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Co-ordination of Research Policies with the Western Balkan Countries

NATIONAL BACKGROUND REPORT ON ICT RESEARCH FOR KOSOVO (under UNSCR 1244)

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Acknowledgements

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EXECUTIVE SUMMARY

Information and Communication Technologies (ICTs) present the technological fundament of the information and knowledge based society. Kosovo[1] has a chance to improve the wellbeing of its citizens through technology-enabled industries and services. Moreover, the results delivered by ICT R&D may be well of use for many other disciplines of science and technologies. In addition, ICTs are the main driving engine of innovation in a modern society, and as such should be given attention at the respectable level.

Kosovo has recently improved in ICT performance (considerable growth of GDP in the sector). However, existing research infrastructure and resources are scarce, and investments should follow to enable research in ICT. There is an urgent need of enabling technologies for building an information and knowledge based society.

The project "Co-ordination of Research Policies with the Western Balkan Countries" (wbc-inco.net)[2] funded by the EU under the FP7 Programme aims to contribute on integration of the Western Balkan Countries into the European Research Area. As part of that project, this national background report on ICT research for the period 2009-2013 has been prepared.

The report first overviews the current ICT research environment in Kosovo, i.e., the local policy framework, fields of competencies in ICT research, the ICT sector trends, and the main socio-economic challenges that impact the R&D in ICT field. Kosovo in the context of its involvement in the EU's research projects with an emphasis on ICT is then discussed, followed by a SWOT analysis of the ICT research capacity in Kosovo.

Finally, the national background report introduces ICT research priorities on the basis of the country's readiness, as well as priorities on the basis of future potential. A summary of the consultation process conducted therefore is presented in the report. Although in a tight priority competition, 10 priorities were identified to represent the highest ICT research priorities of Kosovo for the period 2009-2013. For each priority, specific (socio-economic or other) objectives are defined, and a set of research topics per objective enlisted accordingly.

In terms of a wider objective, the national background report on ICT research is intended to contribute to the shaping of future research cooperation in relations EU-Western Balkan countries through funding programmes and policies of EU research that meet the actual needs of regional ICT domain.

[1] Under UNSCR 1244

[2] Project contact number is 212020.

Contents

Introduction

Research is an important part of higher education, and a central pillar of a knowledge based society. Information and Communication Technologies (ICTs) present the technological fundament of the information and knowledge based society.

Kosovo should follow the European practice of fostering research in ICT which is one of the highest priority themes of the EU's Seventh Framework Programme (FP7) for Research and Technological Development, which will fund research across Europe from 2007-2013.

Investments in ICT research are a chance for Kosovo to boost economic growth and improve the quality of life and work of its citizens.

Although the performance of the ICT sector in Kosovo is steadily increasing (considerable growth of GDP in the sector), the importance of ICT for the wellbeing of its citizens goes well beyond that. ICTs are also critical to:

- Improving the efficiency of public services as well as business-related applications, and modernizing sectors ranging from health to education.
- Delivering cutting-edge solutions to all disciplines of R&D.
- Exploiting European ICT research results and their adoption to local market needs.
- Enabling integration into the global R&D community by boosting innovation and competitiveness in all industrial and service sectors.

1. Purpose of the national background report on ICT research

This national background report on ICT research has been prepared within the framework of the project "Co-ordination of Research Policies with the Western Balkan Countries" (wbc-inco.net)[2] funded by the European Community's Capacities Programme on International Cooperation under the 7th Framework Programme for Research and Technological Development (2007-2013).

The report aims to provide an overview of the current ICT research environment in Kosovo, and to identify ICT research and development (R&D) priorities for Kosovo in the period 2009-2013. A wider objective of the report is provision of data relevant to master and shape the future research cooperation in relations EU-Western Balkan countries through funding programmes and policies of EU research that meet the actual needs of regional ICT domain.

Consultation process was conducted for a month to develop this report. Questionnaires were sent to ICT stakeholders according to their profile:

- National R&D policy-makers: government and ministry representatives.
- Higher education institutions: academic researchers at universities.
- Industrial actors: software companies, Internet and telecom providers, and main public service providers.
- Potential donors: foreign R&D agencies, funding programmes and associations, and NGOs.

A summary of the consultation process with all the actors consulted, and results acquired, is presented in Annex 1 of this report.

Although in a tight priority competition, 10 priorities were identified to represent the highest ICT research priorities of Kosovo for the period 2009-2013 and will be introduced in the remainder of this document.

The report was prepared by Dr. Ing. Lule Ahmedi, Assistant Professor at University of Prishtina, Kosovo, and University of South East Europe, FYR Macedonia. Dr. Ahmedi received her PhD in computer science at University of Freiburg, Germany, where she also did teaching and research for longer then five years as a member of the Databases and Information Systems Department. Dr. Ahmedi is author of several referred papers in renowned international conferences.

2. The ICT research environment in Kosovo

2.1 The Kosovo ICT policy framework

2.1.1 The overall ICT policy framework

Department of Information Technology (DIT) within the Ministry of Public Services is responsible for setting standards and provision of electronic services in all governmental institutions[3]. In 2008 DIT adapted "Electronic Governance Strategy 2009-2015". The strategy reviews the current situation in all governmental institutions regarding the ICT infrastructure, and recommends a strategy for implementing electronic services to citizens in healthcare, education, justice, and business, just to mention few.

Government has approved many laws, administrative directions and policies, and standards applied, which regulate the application of ITC in governmental institutions. Law on Telecommunications No. 2002/7[4] governs all telecommunications services and all telecommunications service providers in Kosovo, and is responsible for creating a

[3] http://www.ks-gov.net/MAP/DocumentsShpalljet/E_Governance_Strategy_2009_-_2015.pdf
[4] http://www.gazetazyrtare.com/e-gov/index.php?option=com_content&task=view&id=102&Itemid=28&lang

transparent legal and regulatory environment which promotes investments and free competition to meet the requirements of all users of telecommunications services. Law on Information Society Services No. 02/L-23[5] is another law in the field of ICT. It makes electronic documentation legally equivalent to its traditional counterpart in paper format, in order to facilitate commercial activities (e.g., e-Trade, e-Banking, e-Payment, e-Government, e-Procurement). Law on The Administrative Procedure No. 02/L-28[6] regulates the electronic execution of activities of the public administration. Moreover, Law on Copyright and Related Rights No. 2004/45[7], and Law on Scientific Research Activity No. 2004/42[8] have been adopted, whereas Law on the Protection of Personal Data[9], and Law on Prevention and Fight of the Cyber Crime[10] have been drafted and are being considered for approval by the government. Further as part of the legislature building, a number of administrative instructions have been promulgated which regulate the use of ICT in government, such as Administrative Instruction on Use of Licensed Software No. 2007/02 - MPS[11], and Administrative Instruction on Using Official Electronic Mail (Official E-Mail) of Kosovo PISG No. 2005/03 - MPS[12]. The legislation infrastructure is still incomplete, thus a need arises to respectively amend it.

The Ministry of Transport and Communications, Department of Information and Communications Technology, is responsible for policy related to telecommunications, and the government approved "Telecommunications Sector Policy"[13] as proposed by this ministry in 2007[14]. The policy's main goals are to promote market entry, promote competition and a level played field, achieve universal access, ensure optimal usage of scare resources, and establish a more effective legal framework for the monitoring and supervision of the telecommunications sector.

In 2003 the Assembly of Kosovo has by the Law on Telecommunications established an independent regulator body for telecom – The Telecommunications Regulatory Authority (TRA)[15] which is responsible for implementing the policies of the government and the Ministry of Transport and Communications pursuant to this law, and all other implementing legislation enacted pursuant thereto. TRA has hereby issued several

[5] http://www.assembly-kosova.org/?cid=2,191,185
[6] http://www.gazetazyrtare.com/e-gov/index.php?option=com_content&task=view&id=43&lang=en
[7] http://www.gazetazyrtare.com/e-gov/index.php?option=com_content&task=view&lang=en&id=62
[8] http://www.gazetazyrtare.com/e-gov/index.php?option=com_content&task=view&id=35&lang=en
[9] http://www.assembly-kosova.org/?cid=2,194,116
[10] http://www.assembly-kosova.org/?cid=2,194,55
[11] http://www.ks-gov.net/map/Documents/UA%20nr.2007-02-%20MSHP%20per%20perdorimin%20e%20softuereve%20te%20licencuar-5.pdf
[12] http://www.ks-gov.net/map/Documents/AI.%20No.2005.03-MPS.pdf
[13] www.vienna-economic-forum.com/uploads/media/Kukaj.pdf
[14] Draft of the policy available at http://www.art-ks.org/docs/publications/Telecommunications_Sector_policy.pdf
[15] http://www.art-ks.org/

regulations[16] for the implementation of this law. An international telephone dialing code and a Country Code Top Level Domain (ccTLD) have yet not been assigned to Kosovo[17], and are thus addressed in the Telecommunications Sector Policy as one of the main activities of the TRA.

Kosovo is active member of the eSEE Initiative - (Electronic South East Europe)[18], which aims to better integrate SEE countries into the global, knowledge-based economy by supporting them in the development of the Information Society, in line with the i2010 framework[19]. Since 2007 the eSEE membership focuses its activities on the implementation of "The eSEE Agenda Plus for the Development of Information Society in SEE 2007-2012". By signing this Agenda, Kosovo shares the objectives of the eEurope and eEurope+ processes, i.e., promote a single, open and competitive internal ICT market, give priorities to innovation and investment in research and education and strives to achieve an inclusive e-Society. In 2005 Kosovo signed a Memorandum of Understanding on the development of a unified market of broadband networks fully interconnected to the European and global networks - Initiative for bSEE - Broadband South Eastern Europe in 2005.

The drafting of national Frameworks of Interoperability is a recommendation that comes from the Pan-European Interoperability Framework and will prepare Kosovo for the networking of its systems and electronic services with that of various countries of EU. Such directions in the field of Interoperability are a great help for countries that wish to integrate in all EU structures. Kosovo is determined to follow all recommendations that come out of the Pan-European Framework of Interoperability[3].

2.1.2 The elements of ICT research policy making

In 2004 Ministry of Education, Science, and Technology (MEST) has adopted a "Strategy for development of Higher Education in Kosovo 2005-2015"[20].

The main objectives determined by this strategy are:

1. Elaborating and implementing a contemporary and all-inclusive education policy and finalizing the higher education legislation.
2. Advancing of management and coordination in higher education.
3. Developing of the management system of the higher education quality.
4. Advancing of the capacity for research and scientific work.

[16] http://www.art-ks.org/index.php?id=27
[17] http://www.art-ks.org/docs/publications/Telecommunications_Sector_policy.pdf
[18] Electronic South East Europe Initiative (www.stabilitypact.org/e-see/, now working under the umbrella of the Regional Cooperation Council (www.rcc.int).
[19] i2010 is “A European Information Society for growth and employment” framework.
[20] http://www.masht-gov.net/advCms/documents/Strategy_EN.pdf

5. Establishing mechanisms for the provision and efficient managing of financial resources for the higher education development.
6. Development of a complete and functional infrastructure of the higher education.

Research and scientific work (Objective 4) is obviously among the main objectives of this 10-year strategy of MEST, yet as this strategy recognizes, there is lack of priorities set for the development of scientific research.

Measures foreseen in the MEST strategy which involve ICT investments are listed next.

- In the area of management and coordination (Objective 2):
    - Setting up of a solid information and telecommunication infrastructure.
- In regard to financial support (Objective 5):
    - MEST will finalize the process of providing information technology and a better access to e-learning
- Related to infrastructure (Objective 6):
    - Modernization of the existing library network:
    - Development and enhancement of the technologic and information infrastructure
    - Establishing of the system of distance learning.

Law on Scientific Research Activity Nr. 2004/42 regulates establishment, activity, organizing, governance and termination of public juridical persons in scientific-research activity field; the rights and liabilities of scientific personnel; status of National Research Council; approval and implementation of National Research Program; financing; and other issues related to scientific-research activity in Kosovo. A 15-member National Research Council elected by the Kosovo Assembly pursuant to this Law is currently developing National Research Program for the period 2010-2015, and ICT priorities are being discussed in course of this exercise.

The 10-year MEST strategy proposes, MEST and Higher Education Institutions shall take measures to provide funds for support of scientific research and transfer of knowledge that aim at reaching level of expenditures comparable to other transitional countries.

In 2008 Government of Kosovo adopted the Medium Term Expenditure Framework 2009-2012 (MTEF) where sectorial priorities have been developed which reflect the strategic initiatives of line ministries.

In MTEF education is seen as one of the highest priorities as reflected by the budget expenditure planned for this sector to constitute 7.4% of total expenditure in 2009. Since improvements in scientific expertise are seen as one of education sector's main objective, then it is realistic to expect that expenditure planned for this sector (total of € 186.7

million proposed for education in 2009-2011) will include investments in actual research projects once the institutional framework is set up, and conditions and scientific research centers are created.

Measures that are foreseen in the MEST strategy and involve ICT investments (should belong within the capital expenditures for education, see the table above) are listed next.

- In the area of management and coordination (Objective 2):
    - Setting up of a solid information and telecommunication infrastructure.
- In regard to financial support (Objective 5):
    - MEST will finalize the process of providing information technology and a better access to e-learning
- Related to infrastructure (Objective 6):
    - Modernization of the existing library network:
    - Development and enhancement of the technologic and information infrastructure
    - Establishing of the system of distance learning.

Government is increasing budgetary allocations for ICT projects, especially for ICT infrastructure along different sectorial domains. The following table gives an overview of fund allocations according to MTEF for 2009-2011 for overall national ICT projects.

Table 1. Fund allocations from the national budget for 2008, and 2009-2011 in ICT

Sector	Description	2008	2009	2010	2011	Total 2009-2011
Transport	Information Technology		9.3	14.1	8.9	32.3
Justice	IT equipment	0.2	0.8	1.1	1.5	3.4
	IT equipment		0.3			0.3
	IT systems upgrade		3.3	2.5	2.5	8.3
Law enforcement	IT upgrade	5.4	5.4	5.4	5.4	16.2
	IT systems upgrade		4.1			4.1
	Communication and information infrastructure		11	12.6	1.5	25.1
Education	Establishment and supply of computer centers with proper equipments	0	2.2	2.2	2.2	6.6
	IT equipment	0.8	0.3	0.5	0.7	1.5
	Establishment of distance learning systems and creating computer centers	0	0.2	0.1	0.1	0.4
	centers with computers		0.1	0.3	0.1	0.5

Sector	Description	2008	2009	2010	2011	Total 2009-2011
Public Administration	Upgrade of payroll and HRM management information systems	0.3	0.3	0.3	0.3	0.9
	E-government	1.1	1.2	1.1	1.1	3.4
	E-government		2.6			2.6
	E-government		2.5	4.6	4.6	11.7
Health	HIS	0	0	1.8	1	2.8
	Enhancing functionality and development of Health Information System				**3.1**	3.1
Private Sector Development	Setting up data base for the Industrial Property Office		0.03	0.04	0	0.07
Total	**Overall budget in ICT for all sectors**	**7.8**	**43.63**	**46.64**	**33**	**123.27**

In April 2008 the Ministry of Education, Science and Technology (MEST) and the Federal Ministry of Science and Research of Austria (BMWF) signed a Memorandum of Understanding[21] for Kosovo-Austria Institutional Partnership (KAIP) in the field of Higher Education and Research. The immediate objectives of this multidimensional project between Kosovo and Austria are to contribute to a sustainable, good governed and knowledge-based higher education system in Kosovo aligned to European practices and standards, including the development of interfaces to research and innovation, integration of Kosovo's universities into the European education and research networks, and interaction between universities and local economy[22].

In October 2008 the government decides to treat favorably employees in all budgetary organizations in deficit sectors including information technology through supplementary incomes[23]. The purpose herein is to keep employees of special deficit categories, as well as stimulate concurrency in special deficit professions in form of incentives.

In May 2009 the government and the Post-Telecom of Kosovo (PTK) signed a Memorandum of Understanding "Fiber to school" for computerization and informatization of all schools in the country within a year[24].

The table below gives a statistical overview in 2008 of the country's human resource potential for research in the field of ICT.

[21] http://www.aei-austria-kosovo.com/?Activities_April_2008:Memorandum_of_Understanding
[22] http://www.aei-austria-kosovo.com/
[23] Decision Nr. 02/39, Date 08.10.2008 of the Government (http://www.ks-gov.net/ZKM/repository/docs/Vendimet_e_Mbledhjes_se_39-te_te_Qeverise_2008.pdf).
[24] http://www.kryeministri-ks.net/?page=2,9,583

Table 2. R&D intellectual capacity in ICT in Kosovo in 2008.

Intellectual capacities for ICT R&D in Kosovo	2008
Total number of research organizations	10
Of which universities	1
Of which public research organizations	6
Of which private research organizations	4
Number of PhD students graduated	1
Total number of R&D personnel	114
Percentage of women in the total number of R&D personnel	6.14%
Total number of employees on a Full-Time-Equivalent (FTE) basis	76
Total number of researchers	74
Percentage of women in the total number of researchers	5.4%
Total number of researchers on a FTE basis	37
Number of researchers with Ph.D. degree or higher	30
Number of researchers with Ph.D. degree or higher on a FTE basis	17
Number of researchers under the age of 35	36
Number of researchers under the age of 35 on a FTE basis	21

University of Prishtina[25] is the only institution in the public sector conducting R&D in ICT in the following academic units: Faculty of Electrical and Computer Engineering, Faculty of Mathematical and Natural Sciences, Faculty of Economics, Faculty of Applied Sciences for Business, Faculty of Technical Applied Sciences in Mitrovica, and Faculty of Education. R&D performers in ICT in the private sector are American University in Kosovo[26], AAB - Riinvest College[27], FAMA College[28], and UBT College[29].

MEST strategy also provides figures reflecting the situation in the intellectual capacities in higher education in 2004.

2.2 Key competencies in ICT research fields

Most of the ICT projects in Kosovo fall mainly into one or more of the following research areas as categorized by the FP6 funded project "Coordination of IST research and national activities (CISTRANA)":

- Database management
- Middleware
- Software engineering
- Electronic commerce
- Geographic Information Systems (GIS)
- ICTs for Energy

[25] http://web.uni-pr.edu
[26] http://www.aukonline.org
[27] http://www.aabriinvest.net
[28] http://www.universitetifama.eu
[29] http://www.ubt-uni.net

- ICTs for Enterprises and eBusiness
- ICTs for Government & eGovernment
- Broadband technologies
- Internet technologies
- Network security
- Network technology
- Wireless & mobile technologies
- ICTs for Cultural Heritage
- ICTs for Learning and eLearning

These data provide an understanding of the key research competencies in broader terms currently in the country, as a potential to build upon when defining the priorities for the future research.

The results of the questionnaires delivered to the software industry firms in the country confirm that there is low to no participation at all of the Kosovar business sector in ICT research. Research at universities on the other hand rarely involves collaboration with commercial enterprises. A common agenda in ICT research between higher education institutes and industry representatives should follow in order to set-up and implement the ICT business-relevant objectives in the country.

National funds for research and other funding bodies should be urgently established in order to support research and build excellence capacities in the country per research area.

2.3 Key drivers of ICT research

2.3.1 Main ICT sector trends in Kosovo

Next we will give a quick overview of the ICT sector profile, namely main trends in the IT sector and the telecommunications sector separately. The latest will also include how its services are build or used by IT companies to make the overview complete.

IT sector trends

According to "Assessment of the Kosovo ICT sector" prepared for the USAID in November 2007[30], the IT sector experiences annual growth of roughly 20 to 25%.

[30] http://pdf.usaid.gov/pdf_docs/PNADK675.pdf

Interviews conducted for that report estimated an annual revenue of approximately 35 to 50 million Euros in the sector. Roughly 25 to 30 % of this revenue is for IT services, the remainder for equipment resell, installation and related services. There were fewer than 100 firms in the sector. Fewer than 8 have more than 20 employees, and there are probably dozens of one or two person "shops". In total, there might have been about 400 to 600 people working directly in the sector, not including those in IT departments of non-IT companies. Labor costs are equal to or a bit higher than those in neighboring countries (e.g., Macedonia and Serbia).

According to another more recent resource (January 2009) "Kosovo IT Market 2008-2012 Forecast and 2007 Vendor Shares" by the research company IDC Adriatics[31], the IT market in Kosovo in 2007 reached 58.22 EUR ($85.17) million. Measured in local currency, the market expanded approximately 30% year on year in 2007. Overall IT expenditure in Kosovo in 2007 by sector is as follows:

- Spending on hardware resell captured 74%
- Spending on software captured 13.1%, and
- IT services captured 12.9%

of total IT spending in the country in 2007.

Moreover, following the same IDC study, IT expenditure in Kosovo is expected to increase at compound annual growth rate of 9.9% during the five-year forecast period to reach 93.38 EUR ($136.73) million in 2012.

Telecommunications sector trends

Internet. There are currently three major Internet service providers (ISP) in Kosovo with several other smaller ISP's that focus in extending Internet access beyond the service areas of the big three ISP's. Referring to the Internet World Stats statistics[32], as of December 2008, Internet penetration for Kosovo is 20.9%. Despite steep increases, Kosovo's Internet penetration still lags many of its neighbors, the EU and the world (Figure 1.). All three providers report relatively high Internet usage by businesses[30]. ISP's are expanding steadily and upgrading their infrastructure (network to fiber). A "triple play" service approach, providing voice, data and video over the same broadband IP network is meanwhile pushing ahead.

[31] http://www.newkosovareport.com/200812221508/Business-and-Economy/IT-market-in-Kosovo-small-but-growing.html
[32] http://www.internetworldstats.com/stats4.htm#europe

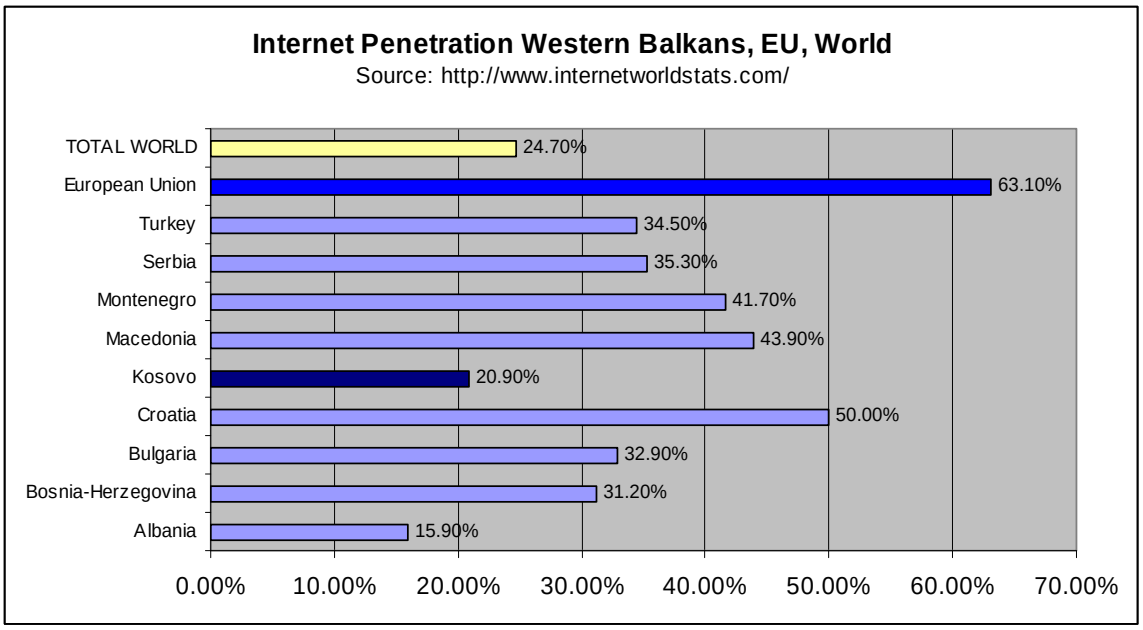

Figure 1. Internet penetration in the world referring to *Internet World Stats* in 2008.

Fixed and Mobile Phone Service. Per the Cullen International assessment report[33], less then 5% of the population has fixed line phone service (Figure 2.). Given the fast growth of Internet access and mobile phone service, traditional fixed phone coverage is becoming irrelevant.

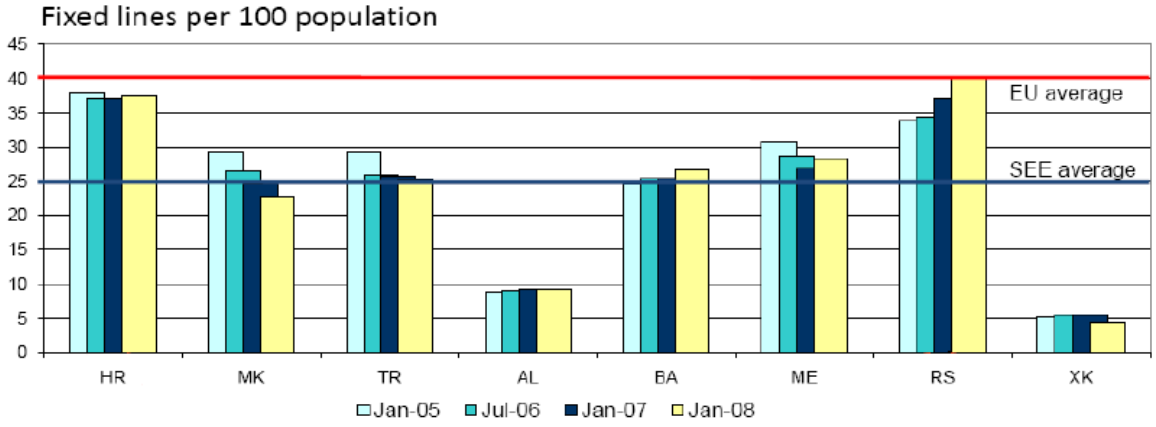

Figure 2. Fixed telephony in Kosovo referring to *Cullen International* in 2008.

In 2008 more then 50% of the population has mobile phone service, whereas the mobile penetration has reached 59%[13].

[33] http://www.cullen-international.com/

2.3.2 Main socio-economic challenges in Kosovo

Commission's Progress Reports since 2006 confirm that Kosovo has made progress in its approximation to European standards[34]. The presentation of a Medium-Term Expenditure Framework in 2008 and 2009 marked progress towards a sustainable fiscal framework for Kosovo.

Economy. The economy of Kosovo marked a growth of 5.5 % (from 4.4% in 2007), mostly based on consumption and public investment. A broad consensus on free-market policies has been maintained. The banking sector remained sound. However, the already large trade deficit continued to widen. Exports fell sharply in 2009, from an already very low base. The cost of finance remained high, as banks continued to attach high risk premiums. The weak rule of law, widespread corruption, and uncertainty over property rights continued to be major impediments to economic development.

Inflows of foreign direct investment and remittances are expected to decrease. Levels of public investment are expected to drop as government revenues come under increasing pressure. Kosovo's budget deficit is forecast to increase to 7% of GDP in 2009.

In addition to implementing sustainable macro-economic policies, Kosovo needs to address supply-side constraints such as infrastructure weaknesses, energy shortages, high capital costs and low levels of skill.

The EU is Kosovo's main trading partner. The progressive entry into force of the respective SAAs/IAs14 for the rest of the Western Balkans and the expiry of the current preferential regime will therefore result in a deterioration of Kosovo's trading position. This also reduces the attractiveness of Kosovo to foreign investors and limits the ability of Kosovo producers to export to the EU. For Kosovo to continue to benefit from the current preferential regime, this regime would need to be extended. However, the validity of an extension would only be temporary. A substantive perspective for the sustainability of Kosovo's long-term economic development. can only be provided through a trade agreement between the European Community and Kosovo. Finally, an agreement is a precondition for Kosovo to participate in the diagonal cumulation of origin between the EU and SAP countries.

Private sector development. Small and medium-sized enterprises are estimated to make a contribution of some 40% to Kosovo's GDP and 60% of its employment and constitute 99% of its businesses. SMEs play a key role in enhancing productivity, innovation and job creation. Support for the sector needs to be improved to provide incentives for entrepreneurship and transform informal entrepreneurial activity into formal businesses.

[34] A communication on Kosovo issued by the Commission in October 2009 (http://ec.europa.eu/enlargement/pdf/key_documents/2009/kosovo_study_en.pdf).

Kosovo would benefit from programmes aimed to raise the competitiveness of its economy, focusing on the adoption of new technology, increased productivity, reduced labor costs and the generation of jobs.

Kosovo needs to make further progress with privatization. Kosovo would benefit from the further development of micro-finance institutions to support small businesses in sectors with growth potential, including agriculture, rural tourism, small-scale manufacturing and urban services.

Kosovo would benefit from membership of the European Bank for Reconstruction and Development and increased European Investment Bank lending. Kosovo's business environment and its SMEs in particular would benefit from increased participation in and closer association with relevant EU initiatives, the Small Business Act and the 7th Framework Programme for Research. Provided Kosovo meets the relevant conditions, the Commission proposes it participate in activities that take place within these frameworks, with the help of technical and financial assistance, where appropriate.

Employment and social policies. Kosovo has a very high unemployment rate (estimated at around 40% in 2008). The capacity of job centres should be improved and links with universities and schools further developed so as to bridge the gap between education and the workplace. Kosovo should better target its employment and social policies.

3. Integration of Kosovo in the European ICT research environment

All Western Balkan countries except Kosovo are associated to EU's 7th Framework Programme for Research (FP7). Association to FP7 allows for increased research opportunities because associated countries have minimum requirements for participation in FP7 projects as the EU Member States. Kosovo is entitled to participate in FP7 as a third country with the International Cooperation Partner Country (ICPC) status[35]. Special conditions apply for participation of ICPC countries in FP7 projects/activities. Kosovo has nominated an FP7 contact point.

[35] The list of the International Cooperation Partner Countries (ICPC) available at **ftp://ftp.cordis.europa.eu/pub/fp7/docs/icpc-list.pdf**

FP7 is the EU's main instrument for funding research and technological development across Europe from 2007-2013. FP7 has earmarked a total budget of € 53,2 Billion. Among the scientific themes funded by the Cooperation Programme (ten themes, see Figure 3.) which has by far the largest budget within FP7 (€ 32.4 billion, i.e., around 60% of the total budget), ICT represents the highest priority theme, as reflected by the largest share of funding (€ 9.1 billion, i.e., 28% of the total Cooperation budget) it attracts.

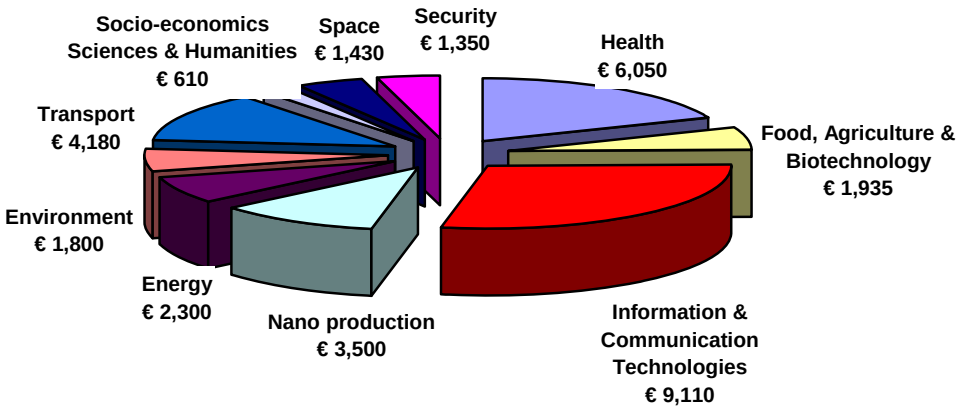

Figure 3. FP7 Cooperation programme budget breakdown (in € million).

The current FP7 Work Programme for ICT research 2009-2010 focuses on seven key research challenges and two cross-area actions. Challenges have been selected in line with the policy priorities defined in EU's i2010 initiative "A European Information Society for Growth & Employment". Three challenges aim at industrial leadership in key ICT sectors, while four are driven by socio-economic targets. Figure 4. presents budget breakdown of the ICT Theme for 2007-2008.

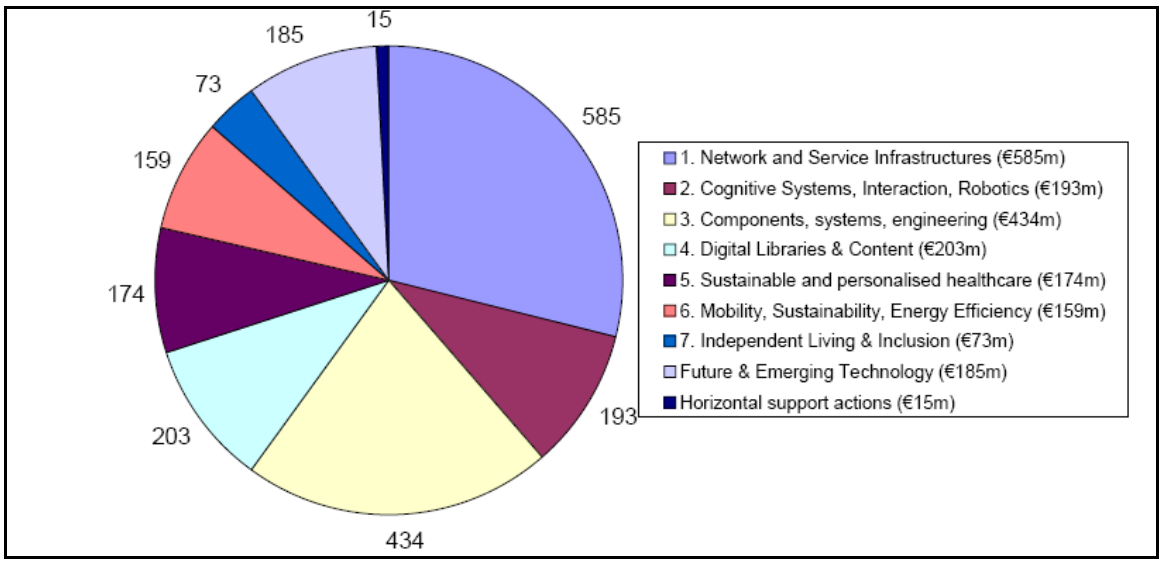

Figure 4. ICT Theme's budget breakdown for 2007-2008.

The association of Kosovo to the 7th (EC) research framework programme (FP7) has to be seen as a means to facilitate integration of the country in the EU and support its economic development through joint research efforts and allowing the WBCs to get familiar with the EU decision-making on research policy. In short, association to FP7 is a necessary pre-accession tool. Kosovo is working on a national action plan to strengthen its research capacity. Kosovo's involvement in the EU's research activities needs to continue and increase.

4. SWOT analysis of the ICT research capacity in Kosovo

4.1 Strengths

- research is among the main objectives of the strategy of Ministry of Education, Science and Technology (MEST)
- National Research Council (NRC) established
- ICT recognized among national priorities
- law on scientific and research activities adopted
- increase in budget expenditure for ICT planned by the Ministry of Economy and Finance (MEF) in 2009-2012
- increase in budget expenditure for education planned by MEF in 2009-2012

4.2 Weaknesses

- lack of national R&D priority fields
- lack of ICT R&D priorities
- incomplete legislation for research
- lack of national policies and programs for research
- lack of mechanisms for implementation of policies and strategies
- lack of assessment mechanism for research
- lack of institutional infrastructure for research
- lack of funds dedicated to research
- lack of incentives for research and for faculty involved in research
- lack of innovations
- lack of international cooperation in research
- lack of interdisciplinary approaches in the scientific research work
- up-to-date information on current scientific results is not available to faculty
- lack of presence in the FP6 and other international programs

4.3 Opportunities

- NRC proposing national research priority fields for the next 5 years
- Ministry of Public Administration adopted Strategy for development of e-Government
- MEST advocates policy for reaching regional standards in R&D funding
- digitalization of cultural heritage underway
- health information system getting extended
- advanced communication network and a growing number of internet users
- the youngest population in Europe, and with high fluency in English

4.4 Threats

- low value placed on research
- lack of institutional support for R&D
- lack of human resources for administering research projects
- little to no public and private institutions participating in research
- lack of mechanisms for protection of intellectual property and industrial rights
- all Western Balkan countries except Kosovo are associated to FP7
- none of laws has been enacted thus far
- lack of project management skills

5. ICT research priorities for Kosovo

This section presents the ICT research priorities for Kosovo in the period 2009-2013, identified as the result of the consultation process. ICT Research priorities are grouped as follows:

- ICT research priorities on the basis of the country's readiness: these are priorities for which the country has the appropriate human resources and research infrastructures in order to pursue research and development.
- ICT research priorities on the basis of future potential: these are priorities that are considered attractive for the country and have future potential. However, the level of readiness and capacity to pursue research and development is currently low.

Both types of research priorities address specific (socio-economic or other) needs that are defined in the justification provided per priority.

ICT research priorities on the basis of the country's readiness	ICT research priorities on the basis of future potential
ICTs for Government and eGovernment	ICTs for Health and eHealth
ICTs for Learning and eLearning	Security Technologies
Internet & Broadband Technologies	Digital Content & Digital Libraries
ICTs for Enterprises and eBusiness	Knowledge Technologies
Software Engineering	Artificial Intelligence

5.1 ICT Research priorities on the basis of the country's readiness

5.1.1 ICTs for Government and eGovernment

Kosovo has adopted the Electronic Governance Strategy 2009-2015[3]. It aims at providing governmental services to citizens and businesses in electronic form.

ITC supported services facilitate the communication between the government, and its citizens and businesses by enabling faster access to services, their permanent availability, as well as a significant increase in services' quality. They also strengthen the communication between institutions at different levels within the government itself. This all in turn contribute to the socio-economic development of the country, and its faster accession to the global integration processes.

Currently there are some achievements in provision of electronic services from the government for use by the public administration staff: payment and budget management system, electronic register of cadastral transactions, and system of vehicle registration

and drivers' licenses. Electronic voting is implemented for use within the Assembly of Kosovo. Citizens and businesses may use the online electronic bill payment "pay at the bank" program (Kos-Giro) for services offered by Post and Telecom of Kosovo (PTK), Kosovo Energy Corporation (KEK), Kosovo Property Agency (KPA), customs service, and other large billing organizations. Further steps are being done for establishing an integrated unique system for use by all institutions in the government. Electronic services provided up-to-date for citizens and businesses are mainly at the stage of simple portals with very few solid services which requires extensive R&D to meet requirements of the public administration reform envisioned by the government.

Priority: ICTs for Government and eGovernment	
Research Objectives	**Specific Research Areas**
Build a common network infrastructure, data store center, and a services repository of government.	• Software for storing and management of electronic documents, data and services of citizens, businesses, and public institutions (e.g., accounting management system for revenues, expenses, assets and liabilities). • Identity management and privacy of data of civil and legal entities. • Spatial databases to support meteorological stations, seismologic installations, cultural heritage applications, and map portals. • High-performance network infrastructure and middleware architectures for intra(-inter) communication among different levels and sectors of public administration.
Advanced, secure and innovative access methods to governmental documents, data and services.	• Web services portals and user interfaces at institutional levels to facilitate communication between citizens, businesses, and public institutions. • Security solutions and authentication methods for accessing confidential and trustworthy resources of government, as well as mechanisms to provide permanent storage of civil data and business transactions. • Portals and tools for on-line assistance and consultancy on administrative procedures, rules and regulations. • Data aggregation and statistics for auditing and report-generation purposes. • eInclusion interfaces for citizens with special needs. • eElections, eDemocracy, and other eServices for democratic involvement of society.

5.1.2 ICTs for Learning and eLearning

Electronic learning as a new method of learning enhanced through IT support has made an initial progress in Kosovo with the computerization of schools, and a number of projects implemented[36,37,38] at universities to equip classrooms with basic eLearning infrastructure. Still there is less practice of educational institutions at any level on applying eLearning methods and tools for teaching as assumed by the Bologna process.

There are many opportunities for research in eLearning along with the objective to develop and use eLearning infrastructure, content and tools.

Priority: ICTs for Learning and eLearning	
Research Objectives	**Specific Research Areas**
Develop eLearning software, hardware and legal policy infrastructure.	• Develop in-house Learning Management Systems or adopt among those already available (open source LMS). • Enhance existing eLearning hardware infrastructures according to international standards. • Develop adaptive and intelligent learning management systems for personalization, multilingual support and more knowledge-based features (statistical data, semantic annotation and semantic search). • Advanced Web 2.0 technologies. • Establish the jurisdiction framework for regulating eLearning delivery and use policies.
Develop and publish eLearning content and tools.	• Develop learning materials and publish them according to the eLearning delivery policy. • Develop tools to support enhanced access to public eLearning resources for all citizens.
Promote benefits of developing and using eLearning content and tools.	• Develop multimedia content, learning games, assistant systems based on virtual human interaction, etc. for accelerating learning.

5.1.3 Internet & Broadband Technologies

Government has set up the objective of connecting all its institutions to the microwave and fiber optics network that will improve the bandwidth capacity. Telecom operators are

[36] Tempus Project "Computer Science Master Study Program at University of Prishtina", ref.nr. CD_JEP-19090-2004.
[37] WUS Austria Project "eLearning Task Force Kosovo", 2008.
[38] Telemedicine center, University of Prishtina.

steadily upgrading the electronic communication infrastructure, entering new services with advanced technologies, and intending to cover more and more remote rural areas in the country.

There is evidence of established research community and advanced teaching syllabuses at University of Prishtina[39] in the area of Internet and broadband technologies. Running projects in ICT business sector prove the growing absorption capacity of industry in this area and applications that build upon it. Currently, internet penetration stands at 20% with the goal to rapidly increase in the near future.

Given the above level of country's readiness and capacity, and the fact that there are numerous emerging research opportunities in the area of Internet and broadband technologies, this area has been selected among the highest R&D priorities for ICT at the national level.

Priority: Internet & Broadband Technologies	
Research Objectives	**Specific Research Areas**
Innovative infrastructures and technologies for the broadband for all	• Ubiquitous network infrastructures • Technologies and architectures for the future Internet • Increase of throughput, innovative broadband approaches
Internet applications for the future	• Middleware • Distributed systems, Web Services, Agents • Optimization algorithms for content placement • XML technologies and databases • Semantic Web • Content management systems, and collaborative tools
Integrated new wireless services and network	• Optimized control and flexibility of wireless infrastructures • Wireless sensor and ad-hoc networks • New services in wireless communications • Interoperable services over wireless networks
Secure, resilient and trustworthy infrastructures	• Identity management and privacy enhancing tools • Trusted computing infrastructures • Protection of rights and content security/control
Combination of telephony, internet and TV/video services.	• Convergence of different services towards one access point • Video telephony

[39] Faculty of Electrical and Computer Engineering, Department of Computer Engineering, University of Prishtina (http://web.uni-pr.edu/?cid=1,98).

5.1.4 ICTs for Enterprises and eBusiness

We are witnessing a graduate shift from traditional business models to business processes hosted onto the Web. Added value is achieved via replacing material goods with digital products and services, since the later are easily copied and distributed. To reach added value and integrate into the global eBusiness family, Kosovo shall urge with eBusiness R&D. Establishing a comprehensive eBusiness infrastructure of the whole plethora of eServices among businesses, customers, and public institutions is of a very high priority for the country's economic growth, and its integration into international trade communities.

Priority: ICTs for Enterprises and eBusiness	
Research Objectives	**Specific Research Areas**
Empower the eGovernment portals with support for eBusiness to attract participation of businesses and customers.	• Develop Web-based information systems for eBusiness • Digitalize rules and regulations for registering new businesses. • Implement services to support shortening the paperwork procedures of registered businesses. • Develop interfaces and tools to support citizens for acting as customers. • Manage personal IDs electronically, data privacy and protection. • Organize work structures of eBusiness into eSociety and eTeams.
Facilitate businesses, customers, and public institutions to enter and make use of the eBusiness model integration.	• Develop eServices to support design, development, and selling and purchase of digital products and services. • Develop eServices to support on-line marketing and promotion, procurement, digital signatures and contracts, payment, distribution logistics, and taxation. • Develop eServices to enable operation of eBusiness resources in mobile devices (location-dependent content and services).
Enrich the eBusiness infrastructure with intelligent services.	• Mathematical modeling of business scenarios. • Data warehousing and decision support systems. • Data mining and business intelligence. • Develop Customer Relationship Management (CRM) systems. • Develop Supply Chain Management (SCM) systems.

5.1.5 Software Engineering

Kosovo lays slightly behind the region in approaching a disciplined and systematic method of software development as required by the software engineering. In fact SME companies of ICT have shown a progress in using CASE tools for certain phases of software development (e.g., programming, debugging), but lack to use tools for certain other phases (e.g., analysis, design, testing), as well as follow well-defined software engineering methods and processes throughout the software life-cycle. Much effort should be invested through cooperation between academia, research and industry to strengthen the software engineering competence of domestic ICT companies. As one valuable input, updated curricula-s at universities[36] which include extensive software engineering courses should contribute in building intellectual capacities in this field and push standards in the public sector. Standardization measures which would rank the readiness of a given company to develop a certain profile of ICT projects are essential to boost domestic ITC companies in developing sustainable and efficient software solutions capable of participating in the global trade. Saving time and cost reduction, along with the improved and sustainable software performance as guaranteed by software engineering, are the key prerequisites of success of any other ICT R&D priority.

Priority: Software Engineering	
Research Objectives	**Specific Research Areas**
Push standards of software engineering in the ICT industry	• Software engineering development process approaches • Component-based architectures for reuse of already existing modules • Project plan to increase efficiency of project development and reduce project costs • Optimization methods to improve product performance and ensure product sustainability • Model-driven design • Problem modeling • Software testing approaches • Software quality assurance, software audit • Requirements analysis, modeling languages • Business process modeling languages • Methods for project management • Web engineering
Develop and implement the framework of standardization measures in the field of ICT	• Acquire for domestic ICT companies to undergo a standardization process in compliance with international standards of software engineering • Maintain a database of domestic ICT companies with their corresponding rank by profile

5.2 ICT Research priorities on the basis of future potential

5.2.1 ICTs for Health and eHealth

In the healthcare strategy for the period 2010-2014[40] adopted by the Ministry of Health of Kosovo, the implementation of the healthcare information system is emphasized as one of the main objectives in this sector. The system is supposed to be capable of collecting, storing, exchanging, and analyzing health data in time and in a standard way, useful for decision making in healthcare and for a common healthcare organization at all levels.

Improving the quality and productivity of healthcare by utilizing ICT technologies has been an important topic for now almost two decades in the EU[41]. Kosovo should urge with expanding a unique primary healthcare information management system across all health institutions both public and private, although the readiness of the country is low in relation to its capacities for R&D in this domain. At this stage, building a research team with the focus in medical information systems is crucial for piloting and development of new ICT-based solutions for the healthcare sector.

Priority: ICTs for Health and eHealth	
Research Objectives	**Specific Research Areas**
Completion of the integrated health information system and online health services for citizens.	• Networking of all healthcare institutions including family medicine practitioners, hospitals, laboratories, pharmacies • Electronic medical records, electronic patient records and collateral images • Integration of eCard-based identification and health cards in health IS • Integration of diagnostic devices in health IS • Interfaces to Health IS and online access to data about health for all advices, online consulting, and disease prevention hints for citizens • Interoperability with electronic medical records across multilingual environments abroad • Policies to determine access rights to health IS data

[40] Healthcare Sector's Strategy 2010-2014. Ministry of Health, Kosovo (http://www.mshgov-ks.org/strategjia.pdf).
[41] EU Seventh Framework Programme (FP7), 2010 Work Programmes. Theme *Health* (http://cordis.europa.eu/fp7/wp-2010_en.html).

Research Objectives	Specific Research Areas
Development of IT products and services that support patient safety (PS) and decision-making	• Innovative data analysis techniques to help assess and manage risks to patient safety (PS) better • Multimedia information retrieval, and conversion into searchable information • Medical knowledge acquisition on diagnostics, treatment, and prevention of illnesses • Decision-support systems with patient-specific data (test results, medical history), other patients data with similar problems, treatment possibilities, drugs and medical technologies

5.2.2 ICTs for Security Technologies

One of the most critical points in well-established software provision is the availability, reliability and security level of data and services in one side, and of the communication network on the other side. Security technologies serve to protect user privacy. All current technologies based on eServices (say, eBanking, eHealth, eGovernment) are heavily dependent on secure data exchange.

Communicating over computer network is becoming more and more important for accomplishing our daily activities. When we deal with sensitive data, network security is of main interest. Dealing with sensitive data is of high importance for the modern society.

Further, smart cards are gaining more and more importance in our daily life. Each mobile phone and pocket has at least one smart card. Smart cards are used in many ICT applications for variety of services such as access control, digital signature, and banking. The number of applications that use smart cards is increasing everyday. The ID cards of Kosovo will be based on smart cards.

Security technologies are extensively covered in teaching curricula-s at the University of Prishtina and are subject to research. Effective use of security technologies is vital for ICT research in all other priority fields.

Priority: ICTs for Security Technologies	
Research Objectives	**Specific Research Areas**
Improve the security, resilience and trust of ICT infrastructures, applications and services, including the Future Internet	• Access management, and role based security • Information security standards, spam and malicious software filtering, identity theft protection • Secure and trustworthy ubiquitous communication networks • Emerging security problems in communication networks (e.g. malware, phishing, emerging cyber-threats) • Secure and trustworthy software systems and ICT-based applications and services • Trusted computing, cryptology and advanced multi-modal biometrics
Respect citizens' rights and protects their digital assets, identities and personal data	• Trust, identity management and privacy protection technologies (PETs) • Support to interoperability and standardization • Smart card technologies, ID cards

5.2.3 ICTs for Digital Content & Digital Libraries

Conceptualizing and producing digital content that can be individually selected and manipulated is emerging as a trend. Increasing demands for digital content are appealing to the average person, creative industries, and public and private organizations. Research in this area is seeking for better solutions for creation and access to digital content.

Digital content and digital libraries are an important means of enhanced learning where ICT offers a huge capacity of support. In Kosovo, libraries[42] have started with deploying library management systems to store their bibliographic catalogues in accordance with the international bibliographic standards which enable the integration of the local loan system with other libraries worldwide. Digitalization of the actual content (books and other documents) in libraries would be the next step towards integration into the international family of digital libraries. Archives of cultural heritage are also in place[43] although advanced access techniques to the database, population with data and their maintenance are critical issues at this stage. More public content of educational character should be considered for digitalization and deployment of semantic technologies.

[42] Library management system of the National and University Library of Kosovo (http://www.biblioteka-ks.org/Katalogu.php).

[43] The Cultural Heritage without Borders on the request of Ministry of Culture, Youth and Sports of Kosovo have implemented the temporary Cultural Heritage database.

Priority: ICTs for Digital Content & Digital Libraries	
Research Objectives	**Specific Research Areas**
Develop new digitalization infrastructure and applications	• Develop novel approaches to digital preservation • Develop advanced digitalization and visualization tools • Develop advanced authoring environments for content sharing through automatic tagging with semantic metadata
Build digital libraries infrastructure and content	• Establish multimedia network and service infrastructures for digital libraries • Exploit innovative access services with semantic searches and multimedia retrieval systems
Develop domain oriented digital libraries and interoperability	• Scientific material (papers, reports, and monitored data) • Cultural heritage repository

5.2.4 ICTs for Knowledge Technologies

This is one of the fields in which University of Prishtina[39] has established a research staff with international experience in the community. Moreover, ICT curricula-s are in pace with the actual developments in this emerging field. On the other hand, companies and government have no evidence of adapting to the new knowledge-based economy and society.

Education and training on knowledge technologies will raise the competitiveness of organizations in terms of "applying knowledge to produce new knowledge", which represents a *must* in the global market integration today.

Progress in knowledge representation and management has enabled the creation of innovative commercial and community services. Semantic Web technologies have likewise started to permeate more and more application areas in industry in conjunction with the existing solutions of search engines, data integration, SOA, collaboration, publishing, could computing and alike.

Knowledge technologies are fundamental to some of Europe's key industries also of a central importance in Kosovo - business intelligence, healthcare, media, geospatial, manufacturing, engineering, chemical and pharmaceuticals sectors, as well as other priority areas of ICT research such as eGovernment, eLearning, and digital libraries.

Priority: ICTs for Knowledge Technologies	
Research Objectives	**Specific Research Areas**
Semantic-based and context-aware modeling of content and knowledge	• Enrich content and existing knowledge by adding structure and semantic data annotations • Develop new domain ontologies or adopt existing ones • Develop systems and services to support self-describing content and knowledge, which is adaptive to context and user information needs • Deploy knowledge representation techniques
Discover, access and manage new knowledge	• Document / Knowledge management • Semantic Web • Expert systems / Agents • Machine learning • Data mining • Artificial intelligence • Intelligent and adaptive pattern recognition • Language processing technologies • Semantic search (next generation search engines)
Achieve semantic interoperability between heterogeneous resources	• Data integration across distinct content types and multilingual resources

5.2.5 ICTs for Artificial Intelligence

Artificial intelligence can help to find better solutions for different real life constraint satisfaction and optimization problems that appear also in Kosovo (school and university timetabling, employee scheduling, resource planning, vehicle routing, route planning, packing).

Automate software engineering is currently an intensive research area. Machine learning / data mining techniques could be applied to analyze medical and other problems (e.g., tax fraud) in Kosovo. Initial group of two-three PhD students with supervision from TU Wien could be quickly set-up if funds available. Cooperation with several institutions already exists (Vienna University of Technology, University of Udine, Nottingham University).

Priority: ICTs for Artificial Intelligence	
Research Objectives	**Specific Research Areas**
Develop intelligent solutions for the market and public institutions	• Artificial intelligence techniques for constraint satisfaction and optimization problems • Search based software engineering • Machine learning and data mining

Annex I. Summary of the consultation process

The consultation process involved two types of consultations. One was addressed to experts in academia with the invitation to deliver their suggestions for national priority fields in ICT research in next five years. Following are experts from University of Prishtina that responded to our invitation for determining ICT research priorities.

Dr. Tech. Blerim Rexha is Assistant Professor in the Computer Engineering Department, University of Prishtina, Faculty of Electrical and Computer Engineering, and vice-deputy of the Ministry of Energy and Mining. Dr. Rexha received his PhD at Vienna University of Technology, and has experience in IT industry abroad. His area of expertise includes data security, smart cards, and web services. Involved with designing several curricula programs in ICT. Familiar with the involvement of ICT in government.

Dr. Tech. Nysret Musliu is Privat Dozent in the Databases and Artificial Intelligence Department, Vienna University of Technology, and also teaching at University of Prishtina. Dr. Musliu has an extensive experience in research with a number of projects, and publications in renowned international journals in the area of artificial intelligence and machine learning. Involved with designing several curricula programs in ICT.

Another consultation process took place between 15th of September and 15th of October 2009. Excerpts of the questionnaire and additional consultation hints were sent to different ICT parties of interest according to their profile. A summary of the consultation process grouped by profile of respondents, and results acquired is presented in the following table.

Table 3. Summary of the consultation process respondents by profile.

Type of organization	Consulted	Responded	Responded in %
Governmental body	18	2	11.11
Higher education institutions	10	2	20
ICT companies	13	6	46.15
Public service providers	2	2	100
Potential donors	3	2	66.66
Total	**46**	**14**	**30.43**

The consultation was mainly conducted through e-mail, and partially through face to face or phone interviews especially when collecting data was in place.

Due to the limited time available, it was impossible to organize wider consultations in form of a panel or workshop. Hence we consider this document as preliminary, and would encourage consultations with a wider public to determine final ICT research priorities at the national level.

Annex II. Classification of the ICT research fields

The naming of research fields used during consultations for development of this report and in the report itself refer to the classification shown in the table below. This classification is an adoption of the ICT research taxonomy developed by the CISTRANA project (www.cistrana.org).

Id.	ICT Research Fields
	ICT Software & Information Processing
1	Artificial intelligence
2	Bioinformatics
3	Cognitive systems
4	Computational modelling
5	Database management
6	Distributed systems
7	Entertainment computing
8	Grid technologies
9	Identity management
10	Image processing & pattern recognition
11	Knowledge Technologies
12	Middleware
13	Privacy
14	Security technologies
15	Semantic technologies
16	Sensor systems and networks
17	Service engineering
18	Simulation technologies
19	Software engineering
20	Speech & Language processing
21	Signal processing systems
22	Virtualisation tools
	ICT Software Applications
23	Electronic commerce
24	GIS – Geographic Information Systems
25	ICTs for Agriculture
26	ICTs for Energy
27	ICTs for Enterprises & eBusiness
28	ICTs for Environment
29	ICTs for Government & eGovernment
30	ICTs for Health & eHealth
31	ICTs for Independent living & eInclusion
32	ICTs for Transport & eTransport

Id.	ICT Research Fields
	ICT Hardware Components
33	Digital systems, digital
34	Display systems and technologies
35	Embedded & pervasive systems
36	High frequency technology
37	Micro/nano systems
38	Nanoelectronics
39	Nanotechnologies
40	Organic electronics
41	Optical networks and systems
42	Peripheral technologies
43	Photonic components and subsystems
44	Printed and Integrated circuits
45	Quantum Informatics
46	Robotics
47	Smart cards and access systems
	Telecommunications
48	Broadband technologies
49	Internet technologies
50	Network security
51	Network technology
52	Satellite technologies
53	Wireless & mobile technologies
	Multimedia
54	Digital content & digital libraries
55	Digital video broadcasting
56	ICTs for Cultural Heritage
57	ICTs for Learning & eLearning
58	Multimedia infrastructures
59	Virtual reality
60	Visualisation tools