ARAB E-INFRASTRUCTURE STATUS REPORT

ASREN

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ARAB E-INFRASTRUCTURE STATUS REPORT

Presented to
His Highness Sheikh Nahayan Mabarak Al Nahayan
UAE Minister of Higher Education and Scientific Research

The patrone of the

2nd Platform for Integrating Arab e-Infrastructure in a Global Environment
Dubai, United Arab Emirates
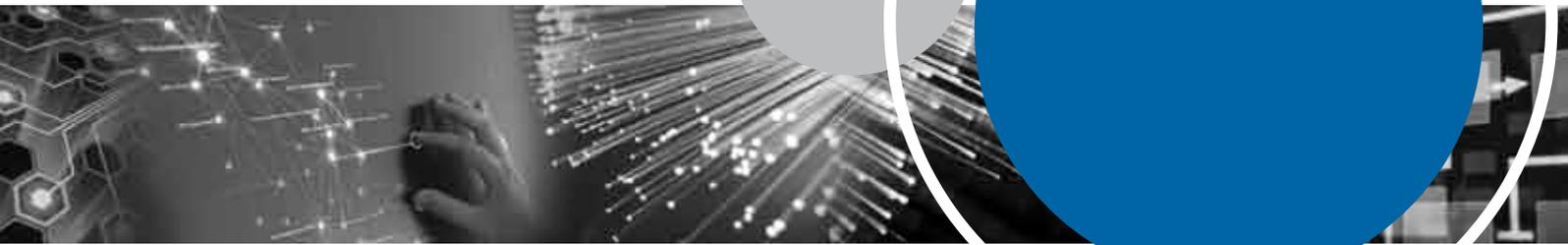December 12-13, 2012

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"Research today is largely driven by e-Infrastructure. With increasing complexities of scientific problems, growing support for global collaboration, and accelerating demand for high performance computing and the sharing of resources, e –Infrastructure has become a driver for innovation and a powerful instrument for advancing science and technology. The Arab e-Infrastructure promises to encourage innovation and strengthen science and technology capabilities for the whole region"

Nahayan Mabarak Al-Nahayan
Minister of Higher Education and Scientific Research
United Arab Emirates

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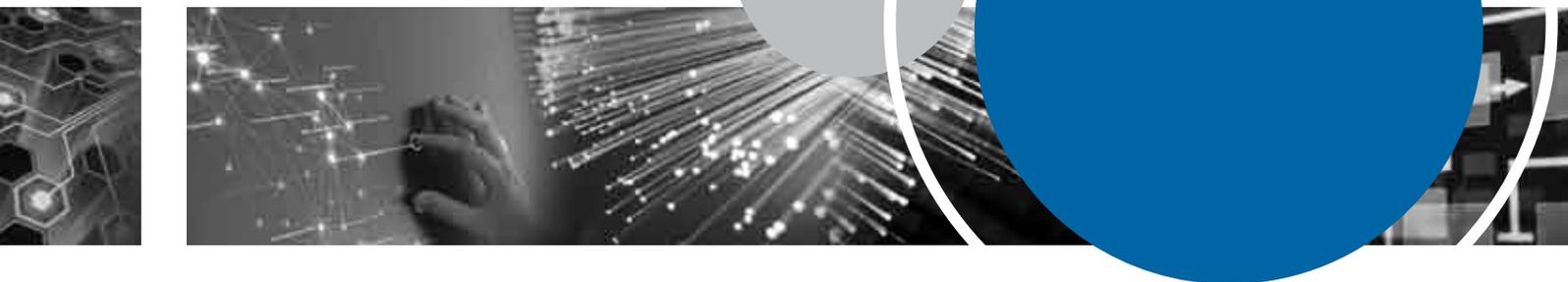Roberto Barbera, INFN & University of Catania (Italy)

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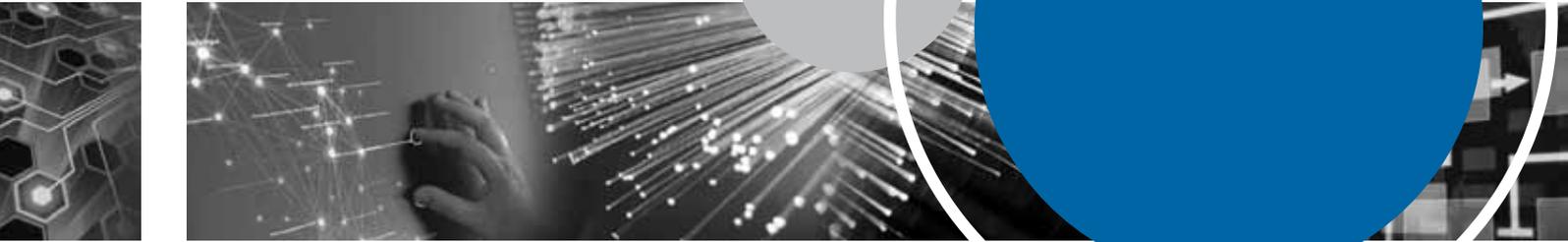

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FORWARD

It is my pleasure to introduce this report on the status of Arab e-Infrastructures, as we move into an era of change towards investing to advance inter-Arab ICT infrastructure for research and education. Research is no more possible without international outreach. Scientists work in research teams to solve common problems in engineering, environment, health, energy, economy and many others. High-speed communication networks provide powerful means for team collaboration, sharing of resources, and exchange of real-time simulation and data transfer. The Arab States Research and Education Network (ASREN) has been striving to make these networks ready for collaboration among Arab scientists and their peers at the international level. Our goal has been 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. Through the unified e-Infrastructure, ASREN will provide its users with services, applications, and means for joint research collaboration. It will also allow for a wider access to educational content and efficient computing facilities. However, financing, political instability, scattered geographical landscape, and lack of expertise are the main challenges. With EUMEDCONNECT funding, EUMEDGrid Support, and other regional initiatives, ASREN will be able to sustain existing networks in the Arab countries.

While still the subject of debate, there is now a growing consensus for the concept of ASREN Arab regional e-Infrastructure with main PoPs (point of presence) possibly originating in Egypt, UAE, Saudi Arabia, Jordan, and Morocco and connecting to the regional networks in Europe, Asia, Africa, and North America. 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 hope to our future scientists towards enhanced educational environments equipped with better tools, connectivity, and services.

ASREN hopes to take advantage of the series of new cables laid in the region to become more economical to connect the Arab national research and education networks to the world and to evolve as a backbone between the East and the West.

Dr. Talal Abu-Ghazaleh
Chairman of ASREN

PREFACE

This status report on Arab e-Infrastructure presents challenges and promising avenues for connecting Arab research and education institutions between themselves and to the globe through high-speed data-communication networks. The way we do research all around the world is being radically changed by advanced broadband infrastructures that make possible collaboration on a massive scale, sharing scientific instruments and computational and data resources (hardware, software and content). The European Commission has a particular interest to improve the level of collaboration that is already uniting scientists on both shores of the Mediterranean. Collaboration is crucial to scientific development and to address today's pressing problems at global level. E-Infrastructures, like the world-leading pan-European research network GÉANT, play a key role in enabling collaboration among scientists at global level; sharing of resources and services; and accessing on-line repositories of scientific data independently of geographical location.

Ensuring that researchers in Europe's neighborhood can connect and collaborate with their peers in the EU has been our aim for a number of years. With the support of the scientific communities on both sides of the Mediterranean, the regional research and education network EUMEDCONNECT linked up our North African and Middle-Eastern neighbors to GÉANT. EUMEDCONNECT connected the Arab Mediterranean states of Algeria, Egypt, Jordan, Morocco, Palestine, Syria and Tunisia since 2004. In the current phase of rapid change, connections are being re-established initially with Algeria, Egypt and Palestine, with additional countries eligible for EC funding support to hopefully follow. The door has always been open to other countries to join. With its direct links to GÉANT, EUMEDCONNECT provides access to over 40 million users at over 8000 research and education establishments across Europe. Via GÉANT's connections to networks in other world regions, EUMEDCONNECT represents a gateway for Mediterranean researchers that aspire to be truly global players.

A number of initiatives have built on this broadband communication infrastructure: EUMEDGRID - an initiative enhancing cooperation in a diverse range of research fields based on Grid Computing, CHAIN - coordinating interoperation of advanced global e-Infrastructures through standard interfaces, namely the science gateway, and the recently launched CHAIN-REDS to further the co-ordination & harmonisation of e-infrastructures in particular for research and education data sharing. These initiatives are now integrated in national and regional strategies for economic development.

E-infrastructures are today engines of scientific progress and their potential in other social and economic areas is enormous. Developing regions stand to benefit in particular because e-Infrastructures lower the barriers of distance and location by supporting collaboration, providing access to data and tools, and creating "intellectual havens" with the potential to reverse brain drain. I would like to thank ASREN for their initiative to prepare this status report, and hope you will all be inspired by what you read.

GLINOS Kostas
Head of eInfrastructure Unit, DG CONNECT
The European Commission

1. INTRODUCTION

The Arab region consists of 22 countries in Asia and Africa, with a total population of about 360 million people, of which 50% are younger than 25 years old. This large young population places limits and creates challenges for the competitive and vitality of the region. With up-scaling education and building innovation capabilities through enhanced research infrastructure, the region will most likely capture the vital energy of youth and meet their ambitions for more opportunities and inspiration, and hopefully reverse a growing brain drain phenomena resulting from high unemployment.

Unfortunately, government spending on higher education in the Arab region does not exceed five percent of the spending of governments in the industrialized countries. Similarly, the spending on research and development does not exceed one percent of the GDP either compared to five percent in the industrialized countries. As a matter of fact, doctorate programs, which drive research, innovation, and development, are very limited, with enrolment (mainly in humanities) that does not exceed two percent of the total number of students estimated at nine million in the whole region. Scientists and researchers working in the Arab universities are usually graduates of European and American universities.
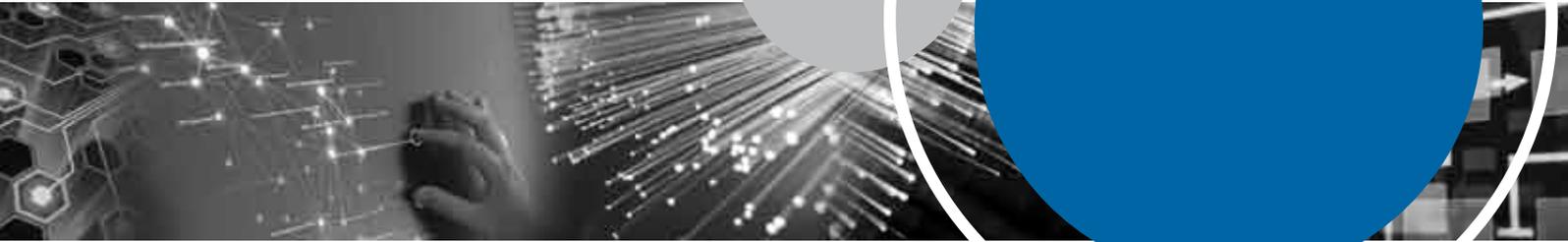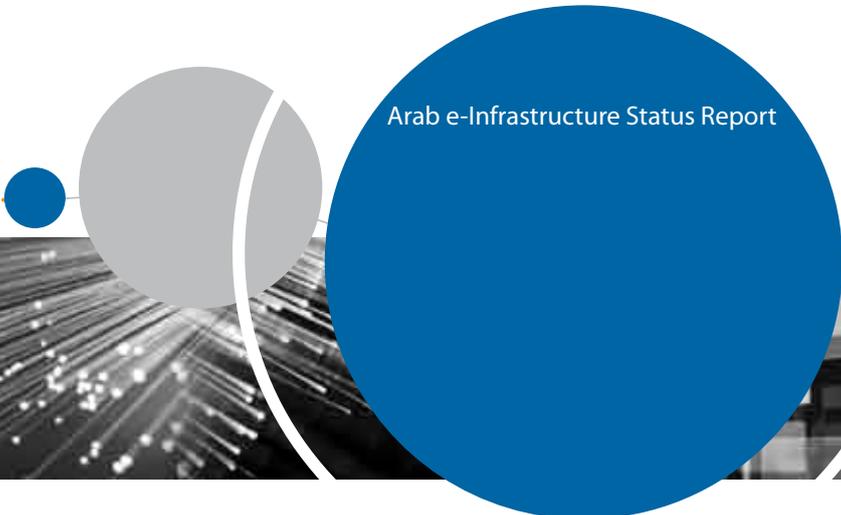
HE Arab region consists of 22 countries in Asia and Africa, with a total population of about 360 million people, of which 50% are younger than 25 years old. This large young population places limits and creates challenges for the competitive and vitality of the region. With up-scaling education and building innovation capabilities through enhanced research infrastructure, the region will most likely capture the vital energy of youth and meet their ambitions for more opportunities and inspiration, and hopefully reverse a growing brain drain phenomena resulting from high unemployment.

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These simple facts indicate a critical status of research and education in the Arab region. Challenges and issues are tremendous with limitations on funding, inadequacy of educational resources, and lacking of ICT infrastructures and connectivity. Many Arab governments have realized this critical status and introduced educational reforms and invested in developing infrastructures to improve performance. The key to succeed is to collaborate for a transfer of foreign knowledge, technology and expertise as

well as sharing of resources. A common platform and infrastructure integration for a pan - Arab regional e-Infrastructure linked to advanced resources and tools at foreign institutions can help support this collaboration and transition to a more science and technology nurtured educational environment.

e-Infrastructure represents an innovative resource for research and education and a powerful scientific instrument, with more and more demand for distributed computations to analyze, model, simulate and visualize diverse datasets and applications. It is based on leading edge and high-performance networks that connect universities and research institutions at large. The development of these networks is seen critical to the competitiveness of research, advancement of science and technology, and development of economies and welfare of societies.

It can be argued that there is no massive demand from the scientific community to e-Infrastructure in the Arab region. Under specific conditions that could put the framework for R&D collaboration between research institutions, these infrastructures could represent a source of innovation. With collaboration, strong research communities evolved to address pressing problems and issues at the global level and have intensively used e-Infrastructure for intensive distributed computations and sharing of resources.

This report contributes to analyzing the status of Arab e-Infrastructures in supporting research

and education communities at the regional level as well as to highlighting connectivity trends and opportunities for developing a pan-Arab regional e-Infrastructure within the context of the Arab States Research and Education Network (ASREN). The results of analysis show a growing digital divide in e-Infrastructures for research and education between Europe and the Arab region. Arab national e-Infrastructure varies but it is well established in many countries. However, connectivity to international links is still lacking. The absence of such links has held back collaboration within the region and excluded researchers from global projects and activities. Breaking out of this vicious circle requires concerted co-operation between all stakeholders and interested parties to support the advancement of research and education. Governments, national RENs, and industry can play an important role in building the Arab e-Infrastructure by taking advantage of the opportunities in liaising with EUMEDCONNECT3 and ASREN towards contributing to a wider Arab research and education network.

The remaining sections of this report are organized as follows: Section 2 presents the concept of research and education network. The status of Arab national e-Infrastructure and coordination is given in Section 3. Section 4 provides insights on the Arab regional e-Infrastructure, with a demonstration of successful case studies in Section 5. Section 6 presents a sustainability roadmap for a regional e-Infrastructure. Finally, recommendations and insights from experts are given in Sections 7 and 8.

2. RESEARCH & EDUCATION NETWORK

In general, the research and education network (REN) comprises dedicated high-speed networks that act at the national or regional level to provide connectivity between universities, research institutions, educational hospitals, schools, further education colleges, libraries and public entities. These networks can be built using dedicated fibre optic connections or utilizing less flexible and high cost leased capacity from telecommunications providers.

There are two key drivers for REN: one is related to the network and the other is related to the type of applications. 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 networks, features like low network latency, consistent temporal delivery of data, low network jitter, sharing of resources, and distributed interaction of applications and visualization of large data sets can be guaranteed.

RENs allow researchers, faculty, staff, and students around the country to communicate with each other and with their peers at the international level as well as access to a broad range of research tools and information resources. They provide applications and services, including videoconferencing, media streaming, IP telephony, access federations, and wireless roaming. In some cases, RENs establish and coordinate distributed computing resources (grids) and operating experimental test-beds for data-intensive applications. RENs can also operate national domain registries for the entire Internet community in their countries and provide security services for their own community, government, and military as well as commercial sectors.

Creating RENs can be motivated on the basis of technological, social, and economic factors:

Technological: To satisfy high demand eScience initiatives, including:
- Multimedia collaboration
- Distributed high performance computing (HPC, GRIDs)
- Earth sciences and high energy physics (CERN, LHC)
- Health sciences, bioinformatics, computational chemistry, radio-astronomy (eVLBI), and genomic applications
- Engineering (computations, emulations, and simulations)
- Cultural heritage (digital archiving and collaborative access and processing)

Social: To meet societal needs towards:
- Common culture of research and education community
- Virtual organizations, collaborative research, and tele-education
- Smoothing the digital divides at the country level and beyond by linkage to the global research community

Economic: To develop capacity for economic prosperity:
- Demand aggregators: university and school staff, students, researchers
- Consolidation and control of diverse public expenditures
- Promotion of information society (e-Government, e-Business, e-Health, e-Learning, etc.)
- Stimulation of technological developments and telecommunication markets

RENs are usually interconnected with other research and education networks at the regional level, as well as to the wider Internet. In most parts of the world regional REN networks interconnect the national RENs to each other and to other regional RENs. The regional level provides economies of scale and efficient use of R&E infrastructure and resources. The European GEANT, US Internet2, Canadian CANARIE, and South American CLARA are examples of regional networks. In the Arab region the EUMEDCONNECT network remains the only international connectivity designed for research and education networking. Since 2004 it has connected 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 national RENs in the beneficiary partners, and connected to the European user communities via links to GEANT.

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. There remain hardly any cable connections directly between southern Mediterranean countries, which is why the EUMEDCONNECT network consisted of bilateral links between beneficiary countries and European destinations. 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. With this new potential for e-Infrastructure and the establishment of ASREN there is finally the opportunity for the development of a true regional network serving not only the southern Mediterranean countries but also the wider region, pooling the resources and talents of the Arab research and education community

3. ARAB NATIONAL E-INFRASTRUCTURE

The status of e-Infrastructure at the national level in the Arab region is presented. The details and statistics are based on the information available through the EUMEDCONNECT, individual national REN documentation and website, as well as the survey analysis conducted as part of the FP7-funded CHAIN project (Coordination and Harmonization of Advanced e-Infrastructure Networks).

A. Algeria Research Network - ARN

The Algeria Research Network (www.arn.dz) provides connectivity services to research institutions through a structured IP broadcast and multicast service that enables communication at the national and international levels through the European GEANT and the worldwide Internet. The technical setup of the network is based on a 622 Mbit/s backbone connecting 76 universities, institutions, and research centres. The EUMEDCONNECT link has been upgraded to 622 Mbit/s allowing fast communications with European counterparts. ARN hosts a 50 Core grid system that runs gLite middleware. In addition to connectivity and grid services, ARN provides email, web, DNS, proxy, and authentication services as well as support to all research and education institutions connected to its backbone. ARN also provides access to content through search engines, websites and databases available to CERIST in particular. It facilitates a videoconferencing service and interactive service audio and video streaming. It has recently facilitated access to research projects totaling about 15,394 topics as well as communication and cooperation between teams of researchers from different academic and research institutions, in the first place, and to allow evaluation and promotion of research in progress. CERIST is also supporting the Africa & Arabia Regional Operation Centre.

B. Egypt University Network - EUN

The Egyptian Universities Network (www.eun.eg) was founded in 1985 under the umbrella of Supreme Council of Universities to serve the higher education community at large. Currently, EUN links all Egyptian universities through two main ISPs at a speed that ranges between 34 Mbps and 1 Gbps. It has a 930 Mbps (Six STM1) international link to the Internet and 34Mbps to Internet2. EUN provides value added services by contributing to some European projects such as EUMEDGRID-Support for a grid-computing infrastructure. The available infrastructure at EUN is a 68-Core CPU running gLite middleware for grid computing. EUN hosts and manages higher education development projects, including e-learning, Training, Digital Library and Management information system for the Supreme Council of Universities. EUN also operates an advanced Video Conferencing system to facilitate communication between all the Egyptian Universities. It also provides electronic mail services to all universities. EUN manages and operates the .eg Top Level Domain infrastructure and services. It provides service protocol supporting communications using IPv6 to generate a wide range of IP addresses to all universities in Egypt. EUN was connected during the first two phases of EUMEDCONNECT for seven years, and is currently connected to "GLORIAD", the global ring network for advanced applications and development, through the Egyptian National Scientific and Technical Information Network (ENSTINET). ENSTINET is also in the process of linking a 622 Mbps international link to GEANT for research and education connectivity with Europe and the EUMEDCONNECT project.

C. Jordan University Network - JUNet

Jordanian Universities Network (www.junet. edu.jo) is a non-profit company connecting the Jordanian Public Universities via a state-of-the-art high-speed broadband network creating the best infrastructure needed for advanced Higher Education and Research in Jordan. The Jordanian Universities Network owns a national broadband network with 1 Gbps fibre optic cables connecting public universities at the national level. It undertakes the offering of many services, including: Internet services, aggregated software licensing, subscription of digital libraries, video conferencing, and technical support and applications. The network runs an 8 Core grid system accessible through gLite middleware. JUNet was connected to EUMEDCONNECT during its first two phases and currently has no dedicated link to the global scientific and research networks. JUNet currently hosts the Africa & Arabia ROC portal.

D. Lebanon National Research Network - LNRN

The initiative to build the Lebanese National Research Network began in 2011 with discussions between the Ministry of Education, the National Council for Scientific Research - CNRS, and ASREN. Connectivity is available on individual basis to the commercial Internet with no interconnection either in between universities at the national level or to the Global REN. Currently the CNRS (www.cnrs.edu.lb) is leading the establishment of LNREN and is interested in wider international connectivity with EUMEDCONNECT3.

E. Morocco academic and research network - MARWAN

The Moroccan Academic and Research Wide Area Network (www.marwan.ma) is the national computer network that is dedicated for education, training and research. It is an information infrastructure connecting educational institutions and is run by the National Center for Scientific and Technical Research (CNRST). Since its inception in 1998, MARWAN has been a driver for Moroccan universities to develop new services in education, technology transfer and scientific research. CNRST relies on the evolution of communication technologies internationally to improve the quality, service and network architecture of MARWAN. In its new topology, MARWAN offers institutions and universities a choice of speed from 2 to 100 Mbps. CNRST services include Student Management System, Digital Work Environment, Moroccan Virtual Campus, National Grid Computing, Moroccan Institute of Scientific and Technical Information, Global Information System, Videoconferencing, and DNS services. The available grid infrastructure at CNRST is a 60-core with12-Terrabyte storage available for grid computing services at the national level. Its connection to the GEANT network was reserved only for academic traffic, when it was connected to EUMEDCONNECT. All Internet traffic "commercial" is conveyed by another Internet link from the core network provided by Meditel. MARWAN has been connected to EUMEDCONNECT 2004 -2011for linking to European research and academic sites and is interested in re-establishing connection. CNRST Team supports the Africa & Arabia ROC.

F. Oman Research and Education Network - OMREN

Oman Research and Education Network is meant to be the national e-infrastructure with high-speed backbone connectivity, connecting all research and education organizations and entities. The current state analysis of OMREN is to identify

the capabilities of the existing private and public telecommunications network infrastructure (technical, financial and commercial aspects), then to ascertain industry trends and assess which approach will be most suited to meet key objectives set out for OMREN, namely, (http://www.trc.gov.om): Organization (Ownership options; Funding models; Governance; Operating models), Regulation (NREN usage; Local loop access; Public or private network accessibility), Market (Currently available services; Future services/roadmaps), and Technology (Optical/packet transport; Network Security; Network Management). OMREN established Oman KID federation to allow restricted access to services, including Electronic Library, Knowledge of the identity system, The electronic system for research proposals, financial system to manage research grants, and programs to support innovation and research.

G. Palestinian National Research and Education Network - PalNREN

Palestinian National Research and Education Network (www.palnren.net) is a network connecting the Palestinian universities electronically. The purpose is to help communicate and exchange services and information between Palestinian universities through providing educational content and experiences. Palestine has reached a favourable agreement with PALTEL to connect all national universities with advanced fibre-optic network, and connecting through the EUMEDCONNECT at 45 Mbps capacity through EUMEDCONNECT3. Current efforts are on building a learning network linking all schools at the national level through the implementation of a unified content and services delivery network.

H. Qatar Foundation Research and Education Network - QFREN

Qatar Foundation Research and Education Network (www.qf.edu.qa) is in the process of being set up to provide a dedicated R&E infrastructure linking the Qatar Science and Technology Park (QSTP), Education City, and the Qatar Foundation's headquarters. The infrastructure network will be based on a 40 Gbps backbone linked with a 1 Gbps to the US Internet 2 REN. The network will enable communication of large volumes of research data and computing processes as well as collaborations on projects and sharing of resources within the research and education communities. It will provide services related to Super Computing, Grid Computing, high definition TV and media sharing, and streaming high quality online teaching and learning.

I. Saudi Academic Research and Innovation Network – SARInet

The Saudi Arabian King Abdulaziz City for Science and Technology (KACST) has been mandated to undertake the planning and implementation phases of the SARInet (www.sarinet.org.sa). KACST has been leading the gradual introduction, adoption and penetration of a Next Generation National Research and Educational Network within Saudi Arabia, servicing the entire Academic and Research communities in the Kingdom of Saudi Arabia. The network will provide a high-capacity Internet network and accompanying services to further improve the collaboration and knowledge sharing between the education and research institutions within Saudi Arabia. SARInet has been administered and operated by KACST, and a 1 Gbps link from SARInet to GÉANT has been implemented

and was set operational by the King Abdullah University of Science and Technology since 2011.

J. Somali Research and Education Network - SomaliREN

Somali Research and Education Network (www.somaliren.org) has a goal is to promote research and quality higher education among the Somalis. It is a network whose members include the major Somali higher education institutions and exists for the sole purpose of brining them together to collaborate on issues that matter not only to them but also to the Somali community at large. The establishment of SomaliREN sprung from the realization that the development of the research capabilities and facilities of those institutions, and the general quality of higher education is a necessary component for finding a way out of the current state of messed affairs. With the belief that knowledge is the real power and research is the only way to gain and share it, representatives of six universities convened to work towards this goal. SomaliREN is a member of a sub-regional backbone (UbuntuNet Alliance) network in eastern and southern Africa connecting National Research and Education Networks (NRENs) to each other and to similar networks on other continents via GÉANT. SomaliREN's efforts are currently focused on the development of the ICT capabilities of the member organizations to facilitate connectivity among them and also connect them to UbuntuNet Alliance. This is a first step towards building a suitable network infrastructure for e-Learning and cross-border research collaborations.

K. Sudanese Research and Education Network - SudREN

The Sudanese Research and Education Network (www.suin.edu.sd) is a specialized Internet Service provider dedicated to supporting the needs of the research and education communities within Sudan. SudREN is a non-profit entity operating under the umbrella of the Association of Sudanese Universities. The network connects more than 40 public and private research and education institutions. The network is based on the national fibre network owned by Sudatel Telecom and Canar Telecom companies. SudREN's operating bandwidth is 155 Mbps and has two Points of Presence (POPs) hosted by the University of Khartoum and the Sudan University of Science and Technology. SudREN is used to transfer the internal traffic between the members and for distributing the Internet bandwidth to its members as well as providing variety of services including: access to the world journals, Virtual Library, host servers internally, video conferencing, and more. SudREN is implementing a link to UbuntuNet, the African Research and Education Network through AfricaConnect.

L. Syrian Higher Education and Research Network - SHERN

Syrian Higher Education and Research Network has been created as a result of cooperation between UNDP, UNESCO and Ministry of Higher Education. Higher Institute of applied science and technology – HIAST (www.hiast.edu.sy) has been active in leading e-Infrastructure and connectivity at the national level and developing SHERN. SHERN builds a modern core network within the different Syrian universities and connectivity between them and other education and research institutions. The pilot project started with 2 Mbps link between universities and 1 Mbps Internet connection as reported

during LinkSCEEM user meeting in 2008. During EUMEDCONNECT2, SHERN interuniversity links should have upgraded to 30-40 Mbps and international link to E1 155 Mbps. SHERN offers variety of services including email, DNS, eLearning, video conferencing, multimedia broadcasting, administrative information exchange, e-libraries, and more. Due to the current situation in Syria, SHERN is no more connected to the EUMEDCONNECT and has no international link to the global research and education network.

M. Tunisia National University Network (RNU)

Tunisia National University Network has been established by the Tunisian Computing Center el Khawarizmi – CCK (www.cck.rnu.tn). Since 1997, as Internet service provider, CCK has been providing Internet services for the sector of the scientific higher education and scientific research. RNU interconnects all universities, teams and research labs and administrative services through a mesh network and provides a set of applications and services, including: Electronic messaging, Telnet, FTP, Web hosting, e-learning, university libraries (BIRUNI). CCK has been an active partner in EUMEDCONNECT2 and has a substantial internal link to the global REN. CCK is interested to find a way to re-establish connectivity with EUMEDCONNECT3 phase.
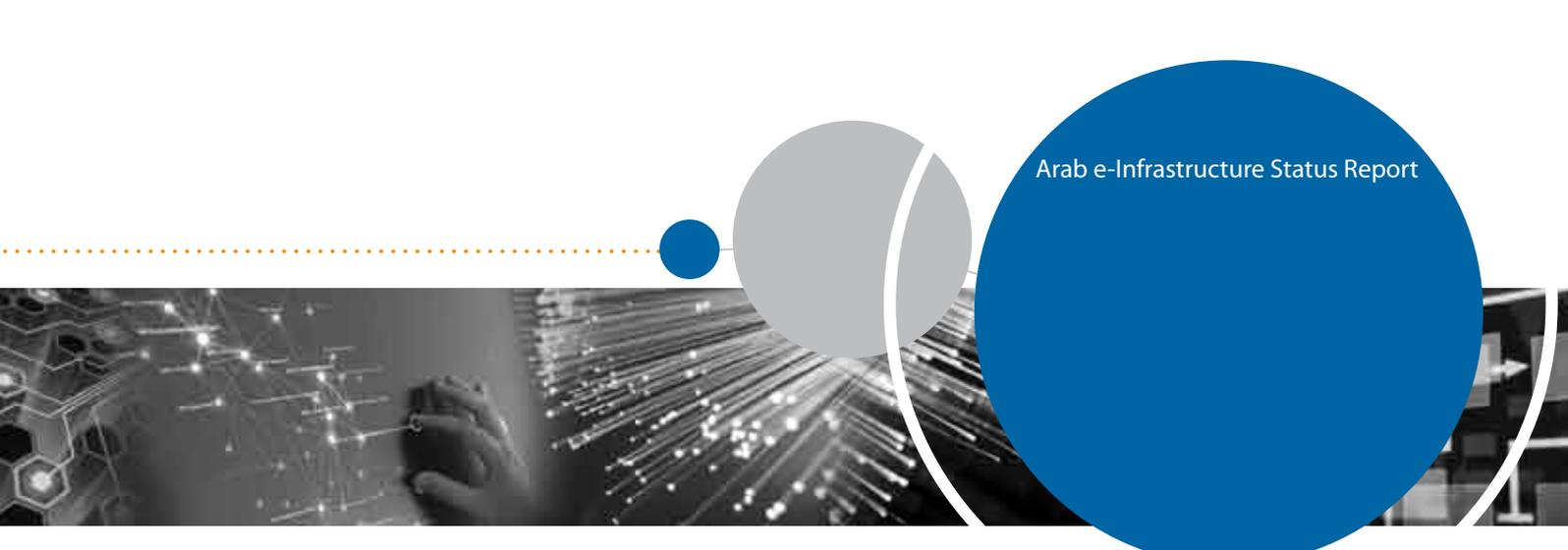
N. United Arab Emirates Advanced Network for Research and Education - Ankabut

United Arab Emirates - UAE's leading universities formed Ankabut (www.ankabut.ae) as a dedicated research and education network within the country. Ankabut caters for the regional educational and research needs, offering great improvements in how research is conducted, as well as improving the teaching and learning processes. It also provides collaboration and sharing of resources. It links for international collaboration with other research network such as the US Internet2 and the European GEANT. The available network bandwidth at Ankabut is 155.52Mbit/s international link and interconnects over 56 UAE university Campuses with a 10G backbone and 1G access links. It provides access via its advanced 6 Core routers (10Gb) backbone and 56 access routers (1Gb). This connects to a High Performance Computing Cluster of 10 TFlops at Khalifa University. Ankabut is a host of 60-core CPU running gLite middleware for grid computing and a 64 Cores High Performance Computing Cluster of 1.2 TFlops over the Cloud. Ankabut has a 5 years plan of the community services, and now is planning to build the UAE Educational Cloud. Ankabut is offering Web Hosting, DNS, NTP Videoconferencing by default to its members. The UAE Library Consortium is under the Operation Management of Ankabut.

O. Remaining Arab Countries: Bahrain, Comoros, Djibouti, Iraq, Kuwait, Libya, Mauritania, and Yemen:

In Bahrain, ASREN has been intensively working with Bahrain University and Bahrain e-Government to launch the development of such a network at the national level. No reports are available on both Comoros and Djibouti developments for research and education network at the national level. ASREN will investigate opportunities for cooperation in the two countries. ASREN has initiated communication with the Ministry of Higher Education in Iraq to support the development of Iraqi national research and education network. In Kuwait, ASREN has supported the development

of Kuwait University (KU-01-KUGRID) grid site as part of the UNESCO-HP Brain Gain initiative. Discussions continued to lead the development of e-Infrastructure at the national level. In Libya, discussions started in 2011 with the Ministry of Higher Education, with no solid actions taken yet. No reports are available on the development of research and education network in Mauritania and Yemen, and ASREN will initiate cooperation to help support the establishment of e-Infrastructure in these countries.

These results show different stages of implementation of national e-Infrastructure and connectivity, while lacking cross-border linkages in between them. There are important network characteristics that need to be taken into account for a further enhancement and development. These include availability and maturity of the network operation center in providing network services and circuit management, development of optical points of presenc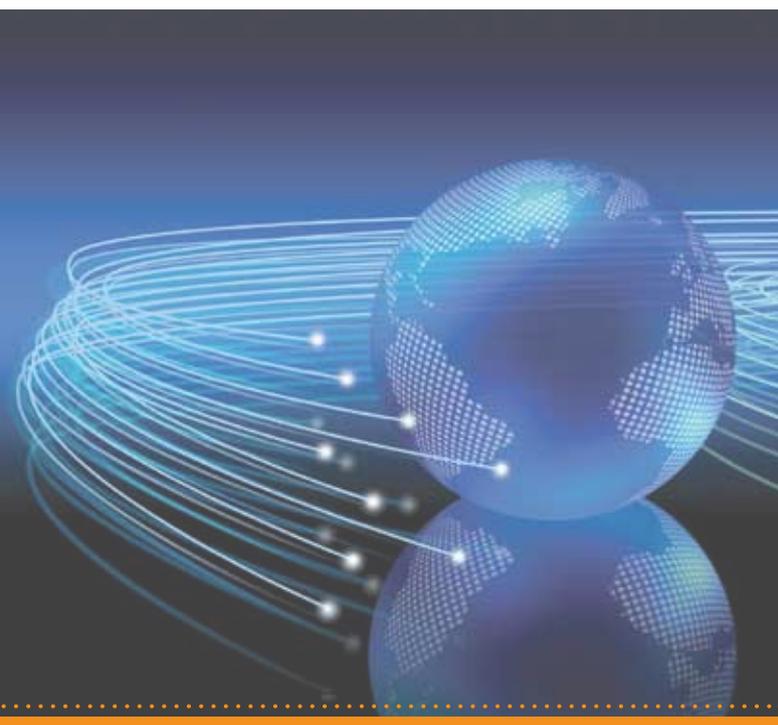e (PoPs) to serve wider research communities and linking to neighbouring academic backbones, and establishing external links dedicated for research and education traffic.

While the network capacity in the Arab countries is less than 1 Gbps, the typical core capacity elsewhere is now exceeding 10 Gbps, with a growing trend towards establishing 100 Gbps dark fibre on national REN backbones. In addition, when there is no cross-border fibre connecting national RENs in the Arab countries, cross-border fibre has reached 10 to 100 Gbps linkages in thousands of kilometres in Europe and elsewhere. The concept of PoPs is not mature in the architectural design of the Arab national RENs and is at very preliminary stages of implementation, compared to 344 PoPs in Netherlands REN alone as an example. The total capacity of external link does not exceed 2 Gbps connecting only very few countries alone, compared to very condensed cross-border connection in Europe with a tendency towards increasing international linkages.
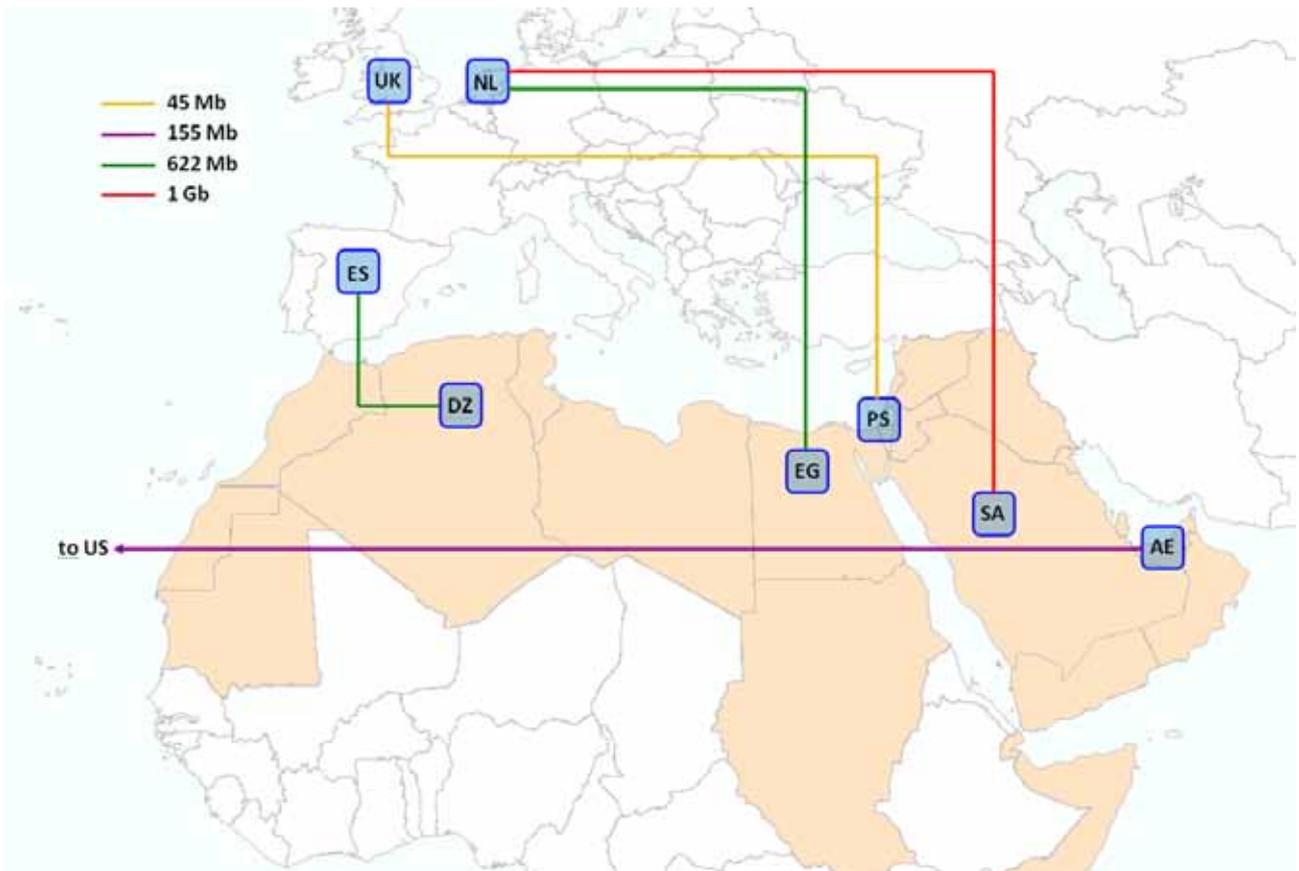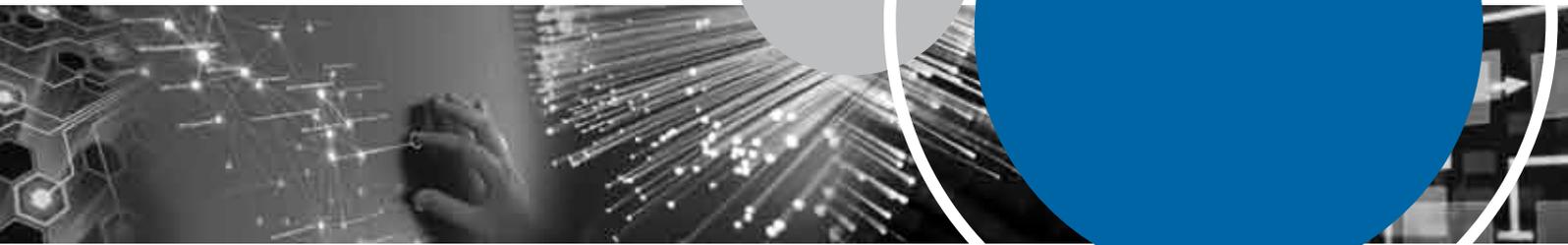
4. ARAB REGIONAL E-INFRASTRUCTURE

The Arab regional e-Infrastructure is at early stages of implementations. It is being coordinated through ASREN, which was established as a non-profit organization in Germany in 2011 with shareholders of JUNet, Morocco CNRS, and Abu-Ghazaleh Gmbh. In 2012, SudREN has become a shareholder, and Algeria, Tunisia, and Palestine are in the process to becoming shareholders of ASREN. ASREN builds on the EUMEDCONNECT and EUMEDGRID Support projects that have been co-funded by the European Commission. Eventually, ASREN will become the regional association of all Arab NRENs, overseeing the Pan-Arab e-Infrastructure development, implementation and management. The main purpose is to setup a dedicated backbone for the Research and Education communities in order to boost scientific research and cooperation in member countries through the provision of world-class e-Infrastructures and e-services.

A. EUMEDCONNECT Network

EThe EUMEDCONNECT has been recognized as one of the most important cooperation projects that the European Union supports. EUMEDCONNECT established the first regional research network for the Mediterranean countries in 2004, then extended as EUMEDCONNECT2 in 2008 and EUMEDCONNECT3 in 2011. During its first two phases the network maintained high bandwidth connectivity to the Mediterranean research and education communities serving over 2 million researchers, academics and students in seven southern Mediterranean countries - 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 Catania – Sicily, Nicosia – Cyprus, and directly in DANTE, London – UK, with links peering to the GÉANT network connecting more than 8000 research and education institutions. Access capacities range from 34 to 155 Mbps and circuits are connected in each case to the EUMEDCONNECT partners' national research and education network. The EUMEDCONNECT network has served as a backbone for many research initiatives.

Therefore, the current regional e-Infrastructure is scattered. As shown in the following diagram, there are four individual links which connect directly to Europethough the capacities of these links total only 2.3 Gbps compared to 6x10 Gbps links between Europe and North America as an example, hence showing a growing digital divide in e-Infrastructures in the Arab region.

B. *EUMEDGRID infrastructure*

EUMEDGRID infrastructure with several grid sites has been established to foster e-Science and promoting e-Infrastructures in the Mediterranean region and to support research communities in accessing grid computing facilities and resources. Efforts are underway to support sustainability and integration between grid e-Infrastructures. Now, there exist 36 Sites in 11 countries, providing Grid services based on the gLite Grid middleware,

for a total of around 4000 CPUs and 600 Terabytes of Storage Capacity. The available grid infrastructures are reported mainly in Jordan, Egypt, Syria, Algeria, Morocco, United Arab Emirates, and Kuwait. The Jordan JO-01-JUNET grid has 2 CPUs, 3250 memory size, and 90.00% availability. The Egypt EG-02-EUN grid values are: 4, 144000, and 95.00%, respectively. The Syrian SY-01-HIAST grid values are: 4, 48000, and 70.00%, respectively. The Kuwait KU-01-KUGRID grid values are: 8, 26000,

and 10.00%, respectively. The Algerian DZ-0\03 1-ARN grid values are 3\4, 48000\152000, and 95.00%\95.00%, and UAE AE-01 ANKABUT grid values are 60, 3000, and 10.00%, respectively.

EUMEDGRID has also contributed to raising awareness about the importance of e-Infrastructure for the development of the region and the creation of strategic partnerships with the EUMED countries. Several conferences, workshops, and forums have been organized to allow policy makers and education stakeholders to meet and exchange ideas to help support sustainability of the EUMED e-Infrastructure. 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. Several grid schools have been held in the region allowing local scientific communities to port and configure their applications at the grid sites. 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 as well 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.
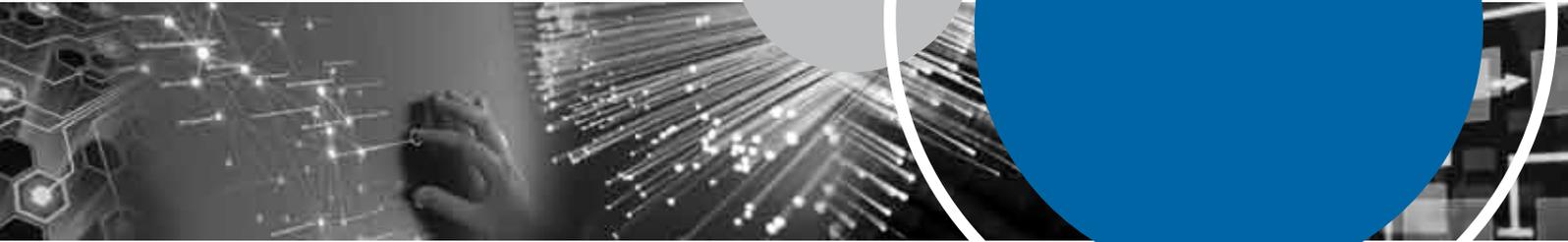
To facilitate access to grid sites, EUMEDGRID has established new digital Certification Authorities in the Mediterranean countries, thus enabling

the usage of X.509 PKI Digital Certificates for users and servers, currently representing a key component of Authentication and Authorization Infrastructures adopted by many distributed Grid infrastructures world-wide. New Certification Authorities were set up in Syria, Algeria, Egypt and Jordan, and are accredited by the EUGridPMA organization.

EUMEDGRID Support was initiated in 2006 as an e-Science development project targeting communities in different domains, including physics, hydrology, bioinformatics, engineering, and archaeology. It contributed to developing several national grid initiatives and technical capacities in a number of countries, with grid operations being consolidated through the Africa-Arabia network operation center. It 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. In the longer term and in the framework of CHAIN project, it is planned to establish interoperation and long-term sustainability to regional initiatives and link them together.

C. Coordination with regional e-Infrastructure

Within the framework of CHAIN, regional e-Infrastructure in Europe, Asia, Africa, Latin America, Arabia, China, and India have been collaborating to establish interoperability tools and allow close collaboration and exchange of know-how with similar technologies. Grid efforts and their results have been leveraged to establish a harmonized and yet optimized interaction model for e-Infrastructure and specifically Grid

interfaces between Europe and the rest of the world. Several instruments have been devised to ensure coordination and interoperation of the European Grid Infrastructures with other external e-Infrastructure. There are two models for the external collaboration with the European Grid Initiative (EGI.eu). The purpose has been to allow resource providers and international organizations outside of Europe to somehow "join" EGI and allow users to seamlessly use available resources. Eventually, a worldwide infrastructure that is capable to run user jobs will be available to provide all necessary information about them regardless of the location of used resources. The key aspect is the interoperability at the level of the infrastructure platform (ability to accept and run jobs and to make results available) and at the collaborative platform level (information and user support systems). The simplest solution is the federated organization model, with its strict rules on the deployed middleware. That is resources are not allowed to run other than approved middleware. The interoperability is taken care of at the entry of the middleware into the system: only components already interoperable with the infrastructure are accepted and endorsed. This is the model currently used within the EGI, where the interoperability is defined through a universal middleware. The main advantage of the federated model is its full integration, but represents a barrier to the adoption of new solutions, especially if they have potentially disruptive effect on existing production infrastructure.

Another interoperability model is the peer-to-peer integration, where different solutions and systems deployed by individual peers may be used. In this case, the interoperability should be achieved through common interfaces, either defined as existing standards or agreed upon among the peers. While this approach reduces the extent of integration of individual infrastructures, it gives much higher freedom to individual partners to select their own "best" solution without leaving them outside.

The interoperation at the middleware level is evolving with the needs of the communities and the technology innovation. The interoperability at application level is less dependent if the layers underneath are based on standards and shielding the user from the different technologies used. The Science Gateway approach, promoted by the CHAIN project, operates as a transversal solution across middleware and applications facilitating the interoperability at application level and leaving sufficient freedom of implementation to the different middleware solutions. Examples of research communities using interoperability models are as follows (gisela-gw.ct.infn.it):

Life sciences: We-NMR (www.wenmr.eu) is a project which aims to optimize and extend the use of the NMR (Nuclear Magnetic Resonance) and SAXS (Small Angle X-ray Scattering) research infrastructures through the implementation of an e-Infrastructure in order to provide the user community with a platform integrating and streamlining the computational approaches necessary for NMR and SAXS data analysis and structural modelling. jModelTest / ProtTest (http://darwin.uvigo.es/) are two other applications in Evolutionary Biology. Both are freely available on-line for the statistical selection of best-fit models of nucleotide substitution (jModelTest)

and amino-acid (ProtTest) replacement for a given set of aligned sequences. Researchers interested in molecular systematics, phylogenetics, phylogenomics, molecular evolution and/or bioinformatics use them continuously all around the world. ModelTest has around 30,000 registered users worldwide while jModelTest (the Java version) has around 11,000 and ProtTest around 5,000, i.e. almost all countries in the world have scientists that are using one of these tools. DECIDE (www.eu-decide.eu) is another project in life sciences aiming to design, implement, and validate a Gridbased e-Infrastructure building upon neuGRID13 and relying on the Pan-European backbone GEANT and the NREN. The purpose is to provide computer-aided extraction of diagnostic markers for Alzheimer's disease and schizophrenia from medical images. Life Science Grid community – LSGC is emerging to serve the worldwide healthcare and life sciences community in its adoption and exploitation of distributed computing infrastructures.

Earth Sciences: WRF4G (www.meteo.unican.es/es/software/wrf4g) is a Grid version of the well-known Weather Research and Forecasting (WRF) modelling system application. It is widely used by the meteorological agencies and many other groups in the Earth Science domain. Its Gridbased version has increased the resources where tasks such as Idealized simulations, Regional and Global applications, Parameterization and Data assimilation research or Forecast and hurricane research can be performed.

Digital cultural heritage: INDICATE (www.indicate-project.eu) and DC-NET (www.dc-net.org) aim at establishing and stimulating a network of common interest made up of experts and researchers in all the relevant fields, whose sustainability will be planned on a long term beyond the project lifetimes.

Other communities: ICTP Climate Change (users.ictp.it) and SuperB (superb.infn.it) are other important research communities using e-Infrastructures.

D. Africa - Arabia regional operation center - ROC

The Africa - Arabia regional operation centre (roc.africa-grid.org) has been created as a coordination and support point for all sites in the two regions, participating in the stimulating and challenging endeavour of creating a common Grid infrastructure to foster e-Science. It was set up to monitor control and manage both the EUMEDGRID and the South African Grid infrastructures, including a user support ticketing system, Grid and Network monitoring based on reference tools adopted by international Grid projects and initiatives. The ROC site facilitates a dynamic map to show both the sites belonging to the Africa-Arabia ROC and those sites belonging to other ROCs but participating in common projects. The site allows users to get more information on the grid cooperation status, facilitates monitoring of activities, and helps running highly complex jobs on regional grid sites.

5. CASE STUDIES

To illustrate the benefits of the EUMEDCONNECT network in non-technical and concrete terms, collaborative projects have been identified to profile in case studies across sectors with high societal impact and relevance to the southern Mediterranean region. The aim is to describe how EUMEDCONNECT facilitates collaborative research and education and its advantages over the commodity Internet in terms of cost-effectiveness, performance and reliability.

Following are some examples produced during the second and third phase of the EUMEDCONNECT project:

- CIRCE: e-infrastructures help save the Mediterranean – focusing on how the network facilitates collaborative research aimed at contributing towards sustainable development in the region (http://www.eumedconnect3.net/upload/pdf/CIRCE.pdf)
- ITHANET: e-infrastructures revolutionising thalassemia treatment - outlines the network's support for research into thalassemia, a blood-related disease, particularly common in the Mediterranean (http://www.eumedconnect3.net/upload/pdf/ITHANET.pdf)
- ICT-LEAP: leaping barriers to education through e-learning - explains how the network contributes towards making learning in the Mediterranean more flexible and accessible (http://www.

eumedconnect3.net/upload/pdf/ICT_LEAP.pdf)
- WISDOM: e-infrastructures speed up the hunt for new malaria drugs - outlines how the network allows researchers in the Mediterranean to participate in the world-class research to help fight killer diseases, such as malaria and avian flu (http://www.eumedconnect3.net/upload/pdf/WISDOM.pdf)
- High-speed networking: freeing epilepsy patients from seizure - describes how the network allows neurosurgeons in Tunisia to collaborate remotely with their French colleagues on the diagnosis and surgical treatment of epilepsy patients, giving them back a seizure-free life (http://www.eumedconnect3.net/upload/pdf/EUMEDCONNECT2_Epilepsy_case_study_FINAL_20100325155239.pdf) –.
- eScience across the Mediterranean: making it a reality - shows how current and future bandwidth-hungry eScience users across the region rely on advanced connectivity (http://www.eumedconnect3.net/upload/pdf/EUMEDCONNECT2_demanding_users_case_study_FINAL.pdf)
- Mapping the landscape, managing the future – EUMEDCONNECT3 and Agadir - explains how the network supports research aimed at contributing to sustainable land management in Morocco (http://www.eumedconnect3.net/upload/pdf/Agadir_FINAL.pdf)

6. SUSTAINABILITY ROADMAP

ASREN will continue to build a sustainable Arab e-Infrastructure on behalf of its Arab national RENs, with initial funding support from the European Commission as part of the EUMEDCONNECT3 Project. The ultimate goal is to provide a vital research e-infrastructure as well as the necessary resources for information technology and telecommunications development. Areas of importance in the sustainability roadmap of ASREN are: network expansion, resources, services, user communities, and funding.
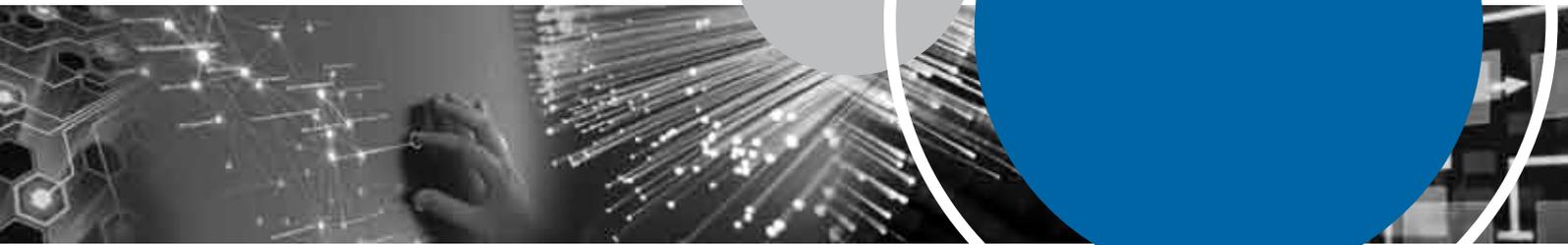
A. Network expansion

The NREN backbone bandwidth and connection to the global research and education network, is at preliminary stages of implementation in the Arab region. Algeria ARN and Palestine PalNREN are currently connected through the EUMEDCONNECT3 through dedicated links operating at speeds: 622 Mbit/s and 45 Mbit/s, respectively. Saudi SARInet, UAE Ankabut, and Qatar QFREN have 1 Gbps, 155 Mbps, and 1 Gbps international links, respectively. EUMEDCONNECT3 has dedicated points of presence (PoPs) at Catania (Sicily) and Nicosia (Cyprus) available for direct interconnection by EUMEDCONNECT3 partners and also options for connecting via hubs in Europe on the GEANT network. In addition to networking the EUMEDCONNECT3 partner countries between them, the links to GÉANT also provide connections to research networks in other world regions:

- Europe - Research and education networks in over 30 European countries
- North America (INTERNET2, National Lambdarail, CANARIE, ESnet)
- Asia Pacific via TEIN3
- The South African research network, TENET
- Latin America via RedCLARA
- Sub Saharan African via UbuntuNet and Africa Connect
- Commercial Internet (optional service, terms and conditions apply).

The other Mediterranean countries: Morocco, Egypt, Tunisia, Syria, and Jordan have been connected to EUMEDCONNECT2, but are now disconnected

because of today's dominating political instability and financial crises. Yet grid applications are being the driving force in this region. The remaining Arab countries are in the process of developing NRENs. In international terms, improvements need to be made towards developing 2.5 – 10 Gbps of NREN backbone and 1 Gbps international links. This will facilitate access to grid sites without bottlenecks at the last mile and will help scientists and researchers to integrate and access computational and data resources available at the world research facilities and advanced centers.

In some countries in the region, NRENs are at early stages of implementation. Within its mandate, ASREN will continue to support emerging NRENs in Lebanon, Libya, Kuwait, Bahrain, and other Arab countries. In some cases, ASREN has been searching for suitable funding sources to acquire sufficient but still realistic connection quality to the global research and education networks. The ultimate goal of ASREN is to develop a Pan-Arab operational network covering the whole region with all NRENs established in the medium term. The network development is being coordinated with the grid infrastructure so that grid sites and the emerging user communities are connected with sufficient bandwidth and acceptable reliability.

B. *Hardware Resources*
In many countries significant computing and storage resources exist but they are used exclusively by a single user community in some cases (or few ones only), with no interconnection to distributed infrastructure via standardized interfaces. Owners and current users of such resources are approached, and interfaces to the grid infrastructure are negotiated. There must be mutual benefits for this process to be successful.

Therefore, advantages for both sides must be carefully and individually identified. From the technical viewpoint, rather strict requirements of the UMD-based software stack can be inconsistent with the current requirements of the resource users. In this case, virtualization technologies should be leveraged, allowing co-existence of different software environments as well as dynamic assignment of hardware resources to the software environments. The process would be initiated by NGIs, with the goal to attract majority of sites in the medium term.

In some countries in the Arab region the resources available to the grid users are very limited. However, the European experience has shown that when the available resources reach certain, they start attracting users. Users then help to bring further resources to the shared infrastructure. NGIs would look, in shorter term for funding sources to set up several "seed" sites providing at least 500—1000 CPU cores and storage in the order of 100 TB. These resources would then need to be interfaced to the grid,

and widely advertised for general use of the scientific community. In this way a critical mass for further infrastructure development will exist to help support scientists.

C. *Software and Services*

Following the EGI pattern, central services necessary for independent operation of the grid infrastructure (BDII, accounting portal, monitoring, GocDB, ticketing system, and more) will need to be deployed thorough out the region as well as network services for dedicated access to research and education e-Infrastructure.

Africa ROC has been coordinating the regional operation of the grid infrastructure. Similarly, optional but desirable services (VOMS for VOs emerging from the region, WMS for supported VOs, data catalogues, FTS) will be gradually deployed in the framework of CHAIN-REDs project. Typically, these services will be installed by the institutions, which are participating in scientific activities. NGIs

can still offer provisioning for some of these services due to their concentrated expertise. Outcomes of the EUMEDGRID project have put emphasis on these topics and are being coordinated with the NGIs.

Network services will include: Connectivity services (basic IP, connections to ASREN-backbone, bandwidth on demand, VPN, MPLS-VPNs, VPN- encryption & IP-tunnels, DNS, NTP, IPv6, IP-multicast, network support); Security services; Authentication services (authentication and authorization, identity federation and management, certification services); Cloud and hosting services (academic/educational software distribution, digital repositories and libraries, FTP and mirroring, hosting R&E services/applications, and media storage and –streaming facilities); communication and conferencing (video conferencing tools/application, VoIP / IP-telephony, search engines).

Integrating a software application to a portal (eg. Science Gateway) requires a non-negligible effort. It enables the application to a wider scattered community of the users for whom the technological barrier of using the raw grid services could be too high otherwise. In the short term, the portals, which are provided by collaborating European institutions can be used by users in the region to access regional services. In the medium term, an independent regional portal(s) should be provided (probably by one of the more mature NGIs in the region). Specific applications, once identified can be integrated through targeted short-term projects with participation of portal experts, experienced users of the application, and infrastructure experts.

D. User Communities

In the region, there are multiple user groups of the same scientific discipline, already using significant computational resources. However, they are rather isolated from one another. NGIs will need to map such existing user groups, interchange the information, and approach them with targeted support, helping them identify how they can benefit from collaboration and sharing resources over the grid. Once such regional per-discipline communities are established, NGIs can also help them establish worldwide contacts.

Computer science and mathematics are reported to be significant user communities in the region. In the short term, stronger links with this community will need to be established. ASREN in coordination with NGIs will develop plans for their support leading to establishing a coordinated collaboration.

A nontrivial number of countries in the region have already established NGIs. These NGIs are approved through the EGI process, even though they are still not full members of the EGI council. This high level of maturity is the outcome of the EU co-funded projects, including the EUMEDGrid Support. In the short term, it is desired to evaluate the pros and cons of linking these countries directly to EGI rather than joining them with the emerging regional grid infrastructure (which is a preferred model in other regions), and in this case ASREN.

In countries where NRENs are still in the implementation phase, establishment of NGIs is a challenge. ASREN, being the regional coordinating body, will work with these countries (their NRENs in particular), and transfer the necessary expertise to help establishing also NGIs (either joint with NREN or independent).

E. Funding

ASREN together with national RENs will need to push on a political consensus to provide funding schemes that would encourage universities and research centers to share resources in larger collaborations, rather than using them exclusively. The Association of Arab Universities and the League of Arab States can play important roles in developing these funding schemes. NGIs together with their European partners will look for continuation of projects like EUMEDCONNECT, which push on extending the global collaborations in the region. NGIs will also need to seek funding from local and regional stakeholders and semi governmental institutions. It is also important for ASREN and its stakeholders to respond to the calls for proposals regularly published by the Islamic development bank, the UAE Maktoum foundation, the Saudi AGFund, the Qatar Foundation, and other international organizations.

7. RECOMMENDATIONS

The results of the status report show a growing digital divide in e-Infrastructures for research and education in the Arab region. Arab national REN connectivity varies but it is well established in many countries. However, the connectivity still lacks both cross-border and international links to allow regional and global activities. The absence of a Pan-Arab regional e-Infrastructure is holding back collaboration within the region and excluding researchers from global projects. Breaking out of this vicious circle requires concerted co-operation between all stakeholders and interested parties to support the advancement of research and education. Governments, national RENs, and industry can play an important role in building the Arab e-Infrastructure by taking advantage of the opportunities provided by the Euro-Mediterranean projects in contributing to a wider Arab research and education network.

His opening speech at the Second International Platform on Integrating Arab e-Infrastructure, eAGE2012, Sheikh Nahyan Mabarak Al-Nahyan expressed his support to the development of a pan-Arab e-Infrastructure. The expectations are to: promote community engagement and support; advance substantially research and education capacity; increase the ability of students, researchers, and institutions to learn together and to collaborate; and help colleges and universities to keep in pace with the global technological innovations and to enhance their collaboration with leading universities and research centres around the world. Sheikh Nahyan has also emphasised on the key role of the United Arab Emirates in establishing a knowledge and connectivity hub in Fujaira, where many international high speed submarine cables land, and so create substantial peering opportunities for the world leading research and education institutions, including the US Internet 2, European GEANT, Central Asia TEIN, Pacific APAN, African UbuntuNet, and Arabian ASREN.

The following table provides concrete recommendations for developing a comprehensive Arab regional e-Infrastructure to better serve research communities at the regional level.

Recommendation	To build, support and enhance research and education networks across the Arab countries.	Ref. N°:	I
Starting date:		End date:	
Action I.1	Supporting the development of national RENs in countries where such networks do not exist		
Action I.2	Establishing ASREN international private leased circuit (initially 155 Mbps STM1) connecting to GEANT and other international RENs		
Action I.3	Creating ASREN Points of Presence within the Arab region for interconnection with additional Arab RENs, and aggregate inter-regional traffic where cost effective		
Action I.4	Encouraging participation of Arab NRENs in the EUMEDCONNECT3 and connecting them with communities of scientific research, worldwide		
Action I.5	Offering in the long term dedicated Lambdas to special customers, deploying hybrid IP-optical networks, and offering end-to-end services		

Recommendation	To promote the utilization of research and education networks through applications support		Ref. N°:	II
Starting date:		End date:		
Action II.1	Utilizing CHAIN and CHAIN-REDs to build a platform of bundled services and develop access mechanisms through the science gateway and federation of identities			
Action II.2	Demonstrating benefits of research and education networks to stakeholders and decision makers through case studies			
Action II.3	Promoting network's dedicated bandwidth and high-speed communication capabilities to enabling researchers in the Arab region in carrying out innovative scientific research			
Action II.4	Introducing state-of-the-art service portfolio, including virtualization, cloud computing, and multimedia content			
Action II.5	Advocating on the importance of research and education networks amongst decision makers and stakeholders to support the development of a Pan-Arab e-Infrastructure			

Recommendation	To support training and capacity building activities in areas related to network management, operation, and administration		Ref. N°:	III
Starting date:		End date:		
Action III.1	Enhancing transfer of knowledge between all ASREN partners to help build expertise in emerging NRENs			
Action III.2	Organizing workshops, technical training sessions, and mentoring programs and encourage participation among NREN members			
Action III.3	Developing specialized professional certificates or diploma program for NREN operation and management			

Recommendation	To support long term sustainability of Arab regional e- Infrastructure		Ref. N°:	IV
Starting date:		End date:		
Action IV.1	Recruiting all Arab NRENs to become members of ASREN			
Action IV.2	Developing ASREN backbone connecting all Arab NRENs through high-speed communication networks			
Action IV.3	Increasing ownership among Arab NRENs of the ASREN regional network			
Action IV.4	Securing regional funding from public and private sources to invest in and manage Arab regional e-Infrastructure			

8. INSIGHTS

Professor Dr. Labib Khadra
President of the German Jordanian University

Recent advances in science and technology have created a new paradigm of research activities in higher education institutions. A global collaboration is becoming a phenomenon for solving common problems in variety of domains. For such collaboration to be possible, a high-speed dedicated ICT infrastructure must be installed to connect universities and research institutions at the global level. Internet connectivity is not possible any more for a wider research collaboration. Today, conducting research requires complex computing facilities, intensive data transmission, and access to highly sophisticated scientific applications.

Universities are no more isolated as they began to thrive to be present on the cyberspace not only to provide online teaching and learning to a larger scale student base, but also to integrate into the global research arena. Unfortunately, several barriers still hinder the move towards such presence, specially for universities in Jordan and the Arab region. This is simply because of the lack of dedicated connectivity. In this case, it will not be possible to meet the increasing demands of our young scientists for capacity and access to world leading scientific resources. Fostering high-impact interdisciplinary research that truly addresses market needs and provides a substantive understanding of technology and its role in the society, therefore, will remain a challenge.

Through our partnership with German universities and industry, the German Jordanian University is continuing its effort to create an exceptional research environment that bridges boundaries; promotes interdisciplinary initiatives; facilitates faculty exchange; increases cultural diversity and multi-cultural communities; and promotes multi-institution collaborations and supports closer interactions with private institutions. The cross-disciplinary research approach is adopted as an essential component. Researchers from varieties of disciplines are encouraged to create an on-going dialogue with professionals and technologists from all over the world. The successful application of technology arising from these variety of fields will influence students, faculty, private, public and local citizens. The objective is to contribute to the advancement of science and technology, and build a modern educational climate that allows more effective resource allocation and utilization, improved efficiency, optimized operational costs and better educational outcomes. Our approach presents a unique international collaboration and a notion of education with greater diversity, interdisciplinary setup, accelerated diffusion of knowledge and technology, and enhanced societal context. Access to research and education networks will enhance international collaboration and accelerate transfer of knowledge.

The case of the German Jordanian University is not different from any other university in the region. The trend is to increase the internationalization dimension, and is not possible without high-speed communication networks.

**Prof. Federico Ruggieri
Director of Research
at INFN Roma Tre
Rome, Italy**

The Arab regional e-Infrastructure for research and education is a fundamental component of a strategy for a rapid development of research and high education in the region.

The progress of a regional infrastructure for south Mediterranean and Middle-East has been marked by several EU co-funded projects that operated since 2005 to deploy a high speed network and a Grid infrastructure across the Mediterranean area. EUMEDGRID-Support has actively participated in the process of building the ASREN organisation that has been established in March 2011 and is now a reference institution for the development of sustainable e-Infrastructures in the region. CHAIN project has designated ASREN as one of the fundamental partners in the proposal of 2009 when the organisation was still under preparation. The participation of ASREN was thus formalised in 2011 when the organisation became a legal entity.

EUMEDCONNECT, EUMEDGRID-Support and CHAIN have fostered the creation of ASREN and recognised the fundamental role that such organisation may have in the evolution of e-Infrastructures in the Arab region. The e-AGE 2011 conference in Amman indeed marked an important step forward, bringing to the attention of politicians, policy makers, stakeholders, professors and researchers the importance of the regional and national research and education networks and the opportunities offered by distributed computing infrastructures.

In these last two years ASREN has increased the number of shareholders and disseminated successfully the paradigm of e-Infrastructures in the Arab region. The results obtained so far, however, require a further series of steps in order to increase the number of users and services and, at the same time, consolidate and make sustainable the e-Infrastructure.

The region indeed needs a very robust and high performance communication network, capable of supporting an advanced distributed computing infrastructure, a data infrastructure and user oriented services. Many countries in the region are in the process of accelerating their development and this, in turn, requires advanced ICT infrastructures which should empower research and education that, together with innovation are the indispensable pillars for durable development.

The challenges, of course, go beyond the R&E domain and are also related to political and economic issues such as: political stability, release of restrictions in the telecom market with liberalisation and true competition, awareness that the ICT potential is not only based on the expansion of mobile communication. It is still necessary to make politicians aware of the specificities of the Research and Education Networks which should not be confused with general Internet access.

Research needs dedicated high bandwidth that

is used in bursts for large data transfer often combined with high throughput and/or high performance computing. On the technical side several areas require some considerations. High Performance Computing, Clouds and Grids should be used in the proper scientific and education contexts without a priori decisions and prejudices. The Research and Education context has peculiar requirements (e.g. very large data storage and huge amount of processors accessible to Virtual research Communities spanning several continents) and specific economical limitations (e.g. funding is very frequently available only for projects of limited duration) and thus it's fairly possible that commercial offers do not fit these needs and limits.

In the communication networks the deployment of Neutral Access Point/Internet Exchange Points in the region should be strongly supported by the different parties: Telecom Operators, Funding Institutions, governments, universities and research centres. The business model and technical architectures are well known and a large number of such realities exist in the other regions of the world. The Arab region is a crossing point from east to west, from India and Asia to Africa and Europe and should apply again the Silk Road approach to Networks.

On top of the previous considerations the Research sector is highly dynamical and always requiring very advanced technologies and services, thus pushing the market towards new high performance products and creating the demand for new business that can then be applied also to the general consumers.

In conclusion the opportunities and technologies are already available, several challenges are defined and a good potential of young and motivated people exists; ASREN can be the right organisational structure to address challenges, promote capacity building and create the platform for advanced e-Infrastructures in the Arab Region.

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