5G Summit R&D Russia – DETAILED AGENDA

June 19 (Monday) and June 20 (Tuesday), 2017

Peoples' Friendship University of Russia (RUDN University), Moscow, Russia

Organizers

- Peoples' Friendship University of Russia (RUDN University) (Russia)
- State-Financed Organization "Information City" (IT Department of Moscow Government) (Russia)

Partners

- Interstate Corporation for Development (Russia)
- OJSC Omsk Production Association "Radio Manufacturing Plant Named after A.S. Popov" (Russia)
- YL-Verkot Oy (Finland)
- Brno University of Technology (Czech Republic)
- Bonch-Bruevich Saint-Petersburg State University of Telecommunications (Russia)

Venues

V1	Monday, June 19, 2017 at RUDN University (main building) **Congress Hall 1, Miklukho-Maklaya str. 6, 117198 Moscow, Russia**
V2	Tuesday, June 20, 2017 at RUDN University (faculty of science building) **Room 110, Ordzhonikidze str. 3, 115419 Moscow, Russia**

Monday, June 19, 2017 at V1 (Congress Hall 1, Miklukho-Maklaya str. 6)

09:30 – 12:00	**Registration**
10:00 – 10:30	**Welcome Address** *Vladimir Filippov*, Rector, RUDN University (Moscow, Russia) *Alexey Chukarin*, CEO of State-Financed Organization "Information City", IT Department of Moscow Government (Moscow, Russia)
10:30 – 11:00	**A Perspective on Cloud and Virtual Radio Access Networks for 5G** *Dr. Luís Correia*, Professor, University of Lisbon (Lisbon, Portugal)

Abstract. A parallel in the evolution between mobile and wireless communications and other areas (computers and cars) will be presented, in an attempt to identify possible directions for systems future evolution. A look into already existing technologies will enable to establish a perspective for future user interface devices and services (e.g., information access, Internet of Things, and geo-location). Then, potential services are identified, after which research challenges for mobile and wireless communications networks are addressed, e.g., network virtualization, and cloud networking. The application of the concepts of cloud computing and virtualization to networks, which are currently being considered for 5G, will be addressed for Radio Access Networks. General network architectures will be presented, addressing the physical and logical perspectives, as well as the new perspectives on the management of radio resources, capacity, and Service Level Agreements. Challenges will be addressed, and application examples will be shown, including the financial impact on CAPEX and OPEX.

Biography. Luis M. Correia was born in Portugal, in 1958. He received the Ph.D. in Electrical and Computer Engineering from IST (University of Lisbon) in 1991, where he is currently a Professor in Telecommunications, with his work focused in Wireless/Mobile Communications in the areas of propagation, channel characterization, radio networks, traffic, and applications, with the research activities developed in the INESC-ID institute. He has acted as a consultant for Portuguese mobile communications operators and the telecommunications regulator, besides other public and private entities, and he has been in the Board of Directors of a telecommunications company. Besides being responsible for research projects at the national level, he has participated in 34 projects within the European frameworks of COST, RACE, ACTS, IST, ICT and H2020, where he also served as evaluator and auditor, having coordinated 4 of them and taken leadership responsibilities at various levels in many others. He has supervised more than 180 M.Sc. and Ph.D. students, having edited 6 books, contribute to European strategic documents, and authored more than 400 papers in international and national journals and conferences, for which he has served also as a reviewer, editor, and board member. At the international level, he has been part of 30 Ph.D. juries, and of 29 research projects and institutions evaluation committees for funding agencies in 8 countries and the European Commission. He has been the Chairman of Conference, of the Technical Programme Committee and of the Steering Committee of several major conferences, besides other several duties. He was a National Delegate to the COST Domain Committee on ICT. He was active in the European Net!Works platform, by being an elected member of its Expert Advisory Group and of its Steering Board, and the Chairman of its Working Group on Applications, and was also elected to the European 5G PPP Association

11:00 – 11:30 **Future X and 5G – The Inflection Point of Next Industrial Revolution**
Dr. Azfar Aslam, Senior Director and Partner, Nokia Bell Labs Consulting (Slough, United Kingdom)

Abstract. This talk focuses on the trends and requirements that lead to the development of 5G services. It covers the need to deliver more data at lower costs, as well as the enablement of the enterprise digitization & industrial automation to create greater value for the society. It also includes the building blocks that define the path to 5G introduction. There is also a focus on the lessons learnt from various network sharing models to enable the enhanced broadband delivery, and how that may play out in the 5G era.

Biography. Azfar Aslam is a Senior Director and Partner of Bell Labs Consulting, and has supported a large number of operators in EMEA, to take optimal strategic decisions for transformation, covering a wide range of Business and Technology topics. Recent engagements include 5G strategy development, use cases and network strategies, Wireless and Spectrum re-farming strategies, SDN and Virtualization strategies, Adjacent/new market entry, and Go-To-Market strategy, Enterprise portfolio and segment strategy, Legacy network transformation, including PSTN, Next Generation Access (FTTx), Regulatory framework development.
In addition to Business & Technology strategy, Azfar has worked with clients on Corporate strategy topics such as go-alone (self-develop), partnerships, and mergers & acquisition strategies to deliver the best enterprise value for the business. He has also been involved in evaluating several innovative/new technologies, solutions and services, to determine the opportunity or threat for the industry. Azfar holds a B.Sc. (Hons) Physics, M.SC. and Doctorate in Telecommunications, studied at University College London and received MBA training at London Business school.

11:30 – 12:00 Coffee Break (Canteen)

12:00 – 12:30 **5G Small Cell Backhaul Networks Using mmWave Bands**
Dr. Andreas Kassler, Professor, Karlstad University (Karlstad, Sweden)

Abstract. A dense deployment of small cells is one of the key characteristics envisioned for future 5G mobile networks in order to provide the required capacity increase. To cut cabling costs for smart cities, small cells are foreseen to form multihop topologies using high capacity backhaul wireless links in the mmWave bands. Such small cells are deployed within the coverage area of a macro cell (eNB) to provide localized capacity where needed according to the Heterogeneous Network concept (HetNet).
However, green networking will be very important because powering on unnecessarily a massive amount of small cells may lead to increased OPEX and CO2 emission. In this talk, we introduce several optimization models that minimize the total power consumption of 5G HetNets deployments while providing the required capacity and coverage. The model cover different aspects such as user association, backhaul routing and small cell switch on/off operations to serve the user demands with minimum power consumption. Our numerical evaluation show significant power savings over a large range of traffic demand distributions while keeping the blocking probability low.

Biography. Dr. Andreas Kassler received his MSc degree in Mathematics/Computer Science from Augsburg University, Germany in 1995 and his PhD degree in Computer Science from University of Ulm, Germany, in 2002. Currently, he is employed as Full Professor with the Department of Mathematics and Computer Science at Karlstad University in Sweden. Before joining Karlstad University, he was Assistant Professor at the School of Computer Engineering, Nanyang Technological University, Singapore, between 2003 and 2004. Dr. Kassler is (co-)author of more than 100 peer reviewed books, journal and conference articles. He served as a guest editor for several special issues, and is on the editorial boards of several international journals. Dr. Andreas J. Kassler is a senior member of IEEE Computer Society and IEEE Communications.

12:30 – 13:00 **Mobile Edge Computing for 5G: A Communication Perspective**
Dr. Kaibin Huang, Professor, University of Hong Kong (Hong Kong)

Abstract. Driven by the visions of Internet of Things and 5G communications, recent years have seen a paradigm shift in mobile computing, from the centralized Mobile Cloud Computing towards Mobile Edge Computing (MEC). The main feature of MEC is to push mobile computing, network control and storage to the network edges (e.g., base stations and access points) so as to enable computation- intensive and latency-critical applications at the resource-limited mobile devices. MEC promises dramatic reduction in latency and mobile energy consumption, tackling the key challenges for materializing 5G vision. The promised gains of MEC have motivated extensive efforts in both academia and industry on developing the technology. A main thrust of MEC research is to seamlessly merge the two disciplines of wireless communications and mobile computing, resulting in a wide-range of new designs ranging from techniques for computation offloading to network architectures. In this talk, I will discuss various research opportunities on MEC from the perspective of a wireless-communication engineer. In particular, I will

focus on joint radio-and-computational resource management and mobile cooperative computing (or known as Fog Computing).

Biography. Kaibin Huang received the B.Eng. (first-class hons.) and the M.Eng. from the National University of Singapore, respectively, and the Ph.D. degree from The University of Texas at Austin (UT Austin), all in electrical engineering.

Since Jan. 2014, he has been an assistant professor in the Dept. of Electrical and Electronic Engineering (EEE) at The University of Hong Kong. He is an adjunct professor in the School of EEE at Yonsei University in S. Korea. He used to be a faculty member in the Dept. of Applied Mathematics (AMA) at the Hong Kong Polytechnic University (PolyU) and the Dept. of EEE at Yonsei University. His research interests focus on the analysis and design of wireless networks using stochastic geometry and multi-antenna techniques.

He frequently serves on the technical program committees of major IEEE conferences in wireless communications. Most recently, he served as the lead chairs for the Wireless Comm. Symp. of IEEE Globecom 2017 and the Comm. Theory Symp. of IEEE GLOBECOM 2014 and the TPC Co-chairs for IEEE PIMRC 2017 and the IEEE CTW 2013. Currently, he is an editor for the newly established IEEE Transactions on Green Communications and Networking, and IEEE Transactions on Wireless Communications. He was an editor for IEEE Journal on Selected Areas in Communications (JSAC) series on Green Communications and Networking in 2015-2016, for IEEE Wireless Communications Letters in 2011-2016, and for IEEE/KICS Journal of Communication and Networks in 2009-2015. He has edited a JSAC 2015 special issue on communications powered by energy harvesting. He was an elected member of the SPCOM Technical Committee of the IEEE Signal Processing Society in 2012-2015. Dr. Huang received the 2015 IEEE ComSoc Asia Pacific Outstanding Paper Award, Outstanding Teaching Award from Yonsei, Motorola Partnerships in Research Grant, the University Continuing Fellowship from UT Austin, and a Best Paper Award from IEEE GLOBECOM 2006 and PolyU AMA in 2013. He held a University Visiting Scholarship at Kansai University, Japan in the summer of 2017.

13:00 – 14:00	Lunch (Canteen)

14:00 – 14:30	**Traffic Aware Interference Management for Flexible 5G Radio Access** *Dr. Antti Tölli*, Professor, University of Oulu (Oulu, Finland)

Abstract. Fully dynamic or flexible time division duplexing (TDD) is an essential 5G ingredient, e.g., in the 3GPP New Radio specification. In small cell scenarios, especially, the amount of instantaneous uplink (UL) and downlink (DL) traffic may vary significantly with time and among the adjacent cells. In such cases, Dynamic TDD allows full flexibility for resources to be adapted between the UL and DL at each time instant thus providing vastly improved overall resource utilization. However, the dynamic variation of resource allocation will change the interference seen by neighboring cells and users, drastically complicating the overall interference management. In particular, this variation can impact systems that employ coordinated beamforming or cooperative multi-cell transmission, which require sufficiently reliable channel state information (CSI) between the mutually interfering network nodes.

The target of the talk is to provide a holistic view of heterogeneous wireless networks for 5G and beyond based on dynamic traffic aware TDD, especially from the perspectives of beamformer training, channel feedback, resource allocation and interference management. The methods discussed will account for variations in user traffic as well the associated overhead from adapting UL/DL resources. First, the performance limits of dynamic TDD systems using scheduling and coordinated beamforming are explored. Subsequently, distributed schemes that seek to approach these performance limits are introduced. Low complexity, near optimal solutions that account for the users' traffic dynamics are considered. Particular emphasis is put on the iterative CSI acquisition mechanisms using precoded pilots, as well as, the overhead and the associated errors due to imperfect channel measurements. In addition, network controlled D2D and cooperative transmission schemes are considered in which network nodes exchange messages to facilitate direct user communication or joint transmission in a dynamic TDD network. The talk concludes with some highlights for future research directions.

Biography. Antti Tölli (M'08, SM'14) received the Dr.Sc. (Tech.) degree in electrical engineering from the University of Oulu, Oulu, Finland, in 2008. Before joining the Centre for Wireless Communications (CWC) at the University of Oulu, he worked for 5 years with Nokia Networks as a Research Engineer and Project Manager both in Finland and Spain. In May 2014, he was granted a five year (2014-2019) Academy Research Fellow post by the Academy of Finland. He also holds an Adjunct Professor position with University of Oulu. During the academic year 2015-2016, he visited at EURECOM, Sophia Antipolis, France. He has authored more than 140 papers in peer-reviewed international journals and conferences and several patents all in the area of signal processing and wireless communications. His research interests include radio resource management and transceiver design for broadband wireless communications with a special emphasis on distributed interference management in heterogeneous wireless networks. He is currently serving as an associate editor for IEEE Transactions on Signal Processing.

14:30 – 15:00	**Practical Overview of Enabling Technologies for Heterogeneous 5G-IoT Ecosystem and its Applications** *Dr. Jiří Hošek*, Professor, Brno University of Technology (Brno, Czech Republic)

Abstract. The society is currently standing on the doorway of new era of wireless technologies, so called 5th generation (5G), which is expected to start its commercial deployment around 2020 and beyond. As already introduced by the community, 5G is supposed to become a heterogeneous end-to-end ecosystem to enable a fully mobile and connected society. This is highly relevant especially for the Internet of Things (IoT) as currently the most dynamic and emerging mass market penetrating almost every segment of our daily-life. Indeed, we are experiencing a raise of new IoT applications in many different fields, where such connectivity was not expected before (e.g., industrial automation, medical aids, emergency services, mobile healthcare, elderly assistance, intelligent energy management, traffic management, etc.). However, such a varied domain of applications makes the identification of technological solutions capable of satisfying the requirements of all possible use cases a formidable challenge. Therefore, 5G is understood by many as a mix of different wireless technologies acting all together as a transparent communication infrastructure for heterogeneous IoT applications and services.
Inspired by this, the main target of this talk is to provide a practical overview of emerging enablers of this revolutionary transformation happening in mobile world, which is expected to deliver an ultimate and ubiquitous connectivity for any single human user or electronic device. Particular focus is given to the discussion of mechanisms like network densification, mobile data offloading, device-to-device (D2D) communication or data transmissions in ultra-high frequency bands. Moreover, we will introduce selected IoT technologies like SIGFOX, LoRaWAN, 3GPP Narrow-Band IoT together with some of the IoT applications like Smart Home, Smart City or Industry 4.0.

Biography. Dr. Jiri Hosek is an Associate Professor and Head of WISLAB research group (http://wislab.cz) at Department of Telecommunications, Brno University of Technology, Czech Republic. Jiri deals mostly with industry-oriented R&D projects in the area of future mobile networks, Internet of Things and home automation services. Jiri (co-) authored more than 70 research works on networking technologies, wireless communications, quality of service, quality of experience and IoT applications including those published in the IEEE Communications Magazine. Jiri is an experienced speaker regularly participating and actively presenting his research work on premier international conferences and workshops (see the list of publications: https://www.vutbr.cz/en/people/jiri-hosek-47655/publikace).

15:00 – 15:30	Coffee Break (Canteen)

15:30 – 17:30	**Round table: Technological and Economical Challenges for City Digital Economy** Speakers, Industry Experts, and ICT Experts

Tuesday, June 20, 2017 at V2 (Room 110, Ordzhonikidze str. 3)

10:30 – 11:00	**Welcome Meeting** at Applied Mathematics and Communication Technologies (AM&CT) Institute *Konstantin Samouylov*, AM&CT Institute Director, RUDN University (Moscow, Russia)

11:00 – 11:30	**Telecommunication Networks and Digital Economy** *Dr. Andrey Koucheryavy*, Professor and Head of Department, Bonch-Bruevich Saint-Petersburg State University of Telecommunications (Saint Petersburg, Russia)

Abstract. In this talk, we consider telecommunication networks evolution as an integral part of country's GDP. In particular, we analyze fifth generation networks ant its potentials from the view of digital economy development. The fifth generation networks are considered as the integral network for both components: fixed and mobile. The investigations are focused on the ultra small latency and Tactile Internet.

Biography. A. Koucheryavy graduated from Leningrad University of Telecommunication in 1974. He received his Ph.D and D.Sc in 1982 and 1994 respectively. He worked in the Telecommunication Research Institute (LONIIS), from 1974 up to October 2003 (from 1986 up to 2003 as the First Deputy Director).
A. Koucheryavy has been a professor at St. Petersburg State University of Telecommunication (SUT) since 1998. From 2011 he is the head of the SUT department of "Telecommunication Networks". He is honorary member of A.S. Popov society.
Prof. Koucheryavy was vice-chairman of ITU-T Study Group 11 during two study periods. His scientific areas of interest are the network planning, teletraffic theory, IoT and its enablers.

11:30 – 12:00	**Mathematical Modeling Issues in the Future Wireless Networks** *Dr. Valeriy Naumov*, Professor and CTO, Service Innovation Research Institute (Helsinki, Finland)

Abstract. Starting from fundamental research of A.K. Erlang many research tools were developed by applied probability theory for the performance analysis of telecommunication networks. As the telecommunication networks developed, the mathematical models for their analysis became more complicated. In this talk we consider new approaches for modeling of the future wireless networks.

Biography. Prof. Valeriy Naumov has received M.Sc. degree from the People's Friendship University (PFU) in 1972 and Ph.D. degree from the Computing Centre of the Russian Academy of Sciences in 1979. He has been doing research in several positions in PFU (1973-1996, 2006-2007), Helsinki University of Technology (1984-1985), Institute for Problem of Information Transmission (1992-1994), Deutsche Bundespost Telekom (1994-1995), Lappeenranta University of Technology (1996-2005), Norwegian University of Science and Technology (2006), University of Jyväskylä (2008), University of Oulu (2009-2011) and Research Institute of Finnish Economy (2011-2013). Currently he is CTO of the Service Innovation Research Institute, Helsinki. His areas of expertise include information technology and performance analysis.

12:00 – 12:30	**Leveraging Heterogeneous Connectivity in Converged 5G-IoT Ecosystem** *Dr. Sergey Andreev*, Senior Researcher, Tampere University of Technology (Tampere, Finland)

Abstract. In this talk, we comprehensively review the landscape of heterogeneous multi-radio connectivity at the intersection of the 5G and the IoT realms. We explore the potential of a wide range of devices requiring connectivity at different scales (macro, micro, pico, femto, etc.) and across diverse radio access technologies (e.g., cellular and WLAN) to augment system capacity and improve connectivity experience in next-generation heterogeneous deployments. Further, we discuss the emerging concept of proximate device-to-device communication and the changes it introduces to the conventional networking paradigm. We also address the unique challenges posed recently by an impressive variety of machine-type devices, with their characteristic stringent performance requirements, and the capabilities that both short- and long-range radio technologies would need to develop for accommodating those.

Biography. Dr. Sergey Andreev is Senior Research Scientist at Tampere University of Technology (Finland), where he is coordinating W.I.N.T.E.R. Group (http://winter-group.net/) focusing on 5G and IoT centric research. He has (co-)authored over 100 papers (including those in IEEE JSAC, IEEE Communications Magazine, and IEEE Wireless Communications), several patents, and a number of IEEE and 3GPP standardization contributions in the areas of multi-radio heterogeneous networking, cooperative and proximate communications, energy efficiency, and machine-to-machine applications. This innovation activity has been well covered in media on both national and international levels. Sergey has been reviewer for numerous visible conferences and top-level international journals; he was named Exemplary Reviewer by IEEE Communications Letters in 2013. He has also been invited expert at a number of workshops, held many guest lectures at industry and academia worldwide, as well as acted as a keynote speaker. Recently, he has been recipient of highly competitive personal research grant by the Academy of Finland (9% success rate), as well as several other prestigious scholarships and awards.

12:30 – 13:00	Coffee Break (Canteen)
13:00 – 14:00	**Round table**: **Research Issues in the Future Wireless Networks** Speakers, R&D Experts
14:00 – 16:00	Closing Ceremony