

Long-Term Strategic Research Programme for a Specific RIS3 SK Area of Specialisation from the Point of View of Available Scientific and Research Capacities

1. Name of the RIS3 SK area of specialisation from the point of view of scientific and research capacities:

Information and communication technologies

2. Specific subtopics of the areas of research specialisation:

1. Data, information and knowledge space and its use
2. Information security
3. Technological infrastructure of the digital space (cyber space)
4. Interdisciplinary application of ICT

Effective information processing is the prerequisite for a successful functioning and development of the society as a whole. Modern information and communication technologies are used in all areas of social life and are linked to all RIS3 areas of economic specialisation and prospective areas of specialisation. Deeper research and development results will mainly be used in cases where reliable and correct operation of ICT and the modelling of complex social phenomena (elements of critical infrastructure, control and management systems, etc.) are of particular importance.

Subtopic 1 Data, information and knowledge space and its use

Short description

Research, development and innovation in data processing, the collection, creation and use of information and knowledge; data publishing under a free license. The production of data and the obtaining of information require the improvement of existing and the finding of new automatic approaches to work with data to be effectively combined with man-made information and knowledge. The use of the digital space also requires new methods of development of information systems with an emphasis on flexible and efficient integration and interoperability. Effective work with data, information gathering, and the obtaining and management of knowledge and its implementation in information systems is a key to the creation of new services, innovation and economic growth.

Key words

Data; information; knowledge; Open Data; free licences; representation and processing of large-volume data; machine learning; information systems; services; visualisation; simulation; software architectures; interoperability; security

Closer description of the areas of research and development

Subtitle 1: Methods and tools (including organisational and legal) enabling the creation of a framework for an effective creation and sharing of data, information and knowledge

- Legislation and regulatory frameworks for information and communication technologies;
- Creation of data standards.

Subtitle 2: Methods of collection, processing and provision of information obtained from various sources, various types of data and designed for different groups of people

- New approaches to the processing of Big Data, in particular Fast Data;
- Saving and storage of and access to data, Open Data, Linked Open Data;
- Methods and tools for intelligent data processing using semantics, which is the fundamental condition for effective work with large data in large distributed digital spaces (e.g. web environments);
- Machine learning;
- Effective algorithms of data processing;
- Optimisation;
- Methods and tools for a social collaborative digital space reflecting one's individuality in the digital space;
- Methods and tools for privacy protection (identification, authentication) and data security.

Subtitle 3: Interaction between people in a heterogeneous digital space

- Visualisation of data reflecting the specific features of different domains, simulation and virtual reality

tools in industry and in economic and social practice, research and education;

- Optimisation of the design and development of software products, use of the digital space for collaborative development, re-use and round trip engineering;
- Monitoring and evaluation of developers' activities to support an effective use of their knowledge and capacities.

Subtopic 2 Information security

Short description

Information and communication technologies (ICT) form part of the critical infrastructure of the society. The gradual informatisation of society is accompanied by its dependence on ICT and increasing threats to ICTs; the ensuring of information security (IS) is therefore essential for the functioning of the society. In the Slovak context, it will be necessary, as a minimum, to develop basic and applied research in cryptology, examine the vulnerability of existing ICT systems and applications, and look for opportunities to solve them; develop and apply methods for a reliable production of software systems; develop IS management methods; examine the social aspects of IS (privacy protection vs IS, cybercrime, intellectual property rights), build professional capacities to deal with IS problems in Slovakia, and raise security awareness about of ICT users.

Key words

ICT and/as critical infrastructure; threats; information and cyber security; cryptology; privacy and security; cybercrime; legal aspects of ICT; security awareness; education.

Detailed description of the areas of research and development

Subtitle 1. Cryptology

- Basic research will focus on cryptographic algorithms, post-quantum cryptography, cryptographic protocols, modern methods of cryptanalysis;
- Applied research will deal with the implementation of cryptographic algorithms and protocols, cryptographic mechanisms to ensure the security of operation systems, databases, networks, analysis of attacks through secondary channels, ensuring communication channels, multi-party communication, problems of public key and electronic signature infrastructure, examination and development of means and protocols for identification and authentication.

Subtitle 2. Security of systems and applications

- The research focuses on the detection of vulnerabilities in standard operation systems, database systems, networks, in-built systems, web browsers, etc., examines the ways of use and methods of handling such vulnerabilities, including in the business environment;
- Detection, liquidation and analysis of malware.

Subtitle 3. Development of software systems and applications

- System security models, methods of identification and specification of security requirements for systems, methods of development of reliable and safe systems, assessment of conformity with specifications, evaluation of the strength of security mechanisms, detection of vulnerabilities and hidden channels in software systems.

Subtitle 4. Information security management

- Study of IS management methods in the context of new ICTs and threats;
- Development of metrics to assess IS level, economic aspects of IS
- Recognising the symptoms of attacks/emerging security incidents;
- Effective methods of addressing security incidents and subsequent system recovery;
- Analysis of attacks on systems.

Subtitle 5. Social aspects of information security

- Cybercrime (taxonomy, development, legislation, methods of detection, evidence collection);
- Privacy protection vs information security;
- Identification and authentication, the linking of technical and non-technical tools (biometry, etc.), research of the security aspects of e-Government, e-Health, e-Commerce, and social networks;
- Research of ICT impacts on youth development, social relations and the way of life;

- The possibilities and methods of personal data collection, processing and use or misuse to influence the behaviour of individuals and groups;
- Effective methods of developing users' security awareness.

Subtopic 3 Technological and communication infrastructure of the digital space (cyber space)

Short description

Research and innovation in technologies for fixed, mobile and optical networks, wireless communication, Internet, Internet of Things – IoT (Smart Internet, Smart Applications, Smart Devices, Smart Factories), communication infrastructures of new generations and related software applications and smart services.

The acceleration of the speed and volume of communication through computer and communication networks is a prerequisite for innovation and the creation of new effective services.

Key words

Network and communication infrastructures; Internet; IoT; IoE (Internet of Everything); broadband, mobile and wireless networks; smart systems; smart services; sensor systems; clouds; industrial ethernet

Closer description of the areas of research and development

Subtitle 1: Technologies (hardware) enabling the scanning and gathering of information and its subsequent sharing

- Equipment capable of recording and sharing information and of remote receipt and effective use of information (e.g. sensors, robotics, smart systems and services – autonomous systems and artificial intelligence, additive technologies – 3D printing, as well as smart equipment for households and everyday use);
- Computer networks and equipment increasing the interconnectivity of equipment and information flows (e.g. industrial networks and industrial terminals, network solutions, wireless interfaces, improvement of optical and wireless communication networks).

Subtitle 2: Software solutions for effective use of gathered information

- Services and solutions for the processing of large volumes of data, fast data processing (Big Data);
- Information storage and disclosure (Open Data);
- Interoperability of inputs and outputs, forecasting in production, distribution, consumption and market behaviour (e.g. interactive interfaces for work with data by means of extended reality and virtual reality, application of web and mobile technologies, expert systems, cloud systems and services);
- Supporting new business models (e.g. data processing and storage, output generation) and more effective functioning of public institutions.

Subtitle 3: Setting-up and interconnecting horizontal platforms

IoT can be understood as a platform for information exchange and processing and communication at different levels of production, distribution and consumption processes. Research and development in the field of platforms has the potential of standardisation and horizontal integration of existing platforms with the aim to increase the potential of IoT and IoE technologies and services. This will also enable full use of technologies of the future and software applications across industrial sectors, the business environment and services:

- intelligent transport systems (setting up of navigation systems, individual mass transport systems (collaborative economy) and improvement of intermodal transport);
- robotic workplaces and automated systems for production applications in industry;
- management systems for energy accumulation and redistribution in energy, industrial and transport applications.

Subtopic 4 Interdisciplinary application of ICT

Short description

Use of ICT for information processing, modelling, simulation in technical, natural and social systems. Development of applications for medicine, management of technological and other processes. New information and communication products and services for the purposes of public administration, healthcare, education and culture. Analysis of the impacts of informatisation on society.

Key words

Data security; e-Government; e-Health, m-Health; information and communication networks, products and services; smart technologies and production systems; modelling; process monitoring and management; system optimisation; simulations; virtual reality; natural language; social inclusion; marginalised groups; empirical studies.

Closer description of the areas of research and development

<p>Subtitle 1: Information and communication products and services for materials research and nanotechnologies</p> <ul style="list-style-type: none"> • Development and use of methods for computer modelling, simulation and testing of materials; • Management of technological processes of preparation of new materials using ICT.
<p>Subtitle 2: ICT applications in medicine, biotechnology, agriculture and environment</p> <ul style="list-style-type: none"> • Bioinformatic research and processing of biological data; • Obtaining and sharing of reliable and quality medical information and its processing (Big Data) and protection; • Development of ICT methods and means for patient monitoring and assessment; • Increasing the effectiveness and availability of information services for the purposes of doctors and the population (including patients in the home environment, senior people and handicapped individuals) using m-Health mobile services; • Methods and tools for the gathering, processing, visualisation and interpretation of spatial data, time lines and climate conditions for the cultivation of crops; • Modelling of environmental impacts, including prediction of future developments, reduction of energy consumption; • Development and application of the systems of monitoring, modelling and management of processes using pharmaceutical, industrial and environmental biotechnologies for sustainable agriculture and environment.
<p>Subtitle 3: ICT in industry and services</p> <ul style="list-style-type: none"> • Development of software for intelligent production systems, complex systems of production management and recording, service and process management, components and nodes; • Simulation and modelling of industrial, transport and other systems, and optimisation of the energy demands and environmental impacts; • Predictive management systems using datamining and neurone networks; • Advanced business management systems – Total Plant Solutions (TPS); • Technological support of design; • Development of technologies and systems capable of self-regulation and self-management (artificial intelligence),
<p>Subtitle 4: ICT in public administration, healthcare, education, culture and defence</p> <ul style="list-style-type: none"> • Information, communication and application systems to support processes in the field of public administration, education and healthcare (e-Government, e-Health, m-Health); • Computer and ICT supported education (e-Education); • Digital technologies for access to, sharing and use of cultural heritage; • ICT, products and services to support decision-making and management; • Increasing the effectiveness of existing public administration processes; • Modelling and simulation of threats, defence against threats, defence training.
<p>Subtitle 5: ICT and society</p> <ul style="list-style-type: none"> • Social impacts of informatisation (lifestyle, system of values, social life, health impacts, changes in behaviour and communication as a result of ICT use); • Legal aspects of informatisation of society (free licences, personal data and privacy, cybercrime, etc.); • Use of ICT, empirical studies, expert systems in accomplishing the objectives in topics of nationwide concern (population ageing, social exclusion, marginalised groups); • Research and modelling of social phenomena/society development by means of ICT (data collection and processing, prediction of development, modelling of scenarios); • Computer processing of natural language, grammar check and automated translations; • Setting up of an accessible and intelligent environment by means of ICT services and sensor networks

for senior people to support active ageing, social inclusion and better quality of life (autonomy, self-sufficiency, security, social communication).

3. Links/relationships between the long-term strategic research programme and the addressing of some/several development trends on the basis of available R&I capacities:

- ICTs became the critical infrastructure of society, and it is necessary to ensure their reliable functioning; failing to do so, the society will not be able to address topics of nationwide concern defined in the RIS3 and to function in a standard way;
- All development trends require an effective processing of large data volumes;
- The research of new materials apply modelling and numeric simulations;
- Production processes use robotic equipment and ICT based control and management systems;
- The management of complex processes, large organisations and/or systems cannot be handled anymore without automated ICT systems and systems for the support of decision-making;
- Effective methods of data processing will enable the collection and processing of large volumes of data on natural, economic and social systems, model the activity of these systems, and optimise management/interventions in such systems.

The mutual relationships and links between the long-term strategic research programme from the point of view of available R&I capacities and the development trends of economic specialisation and prospective areas of specialisation are shown in the table below.

Development trends for the areas of economic specialisation of the economy	Data and information space and its use	Information security	Technological infrastructure of the digital space (cyber space)	Interdisciplinary application of ICT
Increasing domestic value-added products, particularly through the effective transfer of technology and R&D results into the production process	y	y	y	y
Development of production processes in industry focusing on better use of available resources, greater use of recycling materials and environment-friendly materials through scientific and technological development and innovation	y		y	y
The use, placement and replacement of previously used materials for advanced materials with a new and more complex performance, including technological processing (machining, forming, binding)				y
Development of technological investment units, particularly in the field of metallurgy, engineering, energy and integrated industrial equipment, with respect to the application and use of light metals and advanced materials in the manufacture of transport and construction facility to reduce overall weight and contribute to the green economy, development and application usage of composite materials			y	y
Development of technological investment units, particularly in the energy and industrial facilities, with respect to internationalisation activities and the development of “emerging countries”	y	y	y	y

	Increasing the effectiveness of production and logistics processes	y		y	
	Use of ICT and robotics in production processes	y	y	y	y
	Involvement in supply chains and internationalisation - "the purchase of cooperation is a purchase, too"				
	Know-how transfer from large to small subjects and vice versa in the framework of cooperation	y			
	Energy efficiency and renewable energy	p		y	y

Areas of economic specialisation		Data and information space and its use	Information security	Technological infrastructure of the digital space (cyber space)	Interdisciplinary application of ICT
	Automotive and mechanical engineering industries	y	y	y	y
	Consumer electronics and electrical equipment	y	y	y	y
	ICT products and services	y	y	y	y
	Production and processing of iron and steel	p	p	y	y

Prospective areas of specialisation		Data and information space and its use	Information security	Technological infrastructure of the digital space (cyber space)	Interdisciplinary application of ICT
	Automation, robotics and digital technology	y	y	y	y
	Processing and increasing the value of light metals and their alloys				
	Production and processing of polymers and advanced chemical substances				
	Creative industry	y	y	y	y
	Increasing the value of domestic raw material base			p	
	Supporting smart technologies in the processing of raw materials and waste in the region of their occurrence	y		p	y

Development trends in the prospective areas of specialisation		Data and information space and its use	Information security	Technological infrastructure of the digital space (cyber space)	Interdisciplinary application of ICT
	New technologies allowing the transmission, processing and storage of data	y	y	y	y
	Smart production systems	y	y	y	y
	Smart and industrial transport	y	y	y	y
	Technologies for intelligent consumption management	y	y	y	y
	Progressive chemical technologies for the production of modern fertilisers				
	Technologies and services for active life and aging, i.e. health care, diagnostics and wellness	p	y	y	y

Supporting smart technologies in the processing of raw materials and waste in the region of their occurrence	p	p	p	y
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y – yes, p – partially

4. **Expected outputs and the potential of their application and use in economic and social practice:**

- Innovative solutions leading to the set-up of new innovative companies, the implementation of IoT (Internet of Things) and of internet and network solutions in production operation and the implementation of the Smart Industry or Industry 4.0 concept. Automation and robotisation of production processes;
- Increasing the share of ICTs and of the creative and information industry in GDP, and employment growth in the field of ICTs;
- Data publishing under free licensing will enable a much more effective use of data and information and an effective access to data for potential service providers, create an environment for data providers and the conditions for activities of “data processors”;
- The new methods and tools developed for work with data, information and knowledge will increase competitiveness through the innovation of existing products of Slovak ICT companies, and will enable business development in specific areas;
- The new methods and tools used for the interaction of people in the digital space through also virtual reality and simulations will enable the innovation or development of new products for education, research (mainly experimental), medicine and industry;
- The identification of the weaknesses of the existing systems (applications, equipment, algorithms, protocols) will allow the operators of these services to eliminate or remedy detected vulnerabilities and eliminate the risk of their misuse;
- The methods of correct implementation and verification of compliance will allow increased reliability and credibility of systems, which is the basic prerequisite of use in the case of special systems;
- Effective methods for information security management will allow the attaining of a higher level of security in organisations and reduce the number and severity of the impact of security incidents;
- The ensuring of reliable communication, identification and authentication of communication participants and data protection in data processing and storage is the prerequisite for a successful implementation/use of e-Government, e-Commerce, e-Health, sensor networks operation and other global systems/projects;
- The research and development of internet security will contribute to increasing Slovakia’s competences in the field of IS, capacity building for dealing with cybercrime, the development of legislation, enhancing security awareness of the population, and better use of the ICT potential;
- Proposals for legislative changes in areas of nationwide concern, especially with regard to the social inclusion of marginalised groups and an ageing population;
- The system of empirical data collection, information, expert and communication systems targeting issues of nationwide concern.

5. **Quality objectives to which the support of long-term strategic programme is expected to contribute:**

The use of ICTs moves from the addressing of specific problems to the creation of a new – interconnected – world in which “things” around us communicate and cooperate so as to improve the quality of life of people.

The main objectives in this priority area are the following:

- Strengthen the competitiveness of Slovak industry in the development, use and shaping of the next generation internet which will gradually replace the current web, fixed and mobile networks and service infrastructures, and will enable the connection of devices (IoT and IoE) of different operators and domains, thereby changing the method of communicating knowledge, access to knowledge and its use;
- Reach the objectives of inclusive growth set out in the Europe 2020 strategy;
- Enable the innovation of existing products and solutions of Slovak companies, thus creating new ones, and support the development of the internet economy in Slovakia and the success of Slovak

- businesses on the global market;
- Support the digitisation of industry and entrepreneurship in all sectors and at all levels; modernise not only production processes, but also the way of leading and managing businesses and SMEs, thus ensuring the sustainability and continuity of the implementation of innovation and of the Smart Industry concept;
- The application of ICTs in public administration, healthcare, education and culture will significantly extend and improve the quality of life of citizens and will contribute to a better and more efficient use of public resources;
- Build additional expert capacities capable of dealing with current and future information security problems of the country (alone or in cooperation with partners from abroad); create and develop know-how in the field of information security;
- Use of know-how in the field of IS to improve the security level of the existing ICT systems, development of secure systems and applications;
- Improvement and extension of analytical capacities and independent research on societal issues, especially with regard to marginalised communities;
- Raise the level of security awareness of the population and the level of protection of the Slovak virtual space;
- Increase the accessibility of ICT services for disabled persons, including the growing community of senior people (loss of quality of sensory functions, mobility, skills, cognition functions, self-sufficiency in daily activities) with an impact on increasing safety and quality of life.

6. Links to research trends within the EU:

ICTs are essential to support research, development and innovation and as such are included in a number of Horizon 2020 areas. Support for health care, quality of life, green, integrated and intelligent transport, climate change, inclusion of social groups, security and energy are strongly supported by ICT in Horizon 2020. Topics such as high-performance computing network with advanced applications, internet of the future and content creation are priorities of Horizon 2020. All these topics are directly linked to the focus of research, development and applications in the following areas:

- network networks and communication;
- web and mobile technologies and related applications;
- smart systems and services;
- sensor systems;
- health, demographic changes and quality of life;
- expanded reality;
- cloud systems and services;
- 3D printing and application in production, industry and business;
- inclusive and reflected society;
- technologies and services for active life of the aging population.

Research in the field of ICT is also largely supported by the following European initiatives:

- The Joint Research Centre (JRC) supports the creation of multi-disciplinary teams for socio-economic and technological analyses related to the single digital market and digital agenda for Europe;
- the EUREKA programme under the Celtic-Plus cluster focuses on European projects primarily initiated by industry through public and private funding of joint research projects in the field of telecommunications, new media, future internet, applications and services focusing on the "Smart Connected World" paradigm;
- Nine of the total number of 32 European Technology Platforms (ETPs) directly focus on ICT areas http://ec.europa.eu/research/innovation-union/index_en.cfm?pg=etp#etps;
- COMSODE project (Components Supporting the Open Data Exploitation) targeting data disclosure;
- Ambient and Assisted Living (AAL) programme focused on the use of ICTs in the research and development of new assistance technologies and services in order to improve the quality of life of senior people and enhance the silver economy and industry, including SMEs.