Future Internet Research, Services and Technology

International Workshop

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NEW SZÉCHENYI PLAN

Future Internet Research, Services and Technology

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Foreword

The primary aim of the present Proceedings is to show the results of the FIRST (Future Internet Research, Services and Technology) project launched at 01.10.2012. This means not only the scientific achievements but also other activities connected to our works. Each subproject prepared its annual report introducing their contributions as you can read in the following pages.

You can get insight into the new scientific results, methodologies, approaches born during the first project year by the workshop talks. The six research subprojects deliver 3 presentations, respectively. Furthermore, you are informed about the activities in the subprojects connected to the educational matters as well as the Future Internet Research Coordination Centre.

Performing the annual evaluation I can declare that our plans were fulfilled. During the last year our researchers took part several important international conferences, well-known scientists visited us for conducting joint research, several international and national project proposals were submitted, quite a lot research and development projects were granted, and many young colleagues were involved into the work. The Research Coordination Centre was established aiming organising activities and co-operations in national and international level. I must point out that 133 of the total 180 publications planned for the entire project duration were fulfilled.

The main goal of this international Workshop is that the researchers working in different groups can learn about the research carried by other subprojects and the cooperation between groups should strengthen. In addition, that our industrial partners and our foreign guests could be informed about our international level research results and activities.

I wish you a successful participation

Dr. János Sztrik
Head of Research

Subproject 1

Theoretical foundation of Future Internet

Subproject Leader: Attila Pethő

Professional work of the subproject is diversified. There are three consortium members: University of Debrecen (UD), Hungarian Academy of Sciences, Institute of Nuclear Research and research groups of ETIK. Concerning UD, there are researchers from department of Computer Science, department of Applied Mathematics and Probability Theory from Faculty of Informatics and department of Theoretical Physics from Faculty of Science and Technology. In spite of the research group is heterogeneous, it is productive. We have organized two workshops one on Mátrafüred on 1st of February in 2013, and one on Mátraháza on 21st of September in 2013. The first mini conference was held at the beginning of the project, hence its goal was to formalize project goals, to find common and connected research topics and to determine administrative structure of the research work. All leading researchers presented their ideas on this workshop.

Main goal of the second workshop was to present the first results of the project. We gladly observed that there were several topics that were researched separately by researchers before, became common research. We assume synergies will be strengthened, in the following year.

Members of the research group mainly with coauthors created 17 scientific papers, and a conference proceeding. They participated in several conferences, they presented two conference talks per researcher in average.

Our research work can be classified in three topics, according to these topics we have three subgroups, even if we have research projects that belong to different topics. In the following we detail the most important results we achieved in the first year:

1.1. Data security and cryptography

Leader: Attila Pethő

We have analyzed a key exchange protocol, published in 2012. It is based on the difficulty of solving diophantine equations. Our paper containing these results was selected among the best papers of conference CECC2013, and its under publication in Infocommunications journal. We have investigated possible solutions of message authentications in client-server systems operating in broadcast mode. We have developed a modified version of protocol TESLA, which tolerates longer stops on server side. We have investigated security issues of mixnets based on bilinear pairings. We have designed a mixnet, which makes it possible to transfer arbitrary long messages and the receiver can reply to the anonymous sender without revealing his identity. We have developed theoretical bases of a pseudorandom number generator based on normal distributions. We have examined the possible applications, especially for lattice based encryption that is one of the most well-known candidates in post quantum cryptography. We have developed a new encryption process for the Dömösi cryptosystem that is based on Gluskov products. We have investigated the possibilities of device independent processing of quantum information. Our goal is to develop quantum protocols, where with the help of non-local quantum correlations we can estimate the size of quantum devices in the protocol, handling them as a black box.

1.2. Theoretical foundation of computer networks

Leader: Tamás Mihálydeák

We generalized set theoretical approximation spaces and dealt with the questions of their possible applications, in particular, how the new scheme could be applied to the real databases. After generalizing approximation spaces for multisets we build a two-layered model consisting of a membrane system and an approximation space for multisets in

order to handle the boundaries of membranes. From the logical point of view, we investigated how fuzzy systems could be generated relying on different approximation pairs. In addition, we studied how a logical system based on general approximation spaces could be built which met the requirements of the decision theory based on rough sets; what possibilities there were to introduce new approximation pairs; which properties the approximation spaces with different approximation pairs had.

We have implemented, tested and documented several search methods. Therefore all the implemented methods are sound. We have started to make hybrid methods. Hence by combining two own methods we got better result (for all dense graphs) than we earned with the hill climbing which is our etalon among search methods. We have examined paralell, classical computing modells. We have analysed the cellular automata as a classical parallel model of computation. We have also established some connection between cellular automata and the interval-valued computing through simulation results.

We investigated properties of P automata and P colonies. Concerning P colonies, we studied the computational power of their automaton-like variants, P colony automata. We showed that the strongest variant is able to generate any recursively enumerable language, and gave bounds on the power of the weaker variants as well.

We studied the general N-interactions random graph model (N>3 fixed). Methods of martingale theory were used to study the N-vertices model; our main tool was the Doob-Meyer decomposition of submartingales. We elaborated the proof of the scale-free property for the degrees in the N-interactions random graph model. The proofs of the analogue versions of the theorems which were used to obtain scale-free property for degrees were also elaborated by us.

The role of the normalized modularity matrix in finding homogeneous cuts of networks will be presented. We will summarize the spectral properties and testability of spectrum of the normalized modularity matrix which is used spectral clustering of networks.

I give an account of the properties of fractal networks. We cover the network by boxes which are sets of nodes such that the distance of any two nodes in a box is less than a given k. If the the ratio of the logarithm

of the minimal number of such boxes needed to cover the network and the logarithm of k tend to a number d as k tend to infinity then d is the dimension of the network and the network is a fractal network. For example the WWW is a fractal network. I will summarize the most important properties of fractal networks.

The construction of the Apollonian networks starts with a plane graph realization of a complete graph of four vertices. Then in every step of the construction we randomly select a domain of the graph we put a new node in it and connect the new node with the already existing ones which are from neighboring domains. The Apollonian networks show similar properties as the real life complex networks, like small world property and scale free property. I will summarize our results about this networks.

1.3. Molecular switches as data storages

Leader: Ágnes Vibók

The basic requirement for a molecular switch is bistability, i.e., the occurrence of two different stable forms of a molecule, which can be interconverted by means of an external stimulus (light, heat, pressure, magnetic or electric fields, or chemical reactions etc...). Since molecular switches have potential applications in a lot of areas, the search for them is of great interest nowadays. Because of their small size, switches play an important role in miniaturization, permitting ultrahigh density data storage on a molecular level.

Several organic compounds have a switching properties (quinolins, fulgides etc...). It is challenging both in experimental and in theoretical point of view to design switchable compounds. The latter is of course much cheaper, but it requires a lot of computational works.

The heart of these calculations is the proper description of the so-called nonadiabatic processes as molecular switches operate on typical nonadiabatic phenomenon. In this situation there is a very strong coupling between the electronic and nuclear motions of the molecule and

the electronic states intersect. The energy exchange between the electrons and nuclei can be very signi_cant.

During the first year we have studied partly the general nonadiabatic properties of selected molecular systems, which are closely related to the switching properties, as well as using theoretical calculations we have tried to look for specific switch molecules too.

Subproject 2

Modelling and Analysis of Future Internet Networks

Subproject Leader: János Sztrik

The researchers solve actual problems in a team work manner. In the following we give a brif summary about our recent activities.

2.1. Modeling and Performance Evaluation of Networks

We have introduced several finite source retrial queueing models to investigate the performance characteristics of wireless transmission problems in sensor networks, for example, with two different types of finite sources (emergency and normal) expanded with non-reliable server, network of sleeping state sensors and another model with multi-state server's breakdowns. In each case the main aim was to get the primary performance measure of the system, such as mean waiting and response times, mean number of jobs in the system, and in the orbit. The investigation was carried out by using modeling tools. The results were published in journal and conference proceedings paper.

Wireless networks are increasingly exposed to the risk of unauthorized access. Our question was to what extent the security of the network affects network performance. The answer of the question that encryption should be used because it does not cause too significantly slower speed. In wireless networks where devices on the network are compatible and security matters, always should be used WPA2/AES encryption. If speed is more important than safety, you can disable the encryption speed of 10-30% gain can be obtained.

We have created a model of information spreading in real social networks. We have worked out a well tunable method to generate a large variety if scalefree networks, which have different topological properties. We managed to find a smaller range of the wild parameter space, where the generated networks behave like real social networks. Using these networks we have finded out that in social network which are in declin-

ing phase of their lifecycle the speed of information spreading is slower, so the efficiency of advertisements are smaller.

Our purpose was to create a mathematical model describing the transmission of optical signals. Generally, we try to get analytical results, if it is too complicated one uses the simulation. In this case it is useful the regenerative approach, we illustrated it on the M/G/1 system and it led to the Pollaczek-Khinchin formula. The transmission of optical signals was described by an embedded Markov chain, we proved the possibility of its application and found the transition probabilities when the system was characterized by the number of present customers.

2.2. Online analyis of QoS/QoE in high speed networks

The primary goal of our research was to elaborate new QoE assessment methods for evaluating service quality of VoIP, IPTV and mobil voice. We performed laboratory evaluation of some critical media traffic types. We investigated the effect of network perturbation on services that integrates new generation media codecs. We analyzed the sensibility of services applying new generation media codecs to packet delivery anomalies in the network: how does the measured packet-level QoS correlate to the subjective perceived quality. During this work we analyze the correlation of three measurement dataset: objective (packet-level) QoS metrics, objective QoE (PSNR, VQM, SSIM) video quality metrics and subjective user evaluations (MOS). Our first QoE evaluation method aims to offer an alternative to the inherently subjective, perception-based service quality assessment approaches. The initial standpoint is an objective, estimation-based method that can be automated and its output correlates to the results of the above mentioned subjective analysis based on human feedback. Belonging to this method, we have developed a hardware accelerated, on-the-fly QoS monitoring system that has been prototyped on NetFPGA networking platform. The basis of the second quality-analysis method is a multi-threaded timestamping mechanism that enables the measurement of network and system perturbation at the endpoint in several layers. The third method was elaborated for the

QoE analysis of conversations in mobile networks. Using the subjective evaluation-based assessments we came up with a solution tailored to mobile environments based on the demands of the operators in which the subscriber evaluates the quality of the voice service at the end of the call. This assessment, depending on the operator's needs and aims, can be a MOS-type grade, but more complex options are also available. The developed method was implemented on Android mobile operating system by our cooperative partner in collaboration with experts from a local mobile operator.

2.3. New traffic characterizing and analysis methods for Future Internet

Modeling of spectrum renting in mobile networks: Our model integrates these characteristics, thus models the behaviour of the system more realistically.

Inspection of queueing algorithms: Our work introduces a generalized model for the investigation of the performance computation intensive tasks in clusters with unknown service times.

The MMBP/Geo/1 queueing system with correlated positive and negative requests: We analysed the background Markov chains of the model and evaluated the performance of the systems using generator functions. We also determined a few parameters of the system explicitly. Finally, we demonstrated the effect of some parameters on the system numerically.

The M/M/c re-trial queueing model: We gave an exact expression for the conditional expected value of customers. We used simplified equations to get a memory-efficient implementation of the computation of performance measures. We developed an efficient algorithm for the calculation of stationary state probabilities using a threshold value.

M/M/1 queue with negative requests and working vacation: We developed an efficient methodology for the computation of steady state distribution of this system.

Queue with two priority classes and feedback control: We exam-

ined a system with two priority classes (high and low). We calculated the steady state distribution using the framework of quasi birth-death processes. Performance measures can also be derived. These we demonstrated through numerical results.

Markovian representation of rational arrival processes: We have developed and implemented a heuristic procedure for transforming non-Markovian representations to Markovian ones. The results show significant improvement in reliability compared to previous methods.

Canonical representation of phase type distributions: Using previous results we have found a group of structures that can be used to describe the whole class except for very few cases.

2.4. New scalable methods for traffic management and resource allocation for Future Internet

In the processor sharing models our results shows that the multiclass processor sharing with limiting the user capacity can be considered as a solution of an extended constrained optimization problem. This constrained optimization can directly be connected to the analysis of strategic behavior of users in resource allocation.

In connection with data centers, we proposed an efficient architecture based on hyperbolic tessellation. This could support incremental upgrade of the system. We also showed an efficient routing mechanism well suitable for the architecture proposed, which are able to solve unicast and multicast forwarding simultaneously using in packet Bloom filters.

In network formation games we apply the two dimensional hyperbolic plane as a metric space. We showed that if simple and thrifty navigation incentives are imposed on the nodes then every equilibrium state of the network game contains a frame and this frame is provably scale-free. We also gave lower and upper bounds on the expected degree and degree distribution of the network formed by the game. We also presented a generally applicable method, which can be used to compute accurate enough approximation of the equilibrium network characteristics.

We had the possibility to implement and OpenFlow based testbed for investigating the behavior of multipath TCP in real traffic and networking environment. Based on extensive measurements we obtained initial results in identifying the weaknesses of mpTCP and performing reliability and performance assessment of the protocol in controllable real networking environment. We found, for example, that if the bandwidth delay product is high then mpTCP performance degrades even to lower level than that of the traditional TCP algorithms.

Regarding network coding we implemented a coding mechanism which are able to code intra and inter flow packets. We demonstrated in a mininet environment, that the simplest XOR coding scheme can also provide efficient improvement in throughput when there heavy congestion presents in the bottleneck of the system. This testing environment can be a useful tool in investigating the performance of network coding in larger networks, identifying those architectures in which efficient througput increase or decrease can be expected and analyzing the optimal coding aware node selection.

Subproject 3

Network architectures and protocols for Future Internet

Subproject Leader: Csaba Attila Szabó

Subproject 3 deals with important issues related to the network architecture of the Future Internet addressing the requirements towards the network. Such requirements include handling multimedia traffic, significant increase of the throughput, QoS and QoE assurance, access to the services from anywhere, from any access network, mobility between arbitrary network technologies and systems, adaptivity to the desired quality, to the capabilities of the user devices, and the network requirements of Internet of Things (wireless multimedia sensor networks, self-organizing networks).

New research goals have been defined in 6 areas.

3.1 Transport protocols of the Future Internet

Within Topic 3.1, „Transport protocols of the Future Internet", we have worked out the concept of a novel transport protocol without congestion control (DFCP, Digital Fountain based Communication Protocol), which can provide a serious alternative to the currently used TCP for future networks. We designed and built a testbed and a simulation environment in which our transport protocol and widely used TCP variants can be investigated. The results pointed out that DFCP can provide efficient data transfer in various network conditions even when TCP suffers from performance degradation.

3.2 Reliable and scalable Future Internet using network coding

In Topic 3.2, „Reliable and scalable Future Internet using network coding", we proposed approaches which are able to provide scalable and reliable solutions for the protection of Future Internet connections. We investigated the approach "1+1 path protection functionality in static routing", and implemented proof-of-concept OpenFlow applications to demonstrate the benefits of network coding. Proposed routing algorithms for this approach and investigated its theoretical properties. Finally, in Q4 we published our findings in a journal publication.

3.3 Self-organizing networks

In Topic 3.3, „Self-organizing networks", we developed a new communication protocol, the Direction Based Handshake Gossiping, which was implemented in our self-organizing network simulator, together with three other location based data dissemination protocols from the literature. The results showed that our solution overperforms the other three solutions. To be able to carry out more complex examinations by using a realistic and detailed model of wireless communication, we have demonstrated a new research platform, integrating the MIT Proto spatial computing suite with the OMNeT++ network simulator framework. To demonstrate the enhanced capabilities gained from integrating these two systems together, we have implemented an urban target-tracking scenario.

3.4 Scalable mobile architectures with distributed, dynamic and proactive mobility management

In Topic 3.4, „Scalable mobile architectures with distributed, dynamic and proactive mobility management", we first presented and analysed the nowadays emerging scalability problems of the mobile Internet. In order to perform extensive analysis and comparison of existing and work-in-progress DMM solutions, we designed and implemented a complex, INET/OMNeT++ based simulation environment where we evaluated MIPv6, MIPv6-RO, NEMO-BS, HIP, HIP-NEMO, and UFA-HIP mobility management solutions. Finally, we have analyzed existing LTE/

EPC simulation models (4GSim and SimuLTE), evaluated their pros and cons, and based on these experiments started to design and develop a complete and well detailed LTE/EPC simulation model by integrating/ extending 4GSim and SimuLTE.

3.5 Wireless Cognitive Infocommunications Technologies

Topic 3.5, "Wireless Cognitive Infocommunications Technologies" deals with the main aspects and the establishment of terrestrial radio using cognitive devices. In the first quarter of the project we overviewed the main research areas based on international publications in three main areas. We dealt with the IEEE 802.22 standard that is widely used in CR technologies. Continued the overview of the international publications related to the cognitive spectrum usage, especially to the TVWS (TV White Space), mobile and sensor networks. We analysed the usage of the satellite frequency bands in cognitive manner for terrestrial applications and dealt with spectrum management issues. In the fourth quarter of the project a wide band discone antenna was created for the 0.53 GHz band. Measurements were performed in several frequency bands using USRP and spectrum analyzer.

3.6 New network architectures and methods for media delivery

Within Topic 3.6, „New network architectures and methods for media delivery", we focused on 3D Free Viewpoint Video transmission in IP networks. Overviewed the technical literature on FVV video coding, viewpoint synthesis, distributed viewpoint generation, caching solutions and 3D streaming, analysed the optimal cache size and the caused delay using the on-off based energy efficient method. We proposed an energy efficient caching scheme that keeps balance between the consumed energy and the cache delay and a multicast scheme in order to decrease the required time of new viewpoint stream playout. As a first step we analyzed the multicast group changing delays in the implemented NS2 simulation environment.

Subproject 4

Customizable content management

Subproject Leader: András Hajdu

In the first year of the project we have set up the management protocols within Subproject 4. We have organized several workshops mainly to discuss about the demonstration of the project results within a common platform, the VIRCA system. We have composed a distributed data storing and running environment for the aims of the subproject considering the Hadoop system and grid engine technology. We have organized session in the conferences IEEE/EURASIP ISPA 2013, IEEE CogInfoCom 2012 and IEEE CogInfoCom 2013. In the latter conference we have also organized a demo section to disseminate the development results of the subproject. As a coordinator, we have submitted a project proposal for the call FP7-ICT-2013-11 including 12 partners from 10 EU countries. We have demonstrated our advancements int he project level workshop.

4.1. Customizable and efficient processing of Big Data

We have developed several algorithms in relation to the demonstrative applications of the subproject (automatic screening and genetic data processing). We have developed complex systems from these individuals algorithms based on voting models. We have generalized diversity measures to describe such systems. We have also introduced novel visualization techniques for our complex systems in 3D. We have started to develop a collaborative platform for the quantitative analysis of competing algorithms. We have integrated new visualization techniques into an existing genome browser for the scalable visualization of large amount of data.

4.2. Collaborative data mining framework

We have given an overview of the currently available techniques in privacy preserving data mining. The corresponding data mining fields are:

classification, clustering, outlier detection, frequent pattern matching, analysis of network data. In a collaboration with topic 4.1, we have developed an install kit to set up the distributed grid engine technology. We have planned and implemented the framework for the privacy preserving data mining algorithms including its runtime and testing environment, and also the measures. We have analyzed and implemented the privacy preserving variants of the k-means and naive Bayes algorithms including some accelerator heuristics. We have also implemented an algorithm for finding association rules in a privacy preserving model.

4.3. User interface for multimodal human-machine interaction

We have checked the literature for a Lucia talking-head system with focusing on the inclusion of a sensor network. We have analyzed the merge of the talking head systems with TTS methods. We have investigated the applicability of geovisualization approaches. We have also checked the state-of-the-art and made demon implementations for gesture-based control using Kinect sensor, virtual mouse solutions and the recognition of facial emotions. We have implemented and tested methods considering head-movement-based controlling. We have tested how these components can be imported into VIRCA.

4.4. Searching and disseminating digital library contents

We have analyzed how digital library contents can be searched and disseminated within the VIRCA system. We have started to virtualize some departments of the University of Debrecen in this 3D collaborative arena including the DEENK Díszműtár and some material coming from the National Library. We have created a demo room based on photos. Besides digitizing library material we also analyze log files coming from user search activities to recognize frequent user behavior patterns in working with library data.

4.5. Semantic multimedia content retrieval

Throughout the Internet, a growing amount of multimedia content exists primarily uploaded from mobile devices. We have analyzed the possibilities of multimedia analysis taking the performance restrictions into consideration. The main aim of our work is to detect object in images and videos for a consecutive multimedia indexing. We have implemented an image browsing application and an image classifier using machine learning. As a complementary study, we have investigated the automatic classification of image content which step is required for semantic multimedia search. We have realized image ranking methods considering relevance and diversity features.

4.6. 3D Interent and media content

We have developed the VirCA-NET component to support the integration of the results of the subproject. Relating immersive cooperative spaces, we have started to check how to match virtual gloves to the system. We have checked and developed the necessary new VIRCA components to be able to visualize library contents and complex, ensemble-based systems. We have installed a 3D virtual wall to support the testing of the algorithms corresponding to the 3D working conditions. We have started to realize the 3D registration algorithms, and also the development of an engine that is able to follow the movements of the user. To support topic 4.3, we have checked the performance of supporting stereo imaging.

Subproject 5

Internet of Things

Subproject Leader: Zoltán Gál

MPT (MultiPath Transmission) software library was developed and utilized for the IP network throughput analysis. The dual stack software is based on IPv4 and IPv6 and supports the tunnel interface communication, as well. A WiFi system with 170 base stations was studied from the point of SDSN (Spatially Distributed Sensor Network) event analysis: the effect of the interference and noise to the radio channel was evaluated. The effect of the new IEEE 1905.1 technology was analysed in PAN/SOHO environment. Nice results were obtained by the analysis of the congestion effect to the streaming transmission in low bandwidth, sensor based network environment. The utilization of the hardware and software resources of the HPC (High Performance Computing) were captured by special developed software monitoring tool based on physical and virtual sensors.

The development of special space of the Cyberphysics was studied where the system is composed by embedded systems connected through the Internet. The research subjects were: reconfigurable design space based on discovery methods; data analysis and knowledge modelling; sensor virtualization; software architectures based on embedded virtualization. We analysed the join possibility of the advanced characteristics of the embedded system and informatics systems in the Cyberphysics space. The effect of the limited stability of the clock in the embedded processors and microcontrollers was tested with success. We analysed the fusion possibility of the sensor information coming from heterogeneous network nodes. We developed a method to measure the dynamic parameters of the AD converters for extra-long sample registrants.

The context dependent behaviour (physical coordinates of a given device, state of the battery, signal intensity and ID reception of the WiFi and 3G microcells, data from accelerometer and light detector) was analysed in the Internet of Things communication topic. We developed application on Android environment to execute measurements and to generate teaching capable set. Our HTM (Hierarchical Temporal Memory) based algorithm recognises the correlations and classifies the ulterior data with high efficiency. It was analysed the Bloom-filter description possibility of the context parameters and IoT devices were grouped and addressed by this method. We executed proof of concept analysis to determine the usability and the size of the counter based Bloom-filters for the classification. We determined the relation between the solution reliability and the number of Bloom-filter parameters.

The electrical energy consumption was studied and analysed in the intelligent home environment. We developed intelligent sensor to calculate directly the power factor by measuring the consumed electrical current and the power from the wall connector. It was developed a hardware and software modules of the multisensory measurement prototype system. We developed a mobile prototype system based on hybrid network to measure multiple human health parameters. We integrated neural network based decision module into the data acquisition system developed. We developed an activity recognition algorithm and solution based on the acceleration sensing capability of the smart phones. We executed deep analysis of the WiFi ZigBee, Bluetooth technologies to collect physical coordinates in interior environment of the buildings.

We executed the statistical calibration of the temperature and wind velocity ensemble prognosis of the National Meteorology Service Institute by BMA and EMOS methods. This algorithm was developed in R programming language environment. We analysed the cosmic background relay with the spectrum of random fields defined on the sphere. We executed analysis of the random fields defined on 3D environment to model the events in WiFi systems. Matlab codes were developed to analyse the WiFi radio channel noise and the interference events and for the efficiency testing of the HPC (High Performance Computing) resources scheduling based data series.

Authentication method with two factors and increased security level was analysed and integrated into the EduID Federation for the Hungarian National Higher Education informatics system. VO (Virtual Organization) supported platform was implemented on Simple SAMLphp environment. The testbed infrastructure was developed to test the non-

web based federative authentication processes. A discovery software tool was developed to manage the network topology and physical ports of the active devices. For NASI (Network Assessment System Interface) service it was developed a MySQL relational database model to store the configuration templates of the intermediate nodes.

The subproject organized a conference for Hungarian and other companies from abroad with title Advanced IT Infrastructure on 24th January, 2013.. Other international workshop was organized for researchers from four universities in the IoT topic with title Advances in Wireless Sensor Networks on 15th April, 2013. The results of the research activity listed above were published in conference and journal papers. The number of publications planned for the first year of the project is compiled with a factor of two. Other indicators are achieved, as well. The IoT subproject made considerable efforts to join to the IERC (Internet of Things European Research Cluster) cluster managed by the European Council. The joining process to an EU IoT stakeholder project is on the fair state.

Subproject 6

Future Internet for Smart City Applications

Subproject Leader: Gábor Fehér

The aim of the 6. subproject is the research and development of crowdsourcing based smart city applications. In the first quarter, the projects partners created the use cases and high level specifications for the current period. A project internal document contains the detailed use cases specific to sensors, interaction types, analytics and services. We defined an abstract case description that will be used to coordinate the research and development tasks during the project. The common abstract description is built on a server-client communication framework, client side sensors and a simple server side analytics. Hereafter the activity was carried on three, closely connected, but individually shaped tasks.

6.1.

Task 6.1 deals with the design and development of the communication framework. We investigated numerous available platform realizations and finally selected the BuddyCloud XMPP (eXtensible Messaging and Presence Protocol) platform. For BuddyCloud, we have developed new clients. Moreover, we have also started the design and implementation of our own communication framework in order to be able to evaluate the features of the different approaches. To gather experiments with XMPP, we did set up an XMPP server and configured its publish/subscribe communication service. We used this setup to implement the previously defined use case applications, such as live public transport information service, intelligent avatar and smart campus, in Task 6.3. Besides the development work, we performed performance evaluation studies to investigate the scalability of the XMPP based system.

6.2.

In Task 6.2, we studied data warehouse building and related analytics. We investigated many document oriented and graph oriented NoSQL systems, such as MongoDB, Redis and Neo4j. A preliminary interface

was created between the XMPP based crowdsourcing platform and the analytics module. Using this interface we examined crowdsensing information coming from Task 6.3. The investigations were performed on a high resolution mobile cell information database. We developed a visual dashboard application that serves as a base for supporting emergency services, carpooling, and traffic optimization. On the analytics side, we investigated several social network graph-evolution models and evaluated the asymptotic analysis of the relating processes. In order to track the time varying events, we studied more seasonal time series models. In the studies, we involved algorithms, like spectral clustering for heterogeneous data or various methods of anomaly detection. We created a project internal document about the analysis and implementation plan of automatic identification and tracking of real-time events originating in social networks. Another document describes the image recognition capabilities on mobile platforms.

6.3.

Task 6.3 is devoted for the design and development of use case smart city applications. We designed a community based public transport information sharing service for mobile users. Later we extended this service with a client side visualization application. We documented our studies in the field of measurement, storage and analysis of public transport related data. With regard to the intelligent civil avatar topic we extended the intelligent soccer fan concept. We implemented and tested the Quantum Consciousness Soccer Simulator (QCSS) mobile client over the XMPP protocol. XML schemes were developed for this avatar system. We began to work on the YANonymous application that investigates the possibility of reproducing social networks from anonymous user connections. We created a document about indoor positioning. We developed a community based course schedule application for smart campus that uses the connections in the widely deployed NEPTUN system. We used the Facebook and Twitter systems to harvest information and created a prototype that uses Twitter posts to detect real-time events.

Subproject 7

Developing curricula for Future Internet training

Subproject Leader: Márton Ispány

The overall objective of seventh subproject is to develop curricula to a Future Internet training program. The knowledge of students who finish this program will be adapted to the challenges of the 21st century and the labor market requirements. The courses of this program provide students with international terms, competitive knowledge and skills if they enter to the labor market. Transfer of Future Internet research results into education is a brand new training direction. Today, in our country there is no such a training program. The Future Internet training program will cover subjects of the Future Internet topic, from theory to applications. Parts of the syllabus are the current limitations of the Internet, future Internet extensions, models, mobility, scalability, quality and safety, adequately manageable network architectures and protocols, data management and content-centric solutions, services, platforms, and several applications for the communities in human-machine and machine-machine relationships supplemented with the social impacts.

During the quarter Q2 we reviewed the themes of the FIRST subprojects that may be able to educate in MSc programs. We asked the subproject leaders to consult with colleagues on their subjects.

In the quarter Q3 the syllabus of the teaching materials designed for the courses were reviewed and updated, taking into account recent progress in the area of Future Internet research. Professional meetings cleared up a curriculum development methodology and technical details.

In quarter Q4, after the planned tender curriculum having reviewed and updated, the authors have made a final commitment. We started to prepare the contracts. We developed a uniform style for the teaching materials. We agreed that the authors develop their presentation in this uniform style with some practical supplements.

Subproject 8

Future Internet Research Coordination Center

Subproject Leader: Péter Bakonyi

The Future Internet Research and Co-ordination Centre (FIRCC) has been established in January 2013, in the frame of the FIRST project, as the 8th subproject. The founders of the Research Centre are the University of Debrecen (DE), the Budapest University of Technology and Economics (BME), the Inter-University Centre for Telecommunications and Informatics (ETIK), the National Information Infrastructure Institute (NIIF) and the Institute for Nuclear Research of the Hungarian Academy of Sciences (ATOMKI). The basic role and function of the FIRCC is to co-ordinate the Future Internet research activity in Hungary and to promote the international cooperation in this field, particularly strengthen the participation of Hungarian researchers in EU programmes, like FP7, and Horizon 2020 in the coming years. The FIRCC is planning to organise workshops, conferences to demonstrate the results of the Hungarian research activity in the field of Future Internet.

The first nine month of operation can be summarised as follows:

Establishment of the organisational units. Appointment of director and the head of units. The planned subproject meetings were held. A brochure of FIRCC was made in English and Hungarian languages.

International activity: Inter alia we participated on

- Future Internet Assembly and Forum in Dublin, organized by EU and presentation was held entitled “Future Internet Research Projects in Hungary”;
- Future Internet PPP workshop on „Building an Eco-System for Delivering Innovative Future Internet Services and Applications” in Budapest, and presentation was delivered entitled „The FIRST Project and the Future Internet National Research Programme”;
- Internet of Things (IERC) cluster meeting, announcement of our joining intent.

Deployment of Future Internet National Research Program. The basic program (JINKA1.0) is based on the 29 research themes of the FIRST project. It was enlarged by the themes of other organisations, initiated and collected by FIRCC and FI NTP. Recently, JINKA1.4 embraces more than 70 research themes from 34 organisations, arranged into 9 chapters, as Internet basic research, Future Internet modelling, analysis and design, Future Internet network architectures, Data and content technologies, 3D Internet and cognitive infocommunications, Internet of Things, Cyber-physical systems and applications, Future Internet community applications, Experimentation, standardisation, regulation.