

DIGITAL CONNECTIVITY FOR PROGRESS IN
RESEARCH, TECHNOLOGY DEVELOPMENT
AND INNOVATION:
POLICIES ON BUILDING OPERATIONAL
CAPACITIES ON THE NATIONAL LEVEL

This edition of policy papers is developed to assist the civil society and citizens, in general, engage in an informed debate and have access to expert knowledge, views and opinions on topics of importance for EU integrations. Areas in which the Republic of North Macedonia will lead its EU accession negotiations are both complex and diverse, while reforms that need to be implemented will open many dilemmas that necessitate an expert debate. For more contents produced under the project “CSO Dialogue – Platform for Structural Participation in EU Integrations”, visit the website: **www.dijalogkoneu.mk**

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INTRODUCTION

This document was developed as a proposal to improve policy-making, within the project рамките на проектот “CSO Dialogue – Platform for Structural Participation in EU Integrations “, and it aims to contribute advancing the digital connectivity on the national level, as a part of sectoral policies on digital technologies, research, technology development and innovation. The development of such sectoral policies is crucial for the reform processes related to EU-integration.

This document will make a chronological overview of the development of digital connectivity on the national level, within the context of its significance for the development of sophisticated digital technologies, research, technology development and innovation; it will describe the current state of play regarding policies for capacity building; it will make a comparative analysis of the state of play in other (proportional) economies in Europe and it will make proposals to improve policies related to building of operational capacities on the national level.

The motivation to develop this document has several aspects. The development of digital connectivity is one of the key factors for the Western Balkan countries EU accession, and it is defined as a provision in several strategic documents, including in the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and The Committee of the Regions (A credible enlargement perspective for and enhanced EU engagement with the Western Balkans[1]. This activity is initiated in a period when the country works intensively on the adoption of the National ICT Strategy[2], where one of the chapters is also Connectivity and Government Infrastructure. Finally, the third aspect is lack of progress in this area, in circumstances when all European countries, including the countries from the region, make massive investments in the modernization of infrastructure.

This document focuses on the role of the Macedonian Academic and research Network MARNET, as a legal entity, which needs to provide for planning of the development, implementation of superfast networks for the purposes of the scientific and research and educational institutions, organization and management, keeping the pace with the technologies and strengthening its position as a legal entity is crucial for policy making in the areas of digital technologies, research, technology development and innovation, since the IT infrastructure, built and maintained according to the state of the art technology standards is the foundation upon which to develop the IT systems and services for the businesses and citizens in the 21st century.

[1] <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52018DC0065>

[2] [ЕНЕР | Нацрт Национална Стратегија за ИКТ 2021-2025 в1.1 \(ener.gov.mk\)](#)

SPECIFICITIES OF CERTAIN ACADEMIC AND RESEARCH NETWORKS

Marnet

Macedonian Academic and research Network MARNET was established in 1995, as an organizational unit within the “Ss. Cyril and Methodius”. The main tasks of MARNET were defined around the inclusion of the University in the family of related academic networks in Europe and around the world, as well as providing Internet – access for the students and lecturers at the University. Several years later, the University “St. Clement of Ohrid” – Bitola was also connected to the Internet via MARNET. Later, after MARNET was pulled out as a separate legal entity (2010), the list of competences of MARNET involved also organization and management of the top-level Macedonian “.mk“ domain and the top-level Macedonian “.мкд“ domain[3].

In 2001, The Ministry of Education and Science opened negotiations for Macedonia to join the GÉANT project, after which MARNET became a member of the pan-European NREN association of research and education networks GÉANT[4]. The joint presentation of MON and MARNET within the GÉANT had the purpose of expanding the competences and services of MARNET by providing support for the digital / Internet-connecting of institutions at all levels of education, cultural institutions, social centers and government institutions, with the vision that the advanced infrastructure, based on superfast optical networks will ensure the prerequisites to develop sophisticated information systems and digitalization of institutions.

Nine years later, this vision was embodied in the Law Establishing MARNET[5], which made this institution a separate legal entity, independent of “Ss. Cyril and Methodius” University - Skopje, and supervised by the Ministry of Information Society. Pursuant to Article 4 of the Law, users of MARNET services shall be educational institutions (higher education, primary and secondary schools), scientific research institutions, as well as non-governmental organizations with activities in the area of child protection, social protection, sports and culture. The 2010 law foresees a broad spectrum of responsibilities for MARNET, although they are not adequately supported in the provisions of the Law pertaining to financing. It is even more absurd that the Law foresees that the extra revenues that MARNET would earn through its work would be paid into the state budget. Although the Law stipulates that MARNET will provide professional and technical connectivity to related “telecommunication networks“ abroad, it is still not supported in the provisions on financing, as defined in the Law. One such item in the provisions on funding would be, for instance, through MARNET’s participation in international projects, especially in the European science, research and development programmes (formerly FP7, and today Horizon Europe). It is observed also that the Law uses only the term telecommunication network, a term that is most general and that does not have a direct association to technology processes related to MARNET’s activities. Amendments to the Law, enacted between 2010 and now, are mainly “cosmetic” in nature, and are related, primarily, to the criteria for selection of MARNET’s director, but not the responsibilities and functions of MARNET or, for instance, with its legal status.

Although academic and research networks, as legal entities, are established primarily in order to provide support to the higher education and research institutions, still, in practice, their reach of influence expands also to provision of ICT – support and operative ICT – infrastructure for a broad spectrum of institutions, with a special focus on the ones in education and culture. That is a shared feature of all European academic and research networks. The intention for continuous upgrading of MARNET and

[3] [Правилник за организацијата and управувањето со врвниот македонски .MK домен and врвниот македонски .МКД домен](#) (Rules on Organization and Management of the top-level Macedonian .MK domain and the top-level Macedonian .МКД domain)

[4] GÉANT Association member map 28 November 2017 (geant.org)

[5] [Закон за основањето на македонската академска истражувачка мрежа - MARnet](#) (Law establishing the MARNET)

positioning of its role as a provider of stable infrastructure for the education and science institutions (schools, universities, training centers, scientific research institutions) and culture (libraries, museums, etc.) is clearly stated in several national strategic documents.

The National Strategy on Information Society[6] of 2005 foresaw the project PR4.02 “Broadband connection to the scientific research, educational and cultural institutions and connecting MARNET to the European Academic Network GÉANT and the global Internet“ with the aim that “this network provide low cost and quality transfer of information between entities, and with the other education entities around the world. In addition to interconnection on the aforementioned institutions in the country, of special interest is also the support and joining the action plans in the region, and corresponding EU-projects in the area of fast networks“. This project was planned for funding through state funds, foreign donors and the GÉANT project. The Strategy very precisely indicates the main risks related to the implementation of the project PR4.02: **Delayed staffing, professionalization and financial stability of MARNET**. Further on, the Strategy foresaw that MARNET be included also in the PR4.03 project for e-Education, where MARNET would have its role in equipping the schools with ICT-equipment and setting the network infrastructure. In the period of development and approval of this Strategy, the Macedonian Academic and research Network was still a component, an organizational unit with the “Ss. Cyril and Methodius” University - Skopje. After clear roles for MARNET were defined in the Strategy, a process was initiated to establish autonomy for MARNET as a legal entity, and it was finally made official with the adoption of the Law on Macedonian Academic and research Network in 2010.

In line with the recent global technology development in the area of network infrastructure, the National Operational Broadband Plan (NOBP)[7] of 2019, developed by the Ministry of Information Society and Administration also entrusts MARNET with specific tasks related provision of network infrastructure for the academic, research, educational and cultural institutions. As indicated in NOBP, by 2029 MARNET should provide a symmetrical Internet access for all educational institutions, with 1Gbps bandwidth. Within the development of NOBP two mappings of the existing network infrastructure were carried out: mapping of the existing optical infrastructure built with public funds and detailed mapping of the existing coverage and plans of operators regarding future investments into NGA networks. While in terms of the second mapping there is a fairly precise overview of the coverage of households on the territory of the entire country, categorized by municipalities, in the first mapping there is missing data on the number of public institutions (not) covered by infrastructure (primarily scientific and research, education, cultural and healthcare) and the quality of their access to infrastructure. Provision of data on the current situation with access to infrastructure by public institutions, and an analysis of their future needs would help to define the scope, development timeframe and financing of MARNET in the future. Within Annex 4, which pertains to the selection of the investment model to build broadband infrastructure, NOBP does not consider the possibility that MARNET could, and should be funded also through its participation in international projects (which had been foreseen in the National Strategy on Information Society and Action Plan of 2005). Financing through participation in international projects will contribute towards quality development of the academic and research network and will advance the professional development of staff. The comparisons of MARNET with academic and research networks from European countries of similar size as North Macedonia show that MARNET is lagging behind in organizational, financial and technological sense. According to the data available, the bandwidth of the university network infrastructure in our country is between 1 and 9 Gbps. The annual budget (2021) of MARNET is around 730 thousand EURO, out of which 30% are foreseen to come from donations. In the structure of the budget, capital expenditures amount to 36%, goods and services to 56% and salaries and benefits for the 10 staff amount to around 8%. Although it is legally possible for MARNET to

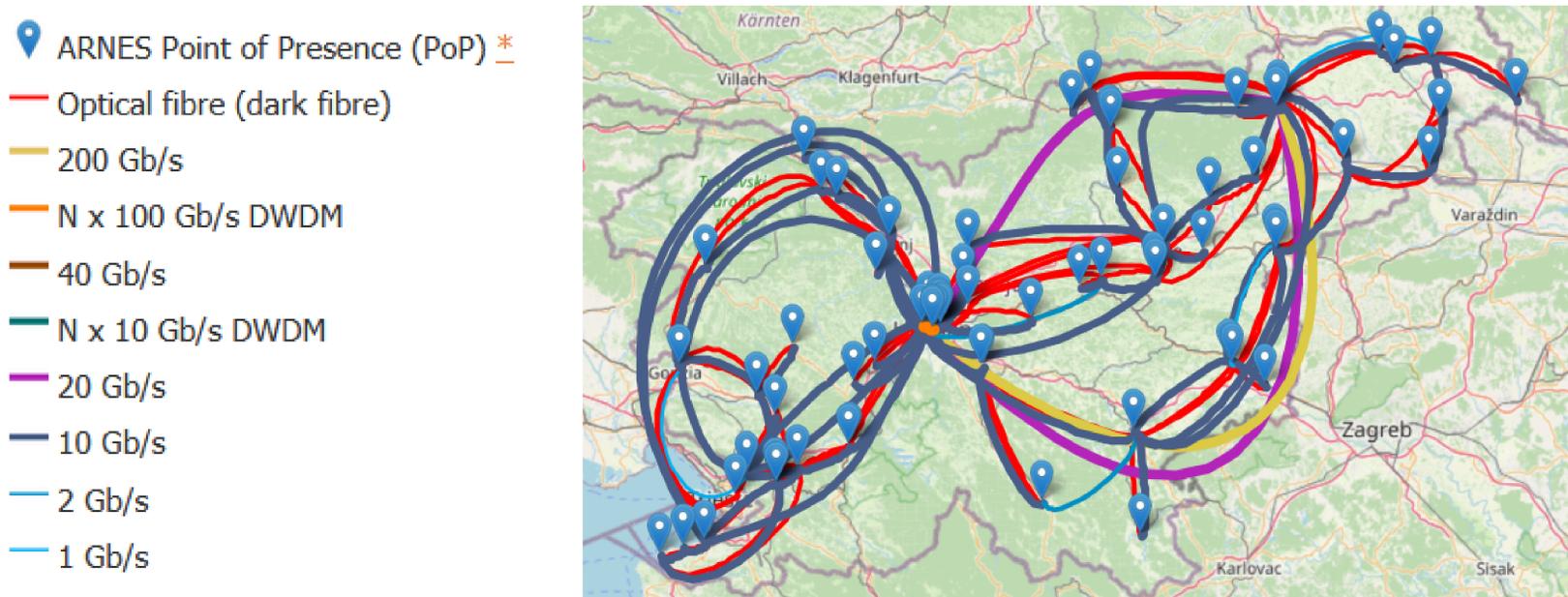
[6] [Национална стратегија за информатичко општество and акционен план, 2005 година](#)

[7] [National Operational Broadband Plan \(NOBP\), 2019](#)

participate in the projects building infrastructure for educational and cultural institutions, still, in practice, MARNET is mainly involved in implementation of infrastructure for the universities in the country and in international projects.

ARNES

Academic and Research Network of Slovenia (ARNES[8]) was established in 1992. In 2020 it had a budget of 9 million Euro (an increase of 1 million compared to 2019) and around 62 staff (4 more than in 2019). Over a period of almost 30 years, ARNES built a complex infrastructure that covers all scientific research institutions in Slovenia, cultural institutions (libraries, museums) and educational institutions[9]. ARNES is involved in projects to secure ICT – equipment for schools, provision of network infrastructure (optical connectivity and internal wireless networks), developing e-services and digital content. ARNES' infrastructure[10] for the connected institutions ensures connections with different bandwidth, in a spectrum between 1 and 100 Gbps, and the two university centers– Ljubljana and Maribor are connected with a 200 Gbps link.



Picture 1. Main broadband infrastructure of the academic and research network of Slovenia (situation in October 2021)

ARNES carries out its activities following the principle of multiannual programmes, which include projects with specific objectives. So, towards the end of 2020 година ARNES completed the SIO-2020 project[11], which practically unified the ICT – equipment in 824 schools in Slovenia, which paved the way for rapid digitalization and more effective execution of the education process. Other results of SIO-2020 are: development of digital contents and e-services in education, setting up Wi-Fi networks in schools, producing guidelines with standards and norm on digital literacy and IT in schools, defining standards for ICT and multimedia equipment in schools, etc. The information about ARNES's activities indicate that ARNES has a close programme cooperation with universities and schools, and as a result of that, ARNES has good overview of their needs and strategic objectives. Owing to that, ARNES manages to deliver services and to provide infrastructure, which is crucial for smooth and efficient implementation of activities of the involved institutions. ARNES, as an institution, is a regular participant in international projects[12], especially in EU-projects in programmes for research and development

[8] [Academic and research network of Slovenia - ARNES](#)

[9] [Institutions – member of ARNES](#)

[10] [ARNES Backbone Network](#)

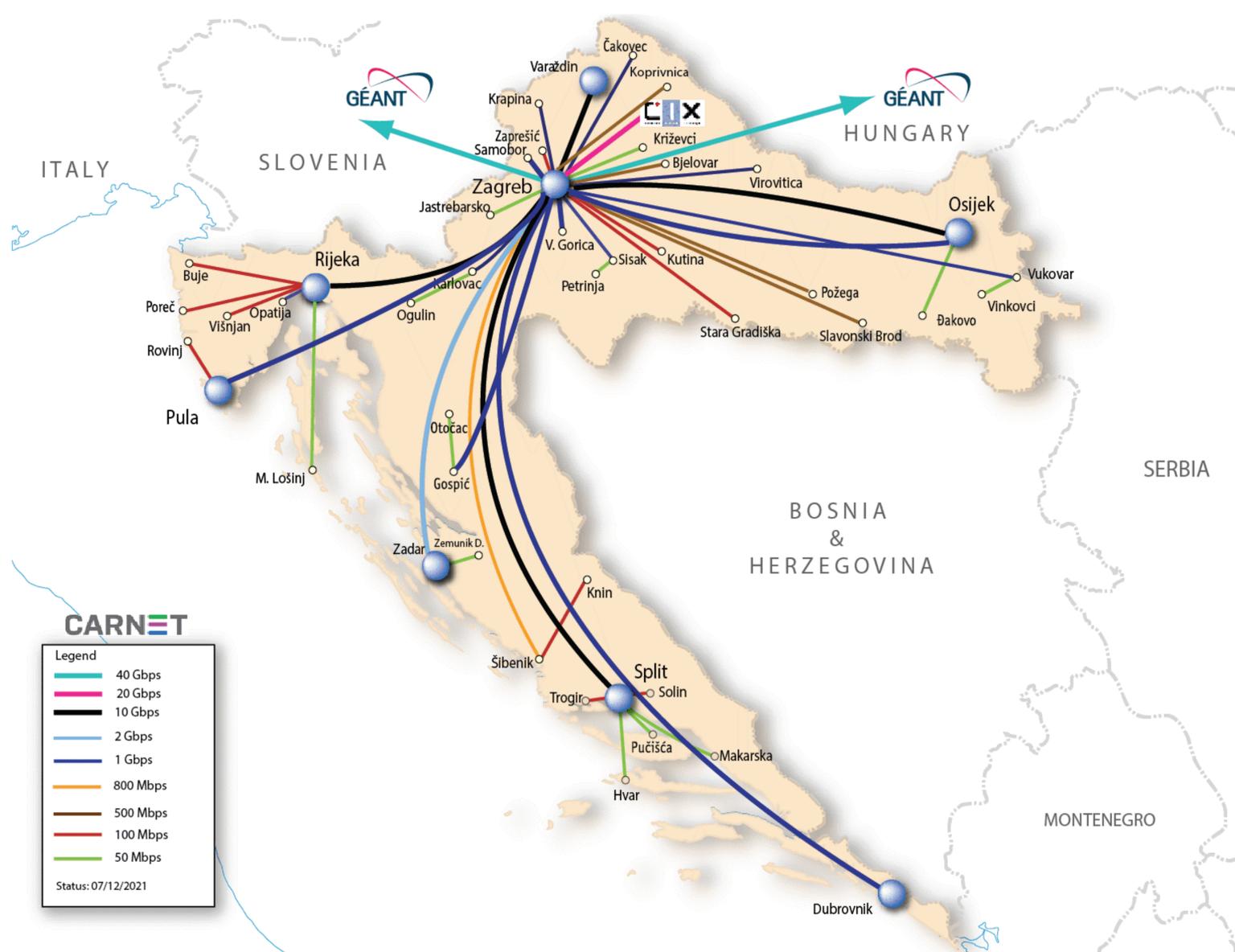
[11] [Program nadaljnje vzpostavitve IKT infrastrukture v vzgoji in izobraževanju – SIO-2020](#)

[12] [ARNES – International projects](#)

(GÉANT, FP7-Infrastructures, Horizon 2020, Horizon Europe,...), European education programmes, etc., which extends the remit of ARNES also to the areas of e-Health, astronomy, elementary particles physics, etc. ARNES cooperates with supreme scientific research institutions from Europe, such as institutes Max Planck, Jozef Stefan, CERN, and others.

CARNET

Croatian Academic and Research Network CARNET[13] was established in 1991 and over a period of 30 years it built a modern network infrastructure, which spans the entire territory of the country. CARNET has more than 176 staff (17 more compared to 2019), deployed in 6 organizational units (Zagreb, Osijek, Pula, Rijeka, Split and Dubrovnik) and an annual budget of more than 30 million Euro.



Picture 2. Main broadband infrastructure of the Academic and research network of Croatia (situation in July 2012)

[13] [Хрватска академска истраживачка мрежа - CARNET](#)

In 2021 the CARNET - network provides connections with bandwidth (speed) between 50 Mbps and 2 Gbps. The university cities are connected to Zagreb with a 10 Gbps link, while the link to the GÉANT-network is 40 Gbps, which is a 10-fold increase in connection speed compared to 2011. CARNET today provides a broad spectrum of services and is a key partner of the academic and research community and the Ministry of Education of the Republic of Croatia in the operationalization of activities foreseen in development strategies and plans. In February 2021, CARNET started the HR-ZOO project, with a 26 million Euro value, to provide a 100 Gbps link between the data centers of CARNET. The upgraded infrastructure has the purpose of installing a cloud environment that will be the foundation for the national research and innovation e-infrastructure. Partner of CARNET in the project, in addition to the universities, is the Scientific and Research Institute “Rudjer Boskovic”. For the educational institutions and for the Ministry of Education, CARNET provides an Internet connection, but also web-hosting, hosting of e-mail services, tools for online collaboration and videoconferencing, licensing applications, platforms for distance learning, digital content, training and consulting. CARNET participates in projects under European research and development programmes.

Comparison

According to official data[14] from GÉANT for 2020, CARNET provides service to 200.000 university students, 5.000 researchers in research institutes, 1.000 participants in adult training at open universities, 100 international researchers, 300 users in cultural institutions (libraries, museums, etc.), 14.000 users in healthcare institutions, 400.000 students in primary schools, 205.000 students in secondary schools, 53.000 users in government institutions and 1.000 users in profit-making organizations.

	Universities	Research Institutes	Further Education	International Research Institutions	Cultural Institutions	Hospitals	Primary Schools	Secondary Schools	Government	For profit organisations
AzScienceNet	100,000	9,000			1,200					
BELNET	543,947	28,669	900	375	2,369	21,791		61,796	123,852	900
CARNet	200,000	5,000	1,000	100	300	14,000	400,000	205,000	53,000	1,000
CESNET	380,000	50,000	4,000	500	1,600	5,000	2,500	22,000		4,000
CYNET	50,000	650	2,000							2,000
DelC	150,000	1,200	100,000	100	1,000	80,000		7,000	1,000	100,000
FCCN	401,174						802,133	297,610		
FUNET	360,000	14,000			1,000				4,000	
GARR	1,500,000	30,000		2,700	1,000	8,000	85,000	205,000		
GRENA	86,000	2,500								
GRNET S.A.	300,000	40,000	20,000		10,000	20,000	100,000	100,000	1,000	20,000
HEAnet	230,000						450,000	350,000		
IUCC	140,000									
Jisc	2,500,000		2,500,000							2,500,000
KIFÜ	100,000	50,000	1,000	200	200,000	5,000	600,000	600,000	100	1,000
MARNET	60,000									
MREN	20,000									
RENAM	74,500	2,900	850					208		850
SURFnet	750,000	120,000	430,000	10,000	20,000	30,000	60,000	60,000		430,000
SWITCH	318,663		770		0		0	0		770
ULAKBIM	3,900,000	5,500							5,000	
URAN	500,000	1,600	1,000	200	180	1,000	0	0	170	1,000
Total	12,664,284	361,019	3,061,520	14,175	238,649	184,791	2,499,633	1,908,614	188,122	3,061,520

Picture 3. Estimates of number of individual users per institution type

[14] GEANT Compendium of the National Research and Educational Networks: Picture 3: Estimates of the number of individual users per institution type

According to the same source, MARNET provides access only for students of universities in the country. In the GÉANT compendium, 2020 edition, there is no data about the categorization of ARNES users, but information on ARNES ‘ completed projects (such as, for instance, SIO-2020) point to the diversity in users of ARNES’ infrastructure.

Service to these users is provided using infrastructure for which’ creation and maintenance the three aforementioned networks allocate amounts that are difficult to compare, as indicated in the text above. What is particularly interesting is that MARNET, ARNES and CARNET are at the top of the list of academic and research networks, in terms of budgets vs. the national GDP. CARNET is by far the leader out of all academic and research networks – members of GÉANT. The index of CARNET is 0.06, of ARNES is around 0.02, and of MARNET is 0.01. The Hungarian scientific and research network KIFU is in this group, too, with an index of around 0.025. All other networks have an index lower than 0.01.

2019	GDP (billion EUR)	GDP per capita (EUR)	NREN budget (million EUR)	Population (~ millions)
MK	11.3	5500	1.14	1.8
SI	42.53	22360	9	2
HR	48.25	13276	30	4

The absorption capacity of MARNET to execute larger budgets needs to be looked for in its status, the number of employees and structure of staff. The official data of GÉANT indicate that MARNET is at the bottom of the list of academic and research networks, based on the percentage of engineering staff among its employees (data from 2020). Having in mind that MARNET has six employees, we can conclude that it provides support to all universities with one engineer on staff; these activities need to include also planning of the development of the network and ongoing maintenance.

Due to the modest human resources available, the computer center of FINKI (within “Ss. Cyril and Methodius” University – Skopje) has provided full technical maintenance to the MARNET infrastructure over the past 2-3 years.

Specifically, regarding this issue, the implication should be that MARNET needs to have a larger budget and more staff (including engineering profiles) so that it can provide more services for more (types of) institutions, and not that the staff numbers in MARNET are low because MARNET provides services only for the higher education institutions in the country.

Implications of the draft ICT strategy 2021-2025

The draft ICT strategy 2021-2025 foresees establishing a national digital agency of North Macedonia (DASM, Macedonian abbreviation). The implicit conclusion from the analysis of the Draft-strategy indicates the potential that MARNET might close. According to the provisions of the Draft-strategy pertaining to DASM, it will have a broad scope of competences and a complex structure that will comprise the following functional domains: Digital public services, IT-mission and operations, Infrastructure, Value implementation, Implementation of the Strategy – Plan to implement the portfolio, Governance, Procurements, Innovation, Management of Knowledge and Best Practices, and Backoffice. Still, in the description of the functional domain Infrastructure the focus is placed on the support and upgrade of the operational capacities of the Government, while “...other ministries or government agencies remain responsible for their own infrastructure in cooperation with DASM“. It is unclear whether, in that situation, MARNET would still have the competence for maintenance of the academic and research IT network infrastructure. It should also be considered that the Draft Strategy foresees taking away from MARNET the competence to manage the top-level Internet domain “.mk“, since in the description of the functional domain “Design and Delivery” it is indicated that one of the competences of DASM would also be “...management of central registration and administration of the national top-level domain of the Internet network .mk“. Further on, the description of “Design and Delivery” reads that DASM will be responsible for:

„...planning, implementation, operation and monitoring of achievements of all virtual and closed user groups in the networks of the Government of RNM (for instance, government’s digital network) and other public networks (for instance, academic research network), supported by the relevant stakeholders..“

A pertinent question is whether MARNET is planned as one of those stakeholders. The notion “academic and research network“ was mentioned only in this place in the Draft Strategy.

In the Education Strategy 2018-2025[15], in chapter 5.3.2 Higher Education and Research, as well as in 5.7 General/common priorities in the education system, MARNET was not included among the priorities, nor was it mentioned in any way.



[15] [Стратегија за образованието за период 2018-2025 and Акциски план](#)

CONCLUSIONS and RECOMMENDATIONS

The key documents of national public policy fail to identify the need of scientific research and educational institutions and governmental bodies that operate in that domain to receive “on demand” components/services/support, for instance cloud-based server architecture, virtual servers, fast internet-connection to certain locations, etc. MARNET could guarantee the provision of the necessary IT-resources and services to targeted institutions, successfully, similarly as it is done by most of the NREN institutions across Europe. Through this at the operational level, MARNET will allow the users of these resources and services to exercise their activities smoothly. In addition to this, long-term strategies for development of the academic and research network and participation in international projects will open a broad spectrum of possibilities for the scientific research institutions, innovators, start-ups and other legal entities or individuals who have the potential to contribute towards the technology development of the country. There are several key prerequisites needed to achieve that role of MARNET:

- » Defining special legal status of MARNET as a legal entity;
- » Including MARNET in all relevant strategic documents;
- » Developing and adopting a Strategy for Development of MARNET;
- » Providing adequate financing.

The legal status is an important factor for the development of MARNET in order to provide for broader spectrum of activities/remit of work of MARNET, which will comprise and facilitate participation in international projects. This measure will have an impact on provision of additional revenues for MARNET, which could be used as incentive for scientific research and applicative projects on the national level, improving of services and resources, financial incentive for the staff. The supervision of MARNET should be entrusted to universities and scientific research institutes, which will make it possible to create a better development vision, between networking on the international level, quality process of staff selection (especially the ones with an engineering profile/position), planning of the professional and career development of the engineering profiles, with a focus on the academic aspects, and better expertise for development of infrastructure and services at the technical level. MARNET with a vision, quality human resources, intensive international cooperation (primarily at the European level) and quality infrastructure will guarantee development of digital technologies, researching, innovation and technology development.

Including MARNET in all relevant strategic documents and the development and adoption of the Strategy for Development of MARNET are key factors and they need to reflect the new vision for MARNET.

The document „*A credible enlargement perspective for and enhanced EU engagement with the Western Balkans*“ clearly defines the orientation to support the implementation of broadband Internet, and it heralds the publication of the Digital agenda for the Western Balkans. The Indicative Strategic Document of IPA2, chapter on competitiveness and innovations, suggests that “efforts need to be made to strengthen the institutions responsible for quality infrastructure”. The indicative strategic document for IPA2, the chapter on competitiveness and innovation, indicates that “efforts need to be made to strengthen the institutions responsible for quality “. At the time of digital transformation of all segments of the society, digital infrastructure is crucial. Building a broadband Internet infrastructure is one of the five priorities of the Western Balkans Digital Agenda. Pursuant to this document, broadband Internet

is the basis of digital transformation in all segments (e-governance, e-health, digitalization of the industry, research and innovation, small and medium-sized enterprises, and startups, education, digital skills) and it identifies the large digital gap between the Western Balkans and the EU, as well as the lack of quality connections to remote locations. Digital connectivity is essential also for the building of enabling environment; therefore, policies to build the capacities of relevant institutions need to comprise and focus on effective participation in “Horizon Europe “ and GÉANT¹⁶].

Finally, financing of the institution in charge of the academic and research network, that benefits several societal activities, needs to be prioritized and to be proportional to the goals set in the strategic documents and action plans.

[16] GÉANT Association Strategy 2021–26, Section 6.: Strategic Goals

