Bulletin

"To build the foundation of a promising career or an industrial success you need three things: Quality, Quality and Quality!"

The Department of Networked Systems and Services, formerly known as the Department of Telecommunications, is focusing on the key areas of networking and networked systems: analysis and design of wired and wireless networks, new network architectures and protocols, mobile communication systems and services, multimedia networking and media distribution systems and services, cryptography and network security. Additional strengths that complement the key areas include quantum computing and communications, acoustics and studio technologies, signal processing, financial information systems.

The recent change of our name from Department of Telecommunications to Department of Networked Systems and Services reflects that our competences have shifted significantly during the last decades. This change has been driven by the convergence of telecommunication systems and the Internet, resulting in a global integrated network of heterogeneous devices, as well as by the widespread deployment of information technologies, and in particular the Web, resulting in innovative new network based services. While the 70 years of experience of the Department of Telecommunications in networking still provides a solid ground on which we can base our teaching, research and development activities, the new name of the department better describes what we are currently focusing on and how we are thinking of the future.

Our team of 7 professors, more than 60 staff members and 30+ PhD students can dynamically respond to the ever-increasing and leading-edge competency demands from the field of Information and Communication Technologies both at the national and the international levels.

Our courses, laboratory exercises, individual student projects and diploma projects create unique opportunities for undergraduate and graduate students to obtain high level knowledge and practical skills. Furthermore, the Department's strong industrial cooperation provides excellent career opportunities for them. We always seek a balance among theoretical work, applied research and development. We are open to work with students eager to learn and to collaborate with industrial partners in different research and development projects.

If you are looking for quality and excellence in research and education, then you are welcome at the Department of Networked Systems and Services!

preface

Prof. Sándor Imre
Head of the Department
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„Egy ígéretes karrier vagy egy ipari siker három tényezőn alapul: minőség, minőség, minőség!"

A BME Hálózati Rendszerek és Szolgáltatások Tanszéke – korábbi nevén Híradástechnikai Tanszék – a hálózatokkal és hálózati rendszerekkel kapcsolatos olyan kulcsterületekre koncentrál, mint a vezetékes és vezeték nélküli hálózatok analízise és tervezése, új hálózati architektúrák és protokollok, mobil kommunikációs rendszerek és szolgáltatások, multimédia hálózatok, médiaelosztó rendszerek és szolgáltatások, kriptográfia és hálózatbiztonság. Tanszékünk további erősségei, melyek jól kiegészítik a fenti fő tevékenységi területeinket: a kvantuminformatika és -kommunikáció, akusztika és stúdiótechnológiák, jelfeldolgozás, valamint üzleti információs rendszerek.

Tanszékünk nevének közelmúltbeli megváltoztatásával kompetenciáinknak az utóbbi évtizedekben bekövetkezett jelentős elmozdulására reflektáltunk. Ezeknek a változásoknak a fő mozgatórugói egyfelől a távközlő hálózatok és az internet konvergenciája, mely különféle eszközök globális és integrált hálózatát eredményezte, másfelől az információs technológiák széleskörű elterjedése, mely új innovatív, hálózatalapú webes szolgáltatásokhoz vezetett. Miközben tanszékünk több mint 70 éves tapasztalata a hálózatok világában olyan biztos alapot jelent, amire bátran építhetjük oktatási, kutatási és fejlesztési tevékenységünket, új nevünk jobban tükrözi a jelenleg folyó tevékenységünket és a jövőre vonatkozó terveinket.

A tanszék 7 professzora, több mint 60 munkatársa és mintegy 30 doktorandusza dinamikus és minőségi választ képes adni az ICT szektor folyamatosan erősödő kihívásaira.

Különböző képzési formáink – kötelező és választható tárgyaink, az önálló laboratóriumi gyakorlatok, a szakdolgozat és a diplomatervezés – mind hallgatóink elméleti és gyakorlati tudásának bővítését célozzák, melyek ipari kapcsolataink révén kiváló karrierépítési lehetőségekkel egészülnek ki. Gondosan ügyelünk arra, hogy az elméleti és alkalmazott kutatás és fejlesztés között egyensúlyt tartsunk, és ipari partnereinknek mindig a megfelelő megoldást nyújthassuk. Nyitottak vagyunk az olyan hallgatók felé, akik kutatási és fejlesztési projektek keretében szeretnének ipari tapasztalatra szert tenni.

Amennyiben Ön a minőség és kiválóság elkötelezett híve, bátran forduljon a Hálózati Rendszerek és Szolgáltatások Tanszék munkatársaihoz.

A jelen bulletinben bemutatott területek magyar nyelvű ismertetéseit lásd a honlapon: www.hit.bme.hu

előszó
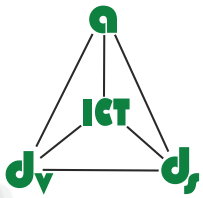
Analysis, Design and Development of ICT Systems Laboratory

The AddICT laboratory has competences on the analysis, design, implementation and operation of ICT systems, clouds, 5G and 6G networks. We actively apply computer science and mathematical modeling to enhance the operational efficiency and reliability of networking solutions of such systems.

The laboratory has built strong scientific and R&D cooperation with universities worldwide and industries (e.g., Nokia Bell Labs, Ericsson Research, Hungarian Telekom, Hungarian SMEs). AddICT members have been working on automatic software testing solutions and the efficient resource management cloud-native network functions for 5G and 6G systems, artificial intelligence based network operation, and capacity dimensioning tools for 5G network traffic solutions. Some of our procedures developed with Nokia and Ericsson are under patent protection.
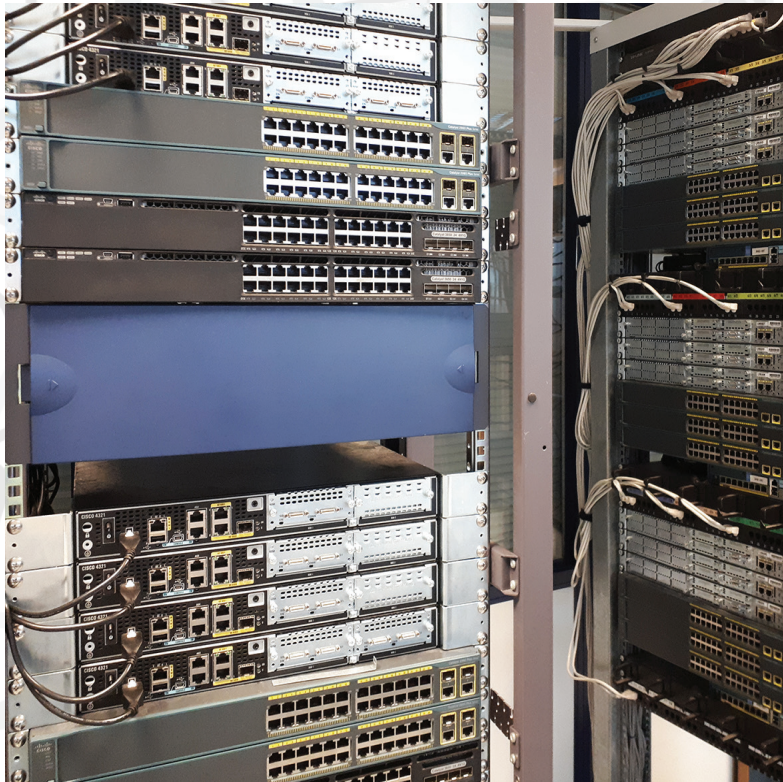
Our objective in education is to provide students with up-to-date and long lasting competences and skills in the aspects of network operation, network design, performance and reliability engineering. AddICT also hosts a Cisco training laboratory and offers CCNA and CCNP level hands-on lab courses for students and industrial partners.

laboratories

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medianets
laboratory

The Laboratory of Multimedia Networks and Services (MEDIANETS Lab) research and development activities include artificial intelligence for smart cities, intelligent transportation systems, machine learning based vehicle and traffic control, V2X communications for autonomous vehicles, artifical intelligence for network and services management, and benchmarking and security analysis of IPv6 transition technologies in smart cities.

MEDIANETS Lab has been active in significant European and national projects. Founded by the National Research, Development and Innovation Office, an intelligent transportation system for cities of the future is being developed in our Lab, utilizing machine learning methods and techniques, to optimise transportation, using historical and real time traffic sensor information, preprocessing it in our stream processing platform.

Our Lab is also involved in the European C-ITS flagship project C-ROADS supporting the V2X deployment activities of Hungarian Public Roads Nonprofit PLC, also working on green-field motorway/highway design projects, planning smart road infrastructures with advanced infocommunication techniques.

MEDIANETS' teaching activity spans over the whole BSc-MSc-PhD structure. Along with basic courses in communication networks, it is responsible for one BSc and one MSc specialization in intelligent networks. Facilities for students include the Commsignia - BME HIT V2X Communication laboratory, where they can design and implement intelligent cooperative services for smart cities.

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laboratories

MCL

Mobile Communications & Quantum Technologies Lab.

Since the foundation of the laboratory in 1997, our research community released a large number of engineers while participating in numerous international and national research and development projects.

Currently, we are focusing on quantum computing, quantum communications (including fiber based quantum key distribution, free-space quantum key distribution, satellite based quantum key distribution, photon based quantum random number generators), 5G solutions (protocols of 5G, 5G and satellite communications), Internet-of-Things (IoT protocols and their applications in different domains including smart homes and agriculture), position based systems (position using wifi and other radio services) and the combination of optical and mobile communications (radio-over-fiber, visible light communication).
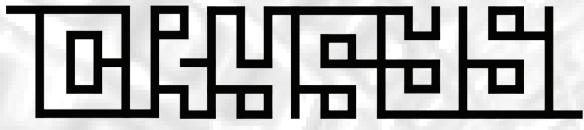
We are proud of our students who received various prizes for their work in quantum and mobile communications.

laboratories

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Laboratory of Cryptography and System Security

www.crysys.hu

The Laboratory of Cryptography and System Security (CrySyS Lab) is committed to carry out internationally recognized, high-quality research on security and privacy in computer systems and networks, and to teach related subjects at the Budapest University of Technology and Economics. We strongly believe in problem driven, project-oriented research, therefore we participate in R&D projects, where we collaborate with industry partners and academic institutions, and maintain international relationships.

An important research domain in the CrySyS Lab is security of cyber-physical systems with an emphasis on three application areas: security of industrial automation and control (ICS/SCADA) systems, security of intelligent transport systems, and security of Internet-of-Things (IoT) systems, especially IoT malware. Another key research area is the security and privacy of machine learning (ML), including attacks and countermeasures with provable guarantees, anonymization of training datasets, and robustness of ML against adversarial examples and data/model pollution. Third, we study the economics of security and privacy, analyzing and re-designing security/privacy/ML mechanisms where the misaligned economic incentives of stakeholders undermine the effectiveness of networked ICT services. The lab is currently active in multiple EU-funded (Horizon RIA SECURED, Horizon RIA COSS, EDIH) and national (AI National Lab, 2 OTKAs, etc.) projects, and has recently succeeded in finishing EU flagship collaborations (H2020 IMI MELLODY, H2020 ECSEL SECREDAS).

The CrySyS Lab is the sole responsible for the new IT Security MSc major specialization introduces the main security problems of IT systems and the approaches, methods, and tools used to solve those problems, with the emphasis on practical applications. The lab also teaches the compulsory IT Security introduction course and offers electives on cutting-edge topics including the security of ML, privacy-preserving technologies, and the economics of security.

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laboratories
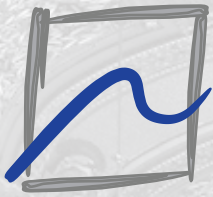
Laboratory of Acoustics
and Studio Technologies

The Laboratory of Acoustics and Studio Technologies is active both in (various fields of) technical- and in musical acoustics (i.e. audio technologies, sound engineering).

Electroacoustics is one of the traditional fields of the laboratory, which was extended later on towards various industrial fields such as vehicle and building acoustics, soil and building vibrations. The current activity of the lab ranges from numerical and statistical prediction of sound and vibration fields through sound recording and audio signal processing to video studio techniques and many aspects of digital media technologies.
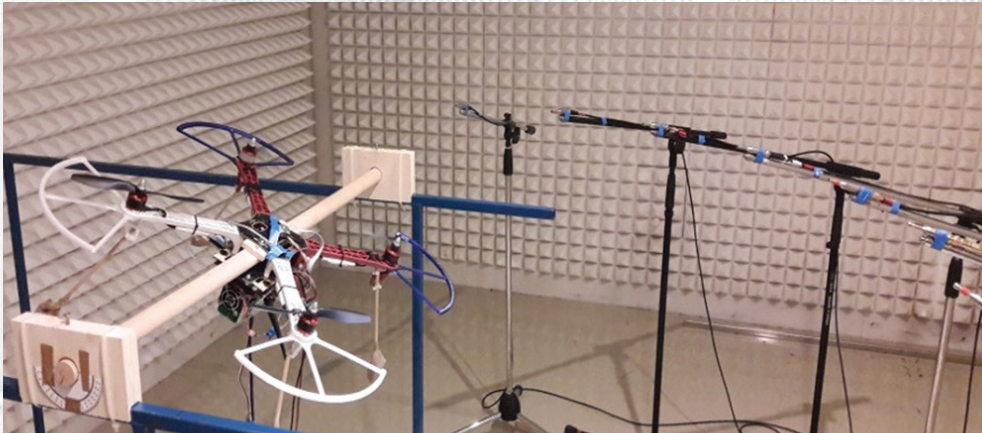
The laboratory equipment consists of a semi-anechoic room, a respectable number of measurement microphones and vibration sensors for in- and outdoor measurement, a laser vibro-mater, a professional acoustic camera, a small educational recording studio with all necessary hardware, wide range of software tools for numerical acoustic simulation as well audio and video processing.

The current staff consists of 4 staff members and 3 PhD students. Besides teaching various subjects at BSc and MSc level and performing national and international projects, the staff has a strong emphasis on fundamental research: from 2017 and on, they received 4 ÚNKP (New National Excellence Program of the Ministry of Human Capacities), 2 Bolyai Research scholarships and 2 OTKA grants.

laboratories

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financial computing and signal processing

The main research and development activities of the laboratory focus on adaptive algorithms, optimization of communication protocols, statistical resource management and admission control, and time series analysis and prediction. Its expertise also includes the mathematical foundations of signal processing, statistical network reliability analysis and mobile gaming optimization.

Recent achievements include novel algorithms for identifying mean reverting portfolios, support vector machines and neural networks for efficient trading, new non-supervised channel equalization algorithms, optimal energy aware routing protocols for wireless sensor networks, adaptive server update strategies for mobile gaming, real-time network reliability analysis based on statistical sampling techniques, intelligent packet classification methods for internetworking based on computational geometry, blind equalization algorithms for radio channels corrupted by selective fading and additive Gaussian noise, novel scheduling algorithms by combinatorial optimization for telecommunication networks, hardware and software implementation of signal processing systems of QAM.

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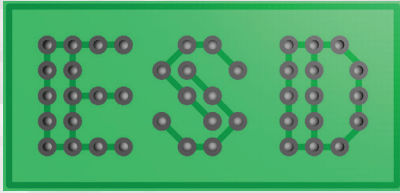
laboratories

Electronic System Design Laboratory

Our laboratory has been working on the electronic system development for decades.

At ESDlab we specialize in hardware, FPGA, and software development of high-speed digital, and analog systems. We have created communication devices, industrial computers, and peripherals, like data acquisition boards, digital signal processor, and FPGA boards, and many more. Most of these are available on the international market, and some of them are still in operation in 24/7 service. Our research & development activities also extend to synthesizing, and analyzing digitally modulated signals, designing digital modulators, and demodulators, utilizing DSPs, general-purpose processors, and FPGAs.

Some of the most recent development activities of the lab:

• We have developed Unmanned Aerial Vehicle (UAV) electronic systems, including the redundant autopilot with sensors, the UAV communication system from the data source to the antenna, video signal acquisition, compression, and radio transmission from the UAV to the ground.

• Our team has been active in research of indoor navigation using Ultra Wide Band (UWB) technology, which is a promising solution to solve precise UAV navigation problem where Global Navigation Satellite System is not available.

• We design a wideband (30 MHz.. 6 GHz) radio wave direction finding system for drone detection application.

• We cooperate with MCL laboratory in the HunQuTech quantum key distribution project where we design the electronic control circuits.

Besides R&D, our group also takes an active part in teaching Electronics 1. (BSc), Engineering Acoustics (MSc), Computer Architectures (BSc), Integrated Design of High-frequency Digital Circuits (BSc/MSc).

laboratories

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The PARIPA is a novel complex program, unique in Hungary, founded by the Department of Networked Systems and Services. The students work on R&D topics defined by the partner companies, together with an academic and industrial adviser, targeting a strong liaison between the department and the industry. There are very strict rules for the admission, therefore only extremely motivated and well progressing students are admitted to the pro- gram. All students are members of a Soft Skill Workshop, where they receive additional skill development in creativity, communication, cooperation and strategic thinking.

In line with the goals set out in the strategy of our department, the aim is to develop university and industry cooperation, which results in the students of the department having a competitive, industry-demanding competence (knowledge-capability-attitude-experience) at the end of their studies.

The PARIPA Program

MTA-BME Information Systems Research group is one of the research groups sponsored by the Office for Research Groups Attached to Universities and Other Institutions of the Hungarian Academy of Sciences. It has been established in 2012 and since then it has conducted basic and applied research in cooperation with the members of the Department of Networked Systems and Services and the Department of Telecommunications and Media Informatics.

One of the main research directions is the stochastic modelling of network traffic and queues; development, analysis, optimization and dimensioning in the presence of various types of network traffic and services. The other main research area is the examination of communication strategies: routing algorithms are studied from a theoretical and practical perspective, including routing related problems such as efficient data structures and compression methods to be implemented in routers. In the field of quantum communication networks, reliable quantum communications over noisy quantum channels is explored.

The Department is hosting a Training Laboratory equipped with Cisco networking devices. The laboratory was established in summer 2009, and the equipments were complemented with a new set of IPv6 capable devices under the umbrella of the 6DEPLOY-2 project funded by the European Union's 7th Framework Program in summer 2011.

This laboratory serves as the place of practical exercises linked with regular university courses, such as Administrating Computer Networks, Administrating Secure Computer Networks and IPv6-based Computer Networks. Besides that, the laboratory hosts also Cisco CCNA courses in close cooperation with the Hungarian headquarters of Cisco Networking Academy.

In 2014, with the support of the local Academy, the Department initiated and launched the BME NetSkills Challenge student competition. After extending the organizing team with colleagues from the University of Pannonia in 2015, now this yearly competition is open for every Hungarian university students in the area of computer networking.

associated organizations

EIT Digital
Budapest Node

is a consortium of two local universities - namely, Eötvös Loránd University (ELTE) and Budapest University of Technology and Economics (BME) - and their leading industrial partners (consortial partners: Ericsson Hungary, Magyar Telekom, OTP, MTA-SZTAKI, E-Group, evopro); and a cooperating partner, Cisco Systems Hungary. The Department of Networked Systems and Services is strongly involved in the EIT Digital Master and PhD education programs, and in the research action lines.

HSN*Lab*
hsnlab.tmit.bme.hu

The High Speed Network Laboratory (HSNLab), as a strategic partner of the Ericsson Traffic Analysis and Network Performance Laboratory in Budapest, Hungary, focuses on high quality research and PhD education in the field of telecommunication networks. HSNLab integrates various research teams from several departments of the faculty.

HSNLab related activities of our department include the formal analysis of security protocols and security APIs, and the design of robust network topologies. Furthermore, our researchers are collaborating with Ericsson on green, i.e., energy efficient mobile networks.

Quantum Information National Laboratory
HUNGARY

As member of a national consortium, we are working on the implementation of a national quantum communication network which can be connected to neighbouring countries as well.

associated organizations

The Department of Networked Systems and Services is devoted to providing high-quality education in electrical engineering and computer science for undergraduate, graduate, and PhD students. The department actively participates in two bachelor level specializations, as well as in two major and two minor specializations at the master level.

Undergraduate program

In the undergraduate program, our department is involved in the following two specializations:

◽ Infocommunications (BSc program in Computer Engineering)
◽ Infocommunication Systems (BSc program in Electrical Engineering)

Within the Infocommunication Systems specialization, our colleagues are responsible for the Multimedia Technologies and Systems branch.

Besides the specialized and elective courses, the students also complete several laboratory exercises, and carry out individual project laboratory tasks and BSc diploma projects. Every year, over 100 students earn their BSc degree at the department.

The department also participates in the Bachelor of Profession (BProf) program, and is the coordinator of the "Networks and Security" specialization.

Graduate program

The master programs in the Department of Networked Systems and Services elaborate on the skills and enhance the knowledge of students through the following major and minor specializations:

◽ IT Security major specialisation (MSc in Computer Engineering)
◽ Quantum Information Science minor specialisation (MSc in Computer Engineering)
◽ Intelligent Networks major specialisation (MSc in Electrical Engineering)
◽ Acoustics and Audio Technologies minor specialization (MSc in Electrical Engineering)

Besides the specialized and elective courses, the students also complete several laboratory exercises, and carry out individual project laboratory tasks and MSc diploma projects. MSc level individual projects are very often related to our research activities and carried out in close cooperation with some of our industrial partners. Every year, around 30 MSc students graduate from the department.

education

Doctoral program

The doctoral training program enables students with an MSc degree to engage in independent research and research oriented postgraduate studies in the fields of wired and wireless networking, cryptography and network security, next generation communication systems, media technologies, and acoustics. Our PhD students and PhD candidates participate in the research and development projects of the department, and they also contribute to the department's teaching activities.

Discovering and working with talented students

Our department pays special attention to discovering and attracting talented students. We established special Knowledge Clubs for students in the following fields: computer security, networking and mobile systems and quantum communications. In these Knowledge Clubs, our leading researchers introduce exciting research topics to students, and in some clubs the students also perform self-study activities. In addition, we organize the CrySyS Security Challenge and the NetSkills Challenge, which are competitions where students are exposed to interesting problems.

Personal coaching

Our colleagues participate in the mentor program of our integrated MSc study program, where they advise individual students on their university studies and career opportunities.

PARIPA Program

The PARIPA is a novel complex program, unique in Hungary, founded by the Department of Networked Systems and Services. The students work on R&D topics defined by the partner companies, together with an academic and industrial adviser, targeting a strong liaison between the department and the industry. There are very strict rules for the admission, therefore only extremely motivated and well progressing students are admitted to the program. All students are members of a Soft Skill Workshop, where they receive additional skill development in creativity, communication, cooperation and strategic thinking.

Management Group

Our Management Group aims to help students develop management competencies through education (disciplines: Theory and Practice of Project Management, Startup Business Management, Self-Training Workshops) and research & development (Agile Methods, DevOp, Trust Building, ePMO).

education

Radio aspects

The 5G New Radio (5G NR) is defined to work above 30 GHz as well. Far

more 5G cell sites are required, each covering a smaller area (because of higher capacity, higher frequencies and smaller latency).

In the Mobile Communications and Quantum Computing Laboratory, we are working on 5G NR, and software-defined networking (SDN) with Network Functions Virtualization (NFV) supporting the underlying physical infrastructure for the 5G networks.

Security aspects

5G is not only about speed. 5G promises extra low latency, and access for all "smart" devices (machines, vehicles, and any smart device). 5G connects millions of small embedded devices. This new trend is called the Internet of Things (IoT).

Our department's CrySyS Lab focuses on the problems of securing embedded computing platforms used by IoT devices. This research area is important, because compromising the platform enables an attacker to take full control over the embedded devices, including all applications running on it.

Application aspects

Vehicular communications benefits from the extra low latency of 5G. In the MediaNets Laboratory we develop simulations of multiple dynamic V2X communications / service provision environments in heterogeneous 5G telco cloud systems.

Advanced 5G features like network slicing, application scaling, hybrid multiaccess V2X communications, adaptive network function placement and intelligent decision algorithms have been applied to examine how use-cases of connected and autonomous vehicles can be efficiently supported in 5G telco cloud systems.

5G

QCIHungary: Deploy Advanced Quantum Communication Infrastructure (QCI) in Hungary (Digital Europe, 2023-2025)

**Quantum Information National Laboratory of Hungary (NRDI, 2020-2025)**

Certain: Complex electronic hardware for free-space entanglement-based quantum key distribution syste (2021-2023)

Quantum mechanics-based computing is one of the most promising subfields of the Information Technology due to the quantum-based algorithms and protocols. Our researchers at Mobile Communications and Quantum Technologies Laboratory (MCL) focuses on quantum-based communications and quantum information theory. Our research group participated in the development of the first Hungarian quantum key distribution device. Due to the nature of the quantum mechanics, an eavesdropper is automatically detected during the key distribution process, which offers revolutionary solutions in the field of cryptography.

SECURED – Scaling Up secure Processing, Anonymization and generation of Health Data for EU cross border collaborative research and Innovation (Horizon RIA, 2023-2025)

The overall goal of the SECURED project is to scale up multiparty computation, data anonymization, and synthetic data generation, by increasing efficiency and improving security, with a focus on private and unbiased artificial intelligence and data analytics, health-related data and data hubs, and cross-border cooperation. The project will address the limitations that are currently preventing the widespread use of secure multiparty computation and effective anonymization.

recent projects
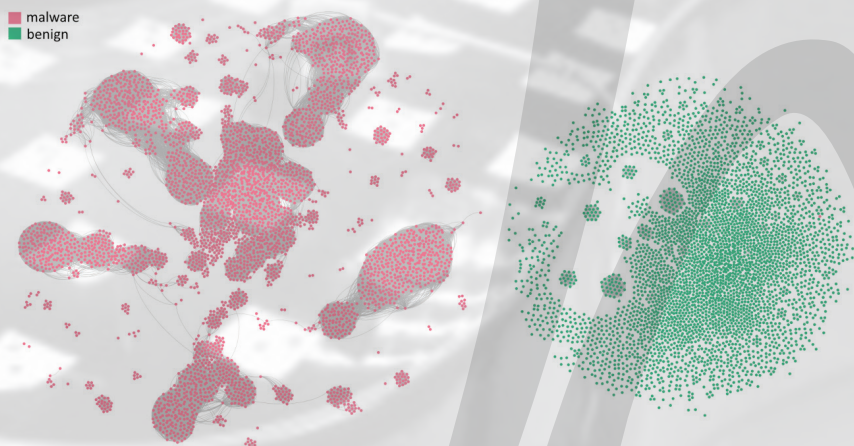
DOSS – Secure-by-design IoT operation with supply chain control (Horizon RIA, 2023-2026)

The project aims to improve the security and reliability of IoT operations by introducing to IoT Supply Chains an integrated monitoring and validation framework that includes all the relevant stakeholders. DOSS elaborates a secure-by-design methodology and implements related technology based on formalized data exchange, component testing and architecture modelling. The DOSS project establishes a "Supply Trust Chain" by integrating key stages of the IoT supply chain into a digital communication loop to facilitate security-related information exchange.

Intelligent transportation system – Competitiveness and excellence cooperations 2018-1.3.1-VKE (NRDI, 2019-2023)

The goal of this R&D project is to develop an intelligent transportation system, a new solution for the needs of urban mobility based on artificial intelligence, which will enable substantial progress in real-life control of the city traffic. Our team is focusing on the stream processing, machine vision, V2X communications, and adaptive traffic light control. Our pilot implementation is currently under testing in the city of Pécs in Hungary.

Machine Learning-Based Cooperative Vehicle and Traffic Control Using Secure ML and V2X Communications (CELSA Research Fund, 2023-2025)

The project investigates the use of machine learning in vehicles on the road to facilitate decision-making in vehicle maneuvering and traffic flow control. The goal is to enable human intervention-free levels (SAE Level 4 and Level 5) of autonomous driving vehicles.

Federated Learning-Driven Network and Service Management (GÉANT Innovation Programme, 2023)

The project developed a federated learning-driven traffic flow categorization approach, aiming to shift from data to model/algorithm sharing. The developed framework provides a common platform for computer network traffic flow measurement, feature computation, and federated model learning, sharing, and deployment.

recent projets

Large language models in log anomaly detection (Nokia Bell Labs, 2023-2024)

The AddICT lab has been cooperating with the Budapest office of Nokia Bell Labs for a long time in the development of algorithms supported by machine learning, with the help of which the operation of telecommunication systems can be made more economical. During the most recent project, procedures were created that can automatically filter out signs of abnormal behavior from various event logs.
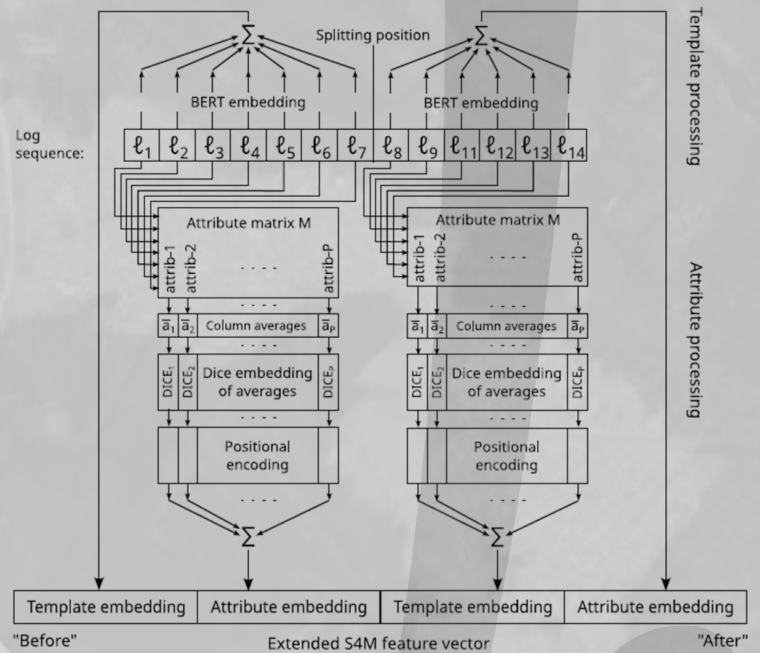
Stochastic models in machine learning systems (NRDI OTKA, 2021-2025)

Incentive design in the intersection of machine learning, information security and data privacy (NRDI OTKA, 2021-25)

Measurement, identification and tracking of moving noise sources by means of acoustic beamforming, (NRDI OTKA, 2022-2026)

Virtualization of reverberant acoustic environments (NRDI OTKA, 2022-2025)

Contribution Score Computation for Secure and Private Federated Learning (NRDI OTKA, 2024-2026)

recent projects

Map labels:
- Petőfi híd
- Tram 4,6
- Danube
- Bogdánfy utca
- Magyar tudósok körútja
- 47°28'21"N 19°03'35"W
  Building of Informatics
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