Questionnaire
Summary of the main activities of a research institute of the Slovak Academy of Sciences

Period: January 1, 2016 - December 31, 2021

1. Basic information on the institute:

1.1. Legal name and address

Institute of Informatics, Slovak Academy of Sciences (II SAS)

Dúbravská cesta 9

845 07 Bratislava 45

Slovak Republic

1.2. URL of the institute web site

http://www.ui.sav.sk

1.3. Executive body of the institute and its composition

Directoriat	Name	Year of birth	Years in the position, from - to
Director	Ing. Mgr. Robert Andok, PhD.	1973	2021 -
Director	Ing. Ivana Budinská, PhD.	1964	2015 - 2021
Deputy director	doc. Ing. Ladislav Hluchý, CSc.	1952	2015 -
Scientific secretary	Mgr. Robert Sabo, PhD.	1981	2015 -

Comment: There was a change in the director possition in the end of the accreditation period. Ivana Budinská, former director was elected as a member of Presidium SAS.

1.4. Head of the Scientific Board

RNDr. Ján Glasa, CSc.

1.4.1 Composition of the International Advisory Board

• Prof. Hung-Yin Tsai, National Tsing Hua University, Hsinchu, Taiwan, holder of the Innovative Technology Award by Ministry of Economic Affairs of Taiwan, fields of scientific expertise: nano/micro technologies, advanced manufacturing

• Prof. Imre Rudas, full professor, head of steering committee of the University Research and Innovation Center, Obuda University, Budapest, Hungary, fields of scientific expertise: cybernetics, robotics and artificial inteligence

• Prof. Jacek Kitowski, full professor of computer science, Member of the Research Department of the Academic Computer Centre CYFRONET AGH, AGH University of

Science and Technology, Krakow, Poland, fields of scientific expertise: computer science.

1.5. Basic information on the research personnel

1.5.1. Fulltime equivalent work capacity of all employees (FTE all), FTE of employees with university degrees engaged in research projects (FTE researchers)

2016		2017		2018		2019		2020		2021		2016-2021	
FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	FTE all	FTE researchers	average FTE all per year	average FTE researchers per year
70.14	56.76	71.38	57.98	71.17	59.07	72.14	58.00	72.56	58.08	70.11	56.38	**71.25**	**57.71**

1.5.2. If applicable, add also a short information on the merger of the institute in the evaluation period. You can also add rows in the above table corresponding to the founding institutes

1.6. Basic information on the funding of the institute

1.6.1. Institutional salary budget, other salary budget[1], non-salary budget[2]

Salary budget	2016	2017	2018	2019	2020	2021	average
Institutional salary budget [millions of EUR]	1.196	1.187	1.337	1.569	1.735	1.718	**1.457**
Other salary budget [millions of EUR]	0.510	0.501	0.500	0.507	0.608	0.587	**0.535**
Total salary budget [millions of EUR]	1.707	1.688	1.837	2.076	2.342	2.305	**1.992**
Non-salary budget [millions of EUR]	0.472	0.371	0.452	0.425	0.496	0.421	**0.439**

1.7. Mission Statement of the Institute as presented in the Foundation Charter indicating the years when it was adopted and revised

The fundamental mission and scope of activities of II SAS cover basic and oriented research to the following fields of science (Foundation Charter valid since February 17, 2014):
- Informatics, Information and Communication technologies,
- Electrical Engineering.

The scientific and research activities of the II SAS are focused on the following basic directions:
- Applied Informatics, Cybernetics, Artificial Inteligence,
- Parallel and Distributed Information Processing, Knowledge Technologies

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[1] Salary budget originating outside the regular budgetary resources of the organization, e.g. from the project funding.
[2] Includes Goods and Services and PhD fellowships

- Microelectronics, design and testability of embedded systems, digital systems and circuits, design of information systems components, microelectronic structures and nano-structures and their technological realization
- Numerical Mathematics and Scientific and Technical Calculations, Mathematical Modelling and Computer Simulation of Complex Natural Phenomena
- Processing and Coding of Digital Signals in Multimedia Systems
- Research of Speech Communication, Automatic Processing of Speech, Processing of Natural Language and Computer Linguistics
- Modelling, Simulation and Control Of Discrete and Hybrid Systems
- Animation, Control, Research and Development of Mechatronic Systems and Sensoric Systems.

The aim of the research is to achive new scientific knowledge in the fields of science covering the II SAS's scope of activities, in desiging and implementation of models, methods, algorithms, simulations, program tools, efficient program systems, architectures, diagnostics and testing, as well as in research of parameters and behaviour of micro-electronic/MEMS structures and methods of developing them. The II SAS performs scientific education within generally valid legal regulations. II SAS's activities include development and realisation of information system components, including micro-/nano-electronic structures and development of laboratory and experimental equipment for research applications.

The II SAS ensures publicity of scientific research results through periodical and non-periodical publications. Publication of periodicals and non-periodicals is subject to SAS Presidium resolutions.

Comment: The Charter was slightly modified in 2018 (on the occasion of the first anniented SAS transformation) and accepted again in January, 2022 (on the occasion of the second successful SAS transformation). Top II SAS management and the Scientific Board (SB) perceive the need of slight modification of the Charter to reflect an actual situation and actual research trends followed and developed at II SAS. The thorough internal discussion in SB with utilization of external feedback of external SB members (top Slovak universities' approach) involving Executive Body and heads of departments indicated the need of Charter modification. The modification was postponed not to complicate rather complicated transformation process (completed in 2022). The discussion will continue after the accreditation and the International Advisory Board contribution will be highly appreciated.

1.8. Summary of R&D activity pursued by the institute during the evaluation period in both national and international contexts. Describe the scientific importance and societal impact of each important result/discovery. Explain on general level – the information should be understandable for a non-specialist (recommended 5 pages, max. 10 pages for larger institutes with more than 50 average FTE researchers per year as per Table 1.5.1.)

II SAS has a rich international cooperation within the European research area focused mainly on, but not limited to, service-oriented distributed computing, knowledge-oriented technologies and spoken language processing technology for a long period of EC 7th Framework Programmes and HORIZON 2020. The II SAS has successfully completed a number of projects during the period 2016-2021: two projects of FP7 and five projects of H2020. Four H2020 projects and one ERANET project are still being implemented. In these projects, II SAS was a leader in 4 workpackages, 6 tasks and coordinated the preparation of 13 deliverables. II SAS has successfully continued to gain fundings for the projects within the Horizon Europe funding programme. The solution of European projects has a strong European dimension, they have an impact on society and industry.

R&D activities in the field of parallel and distributed computing, software engineering and complex applications

Activities in the field are performed in the following projects of the European Research Area:

PROCESS: PROviding Computing solutions for ExaScale challengeS (1.11.2017-31.10.2020)
H2020-777533 [call H2020-EINFRA-2016-2017], https://www.process-project.eu/
PROCESS project was funded by the EU to foster HPC (High Performance Computing) in the development of very large data service prototypes.
PROCESS project developed a set of innovative service tools and prototypes throughout the collaboration of main actors in the data-driven ecosystem: HPC and big data centres; e-Infrastructure solution providers; and communities of top-demanding, innovation-savvy users. The result accelerated the adoption of future extreme scale data processing offerings.
II SAS coordinated 2 WPs focused on architecture design for exascale computing (WP4 and leading 2 tasks within it: Designing the PROCESS architecture and Publication, dissemination and promotion) and WP7 focused on Service Orchestration and User Interfaces, leader of 3 tasks within WP7 (Service deployment and orchestration, Services for data access and integration, Application-oriented scientific gateway). As a partner, it also participated in other tasks in the project. The project was successfully completed by the review in 2020.

DEEP-HybridDataCloud: Designing and Enabling E-infrastructures for intensive Processing in a Hybrid DataCloud (1.11.2017-30.4.2020) H2020-777435 [call H2020-EINFRA-2016-2017], https://deep-hybrid-datacloud.eu/the-project/
The final achievement of the project founded by the EU was to implement a new generation of e-infrastructures that harness latest generation technologies, supporting deep learning and other intensive computing techniques to exploit very large data sources. The project provided the corresponding services to lower the adoption barriers for new communities and users, satisfying the needs of both research, education communities and citizen science.
II SAS within the project coordinated the WP4 workpackage, in which technologies for computing acceleration based on specialized resources (GPU, Infiniband) were developed, by improving access to these resources in cloud and HPC integration with the cloud. Within WP4, a unified GPU approach was developed for various cloud platforms such as Openstack, Mesos, Kubernetes as well as the HPC platform. Except of workpackage WP4, II SAS also participated in the workpackage WP6 in the creation of "DEEP as a Service" platform and "Marketplace" services, further in the WP2 workpackage with the application on analysis of massive data flows using deep learning techniques. The project was successfully completed by the review in 2020.

EGI-ACE - Advanced Computing for EOSC (1.1.2021-30.6.2023) H2020-101017567 [call H2020-INFRAEOSC-2018-2020 / H2020-INFRAEOSC-2020-2], https://www.egi.eu/project/egi-ace/
EGI-ACE is an EU-funded project coordinated by the EGI Foundation with a mission to empower researchers from all disciplines to collaborate on data- and compute-intensive research through free-at-point-of-use services. Building on the distributed computing integration in the EOSC-hub project, EGI-ACE will deliver the EOSC Compute Platform and contribute to the EOSC Data Commons through a federation of cloud compute and storage facilities, PaaS services and data spaces with analytics tools and federated access services. Over 30 months, the project is expected to provide more than 82 million CPU hours, 250 thousand GPU hours for data processing and analytics, and 45 PB/month for hosting and exploiting research data.
II SAS developed two production services: The Cloud Compute service, and the Dynamic DNS service for the Dynamic Domain Name System. In addition to these services, II SAS developed the FedCloud client service, which became an official client command line for EGI Cloud federation. The client can also be used to create scripts for automation and as a Python library for the development of other services in the federation. The EGI-ACE project will continue until 2023.

EOSC-Synergy: European Open Science Cloud - Expanding Capacities by building Capabilities (1.9.2019-31.10.2022) H2020-857647 [call H2020-INFRAEOSC-2018-2020], https://www.eosc-synergy.eu/
EOSC-Synergy project is funded by the EU coordinated by Agencia Estatal Consejo Superior de Investigaciones Cientificas (CSIC) Spain and it introduces new opportunities by making national

thematic services available in Europe by expanding the EOSC offerings for environmental sciences, climate change, Earth observation and about life. This is supported by capacity expansion by federating computing, data and storage resources in line with EOSC and FAIR policies and practices.

II SAS participates in three work packages: WP2 - Capacity building at the level infrastructure, WP4 - Capacity building for thematic services and WP5 - National harmonization policies and practices. Within the WP2 package, II SAS is the leading solver of the T2.4 subtask "Integration of national research data repositories", which deals with technical integrating major national research data repositories into the EOSC ecosystem; and actively works on other integration tasks at the level of basic services, technical standards and policies. Several services have been developed, deployed and integrated with the EOSC-Synergy project infrastructure, in particular the Horizon Dashboard at providing access to all cloud sites in the project and the "COVID-19 Galaxy" service on corona-virus genomic data processing. In WP4 II SAS works on the development and integration of the thematic service MSWSS for modelling and analysis of water supply systems. The MSWSS service allows infrastructure managers to drinking water supply and researchers to use the EOSC computing infrastructure; and data sharing services for the analysis of more complex water supply systems. EOSC-Synergy project will continue until 2022.

EGI-Engage - EU H2020 project: Engaging the Research Community towards an Open Science Commons (1.3.2015-31.8.2017) H2020-654142 [call H2020-EINFRA-2014-2015], https://cordis.europa.eu/project/id/654142

The main achievements of EGI-Engage were to boost the engagement of the EGI community towards Open Science practices. The project enhanced the capabilities offered to scientists with improved cloud and data services. It also increased its scope by sharing its services with large research infrastructures, industry and SMEs. In doing so, this EU-funded project facilitated the work of researchers and allowed an easier exchange of expertise. Ultimately this supported key advances in many scientific fields from biomedical sciences to high energy physics.

II SAS took over the role of the leader of the partial task in the workpackage "JRA2: Platforms for the Data Commons" called "Acceleration for Intensive Computing". II SAS integrated Accelerated Computing Accelerators (GPGPU) into the cloud part of the EGI European Computing Infrastructure. II SAS provided these intensive computing resources to testing new versions of the EGI interface such as accounting, cloudkeeper, open cloud computing interface server and II SAS set up an experimental cloud node with LXD containers with GPGPU. As part of federated services, II SAS set up a VOMS server for the newly created virtual server acc-comp.egi.eu for users from European scientific communities with applications requiring intensive calculations. II SAS continued to support research virtual organizations such as moldyngrid.eu (molecular dynamics), enmr.eu (magnetic resonance), vo.lifewatch.eu (biodiversity and ecosystem research). II SAS's work was used in other important applications including ESFRI. The project was successfully completed by the review in 2017.

EOSC-hub - Integrating and managing services for the European Open Science Cloud (1.1.2018-31.3.2021) H2020-777536 [call H2020-EINFRA-2016-2017], https://www.eosc-hub.eu

The successful achievements made by EGI-Engage fully continued through the next EU-funded project EOSC-hub, which aims at developing a single portal through which researchers will be able to store, manage, analyse and re-use data for research, innovation and educational purposes. This EOSC (European Open Science Cloud) portal was projected to become a reality by March of 2021. II SAS in the EOSC-hub project provided support for accelerated computing in EOSC federal cloud using two cloud sites: II SAS GPU cloud with Openstack and II SAS-Nebula with Open Nebula system. Cloud sites provided virtual machines with connected GPUs for various scientific communities. In addition, the II SAS participated in international cooperation with third cloud site SAS-FedCloud II with Openstack for service hosting purposes NextGEOSS (Earth Observation). II SAS provided a dynamic DNS service for EOSC-hubs for dynamic assignment of DNS records to variable IP addresses. In the fall of 2020 II SAS performed training in the form of a webinar "How to use Accelerated Computing in EGI Federated Cloud". The EOSC-hub was successfully completed by the review in 2020.

SILVANUS - Integrated Technological and Information Platformfor wildfire Management (1.10.2021-31.3.2025 +2 months extension) H2020-101037247 [call H2020-LC-GD-2020-3], https://silvanus-project.eu/

Funded by the EU Horizon 2020 Green Deal programme and coordinated by Università Telematica Pegaso, SILVANUS project includes 49 partners from the European Union, Brazil, Indonesia, and Australia, with a budget of €23 million for a period of 42 months.

The SILVANUS project brings together a large consortium of interdisciplinary experts from four continents to combat the threat of forest fires and improve forest resilience against climate change. The key output of the project is the release of a climate resilient forest management platform to prevent and suppress forest fire. SILVANUS relies on environmental, technical and social sciences experts to support regional and national authorities responsible for wildfire management in their respective countries. SILVANUS scientists and research engineers will aid the civil protection authorities to efficiently monitor forest resources, to evaluate biodiversity, to generate more accurate fire risk indicators, and promote safety regulations among the local population affected by wildfire through awareness campaigns. II SAS participates in several tasks: Big-data analytics framework for institutional awareness on fire danger index, Mobile application for citizen engagement, Citizen engagement programme for preventing wildfires, Data collection, aggregation and pre-processing of in-situ devices, Social media sensing and concept extraction, UAV deployment for remote sensing and identification of wildfire, Semantic framework for information fusion. The Silvanus project will continue until 2025.

REDIRNET - EU 7RP project: Emergency Responder Data Interoperability Network (1.3.2014-31.8.2016) FP7-607768 [Call identifier FP7-SEC-2013-1],https://cordis.europa.eu/project/id/607768

The REDIRNET project was aware that frequently it is non-technical issues that hinder agency interoperability regardless of the quality of technical solutions. Consequently, user engagement across a range of agencies EU-wide was ongoing throughout the duration of REDIRNET. This lead to the first of two elements of the REDIRNET framework - a quality repository of user identified interoperability issues and proposals for their resolution.

The second element of REDIRNET was technology. REDIRNET provided a decentralized framework for interoperability for first responders' systems based on a public meta-data gateway controlled by the agencies themselves via a REDIRNET socio-professional web. Agencies were able to link up to partner agencies of their choice and operational need; they were also able to manage the scope of such interoperability. To help set up these link-up arrangements REDIRNET was enhanced with semantic web methods in accordance with the vocabulary and processes of the user community. Inter-operating agencies needed only to develop one gateway (to REDIRNET) leading to a cost effective solution; agent technologies were also developed to facilitate the integration of user systems into REDIRNET. II SAS contributed to the collection and aggregation of data mainly to support first reposponder and lead task Secure agent-based infrastructure implementation. The project was successfully completed by the review in 2016.

Domestic projects are also important, the successful solution of which enables the preparation of teams at the II SAS to participate in the calls of H2020 and currently HE:

New Methods and Approaches for Distributed Scalable Computing (2020-2022), VEGA 2/0125/20, coordinated by II SAS. Due to the extremely multi-faceted dynamic data we proposed novel methodologies, robust methods and approaches for scalable analytics in conjunction with scalable data collection, processing and management. High-performance platforms were upgraded with the latest cloud technology knowledge for flexible management of large-scale systems. The project also developed appropriate tools and services for distributed and scalable information processingwith the support for high-performance platforms. Project continues until of 2022.

Methods and algorithms for the semantic processing of Big Data in distributed computing environment (2016-2019), VEGA 2/0167/16, coordinated by II SAS. New methods for processing of text resources in multidimensional data space using neural networks and data mining algorithms were proposed. Methods and algorithms for big data processing, distributed data collection and aggregation of information from heterogeneous sources were proposed and implemented. Optimizing the performance of complex systems in a multicloud environment was solved.

U-COMP - Urgent Computing for Exascale Data (1.8.2018-31.12.2020), APVV-17-0619, coordinated by II SAS. The U-COMP project was focused on processing large data in modeling flood scenarios in a powerful cloud environment. The input data were meteorological and hydrological data. DHI Slovakia models were used for pilots in southern Slovakia.

FaceControl - Comprehensive communication device for innovative management of production and support processes in industry (1.3.2019-31.10.2020), OPVal-MH/DP/2017/1.2.2-12
The FaceControl project developed the model of image steganography and created the software prototype for image authentication. The image steganography model is based on inserting and extracting messages using positional matrices generated by the Optimized Pulse-Bound Neural Network Model (OM-PCNN, Optimized Model of Pulse Coupled Neural Network). The solution also included testing of selected neural networks for encryption of hidden data and hashing of images. The software prototype is based on the proposed image steganography model, symmetric encryption using AES-256 and cryptographic hash function SHA-2 with 512 bitprint. Due to the increased safety of the steganographic model, the scales are OM-PCNN initialized using a steganographic key.

ARIEN - Analysis of environmental influences on power industry equipment by the methods of artificial intelligence and cloud computing (1.7.2021-31.12.2023), APVV-20-0548
The project ARIEN is focused on research into the environmental impact of electricity management (impact on insulators) based on artificial intelligence and cloud computing. Possible artificial intelligence methods for predicting influence were analyzed. The input data were meteorological data as well as historical measurements of chemical elements. The project is implemented in cooperation with the Research Institute of Nuclear Energy (VUJE) and will continue until 2023.

ICONTROL - Intelligent Cloud Workflow Management for Dynamic Metric-Optimized Application Deployment (1.7.2021-31.12.2023), APVV-20-0571
The ICONTROL project is focused on sophisticated tools to support the semantic composition of dynamic workflows based on serverless technology in the cloud continuum with application for visibility recognition at airports. Data from a rotating camera is used as input data. The cooperation is with the company Microstep a. s., which develops a product for airports. The project will continue until 2023.

R&D activities in the field of speech analysis and synthesis

The R&D activities were focused both on basic research in automatic speech processing and human-machine communication and on application of the results in several areas.

International cooperation (Air traffic management security, Speech communication research):
In cooperation with large European companies, institutes and universities research was done and a set of tools was developed to increase the security level in air traffic management and in the management of airports. II SAS developed a system for monitoring the radio voice-communication and checking automatically their authorization (by speaker recognition) and measuring level of stress from the voice of the participants (air traffic controllers, pilots, etc.). This research and development was realized in the frame of **Global ATM Security Management – GAMMA**, FP7 (2014-2017), and **Security of Air Transport Infrastructure of Europe - SATIE**, Horizon 2020 (2019-2021) projects.
Project **Conversational brains - COBRA**, Horizon 2020 (2020-2024) has two main aims. The scientific aim is to study higher levels of man-man and man-machine vocal communication, such as entrainment and other phenomena. The paedagogical aspect is focused at creating a chain of European educational institutions, institutes and companies, that will cooperate on doctoral education creating possibilities for the students to interchange information and providing the students with the possibility to visit institutions in several countries and take part in their research. II SAS has two doctoral students from foreign countries (Netherland, India) in this project.

Domestic research (telemedicine, social robotics):
In close cooperation with neurologists, psychologists, and a private company, a research on automatic screening of neurodegenerative diseases from voice is being done in the **Early Warning of Alzheimer - EWA**, Structural Funds EU, (2020-2023). A corpus of recordings of people with Parkinson's disease, Mild Cognitive Impairment and Alzheimer's disease, is being collected, and a smartphone application for at-home screening of these diseases from voice is being developed.
In cooperation with Technical University of Košice, possibilities of automatic detection of COVID 19 vocal cues and use of social robots (FURHAT 2) in communication with patients is researched in the project **Automatic speech processing technologies for support in crisis situations**, VEGA (2021-2024).

Cooperation with private companies (Voice output for the blind, Interactive fairy-tales reading):
A special version of **high-quality DNN speech synthesizer**, with small computational and memory requirements, was developed for the acoustic output of the bus time-table information systems designed by ELEN, s.r.o. and implemented at Spišská Nová Ves railway station.
An **interactive phone-assisted reading** application **READMIO** was developed in cooperation with Readmio, s.r.o. The application enables downloading texts of fairy-tales. It listens to the parent reading a fairy-tale for children and automatically plays illustrative sounds at the appropriate moments. II SAS has developed a speech recognizer based keyword spotting algorithm and provides Readmio, s.r.o. with a service of generating language models for new stories in Slovak and Czech languages.

Social significance - services for the public sphere (SLA for General Prosecutor's Office):
According to the Service Level Agreement, II SAS provides remote **service and maintenance of the Voice Input System** (developed by II SAS) of the PATRICIA information system of the General Prosecutor's Office, used by all prosecutors in Slovakia.

R&D activities in the field of numerical mathematics and scientific calculations, and mathematical modelling and computer simulation of complex nature phenomena

The research was focused on mathematical modelling and computer simulation of fires (mathematical foundations of fire models, their implementation and parallelization, applicability of advanced simulators for selected types of fires, carrying out full-scale fire experiments and validation of simulations). Research objectives (very timely and topical) are in accordance with actual world research trends to apply knowledge and innovative approaches of ICT in the field of safety and protection of citizens, communities, human structures, critical infrastructure and environment from natural disasters and disasters caused by man. II SAS is known as a coordinator of several researches unique in the Central Europe:
− carrying out of full-scale automobile fire experiments in open air and in experimental tunnels in Slovakia and the Czech Republic,
− development of computer simulations of the fires using the FDS Simulator and their validation,
− computer modelling of people evacuation during a fire using FDS+Evac,
− computer modelling of circumstances of tragic fatalities during a forest fire using FARSITE,
− studies on simulation parallelization following our longstanding tradition in research on parallel algorithms, architectures and computer systems.
The fire scenarios and environments (fire in car compartments, fire of single cars, spread of fire to adjacent vehicles, fire in selected structures) are selected and designed in collaboration with the Presidium of Fire and Rescue Force of the Ministry of Interior of Slovak Republic (HaZZ MI SR), the Fire Technical and Expertise Institute of the MI SR (PTEÚ) and the chief safety officer for road tunnels from NDS (Chapter 2.1.5).
The research <u>during the evaluation period</u> utilized former negotiations, knowledge and experience and focussed on computer modelling of fires in structures with higher requirements of fire safety, automobile fires in car parks, fires in road tunnels and controlled vegetation fires.
Great potential of FDS to realistically model the fire behaviour and credibly forecast a safety danger in a car park and cinema hall (selected by specialists from PTEU and HaZZ) was demonstrated using parallel simulations. New knowledge about the impact of parallelization and numerical mesh resolution on efficiency and accuracy of simulation were obtained. In collaboration

with University in Zilina (UNIZA) and within contracts with NDS and PPA INZINIERING (Chapter 2.1.5), series of full-scale smoke tests in 2 motorway tunnels selected by NDS were carried out to validate computer simulations of the tested tunnel fire scenarios. The fire tests were carried out also in collaboration with two foreign companies (from Czech Republic and Switzerland). This research was coordinated by II SAS. It has contributed to increase the fire safety of road tunnels in Slovakia and preparedness of tunnel control operators for fire incidents in Slovak road tunnels (specific national aspect). On the basis of our analyses the customer ordered a modification of some parameters of tunnel control system and a test of functionality of an emergency system in one of the tested tunnels. Our research on simulation parallelization showed that more than 30% of CPU time can be saved utilizing the knowledge about hardware and software disposition of the used HPC cluster. Series of 30 visualizations of critical fire scenarios in a road tunnel in Tunnel Trafic&Operation Simulator (TTOS) installed in Zilina was developed and implemented into TTOS in the form of videos which are used within accredited education and training of tunnel control operators in Slovakia. Five technical reports delivered to the customer were classified by NDS as confidential. In collaboration with the Institute of Hydrology SAS and Technical University in Zvolen, experimental and computer simulation researches related to vegetation fires started within the FIRElinks international research network (CA 18135). II SAS took part in preparation of an analytical review paper on fire problem and fire research in collaborating countries. As specific Slovak contribution to FIRElinks activities II SAS took part in preparation of a series of control vegetation fires and measurements in the Kremnicke Vrchy Mountains to study effects of fire on soil and ecosystem (so far postponed because of COVID situation) and tested abilities of FDS for vegetation fire modelling. II SAS also took part in the WISE-ACT international research network (CA 16222) studying possible impacts of autonomous cars on transport infrastructures in emergency situation.

The research was conducted within 4 national projects coordinated by II SAS (**VEGA 2/0184/14**, **VEGA 2/0165/17**, **VEGA 2/0108/20**, **APVV-15-0340**; both finished VEGA projects received certificates about obtaining excellent scientific results) and 2 COST projects (**CA18135**, **CA16222**; II SAS participated in both MCs). The fire research group also submitted numerous research project proposals: 2 to VEGA and 2 to APVV (as coordinator) and 1 to ASFEU (as WP coordinator). The team signed 2 contracts with NDS and PPA INZINIERING which declared their strong readiness to renew the contract collaboration (4 contracts about contract). The group also contributed to preparation of 3 proposals of new COST Actions (**ESCAPED OC-2020-1-24622**; **EvacDrillNet OC-2021-1-25264**; **NERO OC-2021-1-2547**) as secondary proposer. The outstanding credit of the tire research group in national and international level can be documented also by numerous publications (indexed in WoS/SCOPUS databases) and citations (407 citations including 289 WoS citations).

R&D activities in the field of modelling, simulation and control of discrete and hybrid systems

Research activities in this field include activities oriented on optimization of manufacturing systems, optimization of multi sensory networks, and precise agriculture. According to current trends we have focussed also on cyber-physical systems that are important in many areas. Because cyber security is an important part of cyber-physical systems, we have dealt with security issues, too.

The research is performed as part of the following projects and agreements:

SOON - Social Network of Machines (CHIST ERA, ERANET-Programme, 1.3.2019-30.4.2022), https://soon-project.eu/

This project investigates the impact of the use of autonomous social agents to optimise manufacturing process in the framework of Industry 4.0. "Social" means that cyberphysical entities act autonomously in order to optimize an industrial process following behaviour models inspired by human social networks. Intelligence of smart devices is localised and intelligent heterogeneous entities cannot communicate together even inside the same shop-floor. In this project, a holistic multi-agent paradigm that encompasses machines and humans is proposed. The presence of human operators is therefore crucial both to teach to and to learn from software agents, via deep learning and data mining algorithms. Agents take decisions merging and analysing big and heterogeneous data produced by sensors (vibration, temperature, etc.), information available in the company information systems (such as enterprise resource planning and manufacturing execution

system), and humans in real-time. II SAS contributes to the project in the field of data collection and aggregation. An industrial partner, a plastic recycling company - MAT-obaly, a.s. is involved in this project. Other partners of the projects are: University of Applied Sciences Western Switzerland (coordinator), University of Oviedo - Spain, Petru Maior University – Romania. There are two more industrial partners: Tornos SA – Schwitzerland, ArcelorMittal Innovacion Investigacion e Inversiones S.L. – Spain. As a result of this project a new proposal – Machinet – was submitted for a HE (HORIZON-CL4-2021-TWIN-TRANSITION-01-01: AI enhanced robotics system for smart manufacturing (IA)) with the institute as a coordinator.

Cyber-physical systems (CPS), Internet of Things (IoT), wireless sensor networks, Smart monitoring, tele-medicine, COVID-19 (MAD, SAV - BAV, 1.1.2021 – 31.12.2022)

The aim of the project is research and development of Cyber-Physical System (CPS) for tele-monitoring and tele-medicine in hospital care during pandemic situations, including the following embedded systems: mechanical system, hardware, software, sensors, IoT devices, communication system and web-based user interface containing the necessary functions for work in the hospital environment. This complex system will be controlled via the Internet. The cyber-physical system for epidemiological monitoring in hospital care is built by a specialized modular Robot-Assistant, and IoT devices together with a system for a seamless communication and aggregation of sensory and multimodal data for tele-medicine and tele-monitoring of the patients with Covid-19. Thus, the physical contact between the medical staff with patients is limited. Moreover, the risk of repeated daily exposure to corona virus for physicians during each manipulation will be greatly reduced. The project main goal of the project is to boost up the cooperation of two academic institutions with complementary research activities. The cooperation is focussed on PhD students and young researchers support. Unfortunately, due to pandemic situation, planned visits and exchange of researchers in 2021 were not realized.

Algorithm of collective intelligence: Interdisciplinary study of swarming behaviour in bats (APVV-17-0116, 1.8.2018 – 31.7.2022)

Various algorithms of artificial intelligence inspired by real biological mechanisms are successfully applied in military and civil sector. In this proposed project, cooperative research of four scientific institutions having different basis, methodology and the object of study (biology, computer science, and technology) focuses on interdisciplinary study of social self-organizational behaviour of tree-dwelling bats with the aim to develop new meta-heuristic method capable of space exploration. In the field of artificial intelligence, the project focuses on swarming behaviour of individuals/agents with higher nervous activity and well developed cognitive skills. The model organisms (bats) on which this project is focused are using advanced biological mechanism capable of state space exploration and at the same time preventing group disintegration. This lead to development of new biologically inspired algorithms and methods applicable e.g. in movement coordination of unmanned aerial vehicles.

Ontology representation for security of information systems (APVV-19-0220, 1.7.2020 – 30.6.2024)

This project focuses on new approaches in sharing knowledge about security incidents and indicators. There are several initiatives that seek to formalize and standardize security incidents descriptions. However, it is neither realistic nor desirable to assume that there will be one common standard for describing security incidents. The solution can be offered by creating a core ontology, which semantically integrates various approaches to describing threats and attacks, thus enabling the integration of several standards and knowledge repositories. The tools for representation and processing of ontologies will be used for this purpose. It will be a combination of procedures for collecting data from network communication, creating the necessary ontologies e.g. semiautomatic extraction of ontologies from text in natural language – ontology learning, use of selected advanced methods of ontological knowledge representation, e.g. contextualized representation or methodology of ontological metamodeling. A significant shift will be that the ontology of the model can be represented by a graph. The results can be expected to contribute to more efficient sharing, representation, storage, and use of cybersecurity knowledge.

Modelling and supervisory control of resource allocation systems in discrete-event systems using of Petri nets (VEGA 2/0020/21, 01.01.2021-31.12.2024), **Modelling and Control of Complex Discrete-Event Systems Containing Uncontrollable Events and Unobservable States** (VEGA 2/0029/17, 01.01.2017 – 31.12.2020).

Discrete-Event Systems (DES) are systems that remain in a given state until they are forced to change this state due to the occurrence of a discrete event. In practice, e.g. flexible manufacturing systems (FMS), robot cells, transport and communication systems, etc. are DES. Resource Allocation Systems (RAS) in DES tend to deadlocks. Deadlocks must be eliminated. Petri Nets (PN) will be used to model RAS and synthesize their control to avoid deadlocks. Two approaches to the supervisor synthesis has been explored: (i) on the basis of P-invariants of PN, at the simultaneous thorough analysis of the reachability tree (RT) of PN and at knowledge of the initial state of the PN model; (ii) by the thorough analysis of the PN model structure and finding siphons and traps without the need to know the initial state.

Precise agriculture (Agreement with AgroTrade Group, spol.s r.o., and MATEX, s.r.o.).

The agricultural sector currently has a wealth of new information on the basis of which advanced automated equipment can accurately and purposefully deploy active substances and ensure crop protection. These are sophisticated technologies, the use of which is currently not sufficient for the needs of precision agriculture on a local scale. The interdisciplinary networking of experts from different scientific disciplines contributes to their more effective use. We have proposed a procedure for processing and preparation of application maps, which allows to optimize the dosage with respect to the given technical, local soil and phytological requirements. Early detection of crop damage significantly reduces the time required to apply appropriate protective measures and chemicals. Rapid application is carried out locally, only in the damaged area and the result is a significant reduction in treatment costs. A secondary impact is also a better care for the environment, with the potential to contribute to the fulfillment of the outputs of individual departments listed for the priority areas of the RIS3 strategy.

Multi sensor networks optimization.

The aim of the research is the development of distributed algorithms based on reaching a consensus for data aggregation and their usability in sensor systems. In the research, we focused on the analysis of robustness against potential failures and quantization noise, performance analysis, the impact of mobility of multi-agent system entities on the accuracy of estimation and the applicability of selected algorithms in real systems. We also analysed the robustness of the Metropolis-Hastings algorithm against stochastic line failure and compared it with other techniques. The algorithm generally achieved the highest robustness among the analysed algorithms.

R&D activities in the field of design, analysis and simulation of micro-robotic devices

The research was focused on the development of a new type of the wireless force/displacement sensor using the principle of changing frequency characteristics of the electromagnetic (EMG) field on the side of the source/emitter. This research was supported by the project **APVV-14-0076** "MEMS structures based on load cells". The design studies were carried out and several sensor deformable bodies were designed in order to achieve strictly parallel flexural displacement of capacitor plates, as the part of the integrated LC resonant circuit. The solution of the project is extended to proposal of own methods of mathematical description of the compact compliant structures.

The formulation of the qualitative indicators in the design of the compliant micro-robotic devices enables the precise formulation of constraints and objective functions for the multi-objective optimization of structures. This field of study is still under elaboration, but results actually achieved, enable to increase the dynamical properties of the proposed devices up to the third natural frequency by keeping equal stiffness, required functions and performance characteristics.

Considering different results from analytical, numerical description and experimental verification of the micro-robotic devices, additive manufacturing has been implemented in the manufacturing the physical samples for laboratory tests. Such an approach demands applying new R&D activities to be experimented and various characteristics of more physical samples to be verified. This activity included using the 3D printing technology and various settings (such as speed, infill, used material, etc.). The members of II SAS continuously extend the laboratory test bed for the measurement of compliant mechanisms/devices. Following design of previous versions, the new - modular

approach was implemented for actual versions. The contactless measurement of stress with laser distance sensors and vision systems with the implementation of various algorithms of deep learning and artificial intelligence enables to improve results. Each such HIL/SIL simulation puts stress on the implementation of industrial components and communication protocols.

Another project between the Institute and the industry partner was oriented to development of the robotic device (displacement transformer) that minimizes errors of standard servo drives and enables linear output movement in a small range of motions with very high payload capability. This project analysed approaches that enable the transformation of relative large movements of the servo drive by a monolithic elastic body and amplify their movements to ten times smaller movements. Our design has been successfully verified and integrated into one offered device for LHC. Research has studied mechanical amplifiers, and the influence of the harsh environments (mainly changes in temperature) to output positioning accuracy. In the final control system, the non-linear behaviour of the proposed mechanical devices, the influence of the environment, etc. have been taken into account. The main aim of the research has been to replace very expensive piezoelectric linear actuators with commonly used servo drivers with compliant micro-robotic structures. Results of these works have been published in international conferences (more than 18) and journals (more than 5) with high impact and one utility model/patent.

R&D of advanced micro- and nanotechnological processes using electron-beam lithography

Within the projects **VEGA 2/0134/15** advanced patterning processes that can extend capabilities of the technology into the deep nanoscale regime were examined. Experiments were performed on the positive e-beam lithography resist PMMA for 30 keV electron energy. The influences of exposure dose and resist thickness on the shape of the developed profiles in thick PMMA resist layers were studied experimentally and theoretically in order to achieve high-aspect-ratio of structures. Models for prediction and optimization of the geometry of the developed resist profiles in the PMMA resist were estimated. Corresponding experiments and simulations for different EBL process parameters were carried out and comparisons were made. The results contribute to the knowledge on electron scattering in resist/substrate in e-beam lithography for the case of field emission cathode and Gaussian intensity distribution and to development and approval of simulation tools for prediction and precise control of obtained resist profiles in PMMA for Lift-off nanopatterning. Characterisation of commonly used electron sensitive materials was performed. Experimental and simulation results obtained for EBL nano-patterning using these resists were analysed. The influence of EBL process parameters such as exposure dose, resist thickness and development process conditions on the obtained developed images in electron beam resists was studied. The analysis of the characteristics of the chosen electron-beam resists was performed and the impact of these characteristic on the resolution of the nano-dimensioned electron beam lithography was studied.

Within the project **VEGA 2/0119/18** research of new semiconducting 2D thin films such as dichalcogenides of transition metals was performed with the aim to get a new scientific knowledge in the patterning of nanometer scale structures (20-200 nm) in electron beam resists on 2D thin films with focus on a new progressive nanostructured semiconductive materials based on dichalcogenides of transition metals such as WS_2 and MoS_2. The properties of selected nanostructured disulfides were examined in terms of their use in the sensor technology. Within cooperations with project partners the design of a model sensor device based on specific nanostructured disulfides has been carried out. There has also been basic research into the search for new progressive semiconductor materials based on metal oxides and disulfides, as well as research into the technology of electrode material based on boron-doped diamond layers. The research activities were focused on the preparation and research of the properties of TiO_2, NiO and WS_2 layers, their selected combinations as well as their doping, while such nanostructured semiconducting materials will be integrated into chemoresistive gas sensors placed on thin electrical insulating membranes. Attention was also paid to the research of the integrated voltammetric sensor technology with a protective opaque layer of Nafion for the simultaneous determination of trace concentrations of heavy metals.

Bilateral project **SAS-MOST JRP 2017/1** between Slovakia and Taiwan (NTHU University in Hsinchu) was aimed at individual stimulating system with 3D nano-structure carbon/graphene

based transducer and wireless heater for automated tiny insects (drosophilas) behavior monitoring. The project was divided into three parts: designing and manufacturing a 3D micro transducer; designing and manufacturing an individual insects stimulator made by the wireless heater; and designing a monitoring and analysis system that could observe the behavior of tiny insects systematically. A wireless heater installed on to the body of drosophilas can stimulate them individually under certain circumstances. Such heater is made by connecting a nanometric diamond film with a high density micro coil produced at II SAS. By exerting electromagnetic waves of certain frequency related to the size of the coil, electromagnetic induction will occur and the device will heat up stimulating the insect. Drosophilas were used in this project as a model organism because the hierarchical structure of their brains resembles the brain of mammals, which constitutes to their complicated social behavior. As a broader impact of the results of this bilateral cooperation, by observing the social behavior of these flies, insight on typical human brain disorders (such as the Parkinson's, the Alzheimer's, and the Huntington's disease), neural networks, and biological evolution could be gained. Therefore, it is expected that the results of this project may also affect wider areas of research, including life and medical sciences.

R&D activities in the field of processing and coding of digital signals in multimedia systems

The research focussed on cosine-/sine-modulated filter banks (general properties, fast algorithms and integer approximations). It was conducted by Vladimír Britaňák within 3 national research projects (**VEGA 2/0184/14**, **VEGA 2/0165/17**, **VEGA 2/0108/20**). He benefited from close collaboration with eminent researchers in the field. The outstanding impact and top quality of Britaňák's previous research outputs can be documented by his publicity during the evaluation period (297 citations, including 168 WoS citations). In collaboration with Kamisetty R. Rao (founder of the DCT transform), he wrote significant scientific monograph V. Britaňák and K. R. Rao: Cosine-/Sine-Modulated Filter Banks: General Properties, Fast Algorithms and Integer Approximations, Springer International Publishing AG, Cham, Switzerland, xxvi, 645 p., 2018, ISBN 978-3-319-61078-8 in the field of cosine-/sine-modulated discrete block transforms with perfect reconstruction which was published in reputable scientific publisher. The transformations are basic processing components for conversion of audio signal from time to frequency domain (and vice versa) in numerous information and communication technologies for compression of digital audio signals. As these transformations require up to 70% of total computational time, the development of efficient algorithms for their calculation plays significant role in term of real-time processing. The monograph maps more than 20 years of world research in this area. It contains quite a number of original results of the author published in numerous European and American journals as well as variety of his not yet published original results. It is focussed particularly on: definitions and mathematical properties of cosine-/sine-modulated discrete block transforms with perfect reconstruction, their mutual relations and block matrix factorizations, theory and development of efficient algorithms for calculation of these transforms in information and communication technologies: MPEG standards (MP3), Digital Broadcasting, Dolby Digital (Plus), SBR, etc., theory of complexity of algorithms (minimal number of arithmetic operations, regularity, recursion, etc.) for potential software or hardware implementation. The monograph is intended for students and researchers at European and American universities, research laboratories and companies concerned with design and development of audio coding systems. The author was awarded by Slovak Literacy Fund and by SAS (Chapter 2.3.12).

2. Partial indicators of main activities:

2.1. Research output

2.1.1. Principal types of research output of the institute: basic research/applied research, international/regional (in percentage)

basic research/applied research: 40 / 60 (%)

international research/national research: 80 / 20 (%)

Comment: Most of our basic research activities are "problem-oriented" and are intended for applications in the middle time horizon (5-10 years); however, some of them have direct applications and other could be considered as curiosity-driven research. Without strong basic research it could not be possible to produce high quality applied outputs, nor be accepted in excellent international consortia in European projects. The basic research without no direct outputs for practice covers less than 40% of our reseach activities.

The research conducted at II SAS is internationally oriented. We are not locally, nor geographically constrained. More than 80% of researchers are involved in various types of international research projects and many others take part in informal (non-project) international collaborations such as memberships in conference program committees, editorial boards, reviewer services, non-contract cooperation with foreign SMEs, etc. Almost 80% of publications were published in international periodicals (see e.g. Chapters 2.1-2.2). Within international research consortia (some of them coordinated, or jointly co-ordinated by II SAS) we collaborate with outstanding personels, universities, research laboratories and companies. On the other hand, transfer of internationally accepted knowledge, models, methods, technologies, methodologies and best-practices established and adopted at top European research institutions to national level is considerd by us as our mission and therefore it is of great attention at II SAS. Within nationally founded projects we collaborate with Slovak universities, SAS institutes and leading (IT- or otherwise oriented) companies, some of them being leaders in the Slovak market. In this sense we conduct internationally-oriented research with strong national applications. For example, the research in the field of security and safety (of citizens, human structures, critical infrastructure and environment) as well as in ICT has also strong impact at national or regional level. We also provide research on unstructured text and speach that is specifically intended for Slovak language (with various national applications). In this sense our research could also be considered as national. Some of our research areas have specific direct regional impacts (e.g. the research implications to safety of concrete road tunnels in certain Slovak or cross-border regions) which, while not directly intended, could be considered as regional. That is why it is difficult to specify the research „international/regional" ratio.

2.1.2 List of selected publications documenting the most important results of basic research. The total number of publications should not exceed the number of average FTE researchers per year. The principal research outputs (max. 10% of the total number of selected publications, including Digital Object Identifier – DOI if available) should be underlined. Authors from the evaluated organizations should be underlined.

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2.1.3 List of monographs/books published abroad

BRITAŇÁK, Vladimír - RAO, K.R. Cosine-/sine-modulated filter banks : general properties, fast algorithms and integer approximations. Cham, Switzerland : Springer International Publishing AG, 2018. xxvi, 645 p. ISBN 978-3-319-61078-8 https://doi.org/10.1007/978-3-319-61080-1

BEŇUŠ, Štefan. Investigating Spoken English : A Practical Guide to Phonetics and Phonology Using Praat. Cham : Palgrave Macmillan, 2021. XVII, 272 p. ISBN 978-3-030-54348-8 https://doi.org/10.1007/978-3-030-54349-5

2.1.4. List of monographs/books published in Slovakia
2.1.5. List of other scientific outputs specifically important for the institute, max. 10 items for institute with less than 50 average FTE researchers per year, 20 for institutes with 50 – 100 average FTE researchers per year and so on

- **Investigating Spoken English: A Practical Guide to Phonetics and Phonology Using Praat**

Author: Štefan Beňuš

The book summarizes the author's long-term approach to the study of acoustic and articulatory characteristics of English with a link to phonetic analysis using Praat software and a didactic approach to better understanding and improving English pronunciation. The strength of the publication is the combination of the theoretical and practical approach to knowledge. In addition to the accessible description of the conceptual material, the phonetic features of English speech communication are examined at a gradually expanding level of analysis from individual sounds

through syllables, words to intonation and prosodic characteristics of entire dialogues. Practical activities and mini-experiment designs support a scientific approach to recognizing the cognitive system of human speech. The wide coverage of the prosodic level of speech and the complex connection between the suprasegmental and segmental aspects of research is another strength of this publication.

Main scientometric output:

BEŇUŠ, Štefan. Investigating Spoken English : A Practical Guide to Phonetics and Phonology Using Praat. Cham: Palgrave Macmillan, 2021. XVII, 272 p. https://doi.org/10.1007/978-3-030-54349-5. ISBN 978-3-030-54348-8

- **Security of Air Transport Infrastructure of Europe**

Authors: Rusko, M., Trnka, M., Darjaa, S., Guoth, I., Sabo, R., Ritomský, M.
Project: Horizon 2020, grant agreement ID: 832969, Call H2020-SU-INFRA-2018
Duration: 1. 5. 2019 - 31. 10. 2021

The SATIE project addresses the safety of air transport infrastructure in Europe. A new speaker verification module checking authorization of participants of voice-radio communication between aircraft pilots at the airport and the tower was designed, developed and implemented in the system of the airport tower and control simulator in Braunschweig. A "StressDat" database played by professional actors was created. A new voice-under-stress identification system based on deep-learning and prediction of the level of emotional activation and the level of emotion pleasure was designed, developed and implemented. The created database "StressDat" was used to train the models. Basic research was done and published on the relation between stress and emotion cues in voice.

Main scientometric outputs:

Marián Trnka, Sakhia Darjaa, Marian Ritomský, Meilin Schaper, Róbert Sabo, Tim H. Stelkens-Kobsch, Milan Rusko: Mapping discrete emotions to the dimensional space: An acoustic approach. Electronics. Q2 - SJR, IF 2.397 (2020) ISSN: 2079-9292

Róbert Sabo, Štefan Beňuš, Marian Trnka, Marian Ritomský, Milan Rusko, Meilin Schaper and Jakub Szabo: StressDat – Database of Speech under Stress in Slovak. Journal of Linguistics (Scientific Journal for the Theory of Languages), 2021, vol. 72, No 2, pp. 579-590, (Q3 - SJR, 2019 - Scopus) ISSN 0021-5597 (print ver.), ISSN 1338-4287 (online ver.), DOI 10.2478/jazcas-2021-0030

TRNKA, Marián - DARJAA, Sakhia - RUSKO, Milan - SCHAPER, Meilin - STELKENS-KOBSCH, Tim. Speaker authorization for air traffic control security. In Lecture Notes in Computer Science : Speech and Computer. - Heidelberg : Springer, 2021, vol. 12997, p. 716-726. (2020: 0.249 - SJR, Q3 - SJR). ISBN 978-3-030-87801-6. ISSN 0302-9743. https://doi.org/10.1007/978-3-030-87802-3_64

SCHAPER, Meilin - GLUCHSHENKO, Olga - MUTH, Kathleen - TYBURZY, Lukas - TRNKA, Marián - RUSKO, Milan. The traffic management intrusion and compliance system as security situation assessment system at an air traffic controller's working position. In Proceedings of the 31st European Safety and Reliability Conference: ESREL 2021. - Singapore : Research Publishing, 2021, p. 2825-2831. ISBN 978-981-18-2016-8. (ESREL 2021 : 31st European Safety and Reliability Conference)

- **EGI Advanced Computing for EOSC (EGI-ACE)**

Authors: Ladislav Hluchý, Viet Tran, Ján Astaloš, Martin Bobák, Martin Šeleng
Project: Horizon 2020 – 101017567

The EGI-ACE platform is built on the EGI Federation, the largest distributed computing infrastructure for research. Its services address the needs of major research infrastructures and communities of practice engaged through the EOSC-hub project. The Platform advances beyond

the state of the art through a data-centric approach, where data, tools and compute and storage facilities form a fully integrated environment accessible across borders thanks to Virtual Access. The consortium builds on the expertise and assets of the EGI federation members, key research communities and data providers, and collaborating initiatives. II SAS is delivering two production services: Cloud Compute service on II SAS-FedCloud site [1] and Dynamic DNS service [2]. Beside the services, II SAS has developed FedCloud client [3] that became the official command-line client for EGI Cloud federation. The client can be used also for creating scripts for automation and as a Python library for developing other services in federation.

Main scientometric outputs:

[1] https://www.egi.eu/services/cloud-compute/

[2] https://wiki.egi.eu/wiki/Dynamic_DNS/

[3] https://fedcloudclient.fedcloud.eu/

- **An agent-based algorithm resembles behavior of tree-dwelling bats under fission-fusion dynamics**

Authors: Ján Zelenka, Tomáš Kasanický, Ivana Budinská
Project: APVV-17-0116

This result in the field of modelling and simulation of a complex biological system is based on an interdisciplinary study of the behavior of tree bats of the Nyctalus Leisleri type. Based on the observation of bats, an interesting swarm behavior of a group of bats was described in search of a common shelter to survive the day. A group of bats leaves the hollow of a tree in the evening and starts hunting for food. During hunting, the group is completely disintegrated, i.e. each bat hunts alone, independently of the others. During hunting, bats move in the area of several tens of km^2. After several hours of hunting, the group meets in the morning in a seemingly randomly selected new cavity to survive the day.

An agent model was created to simulate this behavior, into which several characteristics observed from the real world were implemented. The developed model has two basic goals: 1) to simulate the real behavior of bats as faithfully as possible and to enable biologists to simulate the hypotheses about the mechanism of swarm behavior, 2) to apply mechanisms of swarm behavior to other areas, for example to control a group of drones to search unknown areas. The most interesting features of the created model in terms of applicability in other areas include scalability, robustness and the ability to always find a solution in a limited time.

This model has been validated on a number of simulation experiments. The experiments focused on evaluating the effectiveness of simulations as well as the impact of changes in individual parameters on the simulation results. All simulations were performed in close collaboration with colleagues in the field of behavioral biology (L. Naďo, P. Kaňuch).

The results of this integrated research have been published in conference proceedings and journals. The most important output is a publication in the journal Scientific Reports, from the group Nature Research Journals.

Main scientometric outputs:

ZELENKA, Ján - KASANICKÝ, Tomáš - BUDINSKÁ, Ivana - KAŇUCH, Peter. An agent-based algorithm resembles behaviour of tree-dwelling bats under fission-fusion dynamics. In Scientific Reports, 2020, vol. 10, art. no. 16793. (2019: 3.998 - IF, Q1 - JCR, 1.341 - SJR, Q1 - SJR, karentované - CCC). (2020 - Current Contents, WOS, SCOPUS). ISSN 2045-2322.

ZELENKA, Ján - KASANICKÝ, Tomáš - BUDINSKÁ, Ivana. A swarm algorithm inspired by tree-dwelling bats. Experiments and evaluations. In Advances in Intelligent Systems and Computing : Advances in Service and Industrial Robotics, 2020, vol. 980, p. 527-534. (2019: 0.184 - SJR, Q3 - SJR). ISSN 2194-5357.

- **Study of optimization methods inspired by nature with machine learning in network communication**

Author: Giang Nguyen

The research in [1] aimed to robust global optimization influenced by simplicity and efficiency principles introduced in two optimization algorithms of the latest generation. Galactic Swarm Optimization (GSO) is inspired by the motion of stars, galaxies and super-clusters of galaxies under the influence of gravity. It acts as a global controller of the entire optimization process by using several flexible two-phase cycles (exploration and exploitation) to find new and better solutions. The optimization process in the original version of GSO suffers from a shortcoming in the discovery phase, which in our work is enhanced by hybridization with our evolutionary version of the Whale Optimization Algorithm (EWOA). Concretely, the discovery phase in GSO is replaced by EWOA to avoid early convergence. Furthermore, EWOA is improved in comparison with WOA in ensuring global optimization even at higher dimensions of the search space using Levy-Flight trajectory (LFT). The achieved effect in the research is a faster local search with adaptive steps. Evolution approach is also improved by employing a two-point crossing operator. The overall results through extensive experiments have shown that our hybridization and evolution approach delivers excellent performance with the accuracy, speed of convergence, and stability of the optimization process. In the context of nature-inspired optimization methods, the research in [2] is focused on the applicability of optimization approaches with machine learning (neural network) in the domain of network communication. Specifically, it is a scientific solution to improve Quality of Service (QoS) with Extreme Learning Machine (ELM neural network) and an improved version of Tug of War optimization (TWO) in the core.

Main scientometric outputs:

1. NGUYEN, Minh - TRAN, Trung - NGUYEN, Thieu - NGUYEN, Giang. Hybridization of galactic swarm and evolution whale optimization for global search problem. In IEEE Access, 2020, vol. 8, no. 1, art. no. 9072130, p. 74991-75010. (2019: 3.745 - IF, Q1 - JCR, 0.775 - SJR, Q1 - SJR). ISSN 2169-3536. Open Access .
2. NGUYEN, Thieu - HOANG, Bao - NGUYEN, Giang - NGUYEN, Minh. A new workload prediction model using extreme learning machine and enhanced tug of war optimization. In Procedia Computer Science, 2020, vol. 170, p. 362-369. (2019: 0.342 - SJR, Scopus-Q2). ISSN 1877-0509. Open Access.

- **System for Localization, Tracking and Fire Process Control**

Authors: Karol Dobrovodský, Pavel Andris
Contract for customer EVPÚ a.s., Trenčianska 19, 018 51 Nová Dubnica, SR

The system for online localization tracking and fire process control has been worked out. The Fire Process Control consists of several problem oriented image processing modules aimed to reveal and recognize characteristic patterns and to track the motion of the selected object. The system is working autonomously in the Search mode trying to offer recognized objects for tracking. In case of unsuccessful recognition, the operator can point out an object on the screen to start the Track mode. A calculation of the Pearson's Cross Correlation Coefficient between the pattern and the corresponding area of interest under the pattern has been decomposed and efficiently implemented in the Fast Fourier Transform domain in order to localize the tracked object repeatedly in real time.

Main scientometric outputs:

Dobrovodsky, K., Andris, P., Adaptive Recognition for Tracking of Moving Objects. In: Advances in Service and Industrial Robotics. Proceedings of the 28th Conference on Robotics in Alpe-Adria-Danube Region (RAAD 2019). – Springer Nature Switzerland AG 2020, Printed by Printforce, the Netherlands, ISBN 978-3-030-19647-9, ISBN 978-3-030-19648-6 (eBook). ISSN2194-5357, ISSN 2194-5365

Dobrovodsky, K., Andris, P., Real Time Sub Image Localization for Tracking. In: Advances in Service and Industrial Robotics. Proceedings of the 27th Conference on Robotics in Alpe-Adria-Danube Region, (RAAD 2018). – Springer 2019, ISBN 978-3-030-00231-2, ISBN 978-3-030-00232-9 (eBook).

Dobrovodsky, K., Andris, P., Adaptive Recognition for Tracking of Moving Objects. In: Proceedings of the 28th Conference on Robotics in Alpe-Adria-Danube Region, RAAD 2019. - Jun 19 - 21, Kaiserslautern, Germany, 2019. (to appear in Springer 2020)

- **European Open Science Cloud – Expanding Capacities by building Capabilities (EOSC-Synergy)**

Authors: Viet Tran, Ján Astaloš, Miroslav Dobrucký, Martin Bobák.
Project: Horizont 2020 – 857647 (research and development program under the call EINFRA-21-2017: Platform-driven e-infrastructure innovation)
Duration: 1.9.2019 / 31.10.2022

EOSC-Synergy project introduces new capabilities by opening national thematic services to European access, thus expanding the EOSC offer in the Environment, Climate Change, Earth Observation and Life Sciences. This will be supported by an expansion of the capacity through the federation of compute, storage and data resources aligned with the EOSC and FAIR policies and practices.
EOSC-synergy builds on the expertise of leading research organizations, infrastructure providers, NRENs and user communities from Spain, Portugal, Germany, Poland, Czech Republic, Slovakia, Netherlands, United Kingdom and France, all already committed to the EOSC vision and already involved in related activities at national and international level. Furthermore, we will expand EOSC's global reach by integrating infrastructure and data providers beyond Europe, fostering international collaboration and open new resources to European researchers.
II SAS is participating on three workpackages: WP2 - Capacity Expansion at Infrastructure Level; WP4 - Capacity building for thematic services. In WP2, II SAS is leading Task 2.4 "Integration of National Research Data repositories" that deals with technical integration of national research data repositories of wider interest into the EOSC ecosystem and actively works on other tasks for integration at the levels of core services, technical standards and policies. Several services were developed, deployed, and integrated with EOSC-Synergy infrastructure, most notably the Horizon

dashboard for accessing all cloud sites in the project, FedCloud client as the official client for accessing whole cloud federation, and the COVID-19 Galaxy service for processing genomic data of Coronavirus.

In WP4, II SAS is working on developing and integration of the MSWSS thematic service for modeling and analysis of Water Supply Systems. The MSWSS service will allow water infrastructure operators and researchers to utilize EOSC computing infrastructure and data sharing services for analysis of more complex water supply systems.
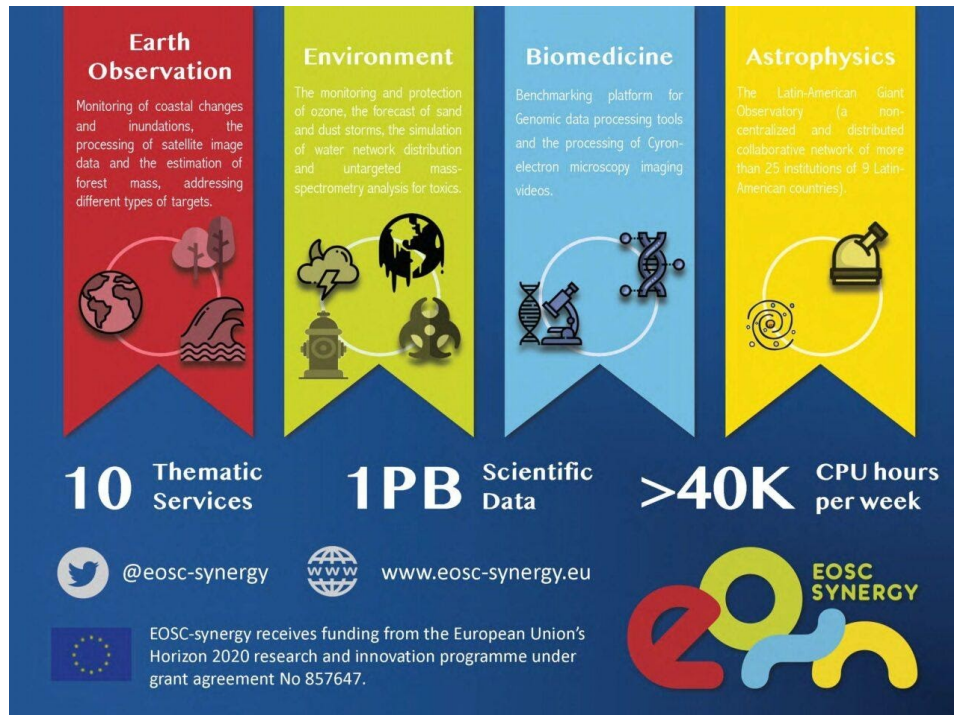
Main outcomes of II SAS in EOSC-Synergy project:

- Project-wide Horizon dashboard portal https://dashboard.fedcloud.eosc-synergy.eu/: developed and deployed at II SAS for accessing all cloud sites in EOSC-Synergy
- COVID-19 Galaxy service @ EOSC Synergy https://www.eosc-synergy.eu/covid19-galaxy-service-eosc-synergy/: deployed in cooperation with other partners in project and supported by II SAS-Cloud site
- Openstack Cloud site II SAS-Cloud https://cloud.ui.savba.sk

- **Designing and Enabling E-infrastructures for intensive Processing in a Hybrid DataCloud**

Authors: Viet Tran, Ján Astaloš, Miroslav Dobrucký, Martin Bobák, Ladislav Hluchý
Project: Horizont 2020
Duration: 1.11.2017 / 30.4.2020

The main objective of DEEP-Hybrid-DataCloud project is to support intensive computing techniques that require specialized HPC hardware, like GPUs or low latency interconnects, to explore very large datasets. A platform "DEEP as a Service" was developed which is consisted as set of building blocks that enable the easy development of applications requiring these techniques: deep learning using neural networks, parallel post-processing of very large data, and analysis of massive online data streams.

II SAS was the leader of WP4 dealing with the integration of high-performance computing resources and accelerators to the cloud computing resources of the project. The WP provided a higher performance capacity by relying on real (non virtualized) hardware, as high-end public cloud platforms are providing recently. A uniform access to accelerators was developed in WP4 for different cloud platforms including Openstack, Mesos, Kubernetes and also for HPC. II SAS also involved in WP6 for development of "DEEP as a Service" platform and "Marketplace" service, and

in WP2 with MODS (Massive Online Data Stream) use case. Development and deployment of use cases was assisted by CI/CD approach (Continuous Integration/Continuous Delivery) with high level of automation. Three CC papers were published in the project, and the project was finished successfully with the final review in June 2020.

Main scientometric outputs:

LÓPEZ GARCÍA, Álvaro - MARCO DE LUCAS, Jesús - ANTONACCI, Marica - ZU CASTELL, Wolfgang - DAVID, Mario - HARDT, Marcus - LLORET, Lara - MOLTÓ, Germán - PLOCIENNIK, Marcin - TRAN, Viet - ALIC, Andy S. - CABALLER, Miguel - CAMPOS, Isabel - COSTANTINI, Alessandro - DLUGOLINSKÝ, Štefan - DUMA, Cristina - DONVITO, Giacinto - GOMES, Jorge - HEREDIA, Ignacio - ITO, Keiichi - KOZLOV, Valentin - NGUYEN, Giang - ORVIZ, Pablo - ŠUSTR, Zdeněk - WOLNIEWICZ, Pawel. A cloud-based framework for machine learning workloads and applications. In IEEE Access, 2020, vol. 8, no. 1, p. 18681-18692. (2019: 3.745 - IF, Q1 - JCR, 0.775 - SJR, Q1 - SJR, karentované - CCC). (2020 - Current Contents). ISSN 2169-3536. https://doi.org/10.1109/ACCESS.2020.2964386

NGUYEN, Giang - DLUGOLINSKÝ, Štefan - TRAN, Viet - LÓPEZ GARCÍA, Álvaro. Deep learning for proactive network monitoring and security protection. In IEEE Access, 2020, vol. 8, no. 1, art. no. 8966259, p. 19696-19716. (2019: 3.745 - IF, Q1 - JCR, 0.775 - SJR, Q1 - SJR, karentované - CCC). (2020 - CC). ISSN 2169-3536. https://doi.org/10.1109/ACCESS.2020.2968718

- **Universal framework for remote firmware updates of low-power devices**

Authors: Ondrej Kachman, Marcel Baláž, Peter Malík

The aim of the research is to increase the efficiency of updating low-power equipment. Today, these devices are used in wireless sensor networks, intelligent systems and cyber-physical systems. Their numbers can exceed hundreds and they can communicate through their own networks or the Internet of Things. Firmware updates are performed over a network. With a large number of devices, it is necessary to reduce the amount of data transmitted over the network. Frequent updates can wear out device memory and reduce the memory operations performed on those devices. Our publication describes the framework for remote firmware updates. It includes processes for increasing firmware similarity, generating difference files, and tracking firmware change history. Each of these processes includes several innovative configurations that allow you to generate update files for different firmware update scenarios. A significant benefit is also the multiplatform framework design successfully tested on three different hardware platforms. It also includes an update module for target devices, which performs updates with a minimum number of overwritten pages in the device memory. The framework reduces the amount of data needed for the update by 80% and is 5-50% better than other solutions, depending on the type of update.

Main scientometric outputs:

KACHMAN, Ondrej - BALÁŽ, Marcel - MALÍK, Peter. Universal framework for remote firmware updates of low-power devices. In Computer Communications, 2019, vol. 139, p. 91-102. (2.766 - IF2018). ISSN 0140-3664.

- **Computer simulation and visualization of fires for improvement of road tunnel safety**

Authors: Ján Glasa, Peter Weisenpacher, Lukáš Valášek
Project number: APVV-15-0340
Main customer: National Motorway Company, Inc. (NDS)
Secondary customer: PPA INZINIERING, Ltd. (PPA INZINIERING)

Series of computer simulations of fire scenarios designed by customer in two motorway tunnels (Poľana and Považský Chlmec) selected by NDS were developed. Full-scale fire experiments and measurements in the tunnels were carried out to validate the simulations. The experiments provided detailed information about emergency systems operation and their logical flow of work in reaction on fire; authentic data from tunnel control system, measuring devices and detectors;

verification of functionality and efficiency of ventilation and other emergency systems; and gave information about smoke propagation. Fires of passenger cars and vans were simulated by a special technology of smoke generation (non-destructive nontoxic aerosol patented by collaborating Czech company). Detailed analysis of the data allowed to evaluate efficiency of emergency ventilation and conditions for smoke stratification during evacuation phase. Detailed studies about results of computer simulations of tested fire scenarios and their comparison with the obtained experimental results were ellaborated. The studies focussed on visualization of smoke propagation and stratification as well as on evaluation of fire danger. Series of visualizations of critical fire scenarios in a road tunnel in Tunnel Trafic & Operation Simulator (TTOS) installed in Žilina was developed and implemented into TTOS in the form of videos. The visualization tool is used in accredited education and training courses for university students and tunnel control operators. The visualizations provide detailed information about smoke stratification and development of selected physical quantities characterizing the fire course as well as about development of tenable conditions and fire danger for people in the tunnel. The visualizations are based on computer simualtions realized on HPC computer cluster. All five technical reports related to this research delivered to the customer were classified by NDS as confidential. Both customers belong to significant Slovak companies. NDS is a state owned joint stock company responsible for the government Program of Motorway Preparation and Construction providing several very important state-regulated activities in particular: planning, preparation and construction of motorways, their maintenance, repairs and development; it is a dominant owner of road tunnels in Slovak Republic responsible for their safe operation and resilience as well as for preparedness of tunnel control operators for emergency incidents. PPA INZINIERING is one of leading companies at the Slovak market in the field of supply of electrosystems and control systems for motorway tunnels, motorways and construction companies. It delivers technological equipment of motorways and motorway tunnels. PPA was a contractor of TTOS developed for UNIZA.

Full-scale smoke tests in real motorway tunnels (left) and visualizations integrated in the screen 6 in TTOS (phosto from Science&Technology telecast about TTOS in RTVS) (right).

Main scientometric outputs:

GLASA, Ján - VALÁŠEK, Lukáš - WEISENPACHER, Peter. On impact of slope on smoke spread in tunnel fire. In Lecture Notes in Electrical Engineering, 2019, vol. 574, p. 157-162. ISSN 1876-1100.

GLASA, Ján - VALÁŠEK, Lukáš - WEISENPACHER, Peter. Note on the impact of slope on smoke spread in tunnel fire conditions. In Journal of Physics: Con. Series, 2018, vol. 1141, art. no. 012150. ISSN 1742-6588.

WEISENPACHER, Peter - GLASA, Ján - VALÁŠEK, Lukáš. Stratification of fire smoke and testing aerosol in a road tunnel: computer simulation. In ITM Web of Conferences, 2019, vol. 24, art. no. 02004, 6 p. ISSN 2271-2097.

WEISENPACHER, Peter - GLASA, Ján - VALÁŠEK, Lukáš. Optical density of testing aerosol and fire smoke in a road tunnel with longitudinal ventilation: comparison by FDS6. In Journal of Physics: Con. Series, 2018, vol. 1141, art. no. 012136. ISSN 1742-6588.

WEISENPACHER, Peter - VALÁŠEK, Lukáš. Computer simulation of airflows generated by jet fans in real road tunnel by parallel version of FDS 6. In International Journal of Ventilation, 2021, vol. 20, no. 1, p. 20-33. (2020: 1.595 - IF, Q3 - JCR, 0.461 - SJR, Q2 - SJR). (2021 - Current Contents). ISSN 1473-3315. https://doi.org/10.1080/14733315.2019.

- **GPU virtual machine and Dynamic DNS service**

Authors: Viet Tran, Ján Astaloš, Miroslav Dobrucký and Ladislav Hluchý
Project: EOSC-hub 777536, H2020-857647

In the EOSC-hub project, II SAS provided a support for accelerated computing in the EOSC federated cloud through two sites: II SAS GPU cloud with Openstack and II SAS-Nebula with Open Nebula software. Both sites offered virtual machines with GPU used by different communities: biomedicine, biodiversity (LifeWatch), magnetic resonance ouput processing (WeNMR) also with training activities. Besides that we provided third cloud site II SAS-FedCloud with OpenStack to host services for NextGEOSS (Earth Observation) community. We provide Dynamic DNS service for EOSC-hub project to keep dynamically changed DNS records for virtual machines IP addresses. This service is important for other services in cloud to provide IP adresses that are not known in advance.
EOSC-hub brings together multiple service providers to create the Hub: a single contact point for European researchers and innovators to discover, access, use and reuse a broad spectrum of resources for advanced data-driven research. For researchers, this will mean a broader access to services supporting their scientific discovery and collaboration across disciplinary and geographical boundaries. The project mobilises providers from the EGI Federation, EUDAT CDI, INDIGO-DataCloud and other major European research infrastructures to deliver a common catalogue of research data, services and software for research.
EOSC-hub is funded by the European Union's Horizon 2020 research and innovation programme under grant agreement 777536.

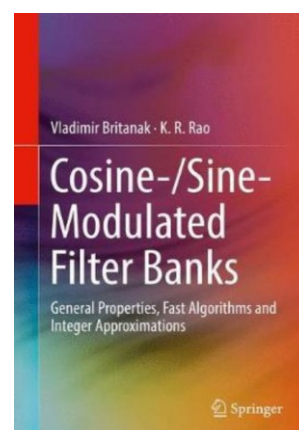**Main scientometric outputs:**

NGUYEN, Binh Minh - HOANG, Bao - TRAN, Huy - TRAN, Dinh Viet: Managing cloud data centers with three-state server model under job abandonment phenomenon. In Lecture Notes in Computer Science, 2018, vol. 10862, p. 668-674. ISSN 0302-9743

NGUYEN, Thieu - NGUYEN, Minh - NGUYEN, Giang: Building resource auto-scaler with Functional-Link neural network and Adaptive Bacterial Foraging Optimization. In: Theoretical Computer Science and General Issues, Lecture Notes in Computer Science (LNCS vol. 11436), pp. 501-517, ISSN 0302-9743, ISBN 978-3-030-14811-9, DOI 10.1007/978-3-030-14812-6_31, Springer, Charm, 2019,

- **Scientific monograph Cosine-/Sine-Modulated Filter Banks: General Properties, Fast Algorithms and Integer Approximations**

Author: Vladimír Britaňák
Project numbers: VEGA 2/0184/14, VEGA 2/0165/17

In the field of cosine-/sine-modulated discrete block transforms with perfect reconstruction a significant scientific monograph was published in reputable Springer International Publishing AG publisher. The transformations are basic processing components for conversion of audio signal from time to frequency domain (and vice versa) in numerous information and communication technologies for compression of digital

audio signals. As these transformations require up to 70% of total computational time, the development of efficient algorithms for their calculation plays significant role in term of real-time processing. The monograph maps more than 20 years of world research in this area. It contains quite a number of original results of the author published in numerous European and American journals as well as variety of his not yet published original results. The monograph is divided into 9 chapters with exercises and lists of open problems and includes 7 extensive appendices. It is focussed particularly on:

- definitions and mathematical properties of cosine-/sine-modulated discrete block transforms with perfect reconstruction, their mutual relations and block matrix factorizations,
- theory and development of efficient algorithms for calculation of these transforms in information and communication technologies: MPEG standards (MP3), Digital Broadcasting, Dolby Digital (Plus), SBR, etc.,
- theory of complexity of algorithms (minimal number of arithmetic operations, regularity, recursion, etc.) for potential software or hardware implementation. The monograph is intended for students and researchers at European and American universities, research laboratories and companies concerned with design and development of audio coding systems.

The monograph is intended for students and researchers at universities, research laboratories and companies concerned with design and development of audio coding systems.

Main scientometric output:

Vladimir Britanak and Kamisetty R. Rao. Cosine-/Sine-Modulated Filter Banks: General Properties, Fast Algorithms and Integer Approximations, Springer International Publishing AG, Cham, Switzerland, xxvi, 645 p., 2018, ISBN 978-3-319-61078-8.

- **New thin film materials for gas sensors and hard metals and MEMS structures for chosen applications**

Authors: Robert Andok, Ivan Kostič, Ivan Hotový, Pavol Nemec, Vladislav Barák, Anna Benčurová, Adrian Ritomský
Project numbers: VEGA 2/0119/18, VEGA 1/0828/16, SAS-MOST JRP 2017/1, APVV-14-0076

In the field of new thin-film materials for gas sensors, we investigated the dependence of the sensitivity of a gas sensor based on a thin layer of titanium metal oxide TiO_2 on the total surface area of the active region. We changed the TiO_2 surface area by plasma etching of structures with different configurations [2]. We also investigated the gas sensor on the basis of semiconducting metal oxide Fe_2O_3, which was deposited by self-organization of nanoparticles with a diameter of 6 - 8 nm on gold interdigital electrodes. We have designed and optimized the technology of preparation of embedded electrodes, which are necessary to form a continuous monolayer of Fe_2O_3 nanoparticles with a diameter of 6-8 nm on massive electrodes with a thin film thickness of 100 nm and an electrode width of several micrometers [3]. We have proposed a new method for the preparation of an active Cu_2O thin film by potentiostatic electrodeposition on gold interdigital electrodes. In this case, the sensitivity of the gas sensor depends on the distance of the interdigital electrodes [8, 9]. We investigated the structure and optical properties of 2D layers WS_2 (as promising new 2D materials in optoelectronics and nanoelectronics), which were prepared by sulfurization of platinum layers of different thickness. These platinum layers were prepared by magnetron sputtering [1]. The properties of the investigated WS_2 layers are a prerequisite for their use as a gas-sensitive active layer. We also investigated the characteristics of selected electron resists PMMA, AR-P 6200, HSQ and limiting factors in the process of electron lithography for the case of a thin layer of TiO_2, which is used in the gas sensor. The original results represent the exposure parameters obtained for the electron energy of 30 and 40 keV and the study of the dependence of the profile of the resist structures on the exposure parameters. We gained new knowledge about the interaction of electrons with electron resists on thin layers of semiconducting metal oxides TiO_2 [4, 5, 6, 7]. We also investigated the use of the MEMS pressure (force) sensor on the principle of measuring the EM field [10]. In cooperation with Taiwan, we have produced a field emitter based on ultra-nano-crystalline (UNCD) and micro-crystalline (MCD) diamond layers using MPECVD [11].

Main scientometric outputs:

[1] HOTOVÝ, I. - SPIESS, L. - SOJKOVÁ, Michaela - <u>KOSTIČ, I.</u> - MIKOLÁŠEK, M. - PREDANOCY, M. - ROMANUS, H. - HULMAN, Martin - REHACEK, V. Structural and optical properties of WS_2 prepared using sulfurization of different thick sputtered tungsten films. In Applied Surface Science, 2018, vol. 461, p. 133-138. (4.439 - IF2017). ISSN 0169-4332.

[2] <u>NEMEC, P.</u> - <u>HOTOVÝ, I.</u> - <u>ANDOK, R.</u> - <u>KOSTIČ, I</u>. Increased sensitivity of a gas sensor by controlled extension of TiO_2 active area. In AIP Conference Proceedings: Applied Physics of Condensed Matter (APCOM 2018), 2018, vol. 1996, no. 020032. ISBN 978-0-7354-1712-0. ISSN 0094-243X.

[3] <u>HRKÚT, Pavol</u> - <u>KOSTIČ, Ivan</u> - BENKOVIČOVÁ, Monika - KOTLÁR, Mário - LUBY, Štefan. Silicon substrates for nanoparticle gas sensors with embedded electrodes and planar surface. In AIP Conference Proceedings: Applied Physics of Condensed Matter (APCOM 2018), 2018, vol. 1996, no. 020018. ISBN 978-0-7354-1712-0. ISSN 0094-243X.

[4] KOLEVA, Elena - VUTOVA, Katia - <u>KOSTIČ, Ivan</u>. Simulation and experimental study on developed profiles in the positive polymer resist PMMA. In Journal of Physics: Conference Series, 2018, vol. 1089, art. no. 012015. ISSN 1742-6588.

[5] KOLEVA, Elena - VUTOVA, Katia - ASPARUHOVA, Boriana - <u>KOSTIČ, Ivan</u> - CVETKOV, K. - GERASIMOV, V. Modeling approaches for electron beam lithography. In Journal of Physics: Conference Series, 2018, vol. 1089, art. no. 012016. ISSN 1742-6588.

[6] <u>KOSTIČ, I.</u> - VUTOVA, K. - <u>ANDOK, R.</u> - <u>BARÁK, V.</u> - <u>BENČUROVÁ, A.</u> - <u>RITOMSKÝ, A.</u> - TANAKA, Takeshi. Experimental and theoretical study on chemically semi-amplified resist AR-P 6200. In Journal of Physics: Conference Series, 2018, vol. 992, art. no. 012057. ISSN 1742-6588.

[7] CVETKOV, Kristian - GERASIMOV, Vladislav - <u>KOSTIČ, Ivan</u> - KOLEVA, Elena - VUTOVA, Katia - ASPARUHOVA, Boriana. Electron beam energy deposition and resist profile modeling during electron beam lithography process. In International scientific conference High technologies. business. society: Proceedings, Volume I "High technologies". - Sofia, Bulgaria: Scientific Technical Union of Mechanical Engineering Industry-4.0, 2018, vol. II, no. 1, p. 124-127. ISSN 2535-0005.

[8] MIKOLÁŠEK, M. - MERI, Július - CHYMO, F. - ONDREJKA, Peter - REHACEK, V. - PREDANOCY, M. - <u>KOSTIČ, Ivan</u> - <u>HOTOVÝ, I.</u> Novel Cu_2O gas sensor prepared by potentiostatic electrodeposition on IDE electrodes and Microsystems. European Workshop. - Bratislava : Slovak University of Technology, Bratislava, 2018, p. 87-92. (MME 2018: 29th Micromechanics and Microsystems Europe Workshop).

[9] Miroslav Mikolášek, Peter Ondrejka, Filip Chymo, Vlastimil Řeháček, Martin Predanocy, <u>Ivan Kostič</u>, <u>Ivan Hotový</u>. Cu_2O Based Gas Sensor Prepared by Electrodeposition. In ASDAM 2018 : the 12th International Conference on Advanced Semiconductor Devices and Microsystems. - IEEE, 2018, ISBN 978-1-5090-3081-1.

[10] <u>ANDOK, Robert</u> - HARŤANSKÝ, René - <u>HRICKO, Jaroslav</u> - HALGOŠ, Ján. Concept of a MEMS load cell sensor of mechanical quantities based on the EM field principle. In AIP Conference Proceedings : Applied Physics of Condensed Matter (APCOM 2018), 2018, vol. 1996, no. 020002. ISBN 978-0-7354-1712-0. ISSN 0094-243X.

[11] CHENG, Wen-Hsiu - TSAI, Ping-Huan - CHEN, Yi-Huang - TSAI, Hung-Yin - <u>ANDOK, Robert</u>. Fabrication of field emitters of ultra-nano-crystalline and micro-crystalline diamond films by the MPECVD method. In AIP Conference Proceedings : Applied Physics of Condensed Matter (APCOM 2018), 2018, vol. 1996, no. 020020. ISBN 978-0-7354-1712-0. ISSN 0094-243X.

- **An individual stimulating system with 3D nano-structure carbon/graphene based transducer and wireless heater for automated tiny insects behavior monitoring**

Authors: Robert Andok, Ivan Kostič, Pavol Nemec, Jaromír Klarák, Mário Ritomský
Project: SAS-MOST JRP 2017/1

Duration: 1.1.2019 / 31.12.2020 (due to pandemic situation extended to 31.12.2022)

In this bilateral project with the National Tsing Hua University in Taiwan we have developed a system that could monitor and analyze insect behavior. Such system can detect the position of the insect and stimulate them individually in real-time. The parameters of the experimental setup are designed based on the characteristics of the Drosophila organism model (made at NTHU), which can also be used on other tiny insects. The nearly negligible weight and size of the insects is what makes them hard to locate in real-time. By using the electron beam lithography and reactive-ion etching equipment that II SAS provides, a micro bridge structure was developed. After that, 3D nano carbon/graphene material was grown onto the structure and the resulting device is a highly sensitive micro transducer that can measure small increments in weight. By placing such transducers all around the experimental platform, the precise position of the insects can be monitored. A wireless heater was installed on to the body of the insects to stimulate them individually under certain circumstances. This heater was made by connecting a nanometric diamond film with a high density micro coil produced at II SAS. By exerting electromagnetic waves of certain frequency (this frequency is related to the size of the coil), electromagnetic induction will occur and the device will heat up stimulating the insect. By using the two devices mentioned above, together with a camera, image processing algorithms, and other hardware equipment, such as a camera stand and a container to place the flies, a system that is used to observe the behavior of small insects, will be developed. The capability of stimulating individual insects and tracking them simultaneously brings up new possibilities of designing more complicating experiments regarding the social behavior of insects.

Drosophilas are commonly used in this project as a model organism. The hierarchical structure of their brains resembles the brain of a mammal, which constitutes to their complicated social behavior. The results of this project may also affect wider areas of research, including life and medical sciences.
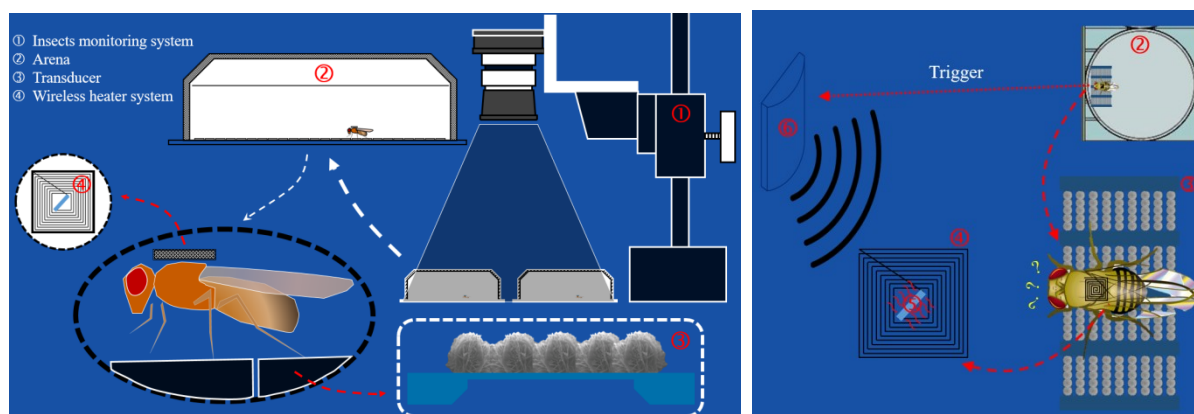
Concept of the proposed set-up of monitoring small insects

Main scientometric outputs:

HRICKO, Jaroslav - HARŤANSKÝ, René - ANDOK, Robert - NEMEC, Pavol - TSAI, Hung-Yin. Force/displacement MEMS based on electromagnetic field principle for tiny insects monitoring. In Journal of Physics: Conference Series: 30th Micromechanics and Microsystems Europe Workshop (MME) 2019, 18-20 August 2019, Wolfson College, Oxford, United Kingdom, 2021, vol. 1837, art. no. 012010. (2020: 0.210 - SJR, Q4 - SJR). ISSN 1742-6588. https://doi.org/10.1088/1742-6596/1837/1/012010

ADIPUTRA, Richard - CHEN, Yi-Hung - ANDOK, Robert. Fabrication of micro-force transducer based on carbon nano-flake balls for assisting drosophila monitoring system. In ASDAM 2020: 13th International Conference on Advanced Semiconductor Devices and Microsystems. - IEEE, 2020, p. 55-58. ISBN 978-1-7281-9776-0. https://doi.org/10.1109/ASDAM50306.2020.9393860

TSENG, Shih-Chun - WU, Shang-Ru - TSAI, Hung-Yin - ANDOK, Robert. Field emission characteristics of multi-walled carbon nanotubes with double gate electrodes. In AIP Conference Proceedings: Applied Physics of Condensed Matter (APCOM 2019), 2019, vol. 2131, no. 020047. (2018: 0.182 - SJR). (2019 - SCOPUS, WOS). ISSN 0094-243X. https://doi.org/10.1063/1.5119500

- **PROCESS - PROviding Computing solutions for ExaScale ChallengeS**

Authors: Ladislav Hluchý, Martin Bobák, Štefan Dlugolinský, Ondrej Habala, Giang Nguyen, Martin Šeleng and Viet Tran.

Within this project II SAS coordinated a working package of tasks focused on the design of an architecture for scalable counting (WP4) and thus coordinated work on technical report D4.5. A module was created for orchestrating cloud services based on Cloudify and for the access to GPU in the cloud to speed up the processing and simulation of emergencies using graphical cards. A reference architecture for scalable cloud applications and HPC systems was tested and developed. The final review of the project took place with the participation of three foreign experts selected by the European Commission. The review was successful. All technical reports, in which II SAS participated, were accepted by an expert commission.

Main scientometric outputs:

1. Bobák, Martin - Belloum, Adam S. Z. - Nowakowski, Piotr - Meizner, Jan - Bubak, Marian - Heikkurinen, Matti - Habala, Ondrej - Hluchý, Ladislav. Exascale computing and data architectures for brownfield applications. In 14th IEEE International Conference on Natural Computation, Fuzzy Systems and Knowledge Discovery (ICNC-FSKD 2018), pp. 461-468, ISBN 978-1-5386-8097-1. Huangshan, China, July 2018. Typ : ADMB
2. Nguyen, Thieu - Tran, Nhuan - Nguyen, Minh - Nguyen, Giang: A resource usage prediction system using functional-link and genetic algorithm neural network for multivariate cloud metrics. The 11th IEEE International Conference on Service-Oriented Computing and Applications (SOCA 2018), Paris, France, November 2018.
3. Bobák Martin: Orchestration platform. In Workshop: Platform-driven e-infrastructure innovations (in conjunction with IEEE eScience 2018 International Conference), Amsterdam, the Netherlands.

Deliverables:

Adam Belloum, Reggie Cushing, Ondrej Habala, Viet Tran, Jan Meizner, Bartosz Wilk. Deliverable D4.2: Report on architecture evaluation and dissemination.

Adam Belloum, Reggie Cushing, Ali Rahmanian, Martin Bobák, Ondrej Habala, Jan Meizner, Bartosz Wilk. Deliverable D5.1: Design of data infrastructure for extreme-large data sets.

Bubak, M., Meizner, J., Nowakowski, P., Rycerz, K., Wilk, B., Hluchý, L., Bobák, M., Dlugolinský, Š., Habala, O., Nguyen, G., Šeleng, M., Tran, V., Pancake-Steeg, J., Spahr, S., gentschen Felde, N., Heikkurinen, M., Höb, M., Schmidt, J., Graziani, M., Müller, H., Maassen, J., Spreeuw, H., Belloum, A., Cushing, R., Rahmanian, A. Deliverable D6.1: First prototype.

Deliverables coordinated by II SAS:

Hluchý, L., Bobák, M., Dlugolinský, Š., Habala, O., Nguyen, G., Šeleng, M., Tran, V., Pancake-Steeg, J., Spahr, S., gentschen Felde, N., Heikkurinen, M., Höb, M., Schmidt, J., Graziani, M., Müller, H., Maassen, J., Spreeuw, H., Belloum, A., Cushing, R., Rahmanian, A., Bubak, M., Meizner, J., Nowakowski, P., Rycerz, K., Wilk, B. Deliverable D4.1: Initial state of the art and requirements analysis, PROCESS architecture.

- **Causal partitioning of dependent variables in structural equations with differentiable right-hand side**

Author: Marcel Kvassay
Causal partitioning is a new method of simulation data analysis which, in conjunction with machine learning techniques, helps to determine the causes of emergent phenomena in complex systems

described by structural equations of the type Y = f (X1 ... Xn) with a differentiable right side. Causal partitioning quantifies the share of the change of the parental variables X1 ... Xn in the resulting change of the dependent variable Y, thus allowing to assess their relative importance in key early periods, when the investigated emergent phenomena just begin to form. This is an extension of the principles of nonlinear structural causality (NSC) and their application to dynamic systems with real variables, which is a significant step forward, because NSC is applied in the literature mostly to systems with strongly discrete (binary or categorical) variables. The proposed method was successfully applied to the agent model of human behavior from the international project EUSAS for the European Defense Agency EDA, where the dynamics of simulated emotions of anger and fear were modeled by nonlinear differential equations. Moreover, the principles of the method can be generalized and applied to other types of systems, from system dynamics (SD) to artificial neural networks. The method is the result of several years of research, culminating in publication [1] in a Q1 journal with an impact factor of 4.6 (IF2016).

Main scientometric outputs:

KVASSAY, Marcel - KRAMMER, Peter - HLUCHÝ, Ladislav - SCHNEIDER, Bernhard. Causal analysis of an agent-based model of human behaviour. In *Complexity*, 2017, vol. 2017, art. ID 8381954, 18 pp. (4.621 - IF2016). ISSN 1076-2787.

KVASSAY, Marcel. A Contribution towards the Discovery of Causal Relationships in Agent-Based Models of Human Behaviour. Dizertačná práca. Bratislava, 2017. 135 pp.

- **Global ATM security management (GAMMA)**

Authors: Rusko, M., Trnka, M., Darjaa, S., Guoth, I., Sabo, R., Ritomský, M.
Project: FP7-SEC-2012-1

The GAMMA project is a predecessor of SATIE project. It addresses the management of the global security of air traffic services in the European airspace of the future. An HMM-based module for the verification of persons during communication between pseudo-pilots and air traffic controllers was designed, developed and implemented in the Air Traffic Management (ATM) simulator, notifying the possible occurrence of unauthorized person's speech. A system for the identification of voice-stress in communication between pseudo-pilots and air traffic controllers was designed, developed and implemented, drawing attention to the possible occurrence of increased levels of speech stress. The proposed modules were implemented in the air traffic monitoring system in cooperation with the Deutsches Zentrum für Luft- und Raumfahrt and presented on 22 November 2017 at the final evaluation of the project in Rome.

Main scientometric outputs:

RUSKO, Milan - FINKE, Michael. Using speech analysis in voice communication : a new approach to improve air traffic management security. In CogInfoCom 2016 : 7th international conference on cognitive infocommunications. - Wroclaw, Poland : IEEE, 2016, proceedings, p. 181-186. ISBN 978-1-5090-2643-2. ISSN 2375-1312.

SABO, Róbert - RUSKO, Milan - RIDZIK, Andrej - RAJČÁNI, Jakub. Stress, arousal, and stress detector trained on acted speech database. In Lecture Notes in Computer Science : Speech and Computer, 2016, vol. 9811, p. 675-682. ISBN 978-3-319-43957-0. ISSN 0302-9743.

SABO, Róbert - RAJČÁNI, Jakub. Designing the database of speech under stress. In Jazykovedný časopis, 2017, roč. 68, č. 2, s. 326-336. ISSN 0021-5597.

- **Integrating accelerators for intensive computing into the EGI e-infrastructure federative cloud**

Authors**:** Ján Astaloš, Miroslav Dobrucký, Ladislav Hluchý, Viet Tran
Project: EGI-Engage - Engaging the EGI Community towards an Open Science Commons (H2020, nr. 654142)

The mission of EGI-Engage project is to accelerate the implementation of the Open Science Commons vision, by expanding capabilities of European federative services for computing, storage, data communication, knowledge and expertise complemented by specific Knowledge Commons.

II SAS took leadership of the task "Accelerated computing" within the JRA2 (Platforms for the Data Commons) workpackage in the second stage of the project. We integrated GPGPU accelerators into the cloud part of the EGI (European Grid Infrastructure). We provided these intensive computing resources for the testing of new versions of EGI interfaces like accounting, cloudkeeper, open cloud computing interface server and we provided experimental cloud site with LXD containers and GPGPU.

In the scope of federate services we have set up a VOMS server for the newly created virtual organisation "acc-comp.egi.eu" for the European scientific communities with the intensive compute demanding applicaions. We continued to support the scientific virtual organisations like moldyngrid.eu (molecular dynamics), enmr.eu (magnetic resonance), vo.lifewatch.eu (biodiversity and ecosystem research). Our results were used in other major applications including ESFRI and the results achieved allowed us to participate in 3 new H2020 projects EOSC-hub, PROCESS a DEEP-HybridDataCloud as well as workpackage leaders in them.

Main scientometric outputs:

ANDREETTO, Paolo - ASTALOŠ, Ján - DOBRUCKÝ, Miroslav - GIACHETTI, Andrea - REBATTO, David - ROSATO, Antonio - TRAN, Dinh Viet - VERLATO, Marco - ZANGRANDO, Lisa. EGI federated platforms supporting accelerated computing. In Proceedings of Science, Vol. 293 Supercomputing, High Throughput, Accelerator Technologies and Integrations, 2017, pp. 1-20, ISSN 1824-8039, Open Access,CC BY-NC-ND 4.0

TRAN, Dang - TRAN, Nhuan - NGUYEN, Giang - NGUYEN, Binh Minh. A proactive cloud scaling model based on fuzzy time series and SLA awareness. In Procedia Computer Science, 2017, vol. 108, p. 365-374. ISSN 1877-0509.

BOBÁK, Martin. Optimalizácia výkonu aplikácií v multicloudovom prostredí : dissertation. Bratislava, 2017. 126 p.

SILÁDI, Vladimír - ASTALOŠ, Ján. Teaching grid technologies and grid computing to undergraduate students of computer science. In DidInfo&DidactIG 2017: Medzinárodná konferencia o vyučovaní informatiky. - Banská Bystrica : Univerzita Mateja Bela, 2017, 195-196. ISBN 978-80-557-1216-1.

- **Relationship between trust and entrainment in speech**

Authors: Beňuš, Š., Rusko, M., Sabo, R., Trnka, M.
Project of Air Force Office of Scientific Research of the United States nr. FA9550-15-1-0055

Relationship between trust and entrainment in speech: In this project, we investigated whether the prosodic variability of certain statements affects people considering these statements to be true or false, and also whether prosodic adaptation of the speech synthesizer to its user affects the user's trust to the automated system that uses such a synthetic voice. It has been shown that although prosodic variability does not affect the perceived veracity of statements, it affects the reaction time of subjects so that statements with a higher fundamental frequency (f0) or intensity support the perception of false statements (longer reaction time if the statement is considered true and shorter if untrue). The original results of the project also include the finding that customizing the synthesizer's prosody can have a positive effect on the user's sense of trust in the automatic dialogue assistant that gives the user advice in this way.

Main scientometric outputs:

GÁLVEZ, Ramiro H. - BEŇUŠ, Štefan - GRAVANO, Agustin - TRNKA, Marián. Prosodic facilitation and interference while judging on the veracity of synthesized statements. In Proceedings Interspeech 2017, 2017, p. 2331-2335. ISSN 2331-2335.

BEŇUŠ, Štefan. Rečové prispôsobovanie sa medzi človekom a automatickým systémom. In Kognícia a umelý život 2017. Igor Farkaš, Martin Tkáč, Ján Rybár, Peter Gergeľ. - Bratislava: Univerzita Komenského v Bratislave, 2017, s. 8-14. ISBN 978-80-223-4346-6.

- **Parallel realization of computer simulation of automobile fire and its spread to adjacent vehicle using HPC computer cluster**

Authors: Peter Weisenpacher, Ján Glasa, Ladislav Halada
Project numbers: VEGA 02/0184/14, APVV-15-0340

To investigate abilities of Fire Dynamics Simulator (FDS) for modelling the course of automobile fires, computer simulation of passenger car fire and its spread onto adjacent vehicle was realized on HPC computer cluster at II SAS. The research included development of 3D model of passenger compartment of automobile and its material properties and detailed analysis of simulation parallelization and the fire course. The simulation results were validated by former full-scale automobile fire experiments coordinated by II SAS. As parallelization by parallel MPI model and simulation realization on computer cluster allow significant decrease of computational time, the impact of parallelization on simulation accuracy were investigated. Analyses showed that considerable increase of efficiency can be achieved without significant loss of simulation accuracy caused by parallelization. The model which allows to simulate automobile fire and its spread onto adjacent objects and the impact of external conditions on automobile fire was subsequently used for investigation of fire scenarios in underground car park. Ability of computer simulation to model automobile fires in open air and in structures is important tool for increase the fire safety of automobiles and transport infrastructures (car parks and tunnels).

Computer simulation of automobile fire and automobile fire in car park.

Main scientometric outputs:

WEISENPACHER, Peter - GLASA, Ján - HALADA, Ladislav. Automobile interior fire and its spread to an adjacent vehicle: parallel simulation. In Journal of fire sciences, 2016, vol. 34, no. 4, p. 305-322. (0.758 - IF2015). ISSN 0734-9041.

WEISENPACHER, Peter - GLASA, Ján - HALADA, Ladislav. Parallel computation of smoke movement during a car park fire. In Computing and Informatics, 2016, vol. 35, no. 6 (0.524 - IF2015). ISSN 1335-9150.

WEISENPACHER, Peter - GLASA, Ján - ŠIPKOVÁ, Viera. Performance of FDS versions 5 and 6 in passenger car fire computer simulation. In Proceedings of the European Modelling and Simulation Symposium, 2016, p. 155-161. ISBN 978-88-97999-76-8.

- **Emergency Responder Data Interoperability Network**

Authors: Zoltán Balogh, Emil Gatial, Ladislav Hluchý
Project: FP7-607768

Within REDIRNET, a decentralized platform was developed for the interoperability of information systems of first responder organizations involved in saving lives and property. REDIRNET strived to create a specialized communication gateway (so-called "Meta-data Gateway"), which allows communication and data interoperability of various information systems.
II SAS worked on the development and research of a platform for mass collection and aggregation of information by the so-called polling method. We mainly developed central services, interfaces for the web and for mobile access and we integrated the system with the Redirnet Meta-Data Gateway.
According to the plan, the REDIRNET project was successfully completed in September 2016. The final review of the project was organized by II SAS in cooperation with the project coordinator and took place on the premises of the Slovak Academy of Sciences. The review was also connected with a demonstration of technologies developed within the project with the participation of rescue services, project evaluators from the European Commission and other invited guests.

Main scientometric outputs:

BALOGH, Zoltán - GATIAL, Emil - HLUCHÝ, Ladislav. Poll sourcing for crisis response. In ISCRAM 2016 conference proceedings. Eds. A.H. Tapla, P. Antunes, V.A. Banuls, K. Moore, J. Porto de Albuquerque. - Rio de Janeiro, Brazil: ISCRAM, 2016, 9 p. ISBN 978-84-608-7984-8. ISSN 2411-3387.

GATIAL, Emil - BALOGH, Zoltán - HLUCHÝ, Ladislav. Data Interoperability approach during major accidents. In ISCRAM 2016 conference proceedings. - Rio de Janeiro, Brazil: ISCRAM, 2016, 1 p. ISBN 978-84-608-7984-8. ISSN 2411-3387.

- **Integration and data processing for agriculture.**

Authors: Zelenka Ján, Kasanický Tomáš, Fajdel Valentín, Mojžiš Ján, Budinská Ivana

This result represents a procedure for processing satellite spectral images to identify spatial and temporal variability of soil properties and agricultural stands. We analyzed satellite data for the period 2017-2019 for selected fields. We consulted the results of the analysis with experts (agronomists). There was a clear correlation between the results of the computer analysis and the facts as presented by the experts. This can be used in the future to predict the development of soil properties resp. identification of biotic/abiotic stress of stands. We have created a database for storing heterogeneous data: aerial images, data from a local weather station, satellite image data, and other data from local sensors. The database also captures tacit knowledge, which currently exists only in the form of written records (e.g. the Book of the Field). Automated collection of tacit knowledge will be enabled in the form of an annotation tool that we have provided to collaborating companies. Based on a contract with a company Agrotrage Group spol s r.o., we gained access to all available data on the model field free of charge. The extension of this research is the subject of a project proposal that was repeatedly submitted in calls of the SRDA.
A new service for the processing and evaluation of satellite images of the Sentinel satellite was launched. The service enables the processing of satellite spectral images for the identification of spatial and temporal variability of soil properties and agricultural stands.

2.1.6. List of patents, patent applications, and other intellectual property rights registered abroad

2.1.7. List of patents, patent applications, and other intellectual property rights registered in Slovakia

HARŤANSKÝ, René - HALGOŠ, Ján - HRICKO, Jaroslav - RAFAJ, Michal. Method and device for non-contact sensing of mechanical quantities. Utility model no. 8653. Document type: Y1. Application Number: 185-2018. Application Date: 26.10.2018. Application Publication Date: 5.8.2019. Bulletin ÚPV SR č.: 01/2020. Publication of Registration Date: 07.01.2020. Bulletin ÚPV SR č. 09/2018. Date of registration and making available to the public: 21.11.2019. International Patent Classification (2020.01): G01L 1/00, G01H 13/00. Applicant(s) or Proprietor(s): Slovak University of Technology in Bratislava, Vazovova 2757/5, Bratislava-Staré Mesto, SK; Institute of Informatics Slovak Academy of Sciences, Dúbravská cesta 5810/9, 845 07 Bratislava, SK; RMC s.r.o., Trenčianska ul. 863/66, Nová Dubnica, SK. Banská Bystrica: The Industrial Property Office of the Slovak Republic, 2019. 5 p.

HRKÚT, Pavol - ČAPLOVIČ, Igor - NOVÁK, Igor - GAŽI, Štefan. Equipment for uniform surface treatment of bulk materials in plasma: Utility model no. 288857. Application Number: 50071-2018. Application Date: 18.12. 2018. Bulletin ÚPV SR č.: 07/2020. Bulletin ÚPV SR č.: 09/2021. Date of registration and making available to the public: 12.4. 2021. Document type: B6. Int. Cl. (2021.01): B01J 19/00, H01J 37/00, H05H 1/00, B65G 33/00. Proprietor(s): Institute of Informatics Slovak Academy of Sciences, Dúbravská cesta 5810/9, 845 07 Bratislava, SK; Institute of Polymers II SAS, Bratislava; Institute of Electrical Engineering II SAS, Bratislava. The Industrial Property Office of the Slovak Republic, 2021, No. 288857 B6, 6 p.

2.1.8. Narrative on the most important research outputs of the institute – especially focused on their importance for society (3-5 pages)

II SAS has research accredited in informatics and cybernetics and in almost all domestic and international research projects the outputs are directed to the application sphere. In addition, II SAS also had contract research for specific customers. In the H2020 projects as well as before in the framework programs, in the monitored period for accreditation it was still FP7. Parts of the solution of these projects are also partners from the application area, the so-called use cases. This impact on the scientific community can be seen from the follow-up projects in which II SAS has participated in the creation of the European Federative Cloud:

EGI-Engage - EU H2020 project: Engaging the Research Community towards an Open Science Commons (1.3.2015-31.8.2017) H2020-654142 [call H2020-EINFRA-2014-2015], https://cordis.europa.eu/project/id/654142, EOSC-hub - Integrating and managing services for the European Open Science Cloud (1.1.2018-31.3.2021) H2020-777536 [call H2020-EINFRA-2016-2017], https://www.eosc-hub.eu and EGI-ACE - Advanced Computing for EOSC (1.1.2021-30.6.2023) H2020-101017567 [call H2020-INFRAEOSC-2018-2020 / H2020-INFRAEOSC-2020-2], https://www.egi.eu/project/egi-ace/ The current fedcloud infrastructure is used by a number of scientific areas as can be seen in the following figure:

EGI-ACE Applications distribution per scientific domains
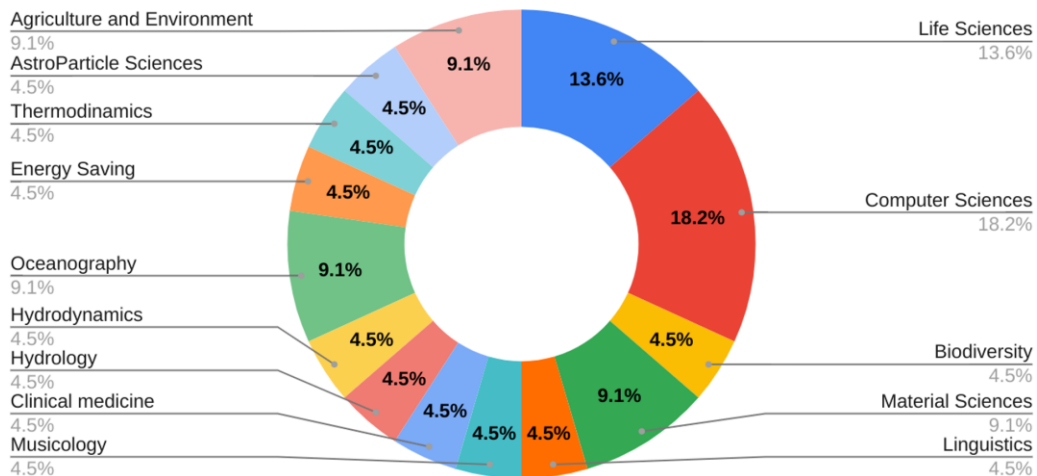
In the PROCESS project: PROviding Computing solutions for ExaScale challengeS (1.11.2017-31.10.2020) H2020-777533 [call H2020-EINFRA-2016-2017], www.process-project.eu/ the main outputs of the project were directed to:

1. **Exascale learning in medical image data**: pattern recognition system as a diagnosis support tool which aimed at improving the performance of decision support in the process of cancer detection, localisation and staging/grading to optimize and personalize treatment planning.
2. SKA (Square Kilometre Array): processing of large amounts of data from telescope observations. A exascale solution for the processing of massive astronomic data for an easiest and more efficient use of LOFAR telescopic observations.
3. Ancillary pricing for revenue management: simulation and generation of optimal prices for ancillary services in airlines. Algorithms for the pricing of ancillary services, in order to increase the airliness revenues while offering passengers a more passenger-centric air traffic experience.
4. Agricultural, Copernicus data-based analysis: advanced techniques based on an **agricultural analysis of earth observation data**. Simulations of earth processes based on satellite information from Copernicus datasets, as a spearhead activity for piloting and stress-testing advanced data analysis techniques.

In the DEEP-HybridDataCloud project:Designing and Enabling E-infrastructures for intensive Processing in a Hybrid DataCloud (1.11.2017-30.4.2020) H2020-777435 [call H2020-EINFRA-2016-2017], https://deep-hybrid-datacloud.eu/the-project/, the main outputs of the project were directed to:

1. The continuous progress in remote sensor resolutions of Earth observation platforms which generates large quantities of hyperspectral data for the mapping and monitoring of natural and man-made land covers.
2. Seismic imaging aimed at providing accurate and detailed 3D maps of the earth subsurface from acoustic wave propagation recording at the surface.
3. The Integrated Forecasting System (IFS) application software which is a state-of-the-art global weather prediction suite developed at ECMWF on behalf of its member states.

In the EOSC-Synergy project: European Open Science Cloud - Expanding Capacities by building Capabilities (1.9.2019-31.10.2022) H2020-857647 [call H2020-INFRAEOSC-2018-2020], https://www.eosc-synergy.eu/, the main outputs of the project were directed to: national thematic services to European researchers, thus expanding the EOSC offer in the Environment, Climate Change, Earth Observation and Life Sciences. II SAS has deloped the thematic service MSWSS for modeling and analysis of water supply systems. The MSWSS service allows infrastructure managers to drinking water supply and researchers to use the EOSC computing infrastructure; and data sharing services for the analysis of more

complex water supply systems. II SAS currently trains customers for MSWSS cloud services such as water companies.

In 2021, contract research was also addressed for:
1. Research Institute of Nuclear Energy in the field of analysis of artificial intelligence methods for **predicting the spread of chemical impurities for their impact on insulators in power lines**.
2. CESSDA Vocabulary Service (CVS), contract, https://vocabularies.cessda.eu/ .
   Participants: CESSDA ERIC (the Consortium of European Social Science Data Archives - European Research Infrastructure Consortium), Norway, GESIS (Leibniz Institute for the Social Sciences), Germany, and II SAS. Activities are in Service Level Agreement ("SLA" or "Agreement") between CESSDA ERIC, GESIS, and II SAS for the maintenance of the CESSDA Vocabulary Service (CVS) product required to support and sustain the collection of managed vocabularies.
   Duration in months: 27 (1.10.2021-31.12.2023).
   Prediction of raining (nowcasting) from 3D radar images based on methods of artificial intelligence and machine learning. **Feasibility study based on cooperation with the Slovak Hydrometeorological Institute** in Bratislava was realized.

Fire research has significant impacts on security and safety of citizens, human structures and critical infrastructures. Direct financial benefits from the increase of protection of human lives and health, property and environment are difficult to quantify and can only be estimated. II SAS conducts experimental fire research and research on computer simulation of fires related to various environments selected by specialists responsible for fire safety in SR. The research on applicability of existing fire simulators for fire modelling and their validation by experimental data are very timely at world level. In collaboration with FSE UNIZA, II SAS is ranked among few outstanding foreing institutions that have successfully conducted full-scale automobile fire experiments in various conditions. The research during the accreditation period focused on automobile fires, fires in structures with higher requirements for fire safety such as cinemas, underground car parks, road tunnels (road tunnels belong to structures of state critical infrastructure). New knowledge about the influence of parallelization on efficiency and accuracy of fire simulation allows significant shortening of computational time utilizing the knowledge about HW and SW specification of the used computer cluster. Research results obtained within collaboration with CTR UNIZA and contract collaboration with significant (Slovak) customers contributed to the increase of the tunnel safety in SR and preparedness of tunnel control operators (specific national impact, see also Chapters 1.8 and 2.1.5). The research reflects requirements of relevant fire safety specialists in SR and abroad, world research trends and up-to-date methodologies used in top research laboratories. The experimental data and good knowledge about advanced fire models are a promising basis for future researcher. To renew former successful contract collaboration with NDS and PPA INZINIERING and with other Slovak and foreign companies is important strategic goal. Carring out of other tunnel fire tests and research on the impact of tunnel geometry, tunnel slope, lay-bys, tunnel curvature, emergency ventilation and external effects (e.g. wind) on smoke stratification are intended. During the accreditation period one new postdoc position was created for a doctoral student who defended his excellently evaluated dissertation; one PhD student started her PhD studies in 2021 (maternity leave taken till 01/2023).

The most significant results in the field of **automatic speech processing**, which have a direct positive impact on society, are mainly those of research and applications in the field of air traffic control security and in the field of telemedicine and e-health. Together with the Deutsches Zentrum für Luft- und Raumfahrt (DLR), the II SAS participated in the development of tools increasing resistance to combined cyber and physical threats at airports within the SATIE project.

The SATIE project addresses the **safety of air transport infrastructure in Europe**. A new speaker verification module checking authorization of participants of voice-radio communication between aircraft pilots at the airport and the tower was designed, developed

and implemented in the system of the airport tower and control simulator in Braunschweig. A "StressDat" database played by professional actors was created. A new voice-under-stress identification system based on deep-learning and prediction of the level of emotional activation and the level of emotion pleasure was designed, developed and implemented. The created database "StressDat" was used to train the models. Basic research was done and published on the relation between stress and emotion cues in voice.

The GAMMA project is a predecessor of SATIE project. It addresses the management of the **global security of air traffic services in the European airspace** of the future. An HMM-based module for the verification of persons during communication between pseudo-pilots and air traffic controllers was designed, developed and implemented in the Air Traffic Management (ATM) simulator, notifying the possible occurrence of unauthorized person's speech. A system for the identification of voice-stress in communication between pseudo-pilots and air traffic controllers was designed, developed and implemented, drawing attention to the possible occurrence of increased levels of speech stress. The proposed modules were implemented in the air traffic monitoring system in cooperation with the Deutsches Zentrum für Luft- und Raumfahrt and presented on 22 November 2017 at the final evaluation of the project in Rome.

II SAS also participated in the development of a method for **screening neurodegenerative diseases from speech**, by auto-examination at home with the help of a smartphone (within the EWA project). This method will be further improved in the ALOIS project, which starts in July 2022. II SAS also maintains the functionality of the **speech recognition system for voice input of the PATRICIA information system of the General Prosecutor's office** (According to the Service Level Agreement and maintenance of 900 licenses). The recognition system was developed at II SAS in 2015.

Experimental research in electron beam lithography contributes to the knowledge on electron scattering in resist/substrate for the case of variable shaped electron beam cross-section at 40 keV electron energy, and for the case of spot beam with Gaussian intensity distribution. Research at II SAS is made in the following areas: Study of the influence of electron beam lithography process parameters on the obtained developed images in electron beam resists; Optimization of electron beam lithography process parameters for the fabrication of structures for research project of the Slovak Academy of Sciences and Slovak Technical university is made, including photomasks fabrication for diploma and postgraduate theses; Research of new semiconducting 2D thin films such as dichalcogenides of transition metals with the aim to get a new scientific knowledge in the patterning of nanometer scale structures (20-200 nm) in electron beam resists on 2D thin films with focus on a new progressive nanostructured semiconductive materials based on dichalcogenides of transition metals such as WS_2 and MoS_2. The results of this research are applied in the sensor technology, partially for environmental gas sensors, and in various MEMS applications.

Precise agriculture. The agricultural sector currently has a wealth of new information on the basis of which advanced automated equipment can accurately and purposefully deploy active substances and ensure crop protection. These are sophisticated technologies, the use of which is currently not sufficient for the needs of precision agriculture on a local scale. The interdisciplinary networking of experts from different scientific disciplines contributes to their more effective use. We have proposed a procedure for processing and preparation of application maps, which allows to optimize the dosage with respect to the given technical, local soil and phytological requirements. Early detection of crop damage significantly reduces the time required to apply appropriate protective measures and chemicals. Rapid application is carried out locally, only in the damaged area and the result is a significant reduction in treatment costs. A secondary impact is also better care for the environment, with the potential to contribute to the fulfillment of the outputs of individual departments listed for the priority areas of the RIS3 strategy.

2.1.9. Table of research outputs

Papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) have to be listed separately

Scientific publications	2016			2017			2018			2019			2020			2021			total			
	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. / one million total salary budget	number	No. / FTE researches	No. /1 million total salary budget	number	averaged number per year	av. No. / FTE researches	av. No. / one million total salary budget
Scientific monographs and monographic studies in journals and proceedings published abroad (AAA, ABA)	1	0.018	0.586	0	0.000	0.000	1	0.017	0.544	0	0.000	0.000	1	0.017	0.427	1	0.018	0.434	4	0.667	0.012	0.335
Scientific monographs and monographic studies in journals and proceedings published in Slovakia (AAB, ABB)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000
Chapters in scientific monographs published abroad (ABC)	1	0.018	0.586	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	1	0.167	0.003	0.084
Chapters in scientific monographs published in Slovakia (ABD)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000
Scientific papers published in journals registered in Current Contents Connect (ADCA, ADCB, ADDA, ADDB)	11	0.194	6.445	6	0.103	3.555	9	0.152	4.899	14	0.241	6.744	14	0.241	5.977	12	0.213	5.207	66	11.000	0.191	5.521
Scientific papers published in journals registered in Web of Science Core Collection and SCOPUS not listed above (ADMA, ADMB, ADNA, ADNB)	32	0.564	18.750	29	0.500	17.181	39	0.660	21.229	39	0.672	18.788	35	0.603	14.943	25	0.443	10.847	199	33.167	0.575	16.646
Scientific papers published in other foreign journals (not listed above) (ADEA, ADEB)	4	0.070	2.344	1	0.017	0.592	1	0.017	0.544	0	0.000	0.000	0	0.000	0.000	2	0.035	0.868	8	1.333	0.023	0.669
Scientific papers published in other domestic journals (not listed above) (ADFA, ADFB)	1	0.018	0.586	1	0.017	0.592	1	0.017	0.544	2	0.034	0.963	0	0.000	0.000	1	0.018	0.434	6	1.000	0.017	0.502
Scientific papers published in foreign peer-reviewed proceedings (AECA)	1	0.018	0.586	0	0.000	0.000	0	0.000	0.000	1	0.017	0.482	3	0.052	1.281	0	0.000	0.000	5	0.833	0.014	0.418
Scientific papers published in domestic peer-reviewed proceedings (AEDA)	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0	0.000	0.000	0.000
Published papers (full text) from foreign scientific conferences (AFA, AFC)	2	0.035	1.172	2	0.034	1.185	4	0.068	2.177	5	0.086	2.409	0	0.000	0.000	2	0.035	0.868	15	2.500	0.043	1.255
Published papers (full text) from domestic scientific conferences (AFB, AFD)	5	0.088	2.930	4	0.069	2.370	2	0.034	1.089	1	0.017	0.482	0	0.000	0.000	0	0.000	0.000	12	2.000	0.035	1.004

Suplementary information: Some of the most important deliverables, where II SAS was a leader or considerable contributor, are as follows:

1. D6.1 "State-of-the-art deep learning (DL), neural network (NN) and machine learning (ML) frameworks and libraries", 2018, leader, https://deep-hybrid-datacloud.eu/wp-content/uploads/sites/2/2019/02/DEEP-JRA3-D6.1.pdf
2. D4.1 "Initial state of the art and requirement analysis, initial PROCESS architecture", 2018, leader, https://www.process-project.eu/wp-content/uploads/2020/02/PUBLIC_PROCESS_D4.1_Initial_-_state_of_the_art_and_requirement_analysis_initial_PROCESS_architecture_v1-1.pdf
3. D4.3 "Updated requirements analysis, validation of 1st prototype, and updated PROCESS architecture", 2019, leader, https://www.process-project.eu/wp-content/uploads/2020/02/PROCESS_D4.3_UpdatedRequirementsAnalysis_v1.0.pdf
4. D4.5 "Validation of the second prototype and final PROCESS architecture", 2020, leader, https://www.process-project.eu/wp-content/uploads/2020/02/D4.5_Validation_of_2nd_prototype_and_final_PROCESS_architecture.pdf
5. D5.2 "Alpha release of the data service", 2019, leader, https://www.process-project.eu/wp-content/uploads/2020/02/PROCESS_D5.2_Alpha_release_of_the_Data_service_v1.0.pdf
6. D6.2 "Second prototype with demonstration using chosen pilot", 2019, leader, https://www.process-project.eu/wp-content/uploads/2020/02/D6.2_Second_prototype_with_demonstration_using_chosen_pilot_application.pdf
7. D2.1 "Roadmap for integration of national capacities into the EOSC and policy gap analysis", 2020, contributor, https://digital.csic.es/bitstream/10261/219305/1/EOSC-SYNERGY-WP2-D2.1.pdf
8. D2.2 "Intermediate report on integration efforts", 2020, contributor, https://digital.csic.es/bitstream/10261/223465/3/EOSC-synergy-WP2-D2.2.pdf
9. D4.1 "Best practices elicitation including data management plans", 2020, contributor, https://digital.csic.es/bitstream/10261/219309/1/EOSC-SYNERGY-WP4-D4.1.pdf
10. D4.2 "First prototype of the EOSC thematic services (demonstration)", 2020, contributor, https://digital.csic.es/bitstream/10261/219311/3/D4.2%20-%20First%20prototype%20of%20the%20EOSC%20Thematic%20services.pdf
11. D4.3 "National/international engagement plan with policy makers and funders", 2021, contributor, https://digital.csic.es/bitstream/10261/219312/4/D5.1%20Nat_Int%20engagement-updated-Final.pdf
12. D3.1: Ontology (ontology and related documentation) (unpublished):
13. D3.2: Multi-agent Social Network and Cloud-based Collaborative Environment Architecture (document + first mock-ups) (unpublished)
14. D3.3: Multi-agent Social Network and Cloud-based Collaborative Environment Prototype (software) (unpublished)
15. GLASA, Ján – WEISENPACHER, Peter – VALÁŠEK, Lukáš. Analysis of experiments in situ in the Polana tunnel (in Slovak), technical report, Institute of Informatics, Slovak Academy of Sciences, Bratislava, 2019, 17 p., classified as confidential.
16. GLASA, Ján – WEISENPACHER, Peter – VALÁŠEK, Lukáš. Analysis of experiments in situ in the Povazsky Chlmec tunnel (in Slovak), technical report, Institute of Informatics, Slovak Academy of Sciences, Bratislava, 2019, 35 p., classified as confidential.
17. GLASA, Ján – WEISENPACHER, Peter – VALÁŠEK, Lukáš. Analysis of results of computer simulation of fires in the Polana road tunnel (in Slovak), technical report, Institute of Informatics, Slovak Academy of Sciences, Bratislava, 2019, 63 p., classified as confidential.
18. GLASA, Ján – WEISENPACHER, Peter – VALÁŠEK, Lukáš. Analysis of results of computer simulation of fires in the Povazsky Chlmec road tunnel (in Slovak), technical report, Institute of Informatics, Slovak Academy of Sciences, Bratislava, 2019, 27 p., classified as confidential.

19. GLASA, Ján – WEISENPACHER, Peter – VALÁŠEK, Lukáš. Vizualizations of fire for Tunnel Control Simulator developed by computer simulation (in Slovak), technical report, Institute of Informatics, Slovak Academy of Sciences, Bratislava, 2020, 21 p., classified as confidential.

2.2. Measures of research outputs (citations, etc.)

2.2.1. Table with citations per annum (without self-citations)

Citations of papers from international collaborations in large-scale scientific projects (Dwarf team, ALICE Collaboration, ATLAS collaboration, CD Collaboration, H1 Collaboration, HADES Collaboration, and STAR Collaboration) are listed separately

Citations, reviews	2015		2016		2017		2018		2019		2020		total		
	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	No. / FTE researchers	number	averaged number per year	av. No. / FTE researchers
Citations in Web of Science Core Collection (1.1, 2.1)	234	4.12	254	4.38	266	4.50	306	5.28	283	4.87	335	5.94	**1 678**	**279.67**	**4.85**
Citations in SCOPUS (1.2, 2.2) if not listed above	86	1.52	64	1.10	70	1.19	74	1.28	134	2.31	143	2.54	**571**	**95.17**	**1.65**
Citations in other citation indexes and databases (not listed above) (3.2,4.2)	0	0.00	0	0.00	1	0.02	0	0.00	0	0.00	0	0.00	**1**	**0.17**	**0.00**
Other citations (not listed above) (3.1, 4.1)	127	2.24	129	2.22	126	2.13	93	1.60	143	2.46	142	2.52	**760**	**126.67**	**2.19**
Reviews (5,6)	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	**0**	**0.00**	**0.00**

2.2.2. List of 10 most-cited publications published any time with the address of the institute, with number of citations in the assessment period (2015 – 2020)

1. BRITAŇÁK, Vladimír - YIP, Patrick C. - RAO, K.R. Discrete cosine and sine transform: general properties, fast algorithms and integer approximations. 1st ed. San Diego, USA: Academic Press, 2007. xiv, 349 p. ISBN 978-0-12-373624-6 Citations: 211

2. MOCZO, Peter - KRISTEK, Jozef - VAVRYČUK, Václav - ARCHULETA, Ralph J. - HALADA, Ladislav. 3D heterogeneous staggered-grid finite-difference modeling of seismic motion with volume harmonic and arithmetic averaging of elastic moduli and densities. In Bulletin of the Seismological Society of America, 2002, vol. 92, no. 8, p. 3042-3066. ISSN 0037-1106. https://doi.org/10.1785/0120010167 Citations: 139

3. NGUYEN, Giang - DLUGOLINSKÝ, Štefan - BOBÁK, Martin - TRAN, Viet - LÓPEZ GARCÍA, Álvaro - HEREDIA, Ignacio - MALÍK, Peter - HLUCHÝ, Ladislav. Machine learning and deep learning frameworks and libraries for large-scale data mining: a survey. In Artificial Intelligence Review, 2019, vol. 52, no. 1, p. 77-124. (2018: 5.095 - IF, Q1 - JCR, 1.055 - SJR, Q1 - SJR (2019 - Current Contents). ISSN 0269-2821. https://doi.org/10.1007/s10462-018-09679-z Citations: 102

4. JANGLOVÁ, Danica. Neural networks in mobile robot motion. In International Journal of Advanced Robotic Systems, 2004, vol.1, no.1, p. 15-22. ISSN 1729-8806. Citations: 99

5. MOCZO, Peter - KRISTEK, Jozef - HALADA, Ladislav. 3D fourth-order staggered-grid finite-difference schemes: Stability and grid dispersion. In Bulletin of the Seismological Society of America, 2000, vol. 90, no. 3, p. 587-603. (2000 - Current Contents). 2/5131/99 Citations: 88

6. LEVITAN, Rivka - GRAVANO, Agustín - WILLSON, Laura - BEŇUŠ, Štefan - HIRSCHBERG, Julia - NENKOVA, Ani. Acoustic-prosodic entrainment and social behavior. In 2012 Conference of the North American Chapter of the Association for Computational Linguistics : Human Language Technologies. - Montreal, 2012, p. 11-19. ISSN 978-1-937284-20-6. http://www.cs.columbia.edu/~sbenus/Research/Levitan_etal_Naaclhlt2012_proc.pdf Citations: 52

7. CIGLAN, Marek - AVERBUCH, Alex - HLUCHÝ, Ladislav. Benchmarking traversal operations over graph databases. In 2012 IEEE 28th International Conference on Data Engineering Workshops : proceedings. - Los Alamitos : IEEE Computer Society, 2012, p. 186-189. ISBN 978-1-4673-1640-8. https://doi.org/10.1109/ICDEW.2012.47 Citations: 40

8. BEŇUŠ, Štefan - GAFOS, Adamantios. Articulatory characteristics of Hungarian "transparent" vowels. In Journal of Phonetics, 2007, vol. 35, p. 271-300. (2006: 1.487 - IF, Q1 - JCR, 1.147 - SJR, Q1 - SJR). ISSN 0095-4470. https://doi.org/10.1016/j.wocn.2006.11.002 Citations: 37

9. BEŇUŠ, Štefan - GRAVANO, Agustín - HIRSCHBERG, Julia. Pragmatic aspects of temporal accommodation in turn-taking. In Journal of Pragmatics, 2011, vol. 43, p. 3001-3027. (2010: 0.856 - IF, Q2 - JCR, 0.649 - SJR, Q1 - SJR, karentované - CCC). (2011 - Current Contents). ISSN 0378-2166. https://doi.org/10.1016/j.pragma.2011.05.011 Citations: 33

10. BEŇUŠ, Štefan. Social aspects of entrainment in spoken interaction. In Cognitive Computation, 2014, vol. 6, p. 802-813. (2013: 1.100 - IF, Q3 - JCR, 0.518 - SJR, Q2 - SJR, karentované - CCC). (2014 - Current Contents). ISSN 1866-9956. https://doi.org/10.1007/s12559-014-9261-4 Citations: 33

2.2.3. List of 10 most-cited publications published any time with the address of the institute, with number of citations obtained until 2020

1. BRITAŇÁK, Vladimír - YIP, Patrick C. - RAO, K.R. Discrete cosine and sine transforms : general properties, fast algorithms and integer approximations. 1st ed. San Diego, USA: Academic Press, 2007. xiv, 349 p. ISBN 978-0-12-373624-6 Citations: 399

2. MOCZO, Peter - KRISTEK, Jozef - VAVRYČUK, Václav - ARCHULETA, Ralph J. HALADA, Ladislav. 3D heterogeneous staggered-grid finite-difference modeling of seismic motion with volume harmonic and arithmetic averaging of elastic moduli and densities. In Bulletin of the Seismological Society of America, 2002, vol. 92, no. 8, p. 3042-3066. ISSN 0037-1106. https://doi.org/10.1785/0120010167 Citations: 323

3. JANGLOVÁ, Danica. Neural networks in mobile robot motion. In International of Advanced Robotic Systems, 2004, vol.1, no.1, p. 15-22. ISSN 1729-8806. Citations: 187

4. MOCZO, Peter - KRISTEK, Jozef - HALADA, Ladislav. 3D fourth-order staggered-grid finite-difference schemes: Stability and grid dispersion. In Bulletin of the Seismological Society of America, 2000, vol. 90, no. 3, p. 587-603. (2000 - Current Contents). 2/5131/99 Citations: 181

5. BARRETT, Chris - MARATHE, Achla - DROZDA, Martin - MARATHE, Madhav V. Characterizing interaction between routing and MAC protocols in ad-hoc networks. In MOBIHOC 2002 : Proceedings of the third ACM International Symposium on Mobile ad hoc Networking and Computing. - Švajčiarsko : ACM Sigmobile, p. 92-103. Citations: 131

6. NGUYEN, Giang - DLUGOLINSKÝ, Štefan - BOBÁK, Martin - TRAN, Viet - LÓPEZ GARCÍA, Álvaro - HEREDIA, Ignacio - MALÍK, Peter - HLUCHÝ, Ladislav. Machine learning and deep learning frameworks and libraries for large-scale data mining: a survey. In Artificial Intelligence Review, 2019, vol. 52, no. 1, p. 77-124. (2018: 5.095 - IF, Q1 - JCR, 1.055 - SJR, Q1 - SJR) (2019 - Current Contents). ISSN 0269-2821. https://doi.org/10.1007/s10462-018-09679-z Citations: 102

7. LACLAVÍK, Michal - BALOGH, Zoltán - BABÍK, Marian - HLUCHÝ, Ladislav. AgentOWL: Semantic knowledge model and agent architecture. In Computing and informatics, 2006, vol. 25, no. 5, p. 419-439. (2005: 0.091 - IF, Q4 - JCR, 0.165 - SJR, Q3 - SJR). ISSN 1335-9150. Citations: 87

8. BRITAŇÁK, Vladimír - RAO, K.R. An efficient implementation of the forward and inverse MDCT in MPEG Audio coding. In IEEE Signal Processing Letters, 2001, vol. 8, no. 2, p. 48-51. ISSN 1070-9908. https://doi.org/10.1109/97.895372 Citations: 85

9. BEŇUŠ, Štefan - GAFOS, Adamantios. Articulatory characteristics of Hungarian "transparent" vowels. In Journal of Phonetics, 2007, vol. 35, p. 271-300. (2006: 1.487 - IF, Q1 - JCR, 1.147 - SJR, Q1 - SJR). ISSN 0095-4470. https://doi.org/10.1016/j.wocn.2006.11.002 Citations: 80

10. NGUYEN, Giang - DANG, Thanh Tung - HLUCHÝ, Ladislav - LACLAVÍK, Michal - BALOGH, Zoltán - BUDINSKÁ, Ivana. Agent platform evaluation and comparison. Institute of Informatics SAS, Technical report, II SAS, Bratislava 2002 Citations: 79

2.2.4. List of 10 most-cited publications published <u>during</u> the evaluation period (2016-2021) with the address of the Institute, with number of citations obtained until 2021

1. NGUYEN, Giang - DLUGOLINSKÝ, Štefan - BOBÁK, Martin - TRAN, Viet - LÓPEZ GARCÍA, Álvaro - HEREDIA, Ignacio - MALÍK, Peter - HLUCHÝ, Ladislav. Machine learning and deep learning frameworks and libraries for large-scale data

mining: a survey. In Artificial Intelligence Review, 2019, vol. 52, no. 1, p. 77-124. (2018: 5.095 - IF, Q1 - JCR, 1.055 - SJR, Q1 - SJR). (2019 - Current Contents). ISSN 0269-2821. https://doi.org/10.1007/s10462-018-09679-z Citations: 220

2. DIETZEL, Dirk - BRNDIAR, Ján - ŠTICH, Ivan - SCHIRMEISEN, André. Limitations of structural superlubricity: chemical bonds versus contact size. In ACS Nano, 2017, vol. 11, no. 8, p. 7642-7647. (2016: 13.942 - IF, Q1 - JCR, 6.948 - SJR, Q1 - SJR). (2017 - Current Contents). ISSN 1936-0851. https://doi.org/10.1021/acsnano.7b02240 Citations: 42

3. LEVITAN, Rivka - BEŇUŠ, Štefan - GÁLVEZ, Ramiro H. - GRAVANO, Agustín - SAVORETTI, Florencia - TRNKA, Marián - WEISE, Andreas - HIRSCHBERG, Julia. Implementing acoustic-prosodic entrainment in a conversational avatar. In Proceedings of the Annual Conference of the International Speech Communication Association, 2016, vol. 1-5, p. 1166-1170. (2015: 0.437 - SJR). (2016 - SCOPUS). ISSN 2308-457X. https://doi.org/10.21437/Interspeech.2016-985 Citations: 33

4. TRAN, Nhuan - NGUYEN, Thang - NGUYEN, Binh Minh - NGUYEN, Giang. A multivariate fuzzy time series resource forecast model for clouds using LSTM and data correlation analysis. In Procedia Computer Science, 2018, vol. 126, p. 636-645. (2017: 0.258 - SJR). ISSN 1877-0509. https://doi.org/10.1016/j.procS.2018.07.298 Citations: 22

5. LÓPEZ GARCÍA, Álvaro - MARCO DE LUCAS, Jesús - ANTONACCI, Marica - ZU CASTELL, Wolfgang - DAVID, Mario - HARDT, Marcus - LLORET, Lara - MOLTÓ, Germán - PLOCIENNIK, Marcin - TRAN, Viet - ALIC, Andy S. - CABALLER, Miguel - CAMPOS, Isabel - COSTANTINI, Alessandro - DLUGOLINSKÝ, Štefan - DUMA, Cristina - DONVITO, Giacinto - GOMES, Jorge - HEREDIA, Ignacio - ITO, Keiichi - KOZLOV, Valentin - NGUYEN, Giang - ORVIZ, Pablo - ŠUSTR, Zdeněk - WOLNIEWICZ, Pawel. A cloud-based framework for machine learning workloads and applications. In IEEE Access, 2020, vol. 8, no. 1, p. 18681-18692. (2019: 3.745 - IF, Q1 - JCR, 0.775 - SJR, Q1 - SJR, Current Contents CCC). (2020 - Current Contents). ISSN 2169-3536. https://doi.org/10.1109/ACCESS.2020.2964386 Citations: 21

6. ŠIMKO, Juraj - BEŇUŠ, Štefan - VAINIO, Martti. Hyperarticulation in Lombard speech: Global coordination of the jaw, lips and the tongue. In Journal of the Acoustical Society of America, 2016, vol. 139, no. 1, p. 151-162. (2015: 1.572 - IF, Q2 - JCR, 0.854 - SJR, Q1 - SJR). (2016 - Current Contents). ISSN 0001-4966. https://doi.org/10.1121/1.4939495 Citations: 20

7. TRAN, Dang - TRAN, Nhuan - NGUYEN, Giang - NGUYEN, Binh Minh. A proactive cloud scaling model based on fuzzy time series and SLA awareness. In Procedia Computer Science, 2017, vol. 108, p. 365-374. (2016: 0.259 - SJR). (2017 - WOS, SCOPUS). ISSN 1877-0509. https://doi.org/10.1016/j.procs.2017.05.121 Citations: 19

8. FRANK, Tobias - DERIAN, René - TOKÁR, Kamil - MITAS, Luboš - FABIAN, Jaroslav - ŠTICH, Ivan. Many-body quantum Monte Carlo study of 2D materials: cohesion and band gap in single-layer phosphorene. In Physical Review X, 2019, vol. 9, no. 1, 011018. (2018: 12.211 - IF, Q1 - JCR, 6.497 - SJR, Q1 - SJR). (2019 - Current Contents). ISSN 2160-3308. https://doi.org/10.1103/PhysRevX.9.011018 Citations: 19

9. NGUYEN, Giang - DLUGOLINSKÝ, Štefan - TRAN, Viet - LÓPEZ GARCÍA, Álvaro. Deep learning for proactive network monitoring and security protection. In IEEE Access, 2020, vol. 8, no. 1, art. no. 8966259, p. 19696-19716. (2019: 3.745 - IF, Q1 - JCR, 0.775 - SJR, Q1 - SJR). (2020 - Current Contents). ISSN 2169-3536. https://doi.org/10.1109/ACCESS.2020.2968718 Citations: 18

10. NGUYEN, Giang - NGUYEN, Binh Minh - TRAN, Dang - HLUCHÝ, Ladislav. A heuristics approach to mine behavioural data logs in mobile malware detection system. In Data & Knowledge Engineering, 2018, vol. 115, p. 129-151. (2017: 1.467 - IF, Q3 - JCR, 0.490 - SJR, Q2 - SJR). (2018 - Current Contents). ISSN 0169-023X. https://doi.org/10.1016/j.datak.2018.03.002 Citations: 17

2.2.5. **List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations in the assessment period (2015– 2020). The cited papers must bear the address of the institute**

	WOS	SCOPUS	other DB	SUM	WOS+SCOPUS
Hluchý	254	115	139	508	369
Beňuš	216	107	182	505	323
Halada	263	39	65	367	302
Britaňák	168	42	87	297	210
Kostič	177	27	34	238	204
Nguyen	106	44	50	200	150

2.2.6. **List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2020. The cited papers must bear the address of the Institute**

	WOS	SCOPUS	other DB	SUM	WOS+SCOPUS
Hluchý	597	285	479	1361	882
Halada	524	90	160	774	614
Kostič	519	83	101	703	602
Britaňák	446	135	222	803	581
Beňuš	308	163	268	739	471
Rusko	169	79	121	369	248

2.2.7. **List of most-cited authors from the Institute (at most 10 % of average FTE researchers per year) and their number of citations obtained until 2021 of their papers published during the evaluation period (2016– 2021). The cited papers must bear the address of the Institute**

	WOS	SCOPUS	other DB	SUM	WOS+SCOPUS
Nguyen	197	78	97	372	275
Hluchý	149	53	85	287	202
Tran	148	49	77	274	197
Dlugolinský	141	48	76	265	189
Bobák	120	41	72	233	161
Malík	113	42	73	228	155

2.3. Research status of the institute in international and national context

- **International/European position of the institute**

    2.3.1. **List of the most important research activities demonstrating the international relevance of the research performed by the institute, incl. major projects (details of projects should be supplied under Indicator 2.4). Max. 10 items for institute with less than 50 average FTE researchers per year, max. 20 for institutes with 50 – 100 average FTE researchers per year and so on**

1. H2020 project EGI Advanced Computing for EOSC (EGI-ACE)
2. H2020 project Integrated technological and information platform for wildfire management (SILVANUS)
3. H2020 project European Open Science Cloud - Expanding capacities by building capabilities (EOSC-Synergy)
4. H2020 project Integrating and managing services for the European Open Science Cloud (EOSC-hub)
5. H2020 project Security of Air Transport Infrastructure of Europe (SATIE)
6. H2020 project Designing and Enabling E-infrastructures for intensive Processing in a Hybrid DataCloud (DEEP-HybridDataCloud)
7. H2020 project PROviding Computing solutions for ExaScale challengeS (PROCESS)
8. H2020 project Engaging the EGI Community towards an open science commons (EGI-Engage)
9. FP7 project Global ATM security management (GAMMA)
10. H2020 project Emergency responder data interoperability network (REDIRNET)
11. H2020 project COversational BRAins
12. AFOSR project Relationship between trust and entrainment in speech
13. COST project Fire in earth system: Science & society (FIRElinks)
14. COST project Wider Impacts and Scenario Evaluation of Autonomous and Connected Transport (WISE-ACT)
15. COST project Improving applicability of nature-inspired optimisation by joining theory and practice
16. ERA-NET project Social Network of Machines (SOON)
17. II SAS is a memeber of EGI - European Open Science Cloud Infrastructure
18. Close collaboration of Vladimir Britanak with eminent researchers in the field of digital signal processing and coding such as Kamisetty R. Rao, University of Arlington, Arlington, USA, and Henrique S. Malvar, Microsoft, Redmond, USA and others led to Britanak's excellent scientific reputation and numerous publications in top European and American scientific journals. During the accreditation period he wrote a significant scientific monograph published in reputable scientific publisher intended for European and American universities, research laboratories and companies involved in research and development of coding systems (for more information see Chapter 2.1.5) and served as a reviewer in numerous top Journals in the Signal Processing field.
19. JRP project An individual stimulating system with 3D nano-structure carbon/graphene based transducer and wireless heater for automated tiny insects behavior monitoring
20. Membership in e-IRG (e-Infrastructure Reflection Group) and organising of the 46th meeting of e-IRG delegates in Bratislava

2.3.2. List of international conferences (co)organised by the institute

- 29th Micromechanics and Microsystems Europe Workshop, Smolenice, Slovakia, 26.08.-29.08.2018
- SAMI2017 − 15th IEEE International Symposium on Applied Machine Intelligence and Informatics, Herľany, Slovakia, January 26-28, 2017
- Research Data Alliance (RDA), Institute of Informatics SAS, Bratislava, May 23, 2017
- Computer architectures and diagnostics – PAD 2017, Smolenice, Slovakia, September, 6-8, 2017
- 2017 IEEE 14th International Scientific Conference on Informatics - Informatics´2017, Poprad, Slovakia, November, 14-16, 2017
- 36th EUGridPMA meeting, II SAS Bratislava, 10 participants, 18.01.-20.01.2016
Regular working meetings of the European Policy Management Authority for Grid Authentication in e-Science with the invitation of representatives of the American and Asian associations (together they form the worldwide IGTF association) are held 3 times a year and this time it was in Bratislava on January 18-20, 2016. At the meetings the internal affairs of the association were discussed together with the design and approval policies aimed at providing user identity and resources for European and global e-infrastructures (EGI, PRACE, WLCG, OSG ...).
10 participants in the meeting were present and 20 other participants in the EUGridPMA meeting were connected by teleconference meeting.
- 46th meeting of E-IRG delegates, Bratislava. Slovakia, 30 participants, 15.09.-16.09.2016
Meeting of e-IRG delegates on the occasion of the Slovak Presidency of the Council of the EU.
- DDECS 2016 - 19th IEEE International Symposium on Design and Diagnostics of Electronic Circuits and Systems, Košice, Slovakia, 100 participants, 20.04.-22.04.2016
The DDECS symposium has become a major scientific event organized annually in Central European countries (Czech Republic, Poland, Slovakia and Hungary and in recent years in Austria, Germany, Estonia and Serbia), which regularly hosts more than a hundred participants from all over Europe, North America, Asia or Africa. The symposium is focused on the presentation and discussion of the results of the latest research and practical applications in the field of design and diagnostics of microelectronic circuits and systems. The program includes lectures by leading experts, regular, student and poster sections as well as comprehensive review lectures. The collection of papers is published in the IEEE Xplore, Web of Science and Scopus databases.
- Seminar "Čav sav!", Bratislava, Slovakia, 25 participants, 18.10.-19.10.2016.
- Seminar of researchers of the Institute of Informatics of the Slovak Academy of Sciences and the Institute of Informatics of the Academy of Sciences of the Czech Republik. The seminar included a panel discussion on ethics in computer science. The seminar was broadcast by videoconference and was also attended by researchers from PF UPJŠ and FEI TUKE in Košice.
- 47th meeting of E-IRG delegates, Bratislava. Slovakia, 60 participants, 14.11.-15.11.2016.
Meeting of e-IRG delegates on the occasion of the Slovak Presidency of the Council of the EU.
- 4th workshop Acoustics and speech processing connected with a workshop on speech processing for the purposes of air traffic control safety. Institute of Informatics SAS, Bratislava, 18 participants, 28.11.-29.11.2016.
The workshop was focused on acoustics and speech processing. The workshop also included a special section "GAMMA Workshop on Speech Processing in ATM Security" on speech processing for the purposes of air traffic control security (ATM Security).
- REDIRNET - Emergency Responder Data Interoperability Network - final evaluation of the project / REDIRNET - Emergency Responder Data Interoperability Network - final

review of the project, Bratislava. Slovakia, 30 participants, 27.06.-30.06.2017 (Ladislav Hluchý, 02/5477 1004, hluchy.ui@savba.sk).

- Final review of the REDIRNET project - Emergency Responder Data Interoperability Network with the participation of foreign reviewers, the project manager of the European Commission as well as with the participation of representatives of the Ministry of the Interior of the Slovak Republic.

- Workshop of the SAS-MOST project JRP 2017/1 "An individual stimulating system with 3D nano-structure carbon/graphene based transducer and wireless heater for automated tiny insects behavior monitoring", 25 participants from II SAS and from other institutes of SAS and the Slovak Technical University, on 22.6.2018 at the Institute of Informatics SAS.

  At the workshop there were several lectures including an invited lecture "Study on field emission characteristics of carbon based structures fabricated by CVD method" of Prof. Hung-Yin Tsai from the Department of Power Mechanical Engineering, National Tsing Hua University, Taiwan

2.3.3. List of edited proceedings from international scientific conferences

2.3.4. List of journals edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

Computing and Informatics

Editor-in-Chief: Ladislav Hluchý

ISSN 1335-9150 (print), ISSN 2585-8807 (online)

Indexed in: CCC, WoS, Scopus, Research Alert, SciSearch, CompuMath Citation Index, INSPEC, DBLP, Zentralblatt Math, VINITI Abstracts Journal, Elsevier's Bibiographical Databases, EBSCO

Metrics:

Year	CC	IF	IF Q (best)	JCR Av Jour IF Perc	5Y IF	SJR	SJR Q (best)	CiteScore
2016	Y	0.488	4	5.63	0.624	0.230	Q3	1.3
2017	Y	0.410	4	2.65	0.581	0.198	Q3	1.1
2018	Y	0.421	4	2.61	0.493	0.186	Q3	0.9
2019	Y	0.496	4	1.82	0.500	0.217	Q3	1.3
2020	Y	0.319	4	0.36	0.430	0.149	Q4	1.4
2021	Y	0.455	4	1.04	0.502	0.226	Q4	1.2

- **National position of the institute**

  ### 2.3.5. List of selected activities of national importance

  - Precise agriculture – Integration and data processing for agriculture - SIPPA (Satelite Image Processing for Precision Agriculture) (https://www.ui.sav.sk/w/odd/mcdp/aplikacie/#SIPPA), Contract with AgroTrade Group spol. s r.o. is a new service of the Institute of Informatics for the processing and evaluation of satellite images of the Sentinel satellite. The service enables the processing of satellite spectral images for the identification of spatial and temporal variability of soil properties and agricultural stands. Such data processing can be used to predict the development of soil properties or identification of biotic / abiotic

stand stress. Created procedure for processing satellite spectral images for identification of spatial and temporal variability of soil properties and agricultural stands. We have proposed a procedure for processing and preparation of application maps, which allows to optimize the dosage with respect to the given technical, local soil and phytological requirements. Early detection of crop damage significantly reduces the time required to apply appropriate protective measures and chemicals. Rapid application is performed locally, only in the damaged area and the result is a significant reduction in treatment costs.

- II SAS is known as coordinator of several researches related to fire research which were unique at the Central European level (Chapters 1.8 and 2.1.5). Experimental fire research and research on computer simulation of fires were/are conducted for significant Slovak customer organizations responsible for fire safety of tunnels (NDS, PPA INZINIERING) and followed from negotiations with specialists responsible for fire safety in Slovakia (HaZZ, PTEU; safety officer from NDS, Chapter 1.8). Research results obtained within the contract cooperation with NDS and PPA INZINIERING (a series of full-scale fire experiments in 2 motorway tunnels and computer simulation of the tested fire scenarios) led to a modification of the tunnel control system and a realization of a functionality test of an emergency system in one tunnel under investigation, ordered by NDS. TTOS (Tunnel Traffic and Control Simulator) a unique facility in Central European sense was innovated by implementation of a set of videos visualizing several critical tunnel fire scenarios. TTOS is used for education and testing of tunnel control operators in SR. Several technical reports elaborated were classified by NDS as confidential (Chapters 1.8, 2.1.9). All finished research projects funded by VEGA agency obtained certificate about achieving excellent result.

- II SAS is an active member of the National platform for development of AI in Slovakia – AislovakIA, https://aislovakia.com/en/

- Mememberships in editorial boards:

Ing. Habala Ondrej - Computing and Informatics – Executive Editor,
doc. RNDr. Ladislav Halada, CSc. - Civilná ochrana, revue pre civilnú ochranu obyvateľstva (Civil protection, review for civil protection of the population) – member,
doc. Ing. Ladislav Hluchý, PhD. - Acta Electrotechnica et Informatica – Editorial Board Member, Computing and Informatics – Editor-in-Chief,
Ing. Martin Kenyeres, PhD. - Computing and Informatics – CAI's Panel,
Ing. Milan Rusko, PhD. - Fyzikálne faktory prostredia (Physical environmental factors) – Editorial Board Member

- Other memberships:

At the request of the Minister of the Interior of the Slovak Republic, we delegated a representative/expert Dr. Zoltán Balogh to an inter-ministerial expert group to prepare an analysis of the security risks of electronic voting. Our representative is actively involved in the work of this expert group.

Dr. Ivana Budinská was appointed as a full member of the Standing Committee on Ethics and Regulation of Artificial Intelligence, which was established at the Ministry of Investments, Regional Development and Informatization of the Slovak Republic, e-Infrastructure Reflection Group (representative of the Slovak Republic)

Dr. Štefan Havlík was apointed at APVV Council for technical sciences

Ing. Zoltán Balogh, PhD. – Governmental Working group established for the purpose of analysis of security risks of electronic voting from abroad in elections to

the National Council of the Slovak Republic and for assessing the suitability of candidate voting systems (member of the working group)

RNDr. Jan Glasa, CSc. - Working group for research and development in information and communication technologies (one of working groups of Ministry of Education for Research and Innovation Strategies for Smart Specialisation (RIS3 SK) from the point of view of available scientific and research capacities of the Slovak Republic) (consultant)

doc. Ing. Ladislav Hluchy, CSc.:

Working group for research and development in information and communication technologies (one of working groups of Ministry of Education for RIS3 SK areas from the point of view of available scientific and research capacities of the Slovak Republic) (consultant)

ESFRI Working group for the field of computer technology and data processing in ESFRI infrastructure (representative of the Slovak Republic)

e-Infrastructure Reflection Group (representative of the Slovak Republic)

Ing. Peter Malík, Ph.D. - HUB for the introduction of artificial intelligence methods in health care (active member, representative of II SAS)

Ing. Milan Rusko, PhD. - Council of the Minister of the Ministry of Culture for the Preservation of Intangible Cultural Heritage (member)

A representative of the II SAS (I. Budinská) was appointed as a full member of the Standing Committee on Ethics and Regulation of AI (Artificial Intelligence), which was established at the Ministry of Investments, Regional Development and Informatization of the Slovak Republic.

A representative of the II SAS (I. Budinská) was appointed as a member of the Monitoring Committee for the Action Plan of cyber security at the NBU (National Security Authority of the Slovak Republic).

2.3.6. List of journals (published only in the Slovak language) edited/published by the institute and information on their indexing in WOS, SCOPUS, other database or no database, incl. impact factor and other metrics of journals in each year of the assessment period

- **Position of individual researchers in the international context**

2.3.7. List of invited/keynote presentations at international conferences, as documented by programme or invitation letter

Lecturer: RNDr. Ivan Kostič

Date: 17.06.2018

Event: EBT 2018 - 13th International Conference on Electron Beam Technologies, Varna, Bulgaria

Lecture name: Limitations of electron beam lithography in the research and industry.

Lecturer: RNDr. Ivan Kostič

Date: 15.10.2020

Event: International Conference on Nanomaterials, Nanofabrication and Nanocharacterization (NANOMACH), October 14-20, 2020 – online; Oludeniz, Fethiye/Mugla, Turkey

Lecture name: Key Factors of Electron Beam Lithography in Research and Manufacturing

Lecturer: Ing. Mgr. Robert Andok, PhD.

Date: 22.01.2018

Event: Invitation within the project SAS-MOST JRP2017/1, National Hsing Hua University, Hsinchu, Taiwan.

Lecture name: Electron-Beam Lithography in Micro- and Nanotechnology

Lecturer: Ing. Pavol Nemec

Date: 22.01.2018

Event: Invitation within the project SAS-MOST JRP2017/1, National Hsing Hua University, Hsinchu, Taiwan.

Lecture name: Nanostructured surfaces of metal oxides for gas sensors

Lecturer: Prof. Ing. Ivan Hotový, DrSc.

Event: Invitation within the project SAS-MOST JRP2017/1, National Hsing Hua University, Hsinchu, Taiwan.

Date: 20.04.2018

Lecture name: Technology and characterization of metal oxides and nitrides for microelectronics, gas sensors and microsystems.

Lecturer: Doc. Štefan Beňuš, PhD.

Date: 13.11.2019

Event: Conference Information Technologies: Applications and Theory. (Donovaly, Slovakia)

Lecture name: Word guessing game with a social robotic head.

Lecturer: Ing. Ivana Budinská, PhD.

Date: 11.10.2018

Event: V4 conference on AI, Brussels

Lecture name: Aritificial intelligence: Opportunities and challenges for research in Slovakia

Lecturer: Doc. Ing. František Čapkovič, CSc.

Lecture name: Petri nets in discrete-event and hybrid systems modelling, analysing, performance evaluation and control, Warsaw, Poland

Date: 15.3.2017

Conference: "Innovation in automation, robotics and measurement techniques"

Lecturer: Doc. Ing. František Čapkovič, CSc.

Lecture name: Petri nets in discrete-event and hybrid systems modelling, analysing, performance evaluation and control (Sofia, Bulgaria).

Date: 6.11.2017

Conference: "16th International Workshop on Generalized Nets"

2.3.8. List of researchers who served as members of the organising and/or programme committees

	Programme	Organising	Programme and organising
doc. Mgr. Štefan Beňuš, PhD.	0	0	1
Mgr. Martin Bobák, PhD.	2	0	0
Ing. Ivana Budinská, PhD.	3	0	0
doc. Ing. František Čapkovič, CSc.	13	0	0
doc. Ing. Karol Dobrovodský, PhD.	2	0	0
Ing. Radoslav Forgáč, PhD.	1	0	0
Ing. Štefan Havlík, DrSc.	2	0	0
doc. Ing. Ladislav Hluchý, PhD.	3	0	0
Ing. Jaroslav Hricko, PhD.	0	1	0
RNDr. Ivan Kostič	0	2	0
Ing. Štefan Krištofík, PhD.	1	0	0
Ing. Peter Malík, PhD.	2	0	0
Ing Giang Nguyen, PhD.	2	0	0
doc. Ing. Miloš Očkay, PhD.	1	1	0
Ing. Milan Rusko, PhD.	3	1	1
Mgr. Róbert Sabo, PhD.	0	1	0
Ing. Martin Šeleng, PhD.	1	0	0
Total	**36**	**6**	**2**

Other international memberships:

doc. Mgr. Štefan Beňuš, PhD.
Journal of Phonetics – member
Laboratory Phonology – Associate Editor
Phonology – member
Speech Communication – member
Topics in Linguistics - Associate Editor
Journal of Slavic Linguistics – reviewer
Journal of the International Phonetic Association – member

doc. Ing. František Čapkovič, CSc.
Advances in Applied Intelligence Technologies (AAIT) Book Series, IGI Global, USA – member
International Journal of Intelligent Information and Database Systems, Inder Science Publishers,
USA – member
Journal of Applied Systems Studies (JASS), Cambridge, UK – member
New Generation Computing, Ohmsha, Springer – member

doc. RNDr. Ladislav Halada, CSc.
Journal of the Applied Mathematics, Statistics and Informatics – member

doc. Ing. Ladislav Hluchý, PhD.

Acta Polytechnica Hungarica −member
The Journal of Computational Science, Elsevier − member

Ing. Martin Kenyeres, PhD.
Future Internet − Reviewer Board Member
Sensors − Reviewer Board Member
Algorithms − Reviewer Board Member
Electronics − Topic Editor Member

Ing. Ladislav Matay, PhD.
Sensors & Transducers − member

Ing. Giang Nguyen, PhD.
Engineering Letters (IAENG) − member

2.3.9. List of researchers who received an international scientific award

- ### Position of individual researchers in the national context
  ### 2.3.10. List of invited/keynote presentations at national conferences, as documented by programme or invitation letter

Lecturer: Ing. Milan Rusko, PhD.

Date: 7.11.2018

Event: Environmental quality assessment. 9th annual conference focused on quality living and working environment.

Lecture name: Influence of emotions on automatic speaker recognition

Lecturer: Doc. Štefan Beňuš, PhD.

Date: 13.11.2019

Event: Conference Information Technologies: Applications and Theory. (Donovaly, Slovakia)

Lecture name: Word guessing game with a social robotic head.

Lecturer: Ing. Marian Trnka

Date: 13.11.2019

Event: Environmental quality assessment (Stará Lesná).

Lecture name: Practical example of using a robotic head

Lecturer: Ing. Milan Rusko

Date: 13.11.2019

Podujatie: Environmental quality assessment (Stará Lesná)

Lecture name: Practical example of using a robotic head

Invited lectures at other important national and international events

Lecturer: Mgr. Róbert Sabo, PhD.

Date: 21.11.2019

Event: The unreal becomes real - a unique conference on artificial intelligence and robotics in practice. (Ždár nad Sázavou, Czech Republic)

Lecture name: Guess what I'm thinking about?

Lecturer: Ing. Ivana Budinská, PhD.

Date: 10.10.2019

Event: National conference UNESCO: "Ethical issues in sciences and technologies"

(Bratislava)

Lecture name: Autonomous vehicles and artificial intelligence

Lecturer: RNDr. Ivan Kostič

Event: Slovak Technical university in Bratislava, Department of Nuclear and Physical Engineering / Faculty of Electrical Engineering and Informatics

Lecture name: Nanotechnológie/Electron beam lithography in nanotechnology

Lecturer: Doc. Ing. Ladislav Hluchý, CSc.

Date: 2.2.2018

Event: Information day in CVTI

Lecture name: European Open Science Cloud

Lecturer: Doc. Ing. Ladislav Hluchý, CSc.

Date: 23.10.2018

Event: CGW Workshop´18 Krakow

Lecture name: From Scalable, Sementically-based Distributed Computing to Exascale Computing

Lecturer: Doc. Ing. Ladislav Hluchý, CSc.

Date: 11. – 12.5.2016

Event: Hotel HolidayInn, Bratislava, Slovakia; Startup projects, companies, conference participants of the TechSummit

Lecture name: Cloud as a service for nanotechnology (Science and research)

Lecturer: Ing. Milan Rusko, PhD.

Date: 26.5.2016

Event: Transcription of the human voice, Hotel DoubleTree by Hilton, Bratislava, Slovakia

Target group: Participants of the DATALAN IT FORUM conference, which was attended by more than 300 guests - fans of innovation not only from business, but also from education, healthcare or public administration.

Lecturer: Doc. Ing. Ladislav Hluchý, CSc.

Date: 6.10.2016

Topic: EGI vision for data and distributed computing in electronic infrastructures for open science, Penati klub, Bratislava, Slovakia

Target group: IWADAY 2016 conference participants, private companies, social practice

2.3.11. List of researchers who served as members of organising and programme committees of national conferences

	Programm	Organising	Programm and organising
Mgr. Martin Bobák, Phd.	1	0	0
Ing. Ivana Budinská, PhD.	1	0	0
doc. Ing. Karol Dobrovodský, PhD.	1	0	0
Ing. Štefan Havlík, DrSc.	1	0	0
doc. Ing. Ladislav Hluchý, PhD.	1	0	0
Ing. Jaroslav Hricko, PhD.	0	1	0
Ing. Peter Malík, PhD.	2	0	0
Ing. Milan Rusko, PhD.	1	0	0

2.3.12. List of researchers who received a national scientific award

Vladimír Britaňák – Premium for exceptional scientific publicity for single publication 2016 awarded by Literacy Fund in category of technical sciences and geosciences (related to the scientific monograph: V. Britanak, P. Yip and K. R. Rao. Discrete Cosine and Sine Transforms: General Properties, Fast Algorithms and Integer Approximations, Academic Press, Amsterdam, 2007, xiv, 349 p. ISBN 978-0-12-373624-6.

Vladimir Britaňák – Prize for scientific and technical literature 2018 awarded by Literary Fund (related to V. Britanak, K. R. Rao, Cosine-/Sine-Modulated Filter Banks: General Properties, Fast Algorithms and Integer Approximations, Springer International Publishing AG, Cham, Switzerland, 2018, xxvi, 645 p., ISBN 978-3-319-61078-8).

Vladimír Britaňák – Top Scientific Monograph Prize, 2018 awarded by SAS (related to V. Britanak, K. R. Rao, Cosine-/Sine-Modulated Filter Banks: General Properties, Fast Algorithms and Integer Approximations, Springer International Publishing AG, Cham, Switzerland, 2018, xxvi, 645 p., ISBN 978-3-319-61078-8).

Havlík Štefan
An important figure of the Slovak Academy of Sciences in 2019
Appraiser: SAS

František Čapkovič
An important figure of the Slovak Academy of Sciences in 2019
Appraiser: SAS

Pavol Hrkút
An important figure of the Slovak Academy of Sciences in 2019
Appraiser: SAS

Havlík Štefan
Gold medal of the Faculty of Mechanical Engineering
Awarded by: Faculty of Mechanical Engineering, Technical University of Košice
Year: 2017

Očkay, Miloš
Commemorative medal of the Rector of the Academy of the Armed Forces
Appraiser: Rector of the Academy of the Armed Forces Gen. M. R. Štefánika
Description: For excellent work results and representation of AOS in public

Kachman Ondrej
Professor Jan Hlavička Award
Appraiser: Seminar Program Committee for Doctoral Students in Computer Architecture and Diagnostics
Description: Award for the best work within the 2nd year of doctoral study. The award was given as part of a workshop for doctoral students in Computer Architecture and Diagnostics 2016

2.4. Research grants and other funding resources

(List type of project, title, grant number, duration, total funding and funding for the institute, responsible person in the institute and his/her status in the project, e.g. coordinator "C", work package leader "W", investigator "I". Add information on the projects which are interdisciplinary, and also on the joint projects with several participating SAS institutes)

- **International projects**
  - **2.4.1. List of major projects of Framework Programmes of the EU (which pilar), NATO, COST, etc.**

    H2020

    EGI Advanced Computing for EOSC (EGI-ACE)
    Grant number: H2020- 101017567
    Total funding/funding for the institute: 12 009 988 € / 178 848 €
    Duration: 1.1.2021 - 30.6.2023
    Responsible person - status: Ladislav Hluchý - I
    Interdisciplinary: yes

    Integrated technological and information platform for wildfire management (SILVANUS)
    Grant number: H2020- 101037247
    Total funding/funding for the institute: 24 186 845 € / 660 000 €
    Duration: 1.10.2021 - 31.3.2025
    Responsible person - status: Zoltán Balogh - W
    Interdisciplinary: yes

European Open Science Cloud - Expanding capacities by building capabilities (EOSC-Synergy)

Grant number: H2020-857647

Total funding/funding for the institute: 5 584 006 € / 225 000 €

Duration: 1.9.2019 - 28.2.2022

Responsible person - status: Ladislav Hluchý - W

Interdisciplinary: yes

Integrating and managing services for the European Open Science Cloud (EOSC-hub)

Grant number: H2020-777536

Total funding/funding for the institute: 33 205 686 € / 61 187 €

Duration: 1.1.2018 - 31.12.2020

Responsible person - status: Ladislav Hluchý - I

Interdisciplinary: yes

Security of Air Transport Infrastructure of Europe (SATIE)

Grant number: H2020-832969

Total funding/funding for the institute: 9 890 595 € / 182 500 €

Duration: 1.5.2019 - 30.4.2021

Responsible person - status: Milan Rusko - I

Interdisciplinary: yes

Designing and Enabling E-infrastructures for intensive Processing in a Hybrid DataCloud (DEEP-HybridDataCloud)

Grant number: H2020-777435

Total funding/funding for the institute: 2 988 750 € / 276 420 €

Duration: 1.11.2017 - 30.4.2020

Responsible person - status: Ladislav Hluchý - W

Interdisciplinary: yes

PROviding Computing solutions for ExaScale challengeS (PROCESS)

Grant number: H2020-777533

Total funding/funding for the institute: 2 972 250 € / 339 750€

Duration: 1.11.2017 - 30.10.2020

Responsible person - status: Ladislav Hluchý - W

Interdisciplinary: yes

Engaging the EGI Community towards an open science commons (EGI-Engage)

Grant number: H2020-654142

Total funding/funding for the institute: 8 650 001 € / 54 750€

Duration: 1.3.2015 - 31.8.2017

Responsible person - status: Ladislav Hluchý - W

Interdisciplinary: yes

Global ATM security management (GAMMA)
Grant number: FP7-SEC-2012-1
Total funding/funding for the institute: 14 511 482,92 / 126 240€
Duration: 1.9.2013 - 31.8.2017
Responsible person - status: Milan Rusko - I
Interdisciplinary: yes

Emergency responder data interoperability network (REDIRNET)
Grant number: FP7-607768
Total funding/funding for the institute: 4 327 171 € / 369 538 €
Duration: 1.3.2014 - 31.8.2016
Responsible person - status: Ladislav Hluchý - W
Interdisciplinary: yes

COnversational BRAins
Grant number: H2020- 859588
Total funding/funding for the institute: 4 009 608 € / 111 190 €
Duration: 1.2.2020 - 31.1.2024
Responsible person - status: Štefan Beňuš - I
Interdisciplinary: yes

<u>AFOSR (Air Force Office of Scientific Research, USA)</u>

Relationship between trust and entrainment in speech
Grant number: FA9550-15-1-0055, Air Force Office of Scientific Research
Total funding/funding for the institute: 300 000 € / 29 000 €
Duration: 25.6.2015 - 14.12.2017
Responsible person - status: Milan Rusko - I
Interdisciplinary: yes

<u>COST</u>

Fire in earth system: Science & society (FIRElinks)
Grant number: CA18135
Total funding/funding for the institute: 9158€
Duration: 1.6.2019 - 1.6.2023
Responsible person - status: Ján Glasa - participation in Managing Committee
Interdisciplinary: yes
Joint (Institute of Hydrology SAS)

Wider Impacts and Scenario Evaluation of Autonomous and Connected Transport (WISE-ACT)
Grant number: CA16222
Total funding/funding for the institute: 7176€

Duration: 1.3.2019 - 1.3.2022

Responsible person - status: Ján Glasa - participation in Managing Committee

Interdisciplinary: yes

Improving applicability of nature-inspired optimisation by joining theory and practice

Grant number: CA 15140

Total funding/funding for the institute: 9997€

Duration: 9.3.2016 - 8.3.2020

Responsible person - status: Ivana Budinská

Interdisciplinary: yes

Add information on your activities in international networks

II SAS is one of partners of **EGI - European Open Science Cloud Infrastructure** - A federation of shared computing, storage and data resources from national and intergovernmental resource providers that delivers sustainable, integrated and secure distributed computing services to European researchers and their international partners.

Institute of Informatics SAS is coordinating National Grid Infrastructure - SlovakGrid which is integrated in **European Grid Infrastructure (EGI)**. SlovakGrid consists of two data centers related to High Energy Physics user groups collaborating with European Organization for Nuclear Research (CERN) and cloud site at II SAS which is integrated in EGI Cloud Compute service in European Open Science Cloud (EOSC). II SAS provides operational support for Slovak HEP Grid sites and SlovakGrid Certification Authority which is accredited member of EUGridPMA (the international organisation to coordinate the trust fabric for e-Infrastructure for research in Europe) to facilitate the authentication of Slovak users and services within EGI and Worldwide LHC Computing Grid (WLCG).

II SAS is involved in the **eduDNS Project**. The proposed eduDNS will provide a universal, vendor-independent Dynamic DNS support for all GÉANT users. Service owners will log in the eduDNS portal via eduTEAMS, register meaningful, memorable hostnames (e.g. service-portal.vo.edudns.eu), assign the hostname to their servers then provide access to their services via the hostnames.

Website: https://www.vietsch-foundation.org/2022/01/20/edudns-project/

Ing. Štefan Havlík, DrSc. was a member of IFToMM Permanent Commission for the History of Mechanism and Machine Science (until 2020).

doc. Ing. Ladislav Hluchý, CSc. is a member of IRG, EGI-Council, EGI-PAC,

IEEE, European Academy of Sciences and Elsevier editorial board.

The COBRA meeting was organized by II SAS (whithin the H2020 Marie Skłodowska-Curie Action) in Bratislava. 15 PhD students in the consortium about their own projects and Show & Tell presentations from industry partners. COBRA's non-academic partners (Furhat, DAVI, Orange and ReadSpeaker) presented an overview of their activities in the field of conversational agents, artificial dialogue systems and text-to-speech synthesis. The main lecture blocks were as follows:

Bilateral accounts of language: Understanding dialogue, language use and social interaction, Martin Pickering (University of Edinburgh), Neurobiology of language, Peter Hagoort (Max Planck Institute), Biological sex and gender in Science, Susanne Fuchs (Humboldt University in Berlin), Neurolinguistics: Perception and Understanding of the Spoken Word, Kristof Strijkers (Aix-Marseille University). The week-long course was attended by 20 doctoral students, 10 experts from the COBRA consortium, and varied numbers of other participants.

- **National projects and their funding, incl. international projects with only national funding**

2.4.2. List of ERA-NET projects funded from SAS budget

Social Network of Machines (SOON), https://www.chistera.eu/projects/soon

2.4.3. List of projects of the Slovak Research and Development Agency (APVV)

Ontology representation for security of information systems
ID: APVV-19-0220
Duration: 1.7.2020 - 30.6.2024

Microelectromechanical sensors with radio frequency data transmission (FRMEMS)
ID: APVV-20-0042
Duration: 1.7.2021 - 30.6.2025

Broadband MEMS detector of terahertz radiation
ID: APVV-14-0613
Duration: 1.7.2015 - 30.6.2018

Automatic subtitling of audiovisual content for people with hearing impairments
ID: APVV-15-0517
Duration: 1.7.2016 - 1.7.2018

Bilateral: Nano-structuring by electron beam lithography for sensor application
ID: APVV SK-BG-2013-0030
Duration: 9.5.2016 - 31.12.2017

Intelligent cloud workflow management for dynamic metric- optimized application deployment (ICONTROL)
ID: APVV-20-0571
Duration: 1.7.2021 - 31.12.2023

Algorithm of collective intelligence: Interdisciplinary study of swarming behaviour in bats
ID: APVV-17-0116
Duration: 1.8.2018 - 31.7.2022

Analysis of environmental influences on power industry equipment by the methods of artificial intelligence and cloud computing (ARIEN)
ID: APVV-20-0548
Duration: 1.7.2021 - 31.12.2023

Urgent Computing for Exascale Data (U-COMP)
ID: APVV-17-0619
Duration: 1.8.2018 - 31.12.2020
IISAS as coordinator

Models of formation and spread of fire to increase safety of road tunnels
ID: APVV-15-0340
Duration: 1.7.2016 - 30.6.2019
IISAS as coordinator

MEMS structures based on load cell
ID: APVV-14-0076
Duration: 1.7.2015 - 30.6.2019

2.4.4. List of projects of the Scientific Grant Agency of the Slovak Academy of Sciences and the Ministry of Education, VEGA (for funding specify only total sum obtained from all VEGA grants in particular year)

Automatic speech processing technologies for support in crisis situations

Modelling and supervisory control of resource allocation systems in discrete-event systems using of Petri nets

Computer modelling of fire dynamics and effects

New methods and approaches for distributed scalable computing

Investigation of processes for the preparation of structures for nanometer scale devices

Electron beam lithography of nanometer structures for 2D materials on the base of metal sulfides

Nanostructured thin-film materials and innovative technologies for MEMS gas and heavy metal sensors

Nanostructured semiconductor materials and their integration into chemoresistive gas sensors and heavy metal sensors

Processing of sensor data via artificial intelligence methods

Modelling and control of complex discrete-event systems containing uncontrollable events and unobservable states

Automatic assessment of acute stress from speech

Efficient parallel realization of computer simulation of fires

Methods and algorithms for the semantic processing of Big Data in distributed computing environment

New architectures for increasing the reliability of digital cores and systems

Networked control of heterogeneous multi-agent systems

Cooperation of discrete-event and hybrid subsystems at intelligent control of complex systems

Modelling and computer simulation of fires and their consequences

Speaker verification as an add-on element of the air traffic management security

2.4.5. List of projects supported by EU Structural Funds

EWA - Early Warning of Alzheimer
ID: ITMS 313022V631
Duration: 1.9.2020 - 31.8.2023

FaceControl - Comprehensive communication device for innovative management of production and support processes in industry

ID: 313012P897

Duration: 1.3.2019 - 31.10.2020

MEMS - Micro-Electro-Mechanical Structures and sensors for application in automotive industry

ID: 313011X741

Duration: 1.1.2016 - 31.12.2019

IISAS as coordinator

Comment: In the evaluated period II SAS submitted 4 EU structural funds projects as a coordinator and 17 as an investigator.

2.4.6. List of other projects funded from national resources

Mobility

Semiconducting metal oxide - new materials for environmental sensors (SK-BG)

Cyber-physical system for smart tele-monitoring and tele-medicine for patients with COVID-19 (SK-BG)

Development of software tools for analysis and synthesis of schedulers for cloud computing (SK-UA)

JRP

An individual stimulating system with 3D nano-structure carbon/graphene based transducer and wireless heater for automated tiny insects behavior monitoring

2.4.7. List of projects funded from private funds

2.4.8. List of projects funded from other competitive funds

2.5. PhD studies and educational activities

2.5.1. List of accredited programmes of doctoral studies, period of validity, source of funding

During the former accreditation period we had 2 accredited doctoral studies

- Informatics - Faculty of Informatics and Information Technologies, Slovak Technical University in Bratislava (till 2020 – law change),
- Cybernetics - Faculty of Electrical Engineering and Informatics, Slovak Technical University in Bratislava (till 2020 – law change),

which were valid also during the period under consideration.

According to the changed legislation in Slovakia, IISAS signed general agreements about participation in executing doctoral studies in two study fields with 4 faculties at 3 universities:

- Informatics
  - Faculty of Informatics and Information Technologies, Slovak Technical University in Bratislava (since 2020 for unspecified time)
  - Faculty of Electrical Engineering and Informatics, Technical University in Košice (since 2020 for unspecified time)
  - Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava (since 2020 for unspecified time)
- Cybernetics
  - Faculty of Electrical Engineering and Informatics, Slovak Technical University in Bratislava (since 2020 for unspecified time).

We believe the increase of number of accredited doctoral studies will help to increase actual low number of PhD students at II SAS. The strategy of II SAS is – in accordance with the institute's actual Plan for Ensurement of Doctoral Studies Excellency - not to further widening the doctoral studies number but collaborate with the best Slovak faculties in informatics and cybernetics and maintain actual widely accepted good quality of PhD studies at II SAS (for more facts about issues related to doctoral studies and efforts to ensure their quality see Chapter 2.5.8).

The doctoral studies at II SAS are basically funded from Slovak Academy of Sciences. Currently we have also two PhD students that are funded by the COBRA project (H2020 Marie Skłodowska-Curie Action). PhD students involved in our projects are partially funded by these projects (APVV).

2.5.2. Summary table on doctoral studies (number of internal/external PhD students at the end of the year; number of foreign PhD students, number of students who successfully completed their theses during the year, number of PhD students who quit the programme during the year)

PhD study	2016			2017			2018			2019			2020			2021		
Number of potential PhD supervisors																		
PhD students	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	unumber, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted	number, end of year	defended thesis	students quitted
Internal total	5	1		3	2	1	1	1		1			6		1	6		
from which foreign citizens													2			2		
External	4	1		3	1		3			2			1	1		2		
Other supervised by the research employees of the institute																		

2.5.3. PhD carrier path – Information on the next career steps of the PhD graduates who received their degree from the institute

Executive Body (EB) and Scientific Board (SB) permanently watch and evaluate activities of young researchers, PhD students and postdocs. Heads of their departments are enquired for them in various occasions (annual scientific departments evaluation carried by SB, workshops of the institute's managerial and constitutional boards, annual Day of Institute, doctoral students evaluation, etc.). Young researchers are watched to support their ambitions for PhD study and postdocs and other researchers are watched to indicate if they meet criteria to increase of their scientific status. During the accreditation period, four young researchers began the PhD studies at the II SAS and 14 researchers obtained higher scientific degree (including 6 new PhD degrees). Five PhD students and postdocs applied for the Schwarz Fund scholarship (3 successfully). Note that the Executive Body

(EB) of II SAS is aware of the problem that our applicants (informaticians) are evaluated by scientometric criteria with chemists, physicists, material scientists, physicians, etc. and therefore are often unsuccessful. The EB supports involving of young researchers, PhD students and postdocs into project solving and to other types of responsibilities, but also supports team building and social activities and activities of the Young Scientists Board established at II SAS. Regarding the PhD graduates defending their scientific degree at II SAS (2016 - Š. Dlugolinský, J. Mojžiš; 2017 - M. Bobák, M. Kvassay, L. Valášek, 2018 - O. Kachman), II SAS created new postdoc positions at II SAS and tries to support them also financially (price for well-defended PhD thesis, salary modification to distinguish between PhD holders and researchers, other motivating tools). During the accreditation period II SAS created postdoc positions for all PhD graduates. In addition, we created 5 more postdoc positions for young researchers that graduated from other institutes or universities. Regarding to their next carrier steps we can add that the only one PhD graduate (O. Kachmann) left II SAS to work with a commercial IT company (R-DAS, a.s. – Research&Development Application Services, in microelectronics field).

2.5.4. Summary table on educational activities

Teaching	2016	2017	2018	2019	2020	2021
Lectures (hours/year)[*]	29	30	89	177	279	169
Practicum courses (hours/year)[*]	738	566	466	673	844	700
Supervised diploma and bachelor thesis (in total)	13	26	21	17	38	53
Members in PhD committees (in total)	2	6	3	2	0	3
Members in DrSc. committees (in total)	1	1	1	1	0	1
Members in university/faculty councils (in total)	4	4	4	4	5	5
Members in habilitation/inauguration committees (in total)	1	2	1	0	2	3

2.5.5. List of published university textbooks
2.5.6. Number of published academic course books
2.5.7. List of joint research laboratories/facilities with universities
2.5.8. Supplementary information and/or comments on doctoral studies and educational activities – focused on what changes have occurred since the last evaluation in 2016

In connection with the amendment to Act 131/2002 on Higher Education Institutions, §54, item 22, we have concluded two new agreements on participation in the implementation of the doctoral study program in informatics with the Faculty of Electrical Engineering and Informatics of the Technical University in Košice, and with the Faculty of Mathematics, Physics and Informatics of the Comenius University in Bratislava.

We have adopted the institute's Plan for Ensurement of Doctoral Studies Excellency that is in accordance with the SAS Plan for Ensurement of Doctoral Studies Excellency. We have two guarantees of our doctoral study, one for each of the two fields of doctoral study. During the period under consideration, one guarantee for the field of Informatics was changed. Dr. Dinh Viet Tran substituted dr Ladislav Hluchy. Both of our internal guarantees can guarantee the study for several future years. By increasing the qualifications of our researchers, we ensure to have new potential guarantees, the quality of our supervisors, and thus the sustainability of our doctoral studies.

We promoted our doctoral studies through the Keystone Academic Solutions, https://www.keystoneacademic.com/. We participated in the joint online promotion of PhD studies organized by P SAV in 2021. In addition, we published advertisements for vacant doctoral positions through the profesia.sk portal.

We evaluated the success of various forms of promotion of doctoral studies and then we decided to make more intensive use of the Euraxes portal https://euraxess.ec.europa.eu/, and intensify cooperation with universities. After a long period of not accepting any new PhD students, we were able to attract students after concluding a contract with more universities and faculties.

II SAS actively participated at an activity organised by SARIO (Slovak Agency for development of investment and business) with the name: "Internship for universities, solutions for companies 4.0" (https://sario.sk/sk/projekty-podujatia/prax-pre-univerzity-riesenia-pre-firmy-40). The goal was to prepare joint doctoral thesis topics with companies and thus respond to the current needs of the IT industry. We believe, it will help us to make our doctoral study more attractive for potential students.

We gained two new PhD students based on an international selection procedure as part of the COBRA project (H2020 Marie Skłodowska-Curie Actions). They are funded from the COBRA project.

Bratislava COBRA (H2020 Marie Skłodowska-Curie Actions project) meeting was organized by II SAS in Bratislava and was originally scheduled to take place in person in November 2020. Due to the COVID pandemic situation, it was postponed to March 14-18, 2021 and finally held online. It lasted five days and included intensive courses in the three basic areas of the project (neuroscience, understanding dialogue and neurolinguistics) and presentations on gender issues in science. It also included presentations by all 15 PhD students in the consortium about their own projects and Show & Tell presentations from industry partners. COBRA's non-academic partners (Furhat, DAVI, Orange and ReadSpeaker) presented an overview of their activities in the field of conversational agents, artificial dialogue systems and text-to-speech synthesis. The main lecture blocks were as follows: Bilateral accounts of language: Understanding dialogue, language use and social interaction, Martin Pickering (University of Edinburgh), Neurobiology of language, Peter Hagoort (Max Planck Institute), Biological sex and gender in Science, Susanne Fuchs (Humboldt University in Berlin), Neurolinguistics: Perception and Understanding of the Spoken Word, Kristof Strijkers (Aix-Marseille University). The week-long course was attended by 20 doctoral students, 10 experts from the COBRA consortium, and varied numbers of other participants.

2.6.   Societal impact

2.6.1. The most important case studies of the research with direct societal impact, max. 4 for institute with up to 50 average FTE researchers per year, 8 for institutes with 50 – 100 average FTE researchers per year and so on. Structure: Summary of the impact; Underpinning research; References to the research; Details of the impact; Sources to corroborate the impact. One page per one case study

1. Evaluation of the degree of environmental pollution for the electric power industry by artificial intelligence methods (feasibility study)

Authors: M. Kvassay, P. Krammer, R. Forgáč, M. Očkay and L. Hluchý
Main customer: VUJE Trnava, Slovakia

Summary of the impact:
Environmental pollution can lead to undesirable and dangerous flashovers on high voltage insulators under unsuitable meteo-rological conditions. In this contractual case study for VUJE (Research Institute for Nuclear Energy in Trnava, Slovakia), we investigated the relationships between the results of VUJE's field measurements of pollution deposits according to the standard STN 33 0405 (total amount of deposit S, soluble fraction of deposit Sr and specific electrical conductivity of its 0.2% solution g0.2) and data on air pollution monitored by the Slovak Hydro-Meteorological Institute SHMÚ (annual average concentrations of principal pollutants PM10, PM2.5, NO2, SO2, O3 for localities where field measurements of deposits took place). The aim

(and impact) of the case study was to assess the possibilities of replacing the complex and time-consuming field measurements according to STN 33 0405 by a simpler and more modern procedure based on the analysis of available data on air pollution by artificial intelligence and machine learning methods. The assignment required analyzing different approaches, designing one or more conceptual models, and also evaluating their advantages, disadvantages, and risks, including risk minimization options. The study concluded that the replacement of field measurements with a prediction model based on artificial intelligence will require the identification and collection of new types of input data, and subsequently led to the follow-up project APVV-20-0548 ARIEN, in which these data will be gradually identified and systematically collected.

Underpinning research:
The character of the case study permitted us to use both quantitative (regression) and qualitative (classification) machine learning approaches. Exploited regression methods included Multivariate Linear Regression, Isotonic Regression, Gaussian Processes, Multilayer Perceptron, Radial-Basis Function Regressor, Regression Tree M5P and Random Forest. Their training goal was to minimize Root Mean Squared Error (RMSE) and their results were validated by 40-Fold Cross Validation, relying on standard metrics like RMSE, Correlation Coefficient, Mean Absolute Error, and Relative Absolute Error. The classification approaches included Radial Basis Function and Multi-Layer Perceptron. Unsupervised methods, namely Kohonen's self-organising maps were also employed. Our research results have been provided to the contractor in a confidential document [1], with selected results subsequently submitted for publication in [2] (currently in press), while further conference papers and journal articles are still under preparation.

Details of the impact:
This case study helped to focus the efforts of VUJE a.s. on obtaining new sources of relevant data, such as the national database of environmental polluters (NEIS), records of the agricultural land use and satellite data. The first positive preliminary results from the exploration of these new sources of data were already published in [3]. (This work was already carried out as part of the newly funded national project APVV-20-0548 ARIEN, described elsewhere in this document, which was a natural outgrowth and continuation of this case study.

References to the research and sources corroborating the impact:

[1] Marcel Kvassay, Peter Krammer, Radoslav Forgáč, Miloš Očkay, Lenka Skovajsová, Ladislav Hluchý. Štúdia realizovateľnosti vhodných prístupov hodnotenia znečistenia prostredia v oblasti

elektroenergetiky. [Evaluation of the degree of environmental pollution for the electric power industry by artificial intelligence methods: feasibility study] 47 pages, 2021. (Confidential document for the contractor VUJE a.s.)

[2] Peter Krammer, Marcel Kvassay, Radoslav Forgáč, Miloš Očkay, Lenka Skovajsová, Ladislav Hluchý. Regression Analysis and Modeling of Local Environmental Pollution Levels for the Electric Power Industry Needs. Accepted for publication in Computing and Informatics, Vol. 41, 2022.

[3] Krammer, P.; Kvassay, M.; Mojžiš, J.; Kenyeres, M.; Očkay, M.; Hluchý, L.; Pavlov, L'.; Skurčák, L'. Using Satellite Imagery to Improve Local Pollution Models for High-Voltage Transmission Lines and Insulators. Future Internet 2022, 14, 99. https://doi.org/10.3390/fi14040099

2. Decision influence and proactive sale support in a chain of convenience stores

Authors: Ladislav Hluchý, Giang Nguyen, Martin Šeleng, Štefan Dlugolinský
Main customer: Slovnaft, a.s.

Summary of the impact:
In online shopping, prediction techniques and recommender systems are well established and are applied to affect the decision of customers. Methods based on techniques such as content-based filtering, collaborative filtering or hybrid approaches of these two are based on personal preferences. These methods are suitable for cases, when it is possible to identify customers and link them with transactions. In this case study for Slovnaft, a.s., we investigated long term transactional data collected from a sales network of brick-and-mortar stores, which lacked personalized information and for which the traditional online shopping approaches were not suitable. Our aim was to provide valuable insights into this otherwise unused data so that the company could make use of it in the process of innovating the business model of retail stores and cafeterias at their gas stations. Their vision was to benefit from transactional data by means of increasing the number of sold items per visit as well as to better understand and provide better services to their customers. The case study was conducted over transactional data of two independent pilot stores. Initial findings showed that more than 99% of the single-item shopping carts can be observed again as part of two-item carts. Analogically, 68% of the two-item carts were observed among three-item carts and 23% of the three-item carts among four-item carts. This led us to aim at recommending missing items in shopping carts at the cash desk according to the actual cart content, historical transactional data and purchase conditions; e.g., spatial and temporal features.

Underpinning research:
We designed a product recommendation model based on Naive Bayes enhanced by item co-occurrence approach using power sets of cart items and an a-priori principle. The model can also use taxonomy (hierarchy of product categories). The problem of data sparsity is tackled by additive smoothing of prior and joint probability estimations.

Details of the impact:
The model was evaluated on historical data using binary hit rate and cumulative item ranking metrics with promising results indicating that there is about 70% accuracy in recommending missing items in the cart from an inventory of 4,500 available products. The case study showed that it is possible to make use of historical transactional data with very limited personalized information by means of improving product model predictions even in situations, where relations among products are very sparse. The study showed that the product aggregations at various levels; i.e., taxonomy models; provide significantly better results than product models. We proposed models with adaptive design with the possibility to extend them by new features on demand. Our recommender system is designed as a scalable solution in order to accelerate data analytics in future stages. It fulfills the needs of the commercial company as a proactive sales support and decision influence tool by means of a help-desk reminder for their customers.

References to the research and sources corroborating the impact:

DLUGOLINSKÝ Štefan - NGUYEN, Giang - ŠELENG, Martin - HLUCHÝ, Ladislav: Decision influence and proactive sale support in a chain of convenience stores. IEEE International Conference on Intelligent Engineering Systems INES 2017, pp. 277-284, ISBN 978-1-4799-7677-5.

3. A method and smartphone application for self-testing and screening neurodegenerative diseases from voice (Project Early Warning of Alzheimer - EWA, ITMS2014+:313022V631)

Summary of the impact:
EWA is a project of European Structural Funds, with a well balanced choice of partners from Slovak Academy of Sciences, one university, Alzheimer Centre, Neurological Department of a hospital, and a private company. The aim is to develop a smartphone application for neurodegenerative diseases screening from voice. The recording is done by the user himself or herself at home and sent to the project's server for automatic evaluation. The result is sent back to the user's phone. Alzheimer's disease (AD) and Parkinson's disease (PD) are the most common neurodegenerative diseases. Non-invasive and potentially low-cost diagnostic approaches are gaining in importance, which would allow for screening large populations in a short time. In recent years, much attention has been paid to the effects of neurodegenerative diseases on speech and to revealing the characteristics that would indicate these diagnoses. From a review of 61 studies conducted in recent years [V. Boschi et.al.: Connected Speech in Neurodegenerative Language Disorders: A Review, in: Frontiers in Psychology, Vol.8, Article 269, 2017], it can be seen that approaches to diagnosing various diseases are somewhat related. Speech recordings were mostly obtained as a description of a picture, storytelling, or an interview. For some of the diagnoses also a prolonged vocalization of a wowel, uttering Pa-Ta-Ka syllables and other approaches are used to obtain recordings of the speech segment carrying cues of the disease. From the point of view of linguistics, we can talk about analysis at the phonetic-phonological, lexico-semantic, morpho-syntactic, syntactic pragmatic level. Aspects of speech that are affected by these disorders can be divided into articulatory, respiratory, phonation, and timing aspects. Such a division makes it possible to define measurable acoustic characteristics on the speech signal, which can characterize the given pathological changes of speech. The acoustic parameters used are therefore very diverse and the selection of those most suitable for a given purpose will also be the subject of research in the EWA project. Prosodic characteristics such as fundamental tone variability or others may also be considered.

Underpinning research / Details of the impact:
In the frame of EWA, a relatively huge open-access database is being built (and is nearly finished) which enables investigations into the problem of acoustic and linguistic cues of the AD and PD. Two applications were developed - one for collecting the data for research and development of the automatic diagnostic system, and one for the end-user to self-test himself or herself. In this way, viability of automatic detection, treatment and management of AD and PD from speech is being investigated.

References to the research and sources corroborating the impact:

Milan RUSKO, Marián TRNKA, Eugen Ružický, Petra Brandoburová, Matej Škorvánek, Alfréd Zimmermann: Acoustic characteristics of speech on automatic diagnostics of neurodegenerative diseases, In: Fyzikálne Faktory Prostredia (In Slovak), No1, year 2022, Vol. XII, pp. 41-47, ISSN 1338-3922.

4. Modeling and simulation of drinking water leaks during its distribution as well as the occurrence of toxicity (performed whitin the project *EOSC-Synergy:European Open Science Cloud - Expanding Capacities by building Capabilities (1.9.2019-31.10.2022) H2020-857647 [call H2020-INFRAEOSC-2018-2020], https://www.eosc-synergy.eu/)*

Summary of the impact:
Modeling of drinking water distribution with possible leaks is currently very important for water companies in Slovakia. Due to the fact that DHI s.r.o. cooperates with drinking water distributors,

we investigated this case study in collaboration with it. At the same time, we also solved the modeling of the occurrence of toxicity in drinking water with the possibility of finding the source of that toxicity.

Underpinning research:
This case study has a large impact on the quality of drinking water in Slovakia. II SAS in cooperation with DHI s.r.o. performed an analysis of existing modeling systems from private to open according to the needs of water distribution companies. Finally, the EPANET system proved to be a suitable model.

Details of the impact:
Given that around 20,000 simulations had to be performed at one time, it was necessary to analyze the appropriate computer infrastructure for effective simulation. As an environment, II SAS used the infrastructure of the EOSC-Synergy project with the provision of its own computing nodes. The study also addressed the problem of input data from measuring stations as well as the resulting visualization suitable for customers. A thematic cloud service for modeling and simulation of drinking water distribution was implemented. Training was provided for DHI s.r.o. employees, who will then train employees of water companies in 2022.
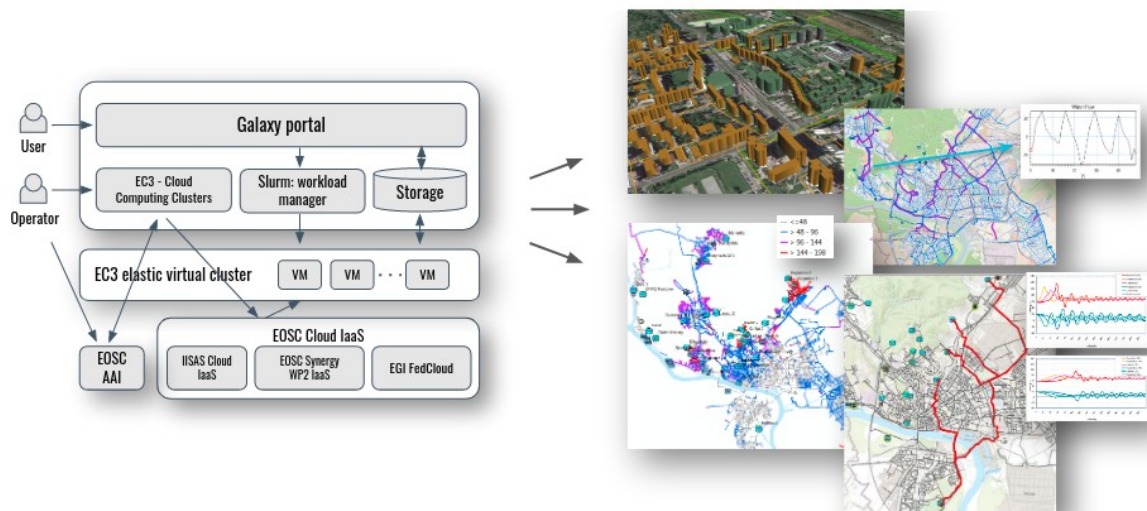
MSWSS (Modeling Service for Water Supply Systems) thematic service includes the following services listed in the EOSC marketplace:
- EC3 (Infrastructure Manager, CLUES), which is used for creation and management of computational backend based on elastic virtual cluster built from virtual worker nodes
- EOSC Cloud computing resources, used to build the elastic virtual cluster for MSWSS service
- EGI Check-in: used by EC3 to authenticate the MSWSS service to EOSC Cloud computing resources.

References to the research and sources corroborating the impact / Links:

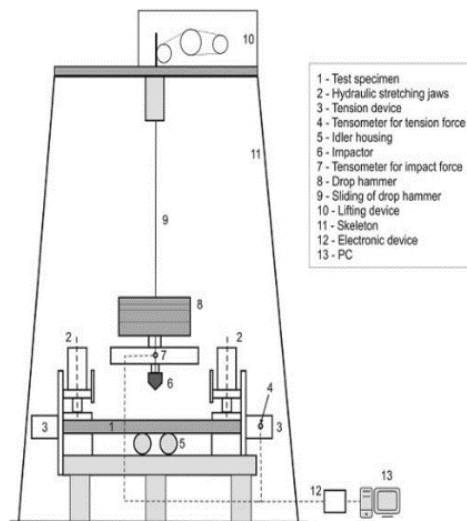EOSC marketplace URL
MSWSS service endpoint
MSWSS service User Guide
MSWSS service Acceptable Use Policy
MSWSS service Privacy Policy

5. Long-Exposure RGB Photography with a Fixed Stand for the Measurement of a Trajectory of a Dynamic Impact Device in Real Scale

Summary of the impact:
A new method of measuring the trajectory of a falling impact hammer under dynamic loading of conveyor belts and determination of their impact resistance was suggested. The main criterion was to design a method whose accuracy would be comparable to the existing solution using minimal

1 - Test specimen
2 - Hydraulic stretching jaws
3 - Tension device
4 - Tensometer for tension force
5 - Idler housing
6 - Impactor
7 - Tensometer for impact force
8 - Drop hammer
9 - Sliding of drop hammer
10 - Lifting device
11 - Skeleton
12 - Electronic device
13 - PC

(a)   (b)

costs. The subject of the research was conveyor belts and other rubber composites, for which it is necessary to determine their resistance to impact under dynamic loading. The elastic-plastic response follows the impact of a material with a certain weight and speed. The value that characterizes the course of such an impact is the impulse of the force of the impact, and its magnitude and direction are primarily influenced by the design of the trough. Thus, when the material, in particular the pieces of material, fall perpendicularly down onto the conveyor belt, this causes strong impact forces which lead to the belt being punctured. The aim is to determine the optimal height of fall on the slides and the optimal trajectory to ensure that the material falls on the center of the conveyor belt without damaging it. One of the main causes of damage to conveyor belts is a point impact load.

Underpinning research:
The proposed method is based on long exposure photography. The analysis and evaluation of the experiments showed a good agreement with the trajectory of the impact hammer provided by the new measuring method in comparison with the currently used and verified measuring device. The standard deviation identified in all experiments was 1 mm.

Details of the impact:
Advantages of the new method are: low costs; no special hardware required; measurement speed and constant measurement accuracy along the entire trajectory of the impacd device.
Disadvantages of the new method: the need for specific lighting conditions; data are obtained only after further processing; only turning points can be identified, not the whole course of the impact hammer movement; some turnovers cannot be evaluated due to overlap or blurring; not every experiment was successful.

References to the research and sources corroborating the impact:

KOVANIČ Ľudovít, AMBRIŠKO Ľubomír, MARASOVÁ Daniela, BLIŠŤAN Peter, KASANICKÝ Tomáš, CEHLÁR Michal. Long-exposure RGB photography with a fixed stand for the measurement of a trajectory of a dynamic impact device in real scale. In Sensors, 2021, vol. 21, no. 20, art. no. 6818. (2020: 3.576 - IF, Q1 - JCR, 0.636 - SJR, Q2 - SJR). ISSN 1424-8220. https://doi.org/10.3390/s21206818

At this place we would like to state that for technical sciences, use-cases are more typical than case studies. We have therefore selected three use-cases which were the outputs of H2020 projects:

6. Exascale learning on medical image data supported by PROCESS's technology (IISAS was the leader of WP4 and WP7)

This use case demonstrates how digital medicine and artificial intelligence (AI) are starting to change clinical practice. Digital histopathology (automated analysis of biopsies or surgical tissues) helps diagnosis process to be faster and more accurate by capturing medical images in high-resolution (>100,000x100,000 pixels) and processing them by AI techniques, such as machine learning (ML) and deep learning (DL), in order to identify Regions of Interest (ROI) for further analysis. This type of application requires advanced forms of exascale computing with GPU acceleration and ML/DL tools like Tensorflow, Caffe, Theano, Keras, Scikit-learn, PyTorch, etc., as well as truly large data repositories: already in 2010, mammography data in the US alone amounted to 3 PetaBytes, and in 2011, 30% of world storage was estimated to be medical imaging.
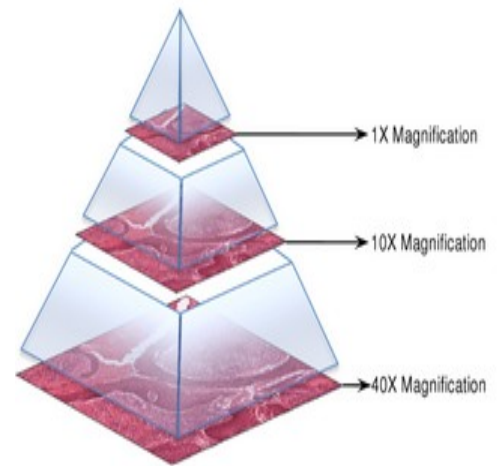
7. LOFAR & Square Kilometer Array (Netherlands eScience Center), supported by PROCESS's technology, II SAS leader of WP4 and WP7

LOFAR (LOw Frequency ARray) radio telescope – is a "distributed software telescope" consisting of ~88.000 antennas in ~51 stations scattered over Europe. It produces up to 1.6 TB/s of raw data, processed in real time to combine the signals of multiple antennas (correlation). This results in up to 35 TB/h of intermediate data (visibilities) which is stored for further analysis. Despite LOFAR's high potential, its end users (astronomers) find it difficult to make use of the collected information due to its size, the difficulty of retrieving it (up to 10 days for a request), and tough processing requirements (several packages and procedures are needed). As a result, LOFAR LTA remains an underused resource. This use case is expected to help unlock the scientific potential of LOFAR LTA and increase its scientific output by providing additional processing capacity in a form that makes astronomy workflows more efficient and enables astronomers to focus on science rather than on pre-processing data.

8. Ancillary pricing for airline revenue management (Lufthansa Systems GmbH & Co. KG), supported by PROCESS's technology, II SAS leader of WP4 and WP7

In the airline industry, "ancillary services" include everything in addition to the actual air transportation such as extra seats, baggage, hotel bookings and many more. Ancillaries are increasingly becoming a large source of revenue for airlines. In order to utilize their full potential, airlines need to shift from a pre-determined pricing to an advanced method offering customers a more passenger-centric experience, with the most useful offers coming at the right time and price according to the customer's interest. Traditional revenue management fails to address the complexity of dynamic ancillary pricing for several reasons:

- **Data volume**: there are millions of different transactions and price decisions every day.
- **Complexity**: numerous factors are influencing the willingness to pay of airline customers.
- **Speed**: a pricing response is required in real-time, i.e. milliseconds.

In this use case we tackle these challenges by employing advanced forms of AI (Machine and Deep Learning) within a hybrid Lambda architecture in order to analyse the current ancillary sales, find hidden sales patterns, and then produce a machine or deep learning model capable of generating dynamically optimized price quotations for selectable ancillaries.

Lambda architecture combining different machine and deep learning methods for Lufthansa GmbH:
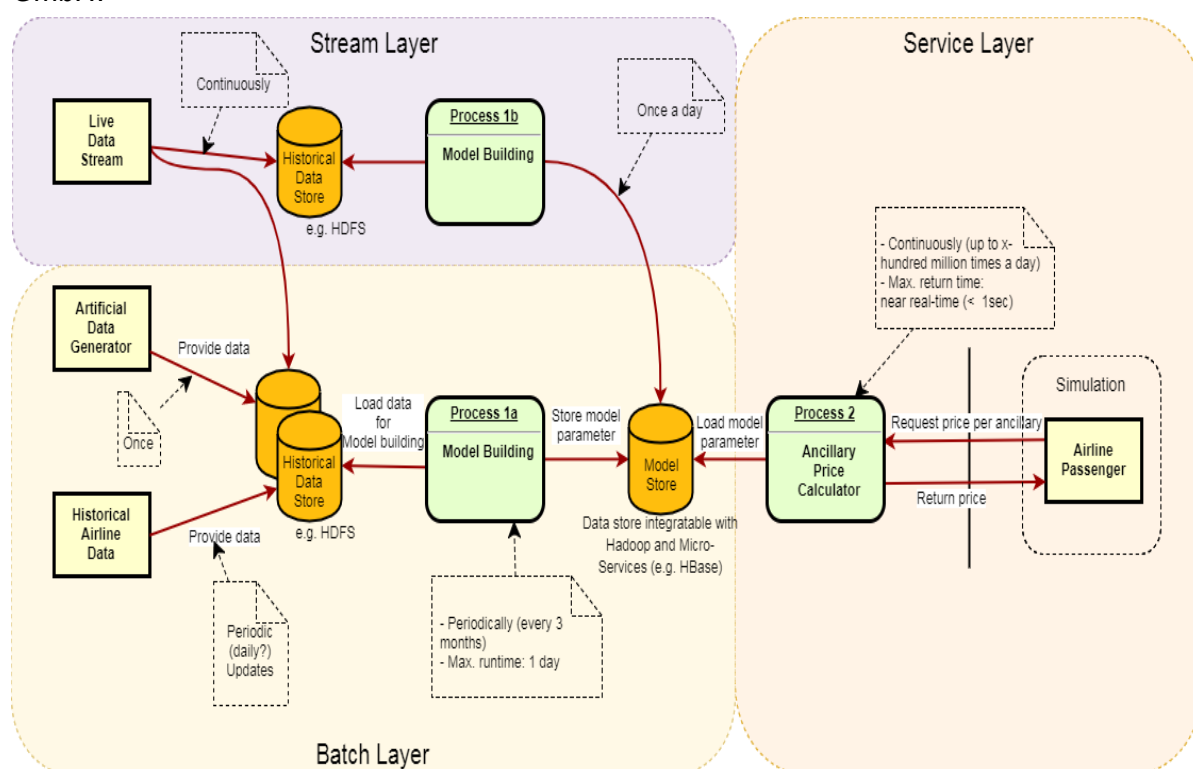
2.6.2. List of the most important studies and/or other activities commissioned for the decision-making authorities, the government and NGOs, international and foreign institutes (title, name of institution, contract value, purpose (max 20 words))

Title: Evaluation of the degree of environmental pollution for the electric power industry by artificial intelligence methods: feasibility study
Industrial partner: VUJE, a.s. Trnava

Contract value: 13 000€
Country of partner: Slovak Republic
Purpose: II SAS predicted the possibility the environmental impact on insulators in the distribution of electricity on the basis of artificial intelligence methods.

Title: Service Level Agreement for General Prosecutor's Office
Industrial partner: General Prosecutor's Office od the Slovak Republic
Contract value: 250 000€
Purpose: According to the Service Level Agreement, II SAS provides remote service and maintenance of the Voice input system (developed by II SAS) of the PATRICIA information system of the General Prosecutor's Office, used by all prosecutors in Slovakia.

Title: Microelectronic technologies
National partner: Slovak University of Technology in Bratislava
Vazovova 5, 812 43 Bratislava 1, Slovak Republic
Project: The impact of the project CENTE ITMS – 26240120011 of the EC structural funds.
Contract value: 15 716,34 €
Country of partner: Slovak Republic
Purpose: We have implemented microelectronic technologies for national customer – photomask fabrication.

Title: Microelectronic technologies
National partner: Institute of Electrical Engineering SAS, Dúbravská cesta 9, 841 04 Bratislava, Slovak Republic
Project: The impact of the project CENTE ITMS – 26240120011 of the EC structural funds.
Contract value: 8 750,00 €
Country of partner: Slovak Republic
Purpose: We have implemented microelectronic technologies for national customer – photomask fabrication.

Title: Microelectronic technologies
National partner: Comenius University in Bratislava, Mlynska dolina, Ilkovicova ulica 6, 842 15 Bratislava 4 Slovak Republic
Contract value: 3 454,00 €
Country of partner: Slovak Republic
Purpose: We have implemented microelectronic technologies for national customer – scanning electron microscopy of special customer samples.

2.6.3. List of contracts and research projects with industrial and other commercial partners, incl. revenues (study title, name of institution, contract value, country of partner, purpose (max 20 words))

Title: Voice output for information tables
Industrial partner: ELEN, s.r.o., Prešov
Contract value: 1200€
Purpose: A special version of high-quality DNN speech synthesizer, with small computational and memory requirements, was developed for the acoustic output of the bus time-table information systems designed by ELEN s.r.o and implemented at Spišská Nová Ves railway station.

Title: Speech-recognition based keyword spotting system and service of automatic Language models generation for READMIO smartphone-application in Slovak and Czech.
Industrial partner: READMIO, s.r.o., V Údolí 175, 251 01 Březí
Country of partner: Czech republic
Contract value: 13 000€

Purpose: An interactive phone-assisted reading application READMIO was developed in cooperation with Readmio s.r.o. The application listens to the parent reading the fairy tale for children and automatically plays illustrative sounds at the appropriate moments.

Title: Development of robotics designed for nuclear energy
Industrial partner: ZŤS Výskumno-vývojový ústav Košice a.s.
Contract value: 13 000€
Country of partner: Slovakia
Purpose: Providing co-operation in the development of Special Robotics for nuclear energy and for this purpose more effective communication and joint action using theoretical knowledge and practical experience.

Title: The system for online localization, tracking, and fire process control
Industrial partner: EVPÚ a.s., Trenčianska 19, 018 51 Nová Dubnica, SR
Contract value: 250 000 EUR
Country of partner: Slovakia
Purpose: The system for online localization, tracking, and fire process control has been worked out.

Title: Software prototype for facial image authentication based on image steganography.
Industrial partner: zákazníci spoločnosti APIS spol. s r.o.
Contract value: 80 564,79 €

Country of partner: Slovakia
Funding: Structural funds EU

Country of partner: Slovakia

Purpose: A model of image steganography and the creation of a software prototype to verify the authenticity of images was designed.

Title: Research of technologies for enterprise port management in heterogeneous distributed systems in real time with support of multimodal communication
Industrial partner: Ardaco a.s., Polianky 3327/5, 841 01 Bratislava
Contract value: 101 450 €

Country of partner: Slovakia
Funding: Structural funds EU

Country of partner: Slovakia

Purpose: Scientific and development activities in the field of informatics, information technology, robotics and artificial intelligence.

Title: Microelectronic technologies
Foreign industrial partner: IMS Nanofabrication, Rennweg 83, 2345 Brunn am Gebirge, Vienna, Austria
Project: The impact of the project CENTE ITMS – 26240120011 of the EC structural funds.
Contract value: 40 560,00 €
Country of partner: Austria
Purpose: We have implemented microelectronic technologies for foreign customer (preparation of electron beam resist thin layers for electron-based multi-beam technology).

Title: Microelectronic technologies
Foreign industrial partner: AMG Technology Ltd., Microelectronica Industrial Zone, 2140 Botevgrad, Bulgaria
Project: The impact of the project CENTE ITMS – 26240120011 of the EC structural funds.
Contract value: 9 815,00 €
Country of partner: Bulgaria
Purpose: We have implemented microelectronic technologies for foreign customer – photomask fabrication.
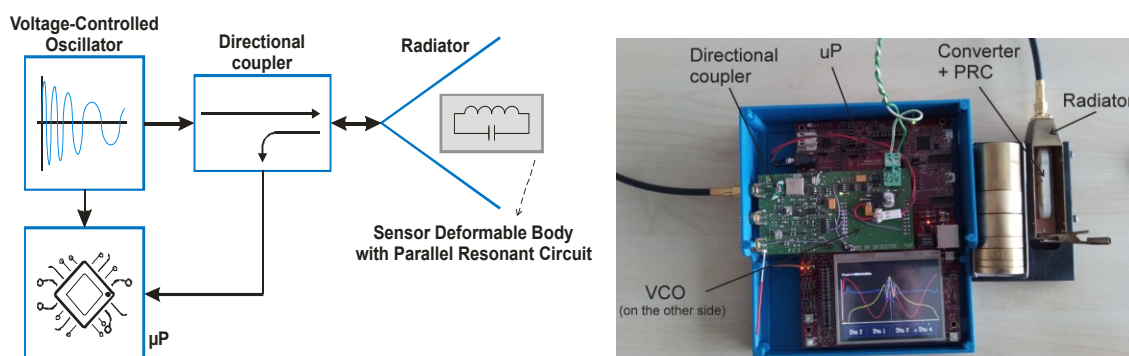
Title: Computer simulation and visualization of fires for improvement of road tunnel safety
Industrial partners: National Motorway Company, Inc. (main customer), PPA INZINIERING, Ltd. (secondary customer)
Contract value: 149 999 €
Funding: APVV Agency
Country of partner: UNIZA, Slovakia
Purpose: Full-scale fire experiments and computer simulations for two motorway tunnels were carried out contributing to increase of tunnel fire safety.

2.6.4.1 List of intangible fixed assets (internally registered IP (confidential know-how), patent applications, patents granted, trademarks registered) denoting background IPR

Patent application 1: Method and device for non-contact sensing of mechanical quantities.

HARŤANSKÝ, René - HALGOŠ, Ján - HRICKO, Jaroslav - RAFAJ, Michal. Method and device for non-contact sensing of mechanical quantities. Utility model no. 8653. Document type: Y1. Application Number: 185-2018. Application Date: 26.10.2018. Application Publication Date: 5.8.2019. Bulletin ÚPV SR č.: 01/2020. Publication of Registration Date: 07.01.2020. Bulletin ÚPV SR č. 09/2018. Date of registration and making available to the public: 21.11.2019. International Patent Classification (2020.01): G01L 1/00, G01H 13/00. Applicant(s) or Proprietor(s): Slovak University of Technology in Bratislava, Vazovova 2757/5, Bratislava-Staré Mesto, SK; Institute of Informatics Slovak Academy of Sciences, Dúbravská cesta 5810/9, 845 07 Bratislava, SK; RMC s.r.o., Trenčianska ul. 863/66, Nová Dubnica, SK. Banská Bystrica : Department of Industrial Property of the Slovak republic, 2019. 5 p.

https://wbr.indprop.gov.sk/WebRegistre/Patent/Detail/121-2018
https://wbr.indprop.gov.sk/WebRegistre/UzitkovyVzor/Detail/185-2018

Flow chart of the sensor (left);
realization of a laboratory prototype of a one-component sensor of force (right).

This utility model was developed by members of the Institute of Informatics in cooperation with the Faculty of Electrical Engineering and Information Technology and the company RMC a.s. The main contribution of this work is in developing of a new method for wireless sensing of mechanical quantities that utilizes changes in the electromagnetic field as a primary information canal for transmitting information about measured quantity. Such work has been verified on the technology readiness level TRL 4, with intersection to TRL 5 (where the technology of manufacturing of the industrial size sensor deformable body is still being developed and improved). Compared with the common industrial wireless sensors, there is no converter to wireless technology (like Bluetooth, ZigBee, Wi-Fi, etc.). Since the information about sensing quantity is saved/transmitted through the frequency response of the electromagnetic field, the whole sensor is more resistant to the jamming compared with the sensors, where such information is transmitted through voltage or current. The frequency, as the main quantity for transmission of the measured information, provides the advantage of high accuracy of measurement (for instance, initial laboratory tests achieved a resolution of approximately 185kHz for 1mN or 1g). Another advantage of such a sensing method is high resistance to change in temperature (compared to strain gauge sensors integrated into the load cells).

The principle of non-contact sensing of mechanical quantities can be described according to a flow chart. In the voltage-controlled oscillator (VCO) a high-frequency voltage is generated which passes directly through the directional coupler onto the radiator terminals. It could be a stripline or

a TEMCell. The radiator will generate an electromagnetic field. In the electromagnetic field, a sensor deformable body (Convertor) with a parallel resonant circuit (PRC) is placed. Due to the mechanical quantity acting on this mechanical unit with the PRC also the distance of the capacitor plates will be changed which causes the change of its capacity and thus change in the resonant frequency of the PRC. The resonant circuit will affect the electromagnetic field created by the radiator. The most significant influence occurs at frequencies close to the resonant frequency of the resonant circuit, causing exhausting of energy of the EMF and its subsequent return (reflection) The returning wave advances back to the radiator and from there, in the form of a high-frequency voltage, it passes through a directional coupler into the control electronics. By comparing the reflected wave and the control voltage VCO, the control electronics will calculate the resonant frequency of the PRC, and by that also the value of the non-electrical physical quantity affecting the mechanical component. The microcomputer can measure the frequency of the reflected wave from the transfer characteristic of the VCO, or it can be measured directly by means of the sum of transitions of the transmitted signal with zero value for a unit of time.

Considering the unique sensing principle, high accuracy and high resistance to jamming, such method and device can be used in a wide range of applications. For instance, in the industry, there are possible applications of various sensors of the mechanical quantities such as force, torque, pressure, and small displacement. As a suitable application compact compliant structures can be mentioned that achieve very high positioning accuracy, but because their bodies are regularly from one piece of material, there is no possibility to measure small displacements inside the mechanism. Another possible application in the automotive industry is the measurement of pressure in tires. Thanks to wireless transmission of the measured quantity it is possible to integrate the deformable body of a sensor into a tire, and the radiator with evaluation electronic will be located on the car frame. A similar application is a measurement of the blood pressure in the human body, where the deformable-body of the sensor should be fabricated from a biocompatible material.

Patent application 2: Transport of powder materials for their modification in plasma by vibrational method.

HRKÚT, Pavol - ČAPLOVIČ, Igor - NOVÁK, Igor - GAŽI, Štefan. Equipment for uniform surface treatment of bulk materials in plasma : Utility model no. 288857. Application Number: 50071-2018. Application Date: 18.12. 2018. Bulletin ÚPV SR č.: 07/2020. Bulletin ÚPV SR č.: 09/2021. Date of registration and making available to the public: 12.4. 2021. Document type: B6. Int. Cl.(2021.01): B01J 19/00, H01J 37/00, H05H 1/00, B65G 33/00. Proprietor(s): Institute of Informatics Slovak Academy of Sciences, Dúbravská cesta 5810/9, 845 07 Bratislava, SK; Institute of Polymers II SAS, Bratislava; Institute of Electrical Engineering II SAS, Bratislava. : Department of Industrial Property of the Slovak republic, No. 288857 B6, 6 p.
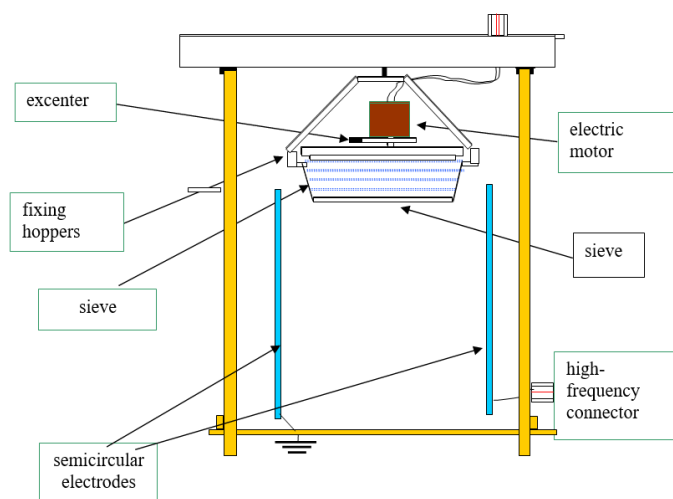
The invention relates to a method of transporting and dosing powdered materials into a plasma volume, wherein the surface of these particles is modified by bombarding plasma ions. The powder materials have been commonly processed in an RF discharge so that in a cylindrical chamber which rotates, the particles are poured from its upper part to its lower part. Such method, however, does not guarantee uniform contact of all particles of material with the particles of electric discharge-plasma and thus it does not allow their homogeneous modification. The new process

described here guarantees a continuous transport of the powder material during the burning of the plasma as well as a regulated and even distribution of the powder particles in the plasma volume. The method of distribution of powder material is characterized in that we pour the powder material into a conical container, the bottom of which is provided with a suitable sieve. We close the container with a lid, which is equipped with a motor with an eccentric wheel, and we hang the whole system on the upper flange of the working chamber. By connecting the motor to an electrical source, the eccentric wheel generates dosing pulses to the strainer, through which the powder regularly falls. By switching on the electric discharge, Ar ions are formed in the vacuum working chamber between the electrodes located on the walls of the chamber, which bombard the surface of the powder particles, while the amount of dosed material can be regulated by the magnitude of the voltage applied to the motor.

2.6.4.2 List of licences sold abroad and in Slovakia, incl. revenues (background IPR identification, name of institution, contract value, country of partner, purpose (max 20 words))

2.6.5. Summary of relevant activities, max. 300 words (describe the pipeline of valorization in terms of Number of disclosure, Number of registered IP internally, number of CCR/LIC contracts and their respective summary values, the support you are receiving in specific points internally at the institute, at SAS, externally – also the limitations and drawbacks.

Name of institution: Ministry of Justice of the Slovak Republic
Purpose: As part of the preparation of a new contract with the Ministry of Justice of the Slovak Republic, the ministry was granted a temporary license to use the new generation of the Automatic Transcription of Dictate (APD) system, based on DNN. According to the ministry, the new version was actively used by at least 500 judges in 2020 and 2021.

Name of the institution: EVPU a.s. Nová Dubnica
Purpose: The system for online localization tracking and fire process control has been worked out. The Fire Process Control consists of several problem oriented image processing modules aimed to reveal and recognize characteristic patterns and to track the motion of the selected object. The system is working autonomously in the Search mode trying to offer recognized objects for tracking. In case of unsuccessful recognition, the operator can point out an object on the screen to start the Track mode. A calculation of the Pearson's Cross Correlation Coefficient between the pattern and the corresponding area of interest under the pattern has been decomposed and efficiently implemented in the Fast Fourier Transform domain in order to localize the tracked object repeatedly in real time. Contract value: 250 000 EUR.

2.7. Popularisation of Science (outreach activities)

2.7.1. List of the most important popularisation activities, max. 20 items

- The Institute organizes every year "Seminars of the Institute of Informatics of the Slovak Academy of Sciences", where the latest results of scientific work of domestic as well as of foreign experts are presented.
- As part of streamlining and making communication to the public more attractive, a new website of the Institute of Informatics of the Slovak Academy of Sciences was created in 2016. A new design of this webpage is planned for the year 2023.
- A short documentary film about the Institute of Informatics was created, which aims to communicate in an engaging way about the activities of our institution and present a modern and accessible way of research in the field of ICT at the SAS. The video was published on the Youtube channel at the end of 2016.
- Important popularization activities include participation in the international ICT Proposers Day event, which was attended by more than 3,000 participants from all over Europe.

- In 2016, we organized a celebration of the 60th anniversary of the institute. Approximately 200 hosts, former and current employees, representatives of partners from the university and the business sector, as well as representatives of the SAS were invited for the celebration.
- Very important popularization activity every year is the Extrapolation event, which we organized in cooperation with all academic and university workplaces dealing with information in Bratislava and some other regions in Slovakia. More information at http://www.extrapolacie.sk/
- In order to inform the professional public about the activities of the II SAS, printed promotional materials in English and Slovak were created in a concise and engaging way.
- In the year 2018 in cooperation with the Academy of Sciences of the Czech Republik, we organized a two-day seminar Robots on the Danube as part of Extrapolacie 2018.
- In 2017 and 2018, we participated in the organization of the nationwide event Girl's Day, which motivates girls to study computer science.
- In 2019 - performance at the Evening of the Curious events as an accompanying event to the Researchers' Night, where doc. Štefan Beňuš presented his research about entrainment in speech in human-machine interaction.
- On 23.2.2020 Night pyramid on Slovak Radio.
  https://www.rtvs.sk/radio/archiv/11436/1284604 doc. Ing. Ladislav Hluchý, CSc., Electrical engineer and computer scientist, creator of several patents.
- On 25.2.2020 „Morning on FM" on Slovak Radio: Interview on speech synthesis and recognition - R. Sabo
- On 5.3. 2020 Science in Theater IV. - lecturer Š. Beňuš
- March 24, 2020 the talk at Science Slam: „What does a linguist do at the Institute of Informatics?" R. Sabo participated, and won the Audience Award as the best speaker of the Science Slam 2020.
- On 7.5. 2020 talk at Scientific Confectionery - Autonomous Vehicles, I. Budinská
- II SAS participated in the Summer School of Young Scientists 2021, which took place in 2020 and 2021. Within the summer school, high school students tried the research in the laboratory of speech synthesis and analysis at II SAS.
- Hosting a visit from from the Catholic University of Leuven, Belgium, at II SAS. Program available at https://www.ui.sav.sk/w/2019/02/06/leuven-be/

2.7.2. Table of outreach activities according to institute annual reports

Outreach activities	2016	2017	2018	2019	2020	2021	total
Articles in press media/internet popularising results of science, in particular those achieved by the Organization	22	16	12	0	9	8	67
Appearances in telecommunication media popularising results of science, in particular those achieved by the Organization	7	5	4	0	5	1	22
Public popularisation lectures	18	23	23	31	5	6	106

2.8. Background and management. Infrastructure and human resources, incl. support and incentives for young researchers

2.8.1. Summary table of personnel

2.8.1.1. Professional qualification structure (as of 31 December 2021)

	Degree/rank				Research position		
	DrSc./DSc	CSc./PhD.	professor	docent/ assoc. prof.	I.	II.a.	II.b.
Male	3	33	3	4	4	14	18
Female	0	4	0	0	0	2	2

I. – director of research with a degree of doctor of science/DrSc.; II.a – Senior researcher; II.b – PhD holder/Postdoc

2.8.1.2. Age and gender structure of researchers (as of 31 December 2021)

Age structure of researchers	< 31		31-35		36-40		41-45		46-50		51-55		56-60		61-65		> 65	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Male	1.0	1.0	4.0	3.4	7.0	7.0	10.0	8.2	7.0	6.6	2.0	2.0	3.0	3.0	5.0	3.7	10.0	9.0
Female	1.0	1.0	0.0	0.0	0.0	0.0	1.0	1.0	2.0	1.3	2.0	2.0	1.0	0.7	0.0	0.0	2.0	1.6

A – number; B – FTE

2.8.2. Postdoctoral fellowships (list of positions with holder name, starting date, duration. Add brief information about each fellow's career path before and after receiving PhD degree, etc.)

2.8.2.1. MoRePro and SASPRO fellowships

II SAS registered several interested applicants for SASPRO and MoRePro. We selected two of them with whom we cooperated in submitting their applications. However, none of the candidates received support. We believe that it is a problem that our candidates (informaticians) were evaluated in competition with other candidates from other scientific disciplines (chemistry, physics, etc.) as candidates with lower scientometric indicators. In one applicant's case, there was an administrative failure in submitting the application; the applicant appealed but his arguments were not accepted.

2.8.2.2. Stefan Schwarz fellowships

Ing. Martin Keneyres, PhD. (awarded in 2019)

Mgr. Martin Bobák, PhD. (awarded in 2020)

Mgr. Marek Košta, PhD. (awarded in 2018, not financially supported because he left II SAS and started to work for a private IT company)

Several other applicants did not received support. We consider as problem that our candidates (informaticians) are evaluated in competition with other candidates from other scientific disciplines (chemistry, physics, etc.) as candidates with lower scientometric indicators.

2.8.2.3. Postdoctoral positions from other resources (specify)

Mr. Dr. Kedar Nath Das from the National Institute of Technology Silchar, Assam, India was at the Institute as a visiting researcher funded from SAIA under the National Scholarship Program.

2.8.3. Important research infrastructure introduced during the evaluation period with the information about the sources of funding *(max. 2 pages)*

We feel a great lack of unsystematic support for science and research. Although II SAS has made great efforts to obtain resources for the renewal of research infrastructure (cloud computing, electron lithography etc.), unfortunately none of the projects that successfully passed the evaluation were funded for various reasons, e.g. due to cancellation of long-term strategic research (DSV) projects in 2020.

The period 2016-2021 was affected by a lack of investment costs for research and development. Grant agencies, with the exception of the Research Agency (ESIF funds), do not allow the spending of investment costs. In addition, the limit for investment costs is 1700 EUR in case of tangible goods and 2400 EUR in case of software. The Ministry of Education, Science, Research and Sports of the Slovak Republic and the Research Agency irregularly announced calls, subsequently several calls were cancelled (2017, 2019, 2021 - info in Slovak on the Ministry's website), despite the fact that our researchers invested a lot of time and energy in preparing administratively demanding funding grants. These facts made it difficult for us to maintain the existing infrastructure, even upgrade the existing infrastructure.

Nevertheless, the Institute managed to raise funds and purchased equipment for maskless lithography worth 80,000 EUR from its own resources. Currently this equipment is part of the Department of Sensor Information Systems and Technologies.

As part of the national project Slovak Infrastructure for High-Performance Computing implemented in 2012-2014 in 2021, an upgrade was carried out also with regard to II SAS's commitments in the H2020 projects and now also in the HE. These are 3 GPU nodes for the II SAS cloud, which is connected to the Egi.eu federated cloud longer time representing the infrastructure as a service. The specification is here:

1 GPU node with 2x 24-core 2.4GHz CPU, 512GB RAM, 2TB disk, Infiniband and 3x NVIDIA A100 80GB HBM2

2 GPU nodes with 2x 24-core 2.4GHz CPU, 512GB RAM, 2TB disk, Infiniband and 4x NVIDIA A100 40GB HBM2

The total investment costs amounted to 250,000 EUR which is not sufficient for the current requirements of users in Slovakia and also for the cooperation of the Egi.eu infrastructure. For this reason, II SAS is preparing a project proposal (started at the end of 2020) from the structural funds for the Slovak cloud for open science (SKOSC) with investment requirements of around 24 mil. EUR.

2.9. Supplementary information and/or comments on all items 2.1 – 2.8 (max. 2 pages in total for the whole section)

Management Board (since 1.1.2022):
Ing. Mgr. Robert Andok, PhD. (president)
doc. Ing. Ladislav Hluchý, PhD.
Ing. Zoltán Balogh, PhD.
Mgr. Róbert Sabo, PhD.
Ing. Marta Mášiková Paulinová

An Executive Board of the director is established at II SAS and meets every two weeks or as required. Other advisory bodies include the Constitutional Council, which consists of the heads of departments and sections, and the Management Board, which also includes all project leaders.
The management of the institute supports cooperation between the departments and supervises the integration of research.

<u>At the department level, the following changes have taken place:</u>

The Department of Numerical Methods and Algorithms has been renamed the Department of Parallel Computational Methods and Algorithms that corresponds better to the current research focus of the department.
The head of the Department of Design and Diagnostics of Digital Systems changed (from Dr. M. Baláž to Dr. P. Malík) and subsequently the name was changed to Intelligent Digital Systems, which is more in line with the current research and development activities of the department.
The Electron Beam Litography department changed its head (from Dr. I. Kostič to Dr. R. Andok).
A new department Sensor Information Systems and Technologies was established by joining two former departments: the Electron Beam Lithography department and the Sensory Systems department. This was motivated also by recommendations from the last accreditation.

<u>Several II SAS staff members work as experts on various national commissions:</u>

Ing. Ivana Budinska, PhD.
- Standing Committee on Ethics Coand Regulations of AI (member)
- Ethics Committee of SAS (member)
- SAS Commiittee for Information and Communication Technologies (member)

<u>doc. Ing. Ladislav Hluchy, CSc.</u>
- SAS Commission for International Scientific and Technical Cooperation (member)

<u>Ing. Zoltán Balogh, PhD., RNDr. Vladimir Britanak, DrSc., Doc. Ing. F. Capkovic, CSc., RNDr. J. Glasa, CSc., Doc. Ing. L. Hluchy, CSc., Ing. M. Rusko, PhD.</u>
- Commission VEGA no. 5 for Electrical Engineering, Automation and Control Systems and Related Fields of Information and Communication Technologies (members)

3. *Implementation of the recommendations from the previous evaluation period*

Specific recommendations for further improvement of the institute

"It would be strongly benefit from external input to develop a realistic strategic plan."

II SAS has been long strategically focused on the priorities defined by the European Commission in EU strategic documents. We benefit from our partnerships in international consortia in preparation of project proposals and their implementation. Evaluation reports from submitted projects are also a valuable source of our strategic research goals.
II SAS formulates its research priorities utilizing discussions, comments and recommendations coming from four main sources:
1. external members of Scientific Council (SC),
2. members of international consortia and evaluation of submitted projects,
3. domestic research institutions and universities collaborating in preparation and implementation of R&D projects, doctoral study programs and knowledge and information coming from memberships of II SAS employees in universities boards and commissions,
4. stakeholders (private companies, organizations, public administration bodies and ministries).

During the evaluated period, we singed Memorandum of Cooperation with the Ministry of Economy of the Slovak Republic and with partners within the framework of the Slovak Cloud for Open Science initiative (SKOSC), where the institute has a leading position as a coordinator and scientific referee.

According to the recommendation of the last accreditation and based on long term cooperation with a number of outstanding researchers (from abroad) we invited 3 external foreign experts to join our External Advisory Board (EAB):

- Prof. Hung-Yin Tsai from National Tsing Hua University (NTHU), Taiwan who was formally appointed as an external scientific advisor for nano-/micro technology and advanced manufacturing in 2017. He visited II SAS personally twice (in 2018 and 2019).
- Prof. Imre J. Rudas from Obuda University, Hungary as an external scientific advisor in 2021 for the field of cybernetics, robotics, and artificial intelligence.
- Prof. Jacek Kitowski from AGH University of Science and Technology, Poland as an external scientific advisor in 2021 for the field of computer science.

Due to pandemic situation, the first constitutive EAB meeting planned to be held at II SAS was postponed, but close informal discussions between EAB members and II SAS representatives continued with first beneficial implications.

Scientific Board (SB) benefits from very useful feedback provided by external members who are leading personalities in computer science and cybernetics fields. Internal discussions within SB focused on researcher priorities of II SAS, Foundation Charter, strengthening of collaborations with universities, especial challenges related to doctoral students recruitment and PhD studies implementation and excellence, and hints following from best practices at universities and their application II SAS level. Each year SB evaluates research activities of scientific departments of II SAS including evaluation of individual researchers according criteria approved by SB. The last discussions involving SB members, top II SAS management and heads of departments indicated the need of the criteria modification. Similar discussions indicated a need of modification of II SAS Foundation Charter to better reflect world/European trends and actual II SAS research priorities and activities. These modifications related to II SAS research scope and mission were postponed not to complicated the II SAS transformations (in 2018 and 2021) and also because of pandemic situation. Based on the departments assessment SB provides an evaluation report including recommendations on strategic goals, future development and sustainability of the departments. In one of evaluation criteria, heads of departments are asking to formulate contribution of their departments to II SAS's visibility at national and international level and face the issues related to their department sustainability. Note that strategy planning at the institution and departments' levels as well as related practical issues are also discussed regularly at other different institution's fora (Managerial Board, Institutional Board, Executive Board of Director) with regular presence of the head of the Scientific Board.

"It needs to address the demographic and PhD formation issues."

II SAS constantly strives for hiring young researchers and new doctoral students. After a period of no new students accepting, 2 new doctoral students were accepted in 2019 and 2020. Note that we have a limit on admission of 2 students per year who are financially supported from SAS. It follows from the FTE and the last II SAS's accreditation evaluation.

Because we were aware of the difficulty in attracting new PhD students, we contacted a professional institution (the Keystone Academic Solution) in order to promote our PhD study globally. Although we recorded a number of applicants (hundreds of applicants every month), we evaluated this activity as inefficient in terms of finance and due to the amount of work in communication with great number of irrelevant applications.

We used other forms to promote doctoral studies and research at II SAS including leaflets, addressing students during our pedagogical activities, individual work with students on their bachelor and master theses, offering researches fellowships at II SAS for universities students, etc. We also participated in joint online promotions of PhD studies organized by P SAS in 2020 and 2021 which appeared not efficient. In addition, we published advertisements for vacant doctoral and postdoctoral positions through the profesia.sk portal.

We evaluated the success of various forms of promotion of our open positions for young researchers and then we decided to make more intensive use of the Euraxes portal and intensify

cooperation with universities. After a long period of not accepting any new PhD students, we were able to attract students after concluding contracts with more universities and faculties.

We employed 11 young researchers including those that completed PhD study at our Institute (Kenyeres, Guoth, Klarak, Ritomsky, Kozak + 6 our PhD students) during the assessment period. Our young researchers are involved in a management of II SAS as well. We have one researcher under 35 years, the Schwarz Fund fellowship holder, who is a member of SB. We have established the Young Researchers Body which works in close cooperation with the Young Researchers of SAS.

Most of older researchers have part-time contracts with II SAS. On the other hand, the only criterion for a part-time contract is achieving scientific results by an individual researcher. We do not discriminate any researcher from any reason, including gender and/or age.

"The profile of the Institute has the capacity to additional income from Framework Programmes/H2020 and other competitive sources that would assist in achieving their strategic goals." and "...more effort should be made towards achieving more prominent positions in FP projects (coordinator/WP leaders)."

During the accreditation period we had 11 EU funded projects, in 6 of them we had a leading role at least in one Workpackage, being task leaders in all of these projects. We have submitted 53 EU projects proposals, in which in 11 proposals we were coordinators and principal investigators. There are more researchers from II SAS who were involved in preparing the proposals. Three proposals of new COST Actions (ESCAPED OC-2020-1-24622; EvacDrillNet OC-2021-1-25264; NERO OC-2021-1-2547) were also submitted with II SAS as a secondary proposer.

"It was not clear to the panel, why certain activities (e.g. lithography) were not linked with other Institutes rather than with Informatics."

Research in information and communication technologies and micro-/nano technologies at II SAS has long tradition including collaboration with several Slovak universities and SAS institutes and participation in European FP projects. In the assessment period, the cooperation of research teams in the area of sensoric systems and electron beam lithography (EBL) was strengthened. They both focused on new trends in the fields of cybernetics, smart devices, IoT and nanotechnology. The integration of the teams was also realized in the form of joint project cooperations on a long term basis. Also Prof. Hung-Yin Tsai (external scientific advisor for advanced manufacturing and nano-/micro technology) strongly recommended continuing in this integration. These activities, fully supported by EB and SB resulted in a formal merging of two departments (Department of Sensory Systems and Department of EBL) forming a new Department of Sensoric Information Systems and Technologies established in the beginning of 2022. This organizational change has potential for further strengthening the orientation of both teams to applied informatics and cybernetics and to the thematic and project interconnection.

General comments and recommendations

We address only the recommendations for SAS institutes that are relevant specifically for II SAS as it is stated in a report of the Meta-panel: Regular assessment of the Research Institutes of the Slovak Academy of Sciences 2012 – 2015, Part I: Overall Evaluation report.

5.1 Training of PhD Candidates, Careers of Post-Doctoral Fellows and Empowerment of the Next Generation of Researchers

"The SAS research institutes are recommended to build relationships with international doctoral schools and training programmes. It is recommended that SAS look into international examples of good practices that promote the empowerment of young researchers."

During the accreditation period II SAS became a partner in a H2020 Marie Skłodowska-Curie Action project. Within the project implementation we have accepted 2 PhD students from abroad. To illustrate the impact of this initiative on the work with our foreign Phd students, we mention

a workshop organized by II SAS at our institute in March 14-18, 2021 within the COBRA project (H2020 Marie Skłodowska-Curie Action). Originally the meeting was scheduled in face-to-face form in November 2020. Due to the COVID pandemic situation it was postponed and finally held online. This five-day event covers intensive courses in three basic areas of the project (neuroscience, understanding dialogue and neurolinguistics). A presentation on gender issues in science was also included in the programme. 15 presentations of all PhD students involved in the consortium about their own research projects and show&tell presentations from industry partners were included as well. Several COBRA's non-academic partners such as Furhat, DAVI, Orange and ReadSpeaker presented an overview of their activities in the field of conversational agents, artificial dialogue systems and text-to-speech synthesis. The main lecture blocks covered bilateral accounts of language: understanding dialogue, language use and social interaction (by Martin Pickering, University of Edinburgh), neurobiology of language (by Peter Hagoort, Max Planck Institute), biological sex and gender in science (by Susanne Fuchs, Humboldt University in Berlin), and neurolinguistics: perception and understanding of the spoken word (by Kristof Strijkers, Aix-Marseille University). The week-long course was attended by 20 doctoral students, 10 experts from the COBRA consortium, and varied numbers of other participants.

We intend to prepare another such project in the field of robotics together with cooperating partners from the community active in RAAD (Robotics in Alpe Adria Danube region).

5.3 Diversity of Academic Staff

"It is recommended that measures are taken for increasing the share of female researchers at SAS Institutes."

The only eligibility criteria that are applied to researchers recruitment and doctoral study positions at II SAS are professional (i.e., achieved research outputs, activities, skills, etc.). Such criteria are also applied in terms of filling management positions in II SAS. EB supports education activities related to prevention of women discrimination organized at the SAS level and adopted the Gender Equality Plan and the Ethics Code. II SAS participated in activities to support the increase of the number of female students in ICT for example by participation in the AjTyvIT ("Ye also in IT") event.

5.5. Academic Leadership and Sharing of Good Practice

"The Research Institutes are recommended to form stronger ties between each other, beyond the directorial level, between Institutes within a Section and across the Sections."

The research at II SAS from the essence integrates various fields of science and technology. In this regard II SAS directly looks for cooperation with other SAS institutes and universities. Such activities also support the integration of research within the institute. We have launched and joined several interdisciplinary researches in the area of image recognition (for animal fMRI), Natural language processing - NLP (e.g. for research of metaphors in literature texts), and many more as stated in descriptions of our projects.   Research teams at II SAS are formed across departments according to the current need of research projects.

We organize scientific seminars at II SAS which are open to all researchers and we invite researchers from other SAS institutes (e.g. from the Mathematical Institute SAS, the Institute of Measurement SAS, etc.) as well as researchers from universities (STU, UK, UPJS, TUKE), and researchers from abroad.

"The Institutes are recommended to enhance intra-institutional and inter-institutional flow of communication."

The Management and Institution Boards of II SAS include heads of departments and project leaders who benefit from direct contacts with EB and heads of relevant management branches (e.g. of Economy Department). These boards are a platform for mutual information exchange about ongoing activities and projects and their orientations and goals as well as for searching opportunities for joint researches and developments. It is also a platform for communicating information on new calls and on focus on research in intended project proposals. It is also

important for mutual transfer of information between EB and middle management (heads of departments) of II SAS.

II SAS organizes at II SAS seminars for PhD students and other researchers which are open also for other researchers. II SAS provides presenters from particular departments and invites presenters from universities and companies from SR and abroad. II SAS has a specific position (scientific secretary) responsible for the institute's publicity and fostering the popularization.

Besides education and training activities organized by II SAS, EB and SB strongly support and recommend education activities organized at the SAS level as well as by universities.

5.6. Strategy Foresight

"It is recommended that the Institutes appoint an independent International Advisory Committee, or a shared one where appropriate."

The formal establishment of the External Advisory Board (EAB) at II SAS began in 2017 and was completed in 2021 as a result of long term discussions of the II SAS top management, SB members and research project leaders with excellent foreign experts in the field of informatics and cybernetics. Main focus of these discussions were our research activities, project intentions and implementation, up-to-date research trends and best practices as well as strengthening of collaboration and doctoral studies. Discussions and participation in international (but also in national) research consortia appeared to be especialy important for strategic thinking at various levels of II SAS. We greeted the advice of the Panel of Experts to shift our external feedback at high level establishing the international advisory board.

"It is recommended that the diversity of theoretical frameworks within some of these disciplines become a focal point in future planning."

II SAS benefits in the long term from experience with leading, coordination and supporting of international (and national) research consortia and from good collaboration at international (and national) level. It follows also from main research fields orientation. Both informatics and cybernetics have great potential for having strong impact onto other scientific disciplines. That is why our research is naturally interdisciplinary and considerably diverse (which is specifically supported by European strategic documents). Strong orientation of II SAS (and also of particular research departments/teams at II SAS) on up-to-date world/European research trends (including new prospective research fields) is evident.

5.7 Multidisciplinary Research and Collaboration between Research Institutes

"Close collaboration between the SAS Institutes and relevant units outside of the SAS is recommended."

EB and SB support strengthening of collaborations between II SAS and other SAS institutes (as well as with relevant units outside SAS) as it was described in this Questionnaire elsewhere. We have many informal (as well as project) collaborations and close contacts with many SAS institutes such as the Mathematical Institute SAS, the Physical Institute SAS, the Institute of Measurement SAS, the Institute of Hydrology SAS and others. We consider this collaboration important (even necessary!) and inspiring. Such collaborations are mutually advantageous and we take them as a part of our mission.

II SAS has long been active in building a pan-European high-performance federated cloud infrastructure and, with its computing resources, provides space for virtual organizations for e.g. "COVID-19 Galaxy" service on corona-virus genomic data processing (covid19.eosc-synergy.eu), moldyngrid.eu (molecular dynamics), enmr.eu (magnetic resonance), vo.lifewatch.eu (biodiversity and ecosystem research), NextGEOSS (Earth Observation), biomed (this VO covers the areas related to health and life sciences), the MATRYCS project (vo.matrycs.eu, modular Big Data Applications for Holistic Energy Services in Buildings), vo.access.egi.eu (this VO collects and makes available resources for the EGI Platform for the long-tail of science).

As for Slovakia, II SAS supports with core services the Faculty of Mathematics, Physics and Informatics of the Comenius University, Bratislava, the Institute of Experimental Physics of the Slovak Academy of Sciences, Kosice for experiments in cooperation with CERN, the Faculty of Natural Sciences of the Matej Bel University, Banska Bystrica. As part of the use of infrastructure, II SAS also supported the private sector such as DHI, s.r.o. (water managment)., VUJE (Research Institute for Nuclear Energy - simulation of environmental impacts on power lines), Microstep-MIS a.s. (visibility prediction at airports), Slovak Hydrometeorological Institute (nowcasting based on AI).

5.10. Publication Practices and Incentives

"Further study for mainstreaming and learning from this good practice is recommended. It is also recommended that the Institutes establish a publication, in-house journal and data dissemination strategy."

The II SAS strategy is to publish the research outputs in international peer-reviewed periodicals. To enhance publication activity of researchers, the director of II SAS in collaboration with SB established a set of motivational measures to stimulate authors to publish in reputable journals and proceedings. SB once a year evaluates publication activity of II SAS according to criteria approved by SB and assigned a weight to each particular publication according to the criteria. II SAS gives to authors the incentives corresponding to this assessment at the end of the year. Direct incentives are also made possible for authors of selected types of high-quality publications (defined in the criteria) during the year. Within the departments evaluation, SB evaluates publication activity and publicity of research departments and individual researchers. Highly cited publications bring also incentives in the end of the year. SB discusses about set up of the existing system with EB and heads of departments to increase the publication activity and publicity of II SAS. The "in-house" journal published by II SAS is not intended for increasing the number of publications of II SAS, but its excellence and uniqueness contributes to the institute's reputation.

"The Institutes are recommended to look for ways to join forces in the interest of efficiency, quality, and visibility of the in-house journals they publish."

The Computing and Informatics journal published by II SAS with collaboration with 4 foreign institutions and 2 Slovak universities is unique current contents journal with long term tradition of peer review which meets international standards required. Financial support from SAS does not cover all publishing costs and therefore II SAS provides the journal publishing by internal II SAS sources with financial help of the collaborating organizations. There are strong efforts to keep the excellence and uniqueness of the journal and its IF at adequate level. The journal editorial board faced serious problem a few years ago caused by enormous increase of the number of submitted manuscripts. The redaction adopted several system measures to reverse the situation including: II SAS has established an international CAI Panel, whose members are important scientists from Poland, England, China and Slovakia, whose task is to propose a quality handling editor for a specific paper and its topic. At the same time, an Executive Board was set up, for the first filtering of papers that are out of the scope of the journal or the scientific value is weaker. The journal went into an open access status, which improved its citations. At present, the journal has 0,455 impact for the year 2021 and for a 5 year period has 0,502, and thus the publications in the journal belong to category A in Slovakia. Due to the economic conditions of the issue of journal, II SAS had to demand a fee of 100 euros per paper from 2021, further increase is not excluded.

4. _Research strategy and future development of the institute for the nextfive years_ (Recommended 3 pages, max. 5 pages)

Research strategy of the institute in the national and international contexts, objectives, and methods (including the information on when the strategy was adopted)

II SAS has long focused on current research trends in the fields of informatics, cybernetics and information technologies, as defined in the EU strategic documents. In terms of global trends and environmental challenges, the institute focuses mainly on the support of domain research in the form of application of artificial intelligence and high-performance computing. II SAS conducts excellent research in the field of Big Data in all phases of the data lifecycle. From the point of view of analytics, we consider cloud services for exascale computing, predictive analytics, and AI use to be the most important direction on which we focus. In connection with IoT, we focus mainly on smart sensors and devices. II SAS is also active in the creation and enforcement of FAIR policies, as an active member of EOSC and GAIA X hub Slovakia. Its role in supporting open science in Slovakia is important, especially through the leading role in the SKOSC (Slovak Open Science Cloud) initiative. Last but not least, cybersecurity whose importance is constantly growing should be mentioned. This is a relatively new direction for II SAS, but it is very much supported. The short-term II SAS strategy is expressed directly by the projects that we will realize in the near future. Three new projects in calls for EOSC (European Cloud for Open Science) with II SAS involved which will start in September 2022 (AI4EOSC, iMagine, EuroScienceGateway) and 5 more projects were submitted (AUDITFOOD, RI-STAR, K-MESH, HEXACoMB, ARBITRATE) with II SAS in coordination position in one of them. Our cooperation with CESSDA continues in the next years. There are four H2020 projects started in 2021 which continue in the next years (EGI-ACE - Advanced Computing for EOSC (1.1.2021-30.6.2023) H2020-101017567, EOSC-Synergy: European Open Science Cloud - Expanding Capacities by building Capabilities (1.9.2019-31.10.2022) H2020-857647, SILVANUS - Integrated Technological and Information Platform for wildfire Management (1.10.2021-31.5.2025) H2020-101037247, COBRA - Conversational brains (1.2.2020-31.1.2024), H2020-EU.1.3. - EXCELLENT SCIENCE - Marie Skłodowska-Curie Actions).

Both the long-term and shot-term strategies of II SAS are developed and modified regularly by applicants for the II SAS director position. The visions of successful applicants are then thoroughly discussed at different institute's fora, mainly in EB, SB, Management Board, Institution Board and Operational Board of Director (OBD). The discussion in the last 3 levels focusses dominantly on short-term issues and principal direction of particular departments research teams and their sustainable development. The main scope of OBD is short-time direction, technical issues, funding and actual tactics of departments and II SAS as a whole. SB participates at each meetings of these boards. For last 7 years, 3 director selection procedures were organized at II SAS (2015, 2019, 2021, see comment in Chapter 1.3). All elected directors came from internal environment of II SAS being deeply familiar with II SAS's strategic orientation onto world/European research trends and best pactices. They made great effort to support possitive development of research departments and II SAS as a whole, reacted on quick development and changes in related disciplines and tried to face the issues related research funding, management and vision of II SAS and particular departments.

In following, we briefly introduce some selected challenges, which stand in front of us in relatively near future:

1. Maintain and intensify good management encompasing close collaboration between the top II SAS management, SB and heads of departments. Continue in streamline, optimizing and concentration of management and services (finalization of transfer of main services at one place, stabilization of research and service employees, revitalization of entrance-hall of II SAS, reconstruction of electric and communication networks).
2. Maintain and improve evaluation processes at II SAS provided by SB (regular evaluations of departments' activities, publication activity and publicity of departments and individuals, best results in basic research, applied research and international collaboration achieved

during given year according criteria approved by SB). Revision of existing criteria utilizing past experiences, thorough analysis of institute's needs and external environment.

3. Utilize (closer) external feedback from external SB members and IAB members. Analyse challenges related to time after the institute's transformation including the role of new constitutional boards established.

4. Face issues related to research funding and research sustainability (analysis of risks and challenges).

5. Further develop collaborations at international/national level (universities, research laboratories and institutes, private companies and stackholders).

6. Face serious problems related to young researchers and PhD students recruitment, doctoral studies excellence, male/female ratio and employees' age issues applying existing best practices and external feedback.

7. Continue in the main strategic goal and set direction to become a more prominent European player with strong national impacts maintained.

To illustrate the <u>research sustainability efforts</u> at II SAS we list the most important projects the implementation of which will begin in the near future:

1. iMagine - Imaging data and services for aquatic science (1.9.2022-31.8.2025) 101058625 [call HORIZON-INFRA-2021-EOSC-01-06], coordinated by EGI Foundation (EGI.eu) Netherlands, Call: HORIZON-INFRA-2021-SERV-01: Research infrastructure services to support health research, accelerate the green and digital transformation, and advance frontier knowledge (2021), Topic: HORIZON-INFRA-2021-SERV-01-06: Enabling research infrastructure services for better use of imaging data to address challenges in thematic research areas
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-infra-2021-serv-01-06
II SAS contributes mainly to WP4 – "Virtual access provisioning: AI and Infrastructure Services". It operates the DEEP AI Application Development Service that allows Artificial Intelligence developers to prototype, build and train AI applications, exploiting resources from EU e-Infrastructures.

2. AI4EOSC - Artificial Intelligence for the European Open Science Cloud (1.9.2022-31.8.2025) 101058593 [call HORIZON-INFRA-2021-EOSC-01-04], coordinated by Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC) Spain, Call: HORIZON-INFRA-2021-EOSC-01: Enabling an operational, open and FAIR EOSC ecosystem (2021)**,** Topic: HORIZON-INFRA-2021-EOSC-01-04: Innovative and customizable services for EOSC
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-infra-2021-eosc-01-04
The most important responsibilities of II SAS is in WP4 - "Next Generation AI Platform as a Service", which provides machine learning practitioners with feature rich services to build and deploy customizable machine learning, deep learning and artificial intelligence applications following a platform and serverless approach with horizontal scalability over the EOSC continuum.

3. EuroScienceGateway - leveraging the European compute infrastructures for data-intensive research guided by FAIR principles (1.9.2022-31.8.2025) 101057388 [call HORIZON-INFRA-2021-EOSC-01-04], coordinated by EGI Foundation (EGI.eu) Netherlands, Call: HORIZON-INFRA-2021-EOSC-01: Enabling an operational, open and FAIR EOSC ecosystem (2021), Topic: HORIZON-INFRA-2021-EOSC-01-04:Innovative and customizable services for EOSC
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-infra-2021-eosc-01-04
II SAS contributes mainly to WP3: "Pulsar Network: Distributed heterogeneous compute" that will develop an innovative distributed computer network across Europe that can be used by different workflow management systems, based on Pulsar technology from EOSC-Life and the GA4GH Task Execution Service (TES) API.

4. Inline evaluation of Li-ion battery electrode porosity using machine learning algorithms (BattPor), ERA-NET, 1. 6. 2022 – 31. 5. 2025, coordinator – Fraunhofer Institute for Ceramic Technologies and Systems, Dresden, Germany (IKTS-MD), M-ERA.NET Call 2021

The main goal of the BattPor project is to develop automated laser spectral photometry (LSP) technology for porosity detection using AI in a continuous roll-to-roll calendering line. The result will be a demonstrator laboratory validated at TLR level 4 as a potential module of pre-industrial innovation for testing technology in electrode production, including AI-based data evaluation. The project falls within the context of battery and electromobility research within the objectives of the planned pan-European energy transformation.

Big data analysis is becoming a subject of interest due to the complexity and interconnectedness of production processes. Therefore, a new software solution (algorithms) for porosity detection developed by a Slovak partner (II SAS) will use artificial neural networks (ANN). The AI algorithms process the optical measured data from the LPS and evaluate the porosity of the thin films in real time during the calendering of the electrode plates. The innovations of the Slovak project partner are focused on the development of the issue of processing a large amount of optical data from LSP using ANN. The II SAS will also cooperate in a data management and repository management for software, models and data.

Two new APVV projects will start in 2022 (AIPOLOGY, ALOIS). One proposal in OPII structural funds is in the evaluation phase (HYSPED).

1. AIPOLOGY - Artificial Intelligence for Personalised Oncology: from Single-Sample Assessment to Real-time Monitoring of Solid Tumours, coordinated by Slovak University of Technologies, Faculty of Informatics and Information Technologies. Call: Public call for applications for R&D projects in individual groups of science and technology - VV 2021

II SAS will be responsible for big data processing in the scope of Apology project by providing not only the cloud based solutions, but also the distributed frameworks e.g. Apache Hadoop and all EcoSystem build on top of it: distributed file system (Hadoop Distributed File System), distributed in memory computing (Apache Spark), distributed databases (Apache HBase or Apache Cassandra).

2. ALOIS - Diagnosis of Alzheimer's disease from speech using artificial intelligence and social robotics, II SAS as a coordinator. Call: Public call for applications for R&D projects in individual groups of science and technology - VV 2021

The aim of the submitted project is to evaluate the use of automatic analysis of speech communication investigated through machine learning and artificial intelligence as a tool for MCI and AD diagnostics, which would find application in the practice of clinical psychologists, based on the analysis of 200 protocols (100 patients, 100 healthy controls). In the field of social robotics, the project aims to research the possibilities of using a social robot as a tool for collecting speech in human-machine interaction for MCI (cognitive impairment) and AD (Alzheimer disease) screening. The output will also be the creation of a professionally annotated database of speech recordings in Slovak, intended for the study of mild MCI and AD expressions in the voice and speech of the investigated, freely accessible for scientific and academic purposes.

Most important projects submitted in 2022:

1. AUDITFOOD: DISRUPTIVE TECHNOLOGIES TO IMPROVE TRACEABILITY AND DETECT FRAUD IN ORGANIC AND GEOGRAPHICAL INDICATION PRODUCTS, coordinated by Gradiant, Spain, HORIZON-CL6-2022-FARM2FORK-01-04: Innovative solutions to prevent adulteration of food bearing quality labels: focus on organic food and geographical indications.
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl6-2022-farm2fork-01-04
The main contribution of II SAS is the proposal of AI models based on ML and neural networks to support the human expert's decision on the authenticity of Bryndza cheese, Rivera del Duero wine and local black chokeberry juice. Improving methodologies to identify authenticity based on composition of organic and GI products.

2. RI-STAR: Research Infrastructure Solutions in Artificial Intelligence for Social Sciences and Humanities, coordinated by CESSDA ERIC - Consortium of European Social Science Data Archives ERIC NO, Call: HORIZON-INFRA-2022-TECH-01: Next generation of scientific instrumentation, tools and methods (2022), Topic: HORIZON-INFRA-2022-TECH-01-01: R&D for the next generation of scientific instrumentation, tools and methods
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-infra-2022-tech-01-01
The main role of II SAS in RI-STAR is the leadership of WP5 - AI platform and enhanced services for RIs, in which an cloud-based AI platform for RIs will be designed and implemented. The AI platform will exploit production services from the DEEP platform and the AI4EOSC project, part of the EOSC exchange offer. Beside WP5, II SAS also has a strong role in WP4 Analysis solutions, where solutions for use cases from WP6 will be analysed and new solutions will be developed or existing ones adapted. It leads Task 4.3 AI-based solutions for semantic discovery and annotation in textual data; and participates in other tasks.

3. K-MESH: towards next generation Kubernetes MESH with a novel orchestrator-agnostic platform for cloud/edge continuum empowered by AI-methods, coordinated SZAMITASTECHNIKAI ES AUTOMATIZALASI KUTATOINTEZET HU, Call: HORIZON-CL4-2022-DATA-01 WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2022, Topic: HORIZON-CL4-2022-DATA-01-02: Cognitive Cloud: AI-enabled computing continuum from Cloud to Edge (RIA), https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2022-data-01-02
The main role of II SAS in K-MESH is in WP2 K-Mesh Orchestration Plane which supports deployment and integration of Kubernetes clusters into Orchestration planes and takes care of execution, management and dynamic workload adaptation according to instruction/decision from AI layers. It leads Task 2.3 Dynamic network configuration and adaptation, which implements the extension of service meshes into the computing continuum for edge-based resources. In addition, the task performs the application service registration and network namespaces and finally elaborates network load balancing. II SAS also participates in Task 2.1 Deployment and integration of Kubernetes clusters to the Orchestration plane and Task 2.4 User interface and API in the WP.

4. ARBITRATE: semAntic distRiButed computIng conTinuum foR extreme dATa procEssing, coordinated by II SAS, SK, Call: HORIZON-CL4-2022-DATA-01: WORLD LEADING DATA AND COMPUTING TECHNOLOGIES 2022, Topic: HORIZON-CL4-2022-DATA-01-05: Extreme data mining, aggregation and analytics technologies and solutions (RIA)
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-cl4-2022-data-01-05
II SAS will be the coordinator of the project and will also lead the definition of the overall system architecture and the necessary APIs in Task 2.3 (Platform Specification and Architecture Definition) of WP2 (Requirements, Specifications and Architectures). It will also participate significantly in the remaing WPs.

5. HEXACoMB: Lightweight, decentralized and Extreme Acceleration for 6G Continuum Multi-domain Cybersecurity, coordinated by Instituto de Telecomunicações, Portugal, Call: HORIZON-JU-SNS-2022 (HORIZON-JU-SNS-2022) Topic: HORIZON-JU-SNS-2022-STREAM-B-01-04: Secure Service development and Smart Security
https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/horizon-ju-sns-2022-stream-b-01-04
II SAS brings to the project its broad range of know-how in artificial intelligence and distributed systems security, covering substantial part of the project's work and thus allowing it to drive collaboration on solving problems.

6. HYSPED: Research of the application of artificial intelligence in the analysis and classification of hyperspectral imaging data, coordinated by Technical University of Zvolen, Call: OPII-VA/DP/2021/9.3-01 - Call for NFP (non-repayable financial contribution) applications to support non-profitable and business research & development capacities in the domains of smart specialization RIS3, https://www.opvai.sk/vyzvy/m%C5%A1vva%C5%A1-sr/dopytovo-orientovane-projekty/opii-vadp202193-01/

The main contribution of the II SAS is the proposal of artificial intelligence models for the objects of interest detection and classification from available hyperspectral and lidar aerial data with the support of cloud infrastructure. The term "object of interest" refers to vegetation that will be defined and regularly monitored by the project applicant and its necessary characteristics will be determined. Objects of interest can also be individual trees and other separate objects within the studied vegetation group. The data will be recorded in different growing seasons as part of aerial hyperspectral and lidar diagnostics of linear power structures.

Bratislava, June 30, 2020

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