacity.

The grid e-Infrastructure has provided support to many scientific domains and applications in physics, fluid dynamics, social science and humanities, engineering, computing science and mathematics, and bioinformatics. General and reference applications and tools in different scientific domains have been deployed to provide scientists with portfolio of popular applications and tools including: ROOT, GCC 4.3, Octave, BLAST, Fluent, OpenFOAM, and Rosetta.

The EUMEDGRID e-Infrastructure supports the execution of parallel applications within the OpenMP and MPICH2 standards for Message Passing Interfaces, thus allowing the inclusion of HPC Clusters within the infrastructure. It has also contributed to consolidating best practices and standards for enabling transparent e-infrastructure provisioning to scientists worldwide across different regional initiatives and permanent infrastructures, such as the EU flagship initiative, EGI.

The CHAIN and CHAIN-REDS are two FP7 projects that aimed to establish interoperation and long-term sustainability to regional initiatives and linking them together for a broader coordination and harmonization of advanced e-Infrastructures.

MAGIC – Middleware for Collaborative Applications and Global virtual Communities seeks to establish a set of agreements for Europe, Latin America and other participating World Regions, aiming at consolidating and completing the building blocks of middleware necessary for the establishment of a marketplace of services and real-time applications for international and inter-continental research groups which facilitates mobility and the work of global science communities.

VII. KEY DEVELOPMENT AREAS

The study is looking at key development areas:

- Establish a high-speed regional/international link to R&E networks in Europe
- Setup research profiles and communities, enable environments, and provide accessibility tools
- Strength access to computational facilities and resources available elsewhere

A. Expected outcomes

- Dedicated high-speed networks linking universities and research institutions to support large data traffic of applications (Multimedia, HPC, GRIDs, CERN, etc.)
- Deploying e-Science services to support common experimental activities among distributed virtual research communities.
- Establishing a common culture of research and education community towards building a collaborative research and distance education
- Smoothing the digital divides and beyond by linkage to the global research and education community

B. Recommendations

The results of the readiness report show a growing divide in e-Infrastructures for research and education in Jordan. Research and education connectivity still lacks international outreach to allow Jordanian researchers access resources and peer with counterpart in the European institutions. The absence of dedicated international linkage is holding back international collaboration and excluding researchers from a variety of European projects. Relevant stakeholders need to put efforts together to support the advancement of research and education through connectivity and better access to international research and educational resources and communities. The funding of EUMEDCONNECT3 and AfricaConnect2 projects provide a great opportunity to interlink with the European, Arab, and African research and education networks. The following represents concrete recommendations for developing a comprehensive Jordanian e-Infrastructure to better serve its research and education communities at the national level.

1. To build, support and enhance high-speed networks dedicated for research and education by upgrading the current network to provide high quality access to network services and resources.
2. To set up international circuit (initially 622 Mbps STM4 or preferably 1 Gbps) connecting Jordanian network to GEANT and other international RENS.
3. To promote the utilization of research and education networks through applications support provided by Science Gateways, Eduroam, and other e-Infrastructure services.
4. To promote network with dedicated bandwidth and high-speed communication capabilities, enabling researchers to carry out innovative scientific research collaborations.
5. To introduce state-of-the-art service portfolio, including virtualization, cloud computing, high performance computing, and multimedia services.
6. To advocate the importance of research and education networks amongst decision makers and stakeholders to support the development of a sustainable national e-Infrastructure.
7. To support training and capacity building activities in areas related to network operation and management, and building expertise in emerging technologies.
8. To organize and participate in national/international workshops, technical training sessions, and mentoring programs.

