Co-operating partners who have chosen Mobile Innovation Centre to their project plans and tender preparations also in 2010

- BHE Bonn Hungary Electronics Ltd.
- E-Group ICT Budapest
- Bird Telecom Ltd.
- Nokia Siemens Networks Ltd.
- AITIA International Plc.
- Broadband Foundation
- Hungarian Telecom
- EURESCOM GmbH
- NETI Kft.
- AMST Vietnam
- System Of Science Innovation Centre cPlc.
- ITware Ltd.
- TCT Hungary Ltd.
- Codenomicon Oy
- National Media and Infocommunications Authority
- Nav N Go Kft.
Executive Summary
Prof. Dr. László Pap, president

Five and half years ago the management of the NKTH decided to invite tenders in order to improve the domestic research, development and innovation and to subsidize local and regional industrial and economical development. Among the thematic tenders the invitation for establishment of a Mobile Communications Research and Development Centre and Innovation Centrum was highlighted of which goals (according to the traditions of domestic ICT sector) are the followings: Establishment of an institute based on university knowledge base and industrial background, of which mission consists of following important elements:

• Support of research and development of high-speed mobile and wireless communication technologies
• Facilitating the initiation of modern mobile and wireless communication technologies and network services, installation of systems and applications based on them, moreover their environment independent testing
• Subserving development and practical application of the newest mobile and wireless communication technologies and services
• Promoting close research and development co-operations of universities and industrial parties, small and medium-sized enterprises, moreover support of small enterprises working in development of mobile and wireless technologies and services

Five years ago based on this tender, with subsidy of Program Oszkár Ashóth and hosted by Budapest University of Technology and Economics the Mobile Innovation Centre started its work, and in the last year successfully completed the centrally subsidized incubation period. In the mentioned period the Centre attained significant professional results and completely fulfilled the professional requirements with the support of its consortium and industrial partners. The NKTH Report published in 2010 contains the subsidy project of the Mobile Innovation Centre as one of the four NKTH pilot projects.

• In 2010 the Mobile Innovation Centre entered into a new period of its activity: according to the spirit and regulations of the original sponsorship agreement the Centre started the post-incubation activity without central subsidies. The management of the MIK intends to build up the future activity of the Centre based on the previous professional results and competences and the thoroughly established industrial and scientific co-operations, respectively.

In order to make an appropriate base for the future activity of the MIK it is worth considering the most important domestic trends of the profession:
• The mobile and wireless communication and mobile computing will remain dominant field of the modern telecommunications and information technology in the future that ensures wide possibilities for domestic small and medium-sized enterprises in the field of application development and content provisioning
• Exploitation of technical and economic possibilities in mobile and wireless infocommunication technologies is efficiently helped by a centre of which main challenge is to research and develop the newest (3G/4G) mobile and wireless technologies and systems, and application development for them.
• The enhancement of the innovation and value-added production in the field of the mobile and wireless technologies can contribute to improvement of the economical competitiveness of the country, reinforcement of small and medium-sized enterprises and therefore establishment of new workplaces as well
• All of these reasons explain further operation of an experimental system in Hungary that supports education and research of the newest mobile and wireless telecommunication technologies in universities and development of advanced services and applications. It requires the operation of a research and development center in the universities that includes third generation (3G) and beyond third generation (B3G) mobile and wireless elements, and involvement of enterprises in the field of telecommunications and information technologies. The Mobile Innovation Centre intends to solve the mentioned tasks after the end of the incubation period keeping the high level of activity also in international aspect.

In order to realize the mentioned purposes the MIK elaborated a new strategy that determinates the activity of the Centre after the incubation period. The main elements of this are the following issues:
• The Centre intends to modify its industrial co-operations according to the following aspects:
  - The Centre reinforces its co-operations with small and medium-sized enterprises that together with the professional staff of the universities and research institutes are able to develop their own professional and business activities. This means that the MIK will reorganized to a formation that can provide the research and development background of the domestic small and medium-sized enterprises.
  - Besides the former consortium members in the future the Centre is making contact with domestic industrial companies that are interested in application of mobile infocommunication services and developments based on these services (e.g. transport or health service providers)

• In the future the Mobile Innovation Centre will organize its professional activities as follows:
  - The MIK intends to work as a professional research and development organization where productivity (by means of R&D results) is in the focus
  - Selection of project members and the objectives of the projects will basically adjusted to the claims of the industrial partners in the future
  - Besides the Centre joins the wide range of European Union initiated research and development programs and make co-operation with the system of EIT KIC and the member institutes of European innovation organizations.
  - Henceforward the most important task of the Centre is to sustain an efficient and productive (producing useful results) co-operation system with industrial partners of which most important components are:
    - Precompetitive co-operation where the industrial partners co-operates with the Centre in solution of their interested technical problems
    - Usage of the testbed, when the industrial partners take the services of the Centre for charge
    - Development of new applications for industrial partners, where the Centre elaborates new themes for industrial partners within the frames of bilateral agreements and gives complete know-how exclusively
    - Industrial partners can contract with the Centre separately or jointly in co-operative groups in order to solve given research and development problems. The Centre typically finances these tasks using the subsidies of industrial partners

Besides the existing professional fields the MIK intends to improve its profile in the following highlighted themes:
• Development of radio systems, network applications and services, and especially IMS based services, integration of wireline and wireless networks and their special applications, respectively
• Development and application of secure electronic services and electronic payment systems including transport and banking systems
• Development and application of wireless communication systems, ad hoc networks and wireless sensor network primarily in the field of environmental protection, disaster recovery and health protection
• Enrichment of medical applications including monitoring systems and remote diagnostics
• Application of infocommunication systems and technologies for support of solutions for special social problems (e.g. scientific tutorials, content filtering etc.)

The achieved results of the Mobile Innovation Centre guarantee that after the finish of the first phase of the incubation subsidy the Centre successfully takes part in prestigious domestic and international research and development works in the field of mobile and wireless technologies and services, and thus contributes to the preparation of the country for handling challenges of the knowledge based society and economy.
Management of Mobile Innovation Centre

Prof. Dr. László Pap, President
Function and competence of the President:
• Strategic and scientific leader of Mobile Innovation Centre,
• Control, harmonization and professional verification of scientific research activities of the MIK
• Realization of the strategic plan of the MIK, casual modification, assembling the long-term R&D plan in cooperation with the Managing Director
• Acts in all issues that are his competence declared by the regulations of MIK
• Organization of domestic and international affiliations of the MIK
• Individual research-professional representation of the MIK

Róbert Schulcz, Managing Director
Function and competence of the Managing Director:
• Individual lawful representation of MIK
• Exercise employer and control rights on employees of the MIK
• Disposition of resources available in the MIK - preliminary in conjunction with the President and Financial manager
• Realization of the operative plan of the MIK, casual modification, assembling the long-term operative development plan, organization of execution of the ratified plan - in conjunction with the President
• Acts in all issues that are her competence declared by the law and internal regulations
• Keeping the contact with National Institute of Research and Technology (NKTH)
• The Managing Director is responsible for the proper professional execution of the undertaken projects and contracts
• Exploration of professional deficiencies and competencies, and development of them
• Ensuring professional background to tender projects
• Contact keeping with partners, mainly in professional issues
• Coordination of the development of the infrastructure

Dr. Barbara Hegyi, Financial Manager
Function and competence of the Financial Manager:
• General substitution of the Managing Director
• The Financial Manager is responsible for the coordination of all reporting activities, which meet the requirements of the partners and Funding Institutes
• Control, harmonization and verification of economical activities of MIK
• Contact keeping in the field of financial and legal issues
• Leading the financial administration
• Cost planning and internal controlling
• Coordination of marketing and PR activites

Prof. Dr. Sándor Imre, Scientific Research Director
The function of the CSO is the management of scientific research activity of the Centre; his competence is the control of scientific research group, organization and supervision of research projects of university departments and research institute groups.

Dr. Charaf Hassan, Service Development Director
The function of the CSDO is the management and organization of service-development activity of the Centre; his competence is the control of service-development (software) group, organization and supervision of development projects of university departments and service-development groups of research institutes.
The new organizational structure of Mobile Innovation Centre

Staff of Mobile Innovation Centre

- Csaba Balogh, engineer
- Zoltán Belső, engineer
- László Bokor, érnök
- Zoltán Faigl, engineer
- Ilőkő Hanicsek, project referent
- Ferenc Hubicsák, engineer
- Ágnes Juhász, tender referent
- András Kocsis, engineer
- László Madarassy, engineer
- Patricia Molnár, economic referent
- Zoltán Németh, head of laboratory
- Zsolt Pálinkás, engineer
- Viktor Rebényi, engineer
- Tamás Szlágyi, engineer
- Gábor Varga, engineer
As a conclusion of the fifth project year of the BUTE Mobile Innovation Centre one can state that the reorganization from mainly subsidy based Mobile 2004 operation to the industrial co-operation based model. The industrial co-operations, systematically established in the first 4 year, became mature up to now and reach the level of self-operation.

In the new model the MIK sustains the three R&D programs based project structure that was efficient thus far. The volume of given programs were determined by actual industrial demands; meanwhile we also started internal projects being the base of professional competence.

The industrial co-operations were successfully extended based on the MIK testbed (IMS based applications, RFID, commercial mobile applications, radio planning etc.).

Within the framework of the R&D Program 1 (air interface) of the incubation tender we developed the wireless communication protocol for land and air units of a high-intelligence high-reliability electronic survey system as an industrial co-operation. We have extended our 3G/4G radio access planning package and have written a professional survey on the 4th generation LTE systems ordered by the National Media and Infocommunications Authority. In proof of international respect of our experts we received a Vietnamese order for further development of X-band adaptive antenna arrays.

The co-operations are enhanced with our industrial partners within the frames of the former R&D Program 2 (networking technologies). Based on our experiences in networking technologies and secure communications we started the development of a novel e- and t-commerce supporting multi-payment platform and credit card adapted cell phone embedded RFID based payment solutions.

The joint projects with Hungarian Telecom were continued in networking related themes. In this year three fields are examined: device- and system-level modeling design and consolidation of Legacy transport and NGWDM-OTN network; delivery and installation of MIK developed IPv6 capable GGSN solution and mobile internet supporting IPv6 developments, respectively.

Using our international experience we participate in MEVICO (Mobile Networks Evolution for Individual Communications Experience) and a project for design of "Ultra Flat" architecture supporting high bitrate convergent networks.

Within projects of R&D Program 3 (mobile application and services) several results have been attained based on the work of the first three years. Beyond the scientific publications and the submitted projects, results are also focused on the aspect of applications according to the nature of Program 3. In the field of applications and services almost all the projects elaborated application or technology. The CMP (Common Mobile Platform) platform that has been worked out for the support of application development tools should be particularly emphasized. Namely, this software package helps in uniform generation of applications for various mobile platforms. The CMP covers three related fields in application generation: user interface, communication, data management. Presently CMP is able to generate applications for three platforms: Java, Symbian, Windows Mobile; moreover also for Android in limited manner.

In the last year we developed an IMS client for Symbian platform that was ordered by the Hungarian Telecom. In this year the work is continued within the frames of a new contract in order to extend the development for more platforms by using the CMP. The MIK is capable of handling the whole spectrum of mobile platforms regarding the competences. The RIM is only platform with less importance; however its relevance is declining in Hungary and abroad as well.

Most of the projects have active industrial co-operation. The established active co-operations with several small and medium enterprises besides the multinational companies should also be emphasized, and these are proven by the following contracts:

<table>
<thead>
<tr>
<th>Contracting Party</th>
<th>Subject Matter of Contract</th>
<th>Period</th>
<th>Project Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungarian Telecom</td>
<td>Development of IMS client for mobile platform and STB</td>
<td>July 2009 – 15th October 2009</td>
<td>Dr. Hassan Charaf</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Strategic design of FTTx layer 0</td>
<td>July 2009 - 30th November 2009</td>
<td>Tamássy Jakab</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Automatic fax testing</td>
<td>July 2009 - 30th November 2009</td>
<td>Róbert Schulcz</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>complementary agreement</td>
<td>July 2009 - 30th November 2009</td>
<td>Róbert Schulcz</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Elaboration of consistent design database algorithm for or examination of MPLS network</td>
<td>July 2009 - 15th October 2009</td>
<td>Tamássy Jakab</td>
</tr>
<tr>
<td>EURESCOM</td>
<td>Ultra Flat Architecture for high bitrate services in fixed mobile convergent networks</td>
<td>December 2008 - September 2010</td>
<td>László Bokor</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Device- and system-level modeling, design and consolidation of legacy transport and NGWDM-OTN network</td>
<td>July 2009 - 30th November 2009</td>
<td>Tamássy Jakab</td>
</tr>
<tr>
<td>NETI</td>
<td>Software module development</td>
<td>September 2009 - 15th December 2009</td>
<td>Róbert Schulcz</td>
</tr>
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<td>Software module development</td>
<td>September 2009 - 15th December 2009</td>
<td>Róbert Schulcz</td>
</tr>
<tr>
<td>iTware Ltd.</td>
<td>New generation multimedia social mobile services on IMS (MIK task: development of SIP protocol stack license and Multimedia developer framework)</td>
<td>1st July 2010</td>
<td>Sándor Szabó</td>
</tr>
<tr>
<td>TCT Hungary Ltd.</td>
<td>Development of Hosted Multimedia Contact Center in IMS (IP Multimedia Subsystem) environment</td>
<td>1st October 2009 – 1st October 2010</td>
<td>Sándor Szabó</td>
</tr>
<tr>
<td>Codenomicon Gy</td>
<td>IMS testing</td>
<td>1st February 2010</td>
<td>Róbert Schulcz</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Installation and delivery of IPv6-capable GGSN solution</td>
<td>November – December, 2009</td>
<td>Dr. Gábor Jeney</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Mobile Internet – Packet-switched network – IPv6 developments</td>
<td>1st May 2010 – 30th November 2010</td>
<td>Dr. Gábor Jeney</td>
</tr>
<tr>
<td>Hungarian Telecom</td>
<td>Implementation of mobile RBS prototype system on IMS</td>
<td>1st May 2010 – 30th November 2010</td>
<td>Dr. Hassan Charaf</td>
</tr>
<tr>
<td>National Media and Infocommunications Authority</td>
<td>Survey on LTE systems</td>
<td>9th April 2010 – 18th August 2010</td>
<td>Dr. NóriTk Vörös</td>
</tr>
</tbody>
</table>
As a serious professional appreciation of the former activity of the MIK it is important to highlight that the Centre has significant role in success of BUTE Research University tender due to the results and experience of the Mobile Innovation Centre. The international NKTH report contains the project of the BUTE Mobile Innovation Centre as one of the four selected representative NKTH pilot projects. The testbed of the Centre is registered to the Assessment of National Research Infrastructure and Roadmap Project (of which ID is NEKIPUT).

Consequently one can state that R&D activities of the MIK fit to the purposes in original business plan that ensures efficient continuation of professional activity beyond the end of the subsidy period. In the period that faces us the MIK intends to extend the group of our inland and foreign partners, which endeavor is significantly supported by our tenders that has been under review since the end of the incubation period.

The professional results of Mobile Innovation Centre has been introduced in the frame of the Annual Workshop, on 24th March 2010.
The management of the Centre conducted professional discussions in the recent past with representatives of the Oulu Innovation Ltd. (Finland) and University of Ostrava (Czech Republic) in order to find possible fields of co-operation. The Mobile Innovation participates in professional activity of the EITI Node in Budapest. The Mobile Innovation Centre contracted with Sharp Telecommunications of Europe Limited and the Foundation of Industry for the Modern Education in Engineering by which the Centre ensures professional coordination of the scholarship activity.

### Media appearances

The competences and projects of the Centre were acquainted also by the following media appearances:

<table>
<thead>
<tr>
<th>Date of appearance</th>
<th>Media</th>
<th>MIK leader</th>
<th>Title of article or program</th>
</tr>
</thead>
<tbody>
<tr>
<td>3rd September 2009</td>
<td>Index.hu, Parameter, delmagyar.hu, blikk.hu, kisalfold.hu</td>
<td>Dr. István Koller</td>
<td>With robotairplane in the wake of woodthieves</td>
</tr>
<tr>
<td>3rd September 2009</td>
<td>HVG</td>
<td></td>
<td>Robotairplain is being developed at a College of Budapest</td>
</tr>
<tr>
<td>3rd September 2009</td>
<td>gondola.hu</td>
<td></td>
<td>Hungarian robotairplanes, college students and the dawn of a new era</td>
</tr>
<tr>
<td>3rd September 2009</td>
<td>Magyar Hírlap</td>
<td></td>
<td>The robot-aviation will get bigger role in the future</td>
</tr>
<tr>
<td>31st August 2009</td>
<td>World Technology Awards</td>
<td>Dr. István Szakadát</td>
<td>Prezi.com</td>
</tr>
<tr>
<td>3rd September 2009</td>
<td>IT Business</td>
<td>Dr. Gábor Jeney</td>
<td>Online videofelügyelet</td>
</tr>
<tr>
<td>3rd September 2009</td>
<td>IT Business</td>
<td>Robert Schulcz</td>
<td>Which platform is going to win?</td>
</tr>
<tr>
<td>31st August 2009</td>
<td>Elet és Tudomány</td>
<td>Dr. István Szakadát</td>
<td>New communication theory of multimedia</td>
</tr>
<tr>
<td>April 2010</td>
<td>Gyártástrend</td>
<td>Dr. László Pap</td>
<td>Knowledge Centres on the eve of age of discretion</td>
</tr>
</tbody>
</table>
The aim of the SMCP (contactless Secure Mobile Payment) project is to develop an NFC contactless payment system, which is compatible with existing credit card systems, and can be used universally on any mobile phone, with the help a secure RFID tag.

The project has four main research directions, the system development tasks are based on the following research areas are:

- research the safe and multi-purpose (multi-use) applicability of RFID tags
- Universal (mobile phone and telecommunications network environment-independent) mobile data push service
- LBS (Location Based Services) activity analysis and user behavior characteristics research in order to increase the security of payment
- integrating opportunities offered by NGN (Next Generation Network) into the payment security

The main tasks of MIK are system architecture design, mobile networks and NGN integration related researches.

During the first year we developed the system architecture, defined the elements of the system functions, access methods, and defined the individual elements of a secure communications channel. We designed and implemented a pilot system in the MIK test network, capable of testing each function (system-critical processes, such as purchases, registration, data verification, etc), and performed measurements on the duration of the transmission of data. The current test system resembles of a client running on a mobile device at the shop at, a seller-side program module and a server application, which controls and monitors the transactions. The system design aspects are the utmost importance to the security of banking transactions to protect the eavesdropping or unauthorized use. The system relies on a number of safety mechanisms. For example besides the communication encryption and mutual authentication of the client and the server, the system checks the buyer’s and the seller’s mobile radio cell identifier, too.

It is also an important task for mobile devices to ensure continuous communication with the SMCP server. We have developed an architecture capable of providing a PUSH type of service, which works both in IPv4 and IPv6 networks, and with minimal addition to the communication traffic, allows the client to continuously access the server.

The system’s internal communication relies on the SIP protocol, conforming to the IMS (IP Multimedia Subsystem) system, which is a central element of next-generation telecommunications networks. The IMS services are important for authentication, SIP-based relationship management, and user profile storage. The application of IMS increases the flexibility of using the system, and the contactless mobile payment services can be achieved in cooperation with mobile operators, too.
The aim of the project is development of a modern intelligent survey system for defense purposes having several unique parameters and market generative ability mainly for aircraft platforms, which can be adapted for sea and terrestrial uses. The development is not for itself, it is only a tool not a purpose. The real background aim is the reinforcement of the Hungarian high-tech/aerospace industry to raise market share and commissions even in international aspect. Thus additional incomes can be ensured those give coverage not only for the enterprises concerned, but even for the aerospace industry (aircraft and space industry) and through it for the whole Hungarian background industry including material technology, plastic industry, composite technologies, a high-tech electronics industry, software industry, navigation technology, on-board computers, autonomous control technologies, modern interference-resistant communication technologies, data and image procession, electronic coding and encryption and real-time satellite communication (only the most important fields mentioned here). The project will have serious role in making close cooperation among the leader domestic institutes and enterprises in Hungarian technology research, development and production. This is a precondition for Hungary to be able to joint the European frontline in high-tech field.

**In order to realize the project a consortium has formed with the following participants:**
1. BHE Bonn Hungary Electronics Ltd. (BHE)
2. BUTE Mobile Innovation Centre (MIC)
3. BMF, Janos Neumann Faculty of Information Technology (NIK)

**The most important results realized up to June 2009:**
- System plan of the communication channel is completed, including OFDM and CHIRP modulation
- The simulation model of the whole communication channel is also completed, behavior of modulators, demodulators, mixers, radio channel can be examined according to their parameters
- Hardware implementation of parts of OFDM and CHIRP modulation has completed by the use of the available hardware development tools and advanced software technology
- Implementation solutions of error correction procedures for the proper communication channel error conditions were elaborated
- According to the mentioned results the requirements for the necessary hardware architecture was able to be determined that allowed of elaboration of the system design and circuit diagram of the communication unit for aircraft platform

**The most important results between June 2009 and June 2010:**
- Based on the previously made system plan and circuit diagram the BBCOM1 card of the communication unit was built with PCIe to PCI bridge, 1 GHz DSP, FPGA containing 5 million gates, 94 MHz A/D and upconverter D/A
- Detailed theoretical examinations were performed on the noise tolerance of the algorithms to be implemented
- Detailed simulation based examinations and measurements on the developing tool were performed regarding the symbol synchronization, frame synchronization and digital AGC
- Channel simulating algorithm was developed for modeling the selective fading
- Examination of applicability and testing of the TMS320C6416 DSP chip Viterbi co-processor
- Theoretical design of the adaption ability of the applied CHIRP modulation algorithm

**Directions of further improvements:**
The project has not finished yet, it runs according to the schedule, further issues to do:
- In co-operation with our partners we build an aircraft prototype in summer 2010 that allows of system testing in real-life environment
- Based on flight experiences the sub-devices are to be refined up to the end of the project in 2011
Mevico: Mobile Networks Evolution for Individual Communications Experience
László Bokor, Róbert Schulcz
- the project has been established by the support of National Office for Research and Technology -

The advance in mobile, cellular telecommunication technologies like HSPA (High Speed Packet Access) and LTE (Long Term Evolution) is motivated by three, not entirely independent factors: the tense technological competition, which aims to preserve the competitiveness of the mainly European-breed 3GPP (Third Generation Partnership Project) against alternative technologies like WiMAX (IEEE); the interest of service providers in technologies that are cheap and cost-effectively operable, converged, packet switched and provide high-bandwidth network throughput, which interest is partly generated by competition in the market and increased voice and data communication traffic; as well as the users’ demand on quality, value-added multimedia services.

The result of this continuous technological evolution is the LTE radio system defined in 2008, which has an entirely packet switched architecture, both in radio and access networks, in order to achieve an increased system capacity, user bandwidth, and decreased latencies. The core network of LTE radio systems is called Enhanced Packet Core (EPC). These systems have to be able to serve a multitude of users accessing high-bandwidth services simultaneously, which requires fast transmission speeds and high network capacity. Operational and servicing costs are decreased by Self Organizing Networks (SON), although only at base stations yet. The commercial release of the first LTE networks is to be expected in the following years.

With the completion of the LTE standardisation process, the research (WINNER+) and standardisation (3GPP) work to improve upon LTE has already begun, with a goal to define and standardise LTE-Advanced in 2010. It is aimed at increasing the capacity of the system (bandwidth and number of users), and to increase the bit rate available to users, thus further raising the requirements on the core network (EPC).

The mobile broadband service, that is an increasingly competitive alternative for wired Internet connectivity, has enabled the spread of online content in radio access networks, so the technological (mobile and wired), system-level convergence has been supplemented by user-level convergence, as the users access the same set of services regardless of the utilised technology (make calls on the Internet, browse web pages on their mobile phones). Convergence not only means increased quality expectations, but also raised resource requirements due to the steeply increasing user bandwidth, as well as high operational and traffic management costs.

The goal of the project

The goal of the MEVICO project is to study and define the medium-term development directions of 3GPP mobile networks and the necessary steps to ensure fitness to the requirements set out by the new radio interface and the increased Internet traffic. The project focuses on packet switched data transfer, mobility issues, network and resource management, as well as virtualisation-related problems, cost-efficiency improvements, and questions of autonomous operation. The results may be utilised in the standardisation process of EPC 11 and 13, and may help the work of standards organisations.

Next generation multi-payment platform supporting e- and t-commerce, e-content driven micro-payment and e-community shaping system for the e-market
Róbert Schulcz
- the project has been established by the support of National Office for Research and Technology -

Although solutions to replace cash have existed for long, the exponential spread of such systems has only begun lately. The reason for this is that people’s mentality regarding alternative payment methods has only been changed in the past few years by the widespread usage of the Internet and the prevalence of other unconventional payment-capable devices (like mobile phones, etc.). The essential idea behind these electronic technologies is that almost every device is suited for payment, charging for services, topping up credit accounts or any other transaction, which its user is identifiable by, and the necessary interaction can be carried out with.

Project goals
Our goal is to create a universal, widely usable commerce platform (both payment and accounting), that supports multiple suppliers and accounting systems, has numerous refills methods and is easy to interconnect with existing systems. The platform is suited to handle any arbitrary currency as well as imaginary money (mostly loyalty points). One of its most important novelty is that it supports many existing and future payment methods, by means of which all transactions can be managed in a single system, ranging from low-value payments (micro-payments) to the largest money transfers between companies.

The system developed will serve as the basis for common services to be deployed in the Chinese and Central European markets. It offers a solution to facilitate the integration of payment systems for online content and online merchandising in these regions; making Central European online content services available in China, and interfacing Chinese and Asian content to Central European payment systems. This system is prepared to be the backbone of multi-loyalty account systems providing customer loyalty services for entire company groups, by creating the technological background to share information about customer bases.

Evaluation of the novelty factor in international and domestic contexts
The attempts at answering the questions above have all been far from satisfactory so far. During the lifetime of this project we expect to see an acceptable response for the practical needs of the industry, by the collaboration of theoretical researchers in the field of computer science, IT engineers, post-doctorate specialists, as well as Ph.D. and undergraduate students.

In the execution phase we work closely together with one of the most prominent domestic supplier and expert in electronic commerce and security solutions. In the process of becoming a product, the manufacturing and product development background of our Chinese partner assures that lack of necessary hardware equipment or embedded software will not obstruct the implementation.

As the result of our research, we expect to resolve at least partly the deficiencies of existing systems, through which E-Group as a solution provider and systems integrator will be able to offer platform solutions to a much wider customer base. However the results of a successful project are more general than this; we hope that laboratories focused on education will remain in existence in the participating institutions, a group of specialists will be trained, and thus a university knowledge base will be established, which could become the centre of further research and the source of professional capacity.

Other impacts of the project include the availability of hardware devices and software tools at the university partners of the consortium, which make the inclusion of the topic into university education possible, in the form of courses, laboratory exercises and thesis projects.
The project aims to develop a distributed application platform for contact centers, based on the NGN (Next Generation Network) network architecture. The developed application platform connected to Virtual PBX services in connection with the same operating principles and service, following constitutes the Contact Center functionality, which is now linked to the PBX systems offer additional applications. The priority goals of the project are the IMS integration and a widespread implementation of IMS services.

In accordance with the system design, we have continued to integrate the modules into a single framework. It is needed to transform the resources of the communication part - the communication layers: Interworking layer and CCAPI - of the system to addressable service nodes, by developing the appropriate interfaces and protocols.

Scalability and expandability were important focus points during the development of network resources layer. Mobile clients and applications enable mobile voice and video transmission through the IMS system, relying on the SIP protocol. During the integration of the new generation IVVR (Interactive Voice/Video Response) system, we have chosen new type of hardware cards (e.g. Dialogic and Aculab) rather than the originally planned Surf-Com cards. It is also an important tendency, which CPU based processing (Host Media Processing) becoming the leading technology rather than DSP based cards, because of price and scalability issues. For these reasons we have chosen Dialogic HMP based technology over the originally planned Surf-Cards.

The testing of new functions and performance measurements are started on the MIK testbed.

IPv6 for mobile subscribers
Partner: Hungarian Telecom
Dr. Gábor Jeney

The Hungarian Telecom Wire-line Division has been installing the new version of Internet Protocol, IPv6, for their subscribers in their system in last and this year.

Installing IPv6 - it is not a trivial operation and obviously requires the help of entities and organizations where practical experiences related to IPv6 are accumulated for any reasons. The BUTE Mobile Innovation Centre has already installed the native IPv6 service in their own UMTS/3G network in 2008. Our solution has been presented for all Hungarian partners, however only the Hungarian Telecom Wire-line Division (T-Mobile) was interested.

In the previous year, 2009, we delivered a GGSN tool to the T-Mobile pilot network that allows of establishment of native IPv6 connections for mobile clients. Thus IPv6 testing became available for T-Mobile colleagues. Previously GGSNs with IPv6 support was not available for the company. The solution properly operates and several tests were passed on it that were performed by the colleagues working for the T-Mobile.

In this year as an extension of our co-operation further orders were given for the Mobile Innovation Centre. We have to investigate the IPv6 support of several present and previous mobile device sets. Devices theoretically bearing with IPv6 capability also have to be tested practically. The testing requirements are being defined by the colleagues of the operator.

Besides the testing of the mobile devices we ought to give recommendations for traditional (IPv4) Internet connection of only IPv6 capable mobile clients. The problem is that the only IPv6 mobile users have a requirement for connecting the Internet segment where there are only IPv4 nodes. As
these two versions of the protocols are incompatible the IPv6 mobile client can not directly connect the IPv4 node.

However, the IPv6 packets can be transformed to IPv4 and vice versa, which process is called translation. By the use of the protocol translation (Network Address Translation - Protocol Translation, NAPT-PT) the two regions can communicate with each other as the IPv6 initiated connections can be terminated on IPv4. The unambiguous drawback of the protocol translation is the break of end-to-end connectivity of the basic Internet concept. The inserted element (translator device) breaks the end-to-end connection that cause various problems (e.g. in case of IP authenticated ESP/IPsec packets).

The next possibility is the Transport Relay Translation (TRT), where two connections are set up in transport protocol level (e.g. by TCP). One of them is build up between IPv6 node and TRT device by the use of IPv6 and the other one is established by the TRT device towards the IPv4 node, certainly by IPv4. Between the two connections binary copied packets are transmitted: the TRT device copies the inward packets from one of the connections to the other one in binary manner and vice versa. The drawback of the solution is violation of the previously mentioned end-to-end connection paradigm. Moreover each transport protocol requires unique TRT implementation.

The third possibility is to use an Application Level Gateway (ALG). This is partially also required for the previously mentioned solutions because for instance the DNS-queries only with A records have to be translated to AAAA IPv6 instead of IPv4 (DNS-ALG). Besides a dual-stack web proxy is also suitable for hosts only with IPv6 connections to access the IPv4 Internet. Similarly we can mention the dual-stack email server that is able to receive any mail (from IPv4 or IPv6 Internet) and the nodes with only IPv6 connections can receive all their incoming mails through this server. The drawback of the solution is that every applications require different implementation.

As it seems we presented several technical solutions and the question is that how these can applied in practice and what problems and difficulties arise for the end user. Since the mentioned solutions we realize in the T-Mobile’s system the solutions it will be possible to test them in practice. The practical tests will reveal the answers for the mentioned questions.

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**X-band Adaptive Antenna Array**

*Partner: Academy of Military Science and Technology (AMST), Radar Institute*

*Dr. Rudolf Seller*

**Antecedents**

Within the framework of the MIK NKTH Sponsorship Agreement our laboratory conducted its research in the program 1. Mobile Radio Technologies in project 1.2 Future Radio Technologies and in 1.2.2 Research of Adaptive Antenna Arrays.

In the theme 1.2.2 several receiver and transmitter adaptive antenna arrays have been developed. These developments attracted the attention of Academy of Military Science and Technology (AMST), Radar Institute, Hanoi, Vietnam.

The representatives of AMST visited our laboratory for professional purposes in March 2009. During the visit we made technical specification of the antenna array that we intend to develop for them, and after it we made the relating contract with them.

**The Task**

The purpose of the AMST is an X-band adaptive antenna array (4x8 elements) that is able to attain the following functions:

- Receiving direction digital beamforming (DBF)
- Adaptive interference filtering (SideLobe Cancellation SLC)
- Adaptive direction finding and tracking (Angular Superresolution AS)

Basic requirements were

- digital IF (f_{IF} = 30 MHz, B = 1 MHz),
- FPGA based signal preprocessing inside the antenna
- and full Labview control of the system.

**The Developed Antenna Array**

![Blockscheme of the developed antenna array](image-url)
Results

The developed antenna was tested in the AMST antenna measurement room in Hanoi in October 2009. The antenna fulfilled the contracted requirements in all parameters, thus the AMST accepted it.

Based on the successful development the AMST expressed its intention to co-operation regarding the further research and development work. Preliminary we agreed in possible fields of work. In order to specify the future R&D tasks the Vietnamese partner will arrive at Hungary in spring 2010.
Participants in the Project: Orange-France Telecom (France, contact person: Philippe Herbelin), Portugal Telecom Inovação (Portugal, contact person: Pedro Neves), Mobil Innovation Center (Hungary, contact person: László Bokor), European Institute for Research and Strategic Studies in Telecommunications (Germany, contact person: Ádám Kapovits)

Motivation
The challenge in the coming years for mobile and fixed-mobile convergent (FMC) networks will be to offer high bitrate data services to mobile customers. The mobile architectures currently deployed or under standardization (3G, LTE-EPC, etc.) follow a centralized approach which can lead to scalability issues.

User plane scalability issues are mainly foreseen for anchor-based mobile architectures. Indeed, IP addresses for users (mobile nodes - MNs) are allocated in high level network elements, called anchor points (GGSN in the UMTS networks and PDN-GW in LTE-EPC architecture) and there are other intermediate network anchor points: SGSN, RNC in UMTS and S-GW for LTE-EPC systems. Each of these anchor points maintains a context per MN that binds the MN identity, tunnel identifier, required QoS, etc. Network elements are limited in terms of simultaneous active context, therefore in case of traffic growth new equipments should be added or existing ones should be replaced with more powerful ones. If the traffic grows rapidly and continuously, adopting this solution will be challenging for operators and cannot ensure Return On Investment (ROI) of these equipments.

Scalability issues are also foreseen on the control plane, concerning IMS standardization. Separating IMS service layer and access layer enables service convergence but introduces complexity regarding session establishment procedures. When the terminal attaches to an IMS network and requests a service, it has to perform a lot of complicated steps like authentication and registration to the access network, discovery of IMS components, registration to the IMS network, and session establishment. Since service and access network levels are separated, PCC (Policy Control and Charging) architecture has been introduced by 3GPP to perform the interaction between the two levels during session establishment, modification and release procedures. PCC ensures that the bearer established on the access network uses the resources corresponding to the session negotiated at the service level and allowed by the policy operator and user subscription. Due to the number of standardized IMS interfaces, in this complex environment interoperability between the IP Multimedia Subsystem and the EPC may cause issues to offer Time To Market services.

To solve the scalability issue and in order to optimize service establishment and mobility procedures the project proposes for fixed-mobile convergent networks the distribution of traditional user and control plane functions in the Base Stations (BS) or in an equipment close to the BS for mobile networks such creating an Ultra Flat Architecture (UFA).

Objectives
Fixed networks were subject to the same scalability problems as introduced above. IP routing function that provides IP connectivity to the users was first implemented within centralized IP routers. When triple- and quad play services took off, network architecture has been modified by pushing IP routing function close to the subscribers, for example in the DSLAM for DSL services. This has solved scalability problems since the centralized routers are no more needed. Besides, the number of required DSLAMs was not impacted by this modification since the most dimensioning criterion is the number of users physically linked to the network. With this flat and distributed architecture, fixed network investments have been reduced.

The project aims to use the same scheme in order to transplant the flat and distributed nature of modern fixed networks and to provide an Ultra Flat Architecture for mobile and fixed-mobile convergent telecommunication systems. The objectives of the project are derived from this point of view in order to deal with the main questions and problems of the UFA paradigm:

- Evaluate the limitations regarding scalability, and also from time to market point of view of 3GPP (and 3GPP2) architectures using anchor based mobility;
- Define an IMS and SIP-based Ultra Flat Architecture for mobile and FMC networks;
- Provide a list of requirements for such an Ultra Flat Architecture;
- Assess the advantages (e.g. cost efficiency) of adopting an Ultra Flat Architecture;
- Integrate IEEE 802.21 MHI standard into the UFA paradigm in order to provide infrastructure for media independent handovers;
- Define the UFA mobility management signaling subsystem in two possible alternatives: on one hand a solution based on Proxy Mobile IPv6 (SIP+PMIPv6+802.21) is to be created, on the other hand a scheme based on Host Identity Protocol (SIP+HIP+802.21) applying advanced ID/Loc separation is to be studied;
- Analyze the different UFA signaling alternatives using the mathematical toolset of the Multiplicative Analytic Hierarchy Process (MAHP);
- Pique interest of vendors and standardization organizations in the UFA design approach.

Figure 1: UFA reference architecture for the Host Identity Protocol based signaling solution
Results and future work

We have successfully analyzed the user- and control plane scalability issues of current centralized mobile architectures. In this subtask MIK’s real-life 3G-IMS testbed played a very important role because proper measurement results gathered from this testing environment helped us to prove the scalability deficiencies rooted at the architectural level of 3G systems. We have created the terminology for the UFA networking paradigm, and also collected all the requirements for an Ultra Flat Architecture. Here MIK’s main contribution was concentrated in collecting and evaluating AAA and mobility requirements, but fixed-mobile convergence, and energy efficiency was also taken into consideration. We have also distinguished four different use-cases for the UFA implementation both describing a unique reference model and considering a possible architectural point where the UFA Gateway might be distributed.

We have also defined two different, integrated UFA signaling approaches: there is a standard IPv6/MIPv6 based solution (SIP+Proxy Mobile IPv6+802.21) using common IP level mobility management, and we have also developed a Host Identity Protocol based scheme (SIP+Host Identity Protocol+802.21) in order to introduce the concept of ID/Loc separation in the UFA paradigm (see Fig. 1). Both of the above schemes have completely formulated including the terminal attachment procedures, the session establishment, maintenance, QoS and mobility procedures together with mobility preparation, decision, execution and completion mechanisms (Fig. 2 shows the details of the UFA Handover completion phase in the HIP-based scenario). A comprehensive analysis and comparison of the alternative scenarios has been made using the effective toolset of Multiplicative Analytic Hierarchy Process (MAHP). The study has proved that a flat and fully distributed architecture, with customized protocols scenarios could provide a solution to the scalability issue of mobile and convergent networks.

The results of the Eurescom P1857 study will be used as background for a CELTIC project named MEVICO. A new collaborative project under the EC will be prepared in 2011, for a possible submission early 2012.
Indoor Location Services and a Context-Sensitive Framework
Partner: System Of Science Innovation Centre cPlc
Róbert Schulcz

In the field of location services numerous systems have already been designed that are able to determine the position of people to a certain degree in one selected network type (for example WLAN). The creation of applications built on these is usually the task of the location module’s end user, although the aggregation of the target audience's requirements would enable the development of systems suited to satisfy all these needs.

The goal of the project
Our goals during the project’s life cycle include the survey of the needs of such a target audience, drafting and designing appropriate applications for them, and then the actual development of an application package, utilising our R&D results previously achieved in the field of location services.

We intend to implement an indoor navigation system similar to current well-known car navigation, usable even in the most labyrinthine building complexes, thus first we would like to target office building operators. By the use of electronic navigation devices, verbal (and almost never fully working) hints and the escorting of guests could be superseded. In such environments office renters often change, and companies also move inside buildings as they grow in size, so usually they don’t know where other companies are located.

Our system could also benefit renters by services such as finding the nearest free common resources (meeting room, technician, etc.) or individual colleagues.

We plan to develop a system that would be, with minor modifications, applicable in other similar environments. Such sites include hospitals, health-care institutions, but also conferences, professional conventions and trade fairs.

As the result of our previous R&D activities, we have a novel method to manage locations uniformly, and a prototype framework that proves its viability. Building on this method we are working towards developing an indoor location and navigation system that is both easy to use and flexible.

Using this system we can combine results from different positioning sources in a single framework that provides the necessary abstraction. This way the accuracy of the location information can be increased, and the area covered by the service can also be extended (for example by using WLAN indoors, and GPS outdoors). The user application becomes independent of the differences between various location technologies.

We set out a goal to create a more intelligent, usable and personalisable mobile service that provides location-sensitive and context-sensitive services, and utilises the model of the environment to achieve this (floor plan, walls).

With the integration of location technologies the properties of different location devices can be unified, and their technological differences can be hidden from users and developers.

The system planned to implement
The application may be accessed on mobile devices too, which ensures another feature that traditional information boards or information desks don’t have: the user continuously receives feedback and orientation under way. Thus an interactive communication process comes into existence, which is entirely personalisable. The user can follow this interactive communication on the screen, listen to audible navigation instructions, and query the software for other informations via the appropriate input controls. This is a time-, energy- and cost-efficient method, because it helps minimise the possibility of human error. The system always contains up-to-date information, so during a navigation session we can trust it to give accurate hints. This way we can have such an active system that’s not only capable of locating the user’s position, but provides real-time navigation services. These navigation devices may be assigned different security credentials, so they can also function as entry cards.

The model provides such a media-oriented framework that enables real-time access to different contents during runtime, dynamically. This framework is supplier- and manufacturer-independent.

Services for the operator:
- A configuration interface that allows setting up and modifying the system’s parameters during installation or at topological changes in the radio network, and provides methods for fine-tuning and branding the software.
- An administration interface that supports the following operational functions:
  - Registering terminals and assigning them to users. Users of the system may be:
Renters
Employees of the building operator
Visitors
• The states and positions of individual users may be queried.
  – A common communication platform, which enables the operator to send text, voice or video messages to users, or initiate communication.

Services for visitors
• Navigation to the offices of the requested company.
  • Remote assistance: communication with the operator or an employee of the company to visit.
  • Displaying further informations or viewing introductory videos.
  • Door entry services.

Services for renters
• Displaying the nearest free common resources: meeting rooms, technicians.
  • Locating individual colleagues.
  • Indoor navigation to selected targets.
  • Placing information materials for visitors on the virtual map (further branding).

Introduction to the MIK Testbed
Zoltán Németh. Head of Laboratory

The network of the Mobile Innovation Centre integrates both the wireline and wireless telecommunication systems. Our system is capable of managing IPv4 and IPv6 wireline and wireless traffic as well. However, the system has a heterogeneous structure, its elements can maximally co-operate with each other. The network has various hardware and software components, which are the followings:

• MPLS and IPv4/IPv6 based backbone network
• Various backbone connected access networks including 3G/HSDPA, several different IMSs and WLAN solutions with IPv4 és IPv6 capabilities, respectively
• Workstations including computers with management, operational and R&D purposes
• PC-based servers for various R&D experimentations
• OSA/Parlay environment for support of R&D developments
• Interfaces for other networks such as Internet, ISDN, T-Mobile GPRS

One can see the actual structure of the network in 2010 in Figure 1. The interconnections with different outer networks are also shown.

Characteristics of the Testbed

Apart from the existing Huawei and Nokia IMS systems we started the open source OpenIMS, which is installed in Server Room 1. Moreover, we started the system Huawei IMS 6.0 meanwhile the operating the Huawei IMS 4.0 simultaneously. Thus we operate 4 different IMS systems in the same network, which is unique all over the world.

The Mobile Innovation Centre had also another important development: we installed the open source OpenGGSN. Thanks to our colleagues’ work the IPv6 protocol is implemented that enables native IPv6 internet connections for mobile user throughout the MIK 3G network. The IPv6 address mapping is shown in Figure 2, and Figure 3 shows the MIK testbed in ANEMONE IPv6 network.

According to Figure 1, the RFID (Radio Frequency Identification) equipments are also the parts of the testbed. The Mobile Innovation Centre uses various readers, antennas, RFID tags, tag printers and other equipments for frequencies 10 MHz (HF) and 865 MHz (UHF).

One can also mention the MIK’s RF instruments and their auxiliaries that are required for various radio measurements.

Also an important novel part of the MIK network is the indoor positioning system. Its operation is based on WiFi routers, our server-side application, Oracle database server and the client applications running on the connected mobile devices, respectively. The testbed of the Mobile Innovation Centre being interconnected with the international Anemone native IPv6 test system enables examination of various mobility-related network functions.
RECENT DEVELOPMENTS ON MIK TESTBED

- Developments of the UMTS Network:
  - 7.2 HSDPA development, elimination of AAL layer and compatibility problems
  - SGSN upgrade, 3GPP TS Release 7 functions (Iu interface, GTP, MBMS)
  - OpenGGSN development, IPv6 protocol stack implementation
  - GGSN development, multi-APN functions (IPv4, IPv6, various services)
  - QoS implementation
  - GGSN-NGSN interoperation tests

- IMS upgrade:
  - Huawei IMS upgrade, IMS 6.0 installation of IMS 6.0 besides IMS 4.0
  - Development of OpenIMS system

- Qualification of the testbed, network qualifications:
  - Structure query, traffic tests
  - IMS security, load tests

- Elaboration of indoor positioning system:
  - WiFi router set-up
  - Server-side developments and data-base solutions
  - Client-side software developments

- New cell phones
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