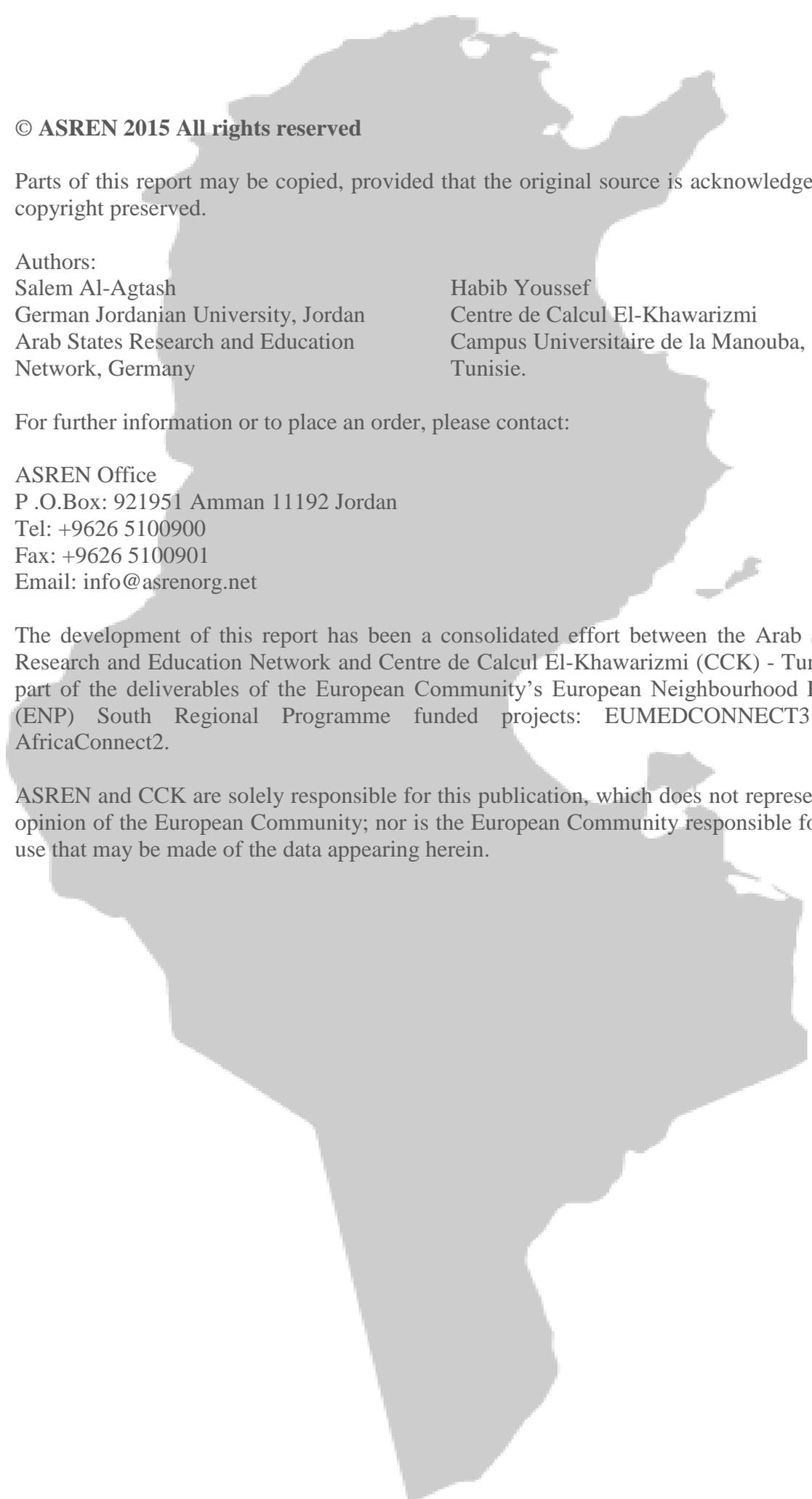


Tunisian National Research and Education Network
Readiness Assessment Report





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The development of this report has been a consolidated effort between the Arab States Research and Education Network and Centre de Calcul El-Khawarizmi (CCK) - Tunis, as part of the deliverables of the European Community's European Neighbourhood Policy (ENP) South Regional Programme funded projects: EUMEDCONNECT3 and AfricaConnect2.

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Forward

It gives me pleasure to introduce this readiness report on Tunisian 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 build a business case for re-connecting the Tunisian NREN to European GEANT network. It provides background information on the status of the Tunisian higher education and research and innovation communities and detailed propositions on why Research and Education Networks are important for the advancement of the Tunisian 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 Tunisian international cooperation. The report proposes key development areas for the Tunisian national e-Infrastructure and recommendations to continue sustainable development of international dedicated capacity, funding sources, and service portfolio.

I. INTRODUCTION

Tunisian student population has been steadily growing over the last 50 years. The total number of students in Tunisia nearly counts to 300,000 students, slightly over 90% of which are registered at public institutions. Since the mid-seventies, Tunisia started decentralizing university education from the capital Tunis to other cities of the country. Now, Tunisia has nearly 200 public institutions, spread all over the country, and organized in 13 public universities (one of which is the Virtual University of Tunis, providing e-education services), and 63 private institutions with nearly 25,000 students. In order to improve the university ecosystem, attract high tech businesses, improve innovation and offer quality employment opportunities, Tunisia created a number of specialized research centers (38 centers), Technology Parks as well as cyber working spaces throughout the country. Furthermore, Tunisia has a number of well-established research and education networks, RNRT for research, RNS for medical field, AGRINET for agriculture, and RNU for higher education institutions. RNU is the main research and education network, providing high-speed connectivity and a variety of application and Internet services to the entire Tunisian academic community (see Figure 1).

Over the last ten years, Tunisia has been witnessing a number of attempts to align its university education to international standards (especially European standards). The introduction in 2003 of LMD system (License, Master, and Doctorate) was a step in that direction. Unfortunately, the lack of adequate higher education ecosystem coupled with a very large number of students, have been hindering the success of the LMD transition as well as the effectiveness of engineering education. The 2011 Tunisian revolution has uncovered numerous weaknesses of the existing Tunisian higher education system, most important of which is the poor match between the universities output (53,000 graduates per year) and the market need (12,000 per year, 80% of which goes to the public sector). A major project, led by the ministry of higher education and scientific research is underway to address the mismatch and main weaknesses of the current system. All parties in the Tunisian education sectors are well aware that a quality education system is a prerequisite to any economic development and expansion. This is especially true in this highly internationally open and competitive world.

The need for highly trained researchers in technical fields will continue to grow to support innovation capabilities and business startups in applied sciences, engineering, energy, environment, ICT, and medical applications. Research and education networks represent a great opportunity for Tunisian 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 as critical to competitiveness in R&E, scientific and technological advancement, and to the economic development and welfare of people.

Economies of scale and service of e-Science have been the main drivers for interconnecting National Research and Education Networks (NRENs). Research and education networks played a major role in the evolution of the Internet based on a distributed peer-to-peer connectivity.

Science and research without access to computation and communication resources is not possible any more. Highly computational intensive tools and applications became necessary to analyze, model, and visualize diverse datasets. Furthermore, these new application services have stringent Quality of Service requirements with respect to throughput, delay, and loss. Therefore forcing scientific traffic to

compete for bandwidth with commercial traffic would necessarily result in the violation of the QoS demands of scientific traffic. Also, such applications may degrade the performance of the commercial networks by consuming most of the network bandwidth resources. E-Infrastructure and interconnected dedicated R&E networks emerged 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.

Tunisia has been a pioneer in the MENA and African regions in developing its National Broadband Network (NBN). Since 1997, the Centre de Calcul el-Khwarizmi (CCK) has been in charge of running the Tunisian NRENs (RNU-Réseau National Universitaire and RNRT-Réseau National de la Recherche Tunisien). Nowadays, RNU is built on a very high speed network with 2x10 Gbps in the backbone, has Internet bandwidth access of 4x1 Gbps, and providing high speed fiber access to all research and education entities. Figure 1 shows the RNU network topology, with back up link of 155 Mbps. RNU was linked to the European research and education network GEANT as part of EUMEDCONNECT project until 2010. Unfortunately, since then, it has no direct connectivity to GEANT.

This study is meant to reassess the needs and requirements for re-linking RNU to GEANT network, to better serve its research and education communities. Tunisia will be eligible for EC funding to cover costs of international R&E circuit up to 60%. 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.

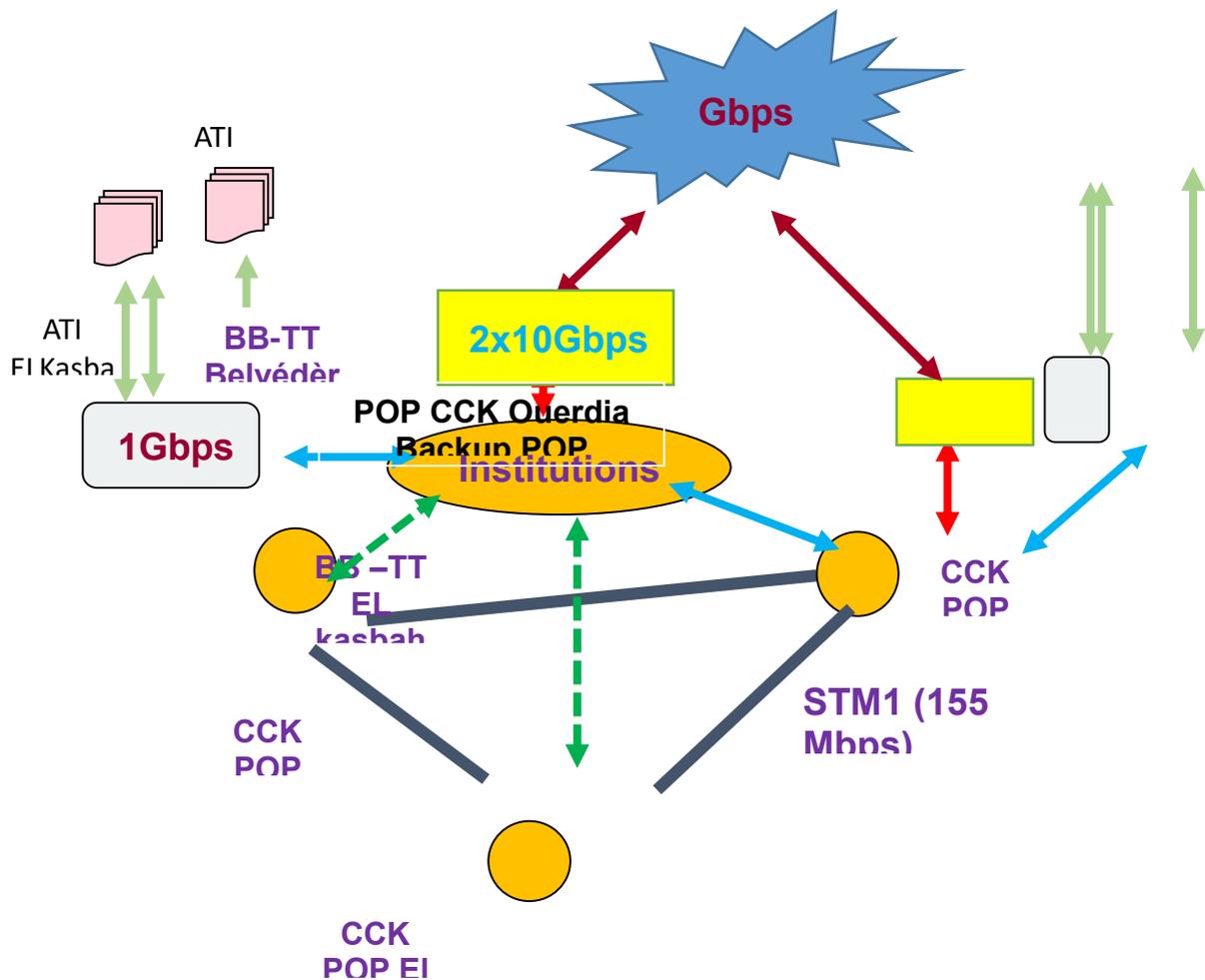


Figure 1. RNU – the Tunisian NREN as of June 2015

II. STATUS OF TUNISIAN HIGHER EDUCATION AND SCIENTIFIC RESEARCH

Higher education in Tunisia began with few hundred students and one university in 1957. Today it comprises 13 public universities having nearly 200 institutions and 63 private institutions, with a total enrolment of 300,000 students in public universities, and about 30,000 students at private universities. The total number of faculty members at public universities is about 25,000, over 90% of which are involved in research.

University education in Tunisia has always been strong, providing quality education to Tunisian and foreign students (slightly over 10,000 foreign students mainly from African and Maghreb countries), and supporting substantial research on issues of national, regional, and international interests. Recently, there has been a significant decline in the quality of teaching and training, mainly due to the increasing enrolment of students at universities and lack of potential funding resources.

On the other hand, Tunisian research activities have been steadily improving in number and quality. According to a study of Tunisian research activities for the period 2005-2009, conducted in the Web of Knowledge by Dr. Guillaume Rivalle, an expert of Thomson Reuters agency, scored extremely well compared to Arab and African nations. Table 1 gives ranking of Tunisia in different research fields and Figure 2 gives comparison of Tunisian research quality to other Arab and African countries.

Further, Tunisia ranks favorably with 3000 researchers per millions of population compared to a 500 ratio in other advanced countries.

According to the same study of Dr. Guillaume, Tunisian researchers published in 2009 around 4300 publications, slightly more than Saudi Arabia (4.200), Algeria (3.200) and Morocco (3.100).

With respect to absolute publication count, Tunisia is preceded by only two African countries of similar level of development: South Africa (14.000) and Egypt (10.100). In terms of number of publications per million inhabitants, Tunisia comes way ahead of all with 270 publications per million inhabitants, followed by South Africa (150), Saudi Arabia (75), Algeria (50) then Morocco (40). In terms of publication impact per million inhabitants, South Africa comes first with 65 points, followed closely by Tunisia (60), followed by Saudi Arabia (20), Egypt (18), Morocco (12) and Algeria (11).

Research fields	Tunisia Rank
Clinical Medicine, Material Science, Mathematics, Microbiology, Genetics and molecular biology, Neuro/behavioral science	2nd
Biochemistry, Chemistry, Computer Science, Engineering Géosciences, Pharmacology, Toxicology, Physics	3rd
Agriculture, Environment/Ecology, Plant and Animal sciences	4th
Economy and business, Immunology, Aerospace	5th

Table 1. African Rank of Tunisia according to its publications in 19 scientific fields

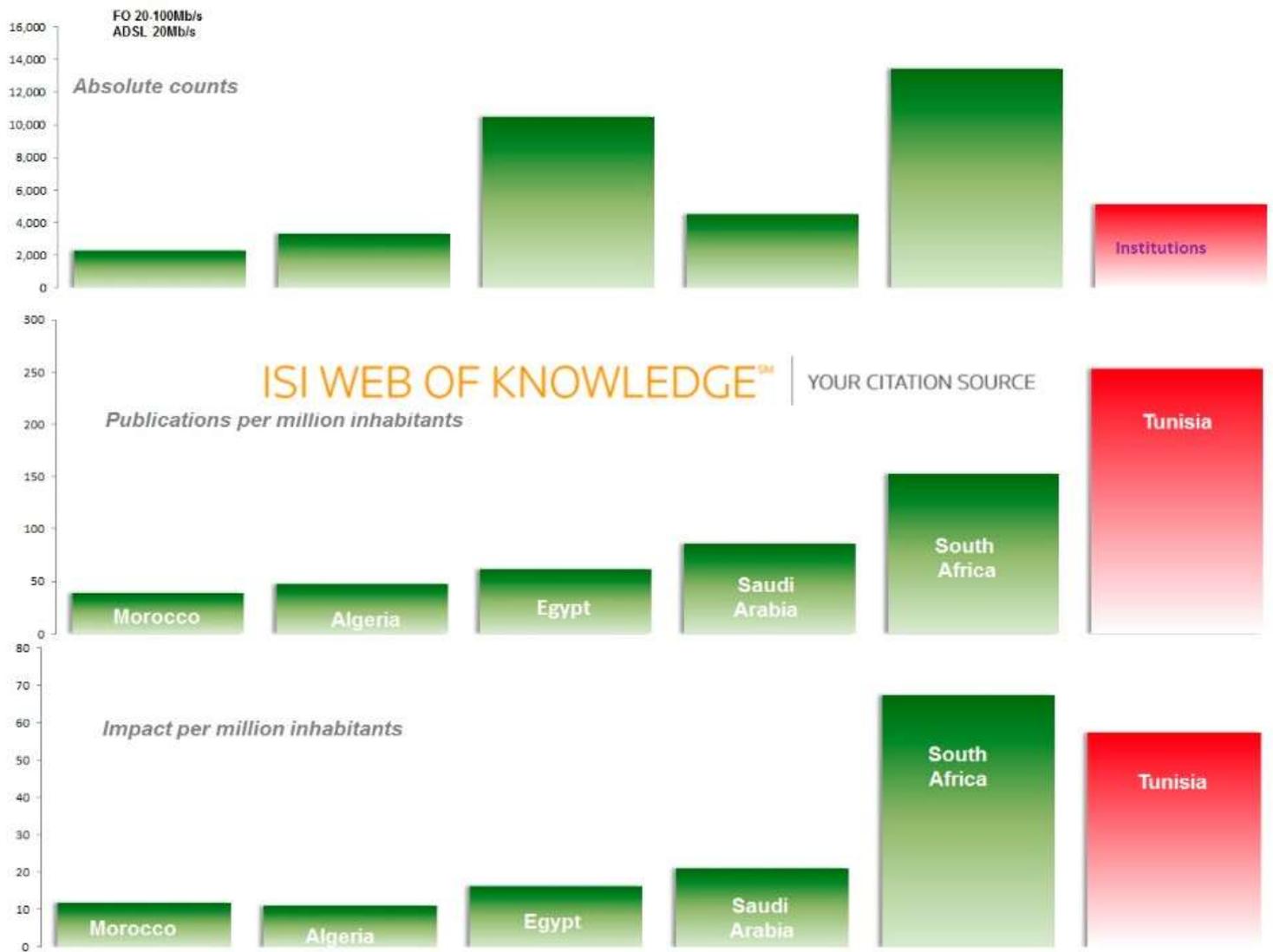


Figure 2. Number and quality of research publications of Tunisia compared to other Arab and African countries

Comparison of the scientific production of Tunisia with that of Malaysia (one of the Asian dragons) over the period 1980-2009 is given in Figure 3.

Web of Science Documents 5 Year Trends

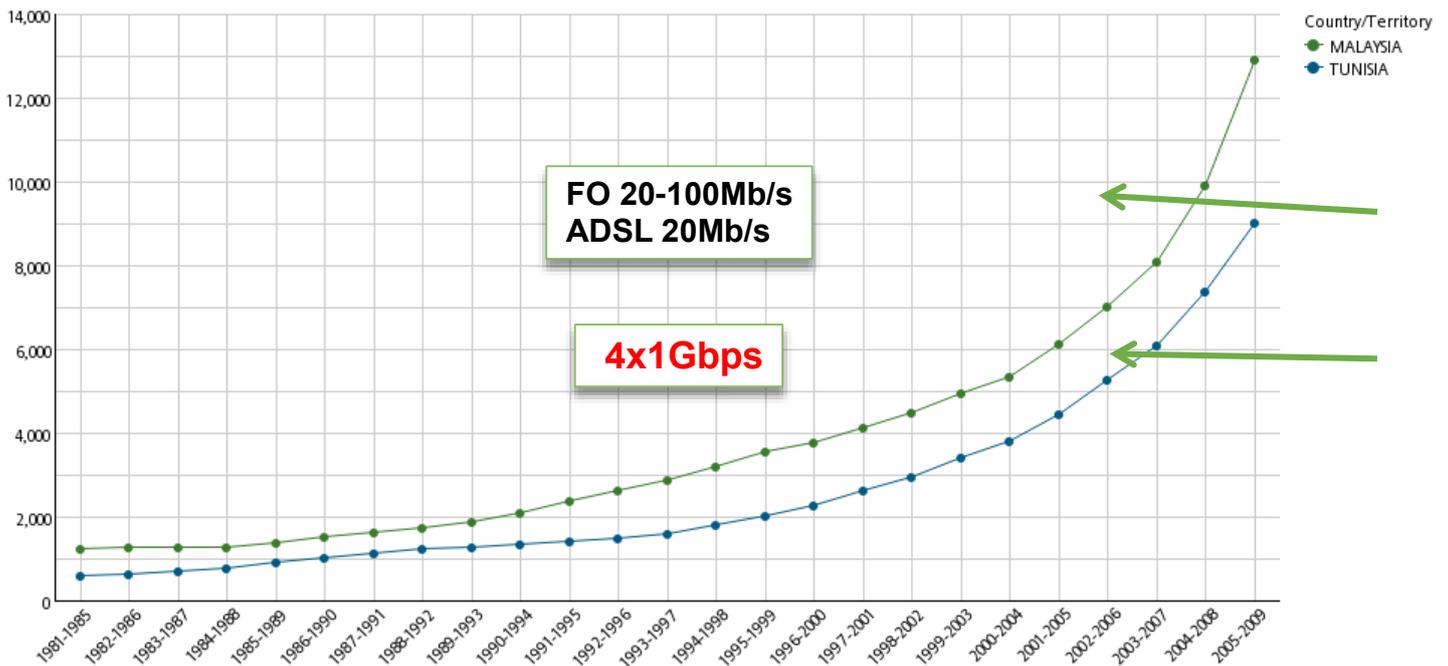


Figure 3. Comparison of the volume of scientific publications between Tunisia and Malaysia

With respect to international scientific collaborations, Tunisian researchers conduct most of their scientific collaborations with the European community (see Figure 4). The aforementioned numbers reflect the size and quality of Tunisian scientists and, where a reinforcement of ties with their peers across the world, can but improve the quality of their output and its impact on the Tunisian educational system and economy. This can be easily achieved by providing reliable high-speed access, with QoS guarantees to every Tunisian researcher and student.

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 for human/youth development, supporting a need-driven universally compatible educational system.

Achieving sustained growth, reducing unemployment and poverty, increasing research and innovation capabilities are the main development challenges in Tunisia. Numerous efforts are underway for a comprehensive reform in order to improve educational quality and innovation capabilities at all levels.

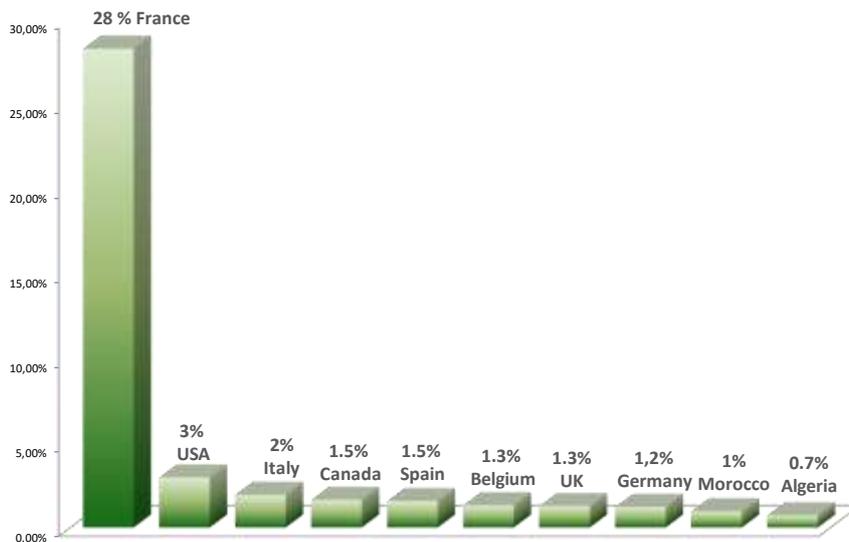


Figure 4. Tunisian scientific collaborations

Services and resources need to develop as well to justify the investment necessary for a dedicated high-speed international connectivity. Providing Tunisian young scientists with seamless access to the European advanced computing resources and facilities through high-speed dedicated networks, allowing them to initiate and maintain quality collaborations with their peers worldwide, is a strong justification to reconnect RNU.

III. RESEARCH AND INNOVATION

Over the last few years, Tunisia has been establishing a number of research centers specializing in various scientific and technological domains. These research centers entertain numerous collaborations with the European community and have pressing need for high-speed access to quality research resources available in European research centers.

Furthermore, Tunisia has been noted as one of the most active partners in the EC funded FP7 program in the Mediterranean region, being involved in 117 projects with an overall financial budget of 15 million Euros. In addition, it has tens of other research projects, financed through other programs. The highest level of cooperation in terms of proposals received is in medicine, environment, food, agriculture and biotechnologies, and ICT.

Despite the extensive involvement of Tunisian 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 RNU, whose traffic is transported via TT national network. Access to research-intensive data and computational resources is not possible through the commercial Internet. The Internet provides no dedicated high-speed capacity for the access of Terabits to 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, educators, 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.

IV. TUNISIAN UNIVERSITY NETWORK

RNU is the official National Research and Education Network in Tunisia. It links the public universities with high-speed connectivity via a 10 Gbps backbone, with a Multi-Protocol Label Switching (MPLS) at the core of its network for Flexibility, Scalability, Security and Management. It provides network and Internet services and facilitates communications, collaboration, experimentation, and learning to all public universities. RNU 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 RNU has access to Internet with 4 fiber links of 1 Gbps of capacity each, and a utilization of 75%. However, the Internet circuits do not provide dedicated access to scientific, research, and educational resources and facilities.

A. Organizational and governance structure

As a legal and independent organization, CCK is directly attached to the Ministry of Higher Education and Scientific Research of Tunisia. CCK is run by a Director General managing a team of 15 engineers, 17 Technicians, 12 administrative staff, and 27 supporting staff members.

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. CCK funding sources and role of ministry

CCK has been charged since 1997 of providing network and application services to the entire research and education community of Tunisia. CCK receives its budget from the Ministry of Higher Education and Scientific Research of Tunisia. Network access as well as Internet and application services are free of charges to all entities belonging to the Ministry of Higher Education.

C. CCK international connection and relations with ASREN

CCK has been running and managing the Tunisian NREN RNU since 1997. RNU has evolved tremendously in size and quality over the last fifteen years. Nowadays, it provides a wide range of services to the entire Tunisian academic community, namely Internet services, registrar and accounting services, library services, etc. Currently, CCK is in the process of establishing a modern data center, equipped with the necessary hardware and software resources that will enable the provisioning of a rich variety of agile services to the academic community. A high performance computing platform will be installed within the CCK premises of Manouba, offering a 100 Tflops of computing resources to the community. The platform is a donation of the Chinese government. CCK is a shareholder of ASREN (Arab States Education and Research Network, GmbH). However, RNU is not directly connected to any of the Arab NRENs. RNU (as well as RNRT, and AGRINET) was among the Arab Mediterranean NRENs connected to the GEANT network under the EUMEDCONENCT project.

Currently, RNU is not connected directly to any regional or global Research and Education Network, which we believe puts limitation of the developments of research in Tunisia. It is crucial that RNU reconnects to GEANT network. More opportunities are now open through the EUMEDCONNECT3 Program so that RNU can benefit from EC co-financing of up to 60%.

D. Ministry views of participating in EUMEDCONNECT3 and longer term EC support

Linking RNU to research and education networks is seen critical at this stage to provide the Tunisian academic community with a vast accessibility options to scientific resources and facilities in the wider context. However, financial charges should be brought down as much as possible to become close to commercial Internet bandwidth charges. The previous EUMEDCONNECT circuit to GEANT ended on 5 August 2011, due mainly to what has been seen as insufficient bandwidth and excessive financial cost. Indeed, at the time the connection to GEANT was suspended, the cost of the 1Mbps/month was nearly 556 Tunisian Dinars, which is more than 10 times than what CCK was paying for 1 Mbps/month of commercial International Internet access (1 Euro = 2.2 Dinars). With connectivity prices going down, and increased budget of EC support, CCK would like to be connected to the GEANT network, moving a step ahead in the new digital era of research connectivity.

V. BENEFICIARIES OF RESEARCH AND EDUCATION NETWORKS AND INTERNATIONAL LINKAGE

The beneficiaries of REN linkage consists of all entities owned by the Ministry of Higher Education and Scientific Research, namely:

- Education and research schools and institutes (200)
- Various administrative buildings (around 20),
- Research centers (38)
- Student dorms and restaurants
- The Sciences City of Tunis (la Cité des Sciences de Tunis)
- The Science Castle of Monastir (le palais des sciences de Monastir)

A library portal is hosted at CCK premises giving access to all Public academic libraries, thus providing an integrated library service platform to better integrate library services and sharing of common library resources at the country level. Scientific and technical documentation services are provided through another portal, which gives integrated and user friendly access to national and international literature (IEEE, Elsevier, Wiley, etc.).

Tunisia has created a network of 38 specialized research centers throughout the country, doing fundamental and applied research in various domains such as Clinical medicine, Material Science, Mathematics, Microbiology, Genetics and molecular biology, Neuro/behavioral science, Agriculture, Information and Communication Technologies, Nuclear and renewable energy, Marine biology, etc. These research centers entertain numerous collaborations with the European research centers.

VI. TUNISIAN INTERNATIONAL COOPERATION

As part of the European Neighbourhood 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 a 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

This study is looking at key development areas:

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

A. Expected outcomes

With dedicated networks, the expected outcomes are as follows:

- Dedicated high-speed networks linking universities and research institutions to support large data traffic of applications (Multimedia, HPC, GRIDs, CERN, etc.)
- Deployed e-Science services to support common experimental activities among distributed virtual research communities.
- Establish a common culture of research and education community towards building a collaborative research and distance education
- Reduce the digital divide 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 Tunisia. Research and education connectivity still lacks international outreach to allow Tunisian researchers access resources and peer with counterpart in the European institutions. The absence of dedicated international linkage is holding back collaboration within Tunisia and excluding researchers from a variety of European projects. CCK with relevant stakeholders needs 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 for Tunisia to interlink with the European, Arab, and African research and education networks.

The following represents concrete recommendations for developing a comprehensive Tunisian e-Infrastructure to better serve its research and education communities at the national level.

Short-term recommendations:

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 CCK international circuit (initially 622 Mbps STM4 or preferably 1 Gbps) connecting the Tunisian NREN to GEANT and other international RENs.
3. To participate in the AC2 funding and be part of the REN community at the African and Arabian countries.
4. To promote the utilization of research and education networks through applications support provided by Science Gateways, eduroam, and other e-Infrastructure services.
5. To deploy a Network Operations Center at CCK headquarters with all required hardware and software resources and trained personnel to adequately manage and monitor traffic activities on the Tunisian NREN.

Medium term recommendations:

6. To demonstrate benefits of research and education networks to stakeholders and decision makers through case studies.
7. To promote network with dedicated bandwidth and high-speed communication capabilities, enabling researchers to carry out innovative scientific research collaborations.
8. To introduce state-of-the-art service portfolio, including virtualization, cloud computing, high performance computing, and multimedia services.
9. To advocate the importance of research and education networks amongst decision makers and stakeholders to support the development of a sustainable national e-Infrastructure.
10. To support training and capacity building activities in areas related to network operation and management, and building expertise in emerging technologies.
11. To organize and participate in national/international workshops, technical training sessions, and mentoring programs.
12. To support long-term sustainability of CCK national integrated e- Infrastructure.
13. To develop Tunisian integrated backbone connecting all universities, research centers, colleges, schools, libraries and other organizations through a one national high-speed communication network.
14. To secure national and international funding to invest in and manage sustainable Tunisian national academic e-Infrastructure.

