Joint IRACON-WAVECOMBE Training Workshop on

RADIO CHANNEL MODELLING FOR 5G MILLIMETRE WAVE COMMUNICATIONS IN BUILT ENVIRONMENTS

15 January 2019, Dublin (Ireland)

Start time: 11:00 - End time: 17:30

Co-located with the 9th MCM of COST IRACON

Organisers

Narcis Cardona, iTEAM - U.P. Valencia, ES
Sana Salous, University of Durham, UK
Katsuyuki Haneda, Aalto University, FI

Speakers confirmed

Vittorio Degli-Sposti, UniBO, IT
José María Molina, UPCT, ES
Andrés Alayón Glazunov, Univ of Twente, NL
Katsuyuki Haneda, Aalto Univ., FI
Pieter Demuytere, Televic, BE
Diego Dupleich, TU Ilmenau, DE
Athanasios Vasileiadis, U. of Sheffield, UK
Johannes Eckhardt, TU Braunschweig, DE
Jie Zhang, RanPlan, UK
Jonas Medbo, Satyam Dwivedi, Ericsson, SE
Mark Beach, Univ. Of Bristol

Local organisation

Conor Brennan, Dublin City University, IR

Venue:

Dublin City University,
All Hallows Campus, Dublin 9, Ireland

Registration:

Registration is available through www.iracon.org and it is free of charge for WaveComBE and IRACON members.

Registration deadline:
December 17th 2018

Student Grants:

IRACON offers grants for PhD students of the institutions participating in the COST Action. Applicants should address www.iracon.org for more information

Millimetre-wave frequencies have been extensively studied during the recent years as the potential candidate bands for allocating mobile access services in 5G and beyond. A future with dense deployments of mobile network nodes working at such frequency bands is foreseen, mainly for environments where demand of extreme mobile broadband connectivity is concentrated, like in the built environments, either indoors or urban outdoors.

IRACON (www.iracon.org) is the COST Action on Radio Communications aimed at the design and analysis for the 5th-generation (5G) and beyond-5G radio networks. IRACON participants develop accurate radio channel models for scenarios including, but not limited to, heterogeneous cells, body area networks and vehicular communications, using carrier frequencies above UHF up to Terahertz.

WaveComBE (www.wavecombe.eu) is an Industrial and Training Network of the Marie Sklodovska-Curie Action, dealing with the ultra-dense deployment of millimetre-wave (mmW) small-cells (SCs) in conjunction with massive multiple-input multiple output (MIMO) in 5G and beyond 5G (B5G) wireless networks.

WaveComBE and IRACON Committees are offering this joint training workshop on the current advances on millimetre-wave radio channel modelling that both communities have produced recently. The objective of the workshop is to provide a comprehensive insight of the propagation aspects of mm-Wave frequencies, the various techniques for channel modelling in these bands, and the system level aspects of implementation and practical aspects, mainly on antennas and MIMO systems when applied above 30GHz.

Detailed program:

Opening

Narcís Cardona, Coordinator of MSCA WaveComBE, Vice-chairman of COST IRACON
10:30-10:45 Tuesday 15-Jan

Session 1: mmWave channel measurements and models

10:45-12:30 Tuesday 15-Jan
Chair: Narcis Cardona, Universitat Politècnica de València, ES

S3.T2. *Characterization of Propagation from Multi-band Measurements for 5G Channel Modelling*

Speaker: Diego Dupleich, Technische Universität Ilmenau, Germany

Abstract: In the present work, we discuss the influence of system aspects as directivity and bandwidth on channel modelling. We compare propagation characteristics from simultaneous ultra-wideband measurements at different bands (6,75 GHz, 30 GHz, and 60 GHz) in multiple scenarios (in-doors, large halls, V2V, industrial, street canyon, etc.). We observe that the propagation channel offers similar opportunities in the different bands, but the main differences arise in the radio channel due to the influence of the high resolution in the spatial and temporal domain provided by directivity and bandwidth. Hence, channel models at mm-waves must consider more deterministic and detailed components.

S2.T0. *On Some Aspects of Antenna-Channel Interactions*

Speaker: Andrés Alayon, University of Twente, Netherlands

Abstract: The talk will provide an overview of advances in the modeling of interactions between antennas and the propagation channel in multiple antenna systems based on the spherical vector wave mode expansion of the electromagnetic field and the antenna scattering matrix. The emphasis is on the unified approach to antenna-channel interaction analysis for various applications with focus on channel modelling and antenna characterization.

S3.T3. *Ray-based modeling of mm-wave indoor and outdoor propagation*

Speaker: Vittorio Degli-Sposti, Università di Bologna, Italy

Abstract - Ray-based models are particularly suitable to mm-wave propagation, where geometrical optics assumptions are easily satisfied due to the small wavelength compared to the size of walls and obstacles usually found in urban environment. Ray based models such as ray tracing and ray launching are therefore becoming popular for map-based channel simulation, system planning and for real-time channel prediction in mm-wave wireless systems. Since ray based models require the input of material characteristics for all obstacles and walls, electromagnetic parameters for a large number of materials need to be estimated at several different mm-wave frequencies, that are being proposed for back-hauling and front-hauling in 5G systems, and beyond. Moreover, mm-wave propagation displays peculiar characteristics: higher vegetation attenuation, strong specular-like scattering from cluttering objects (cars, furniture), higher rough-surface scattering as well as a generally decreasing multipath richness with frequency, to name a few. These effects need to be modelled somehow into ray-based deterministic propagation model. The topics presented above are object of investigation in the present paper.

Session 2: Implementation, planning, testing and deployment of mmWave for 5G

13:30-15:15 Tuesday 15-Jan
Chair: Katsuyuki Haneda, Aalto University, FI

S3. T4. ***Measurements, Modelling and Emulation for Testing Millimetre Wave Communication Systems***
Speaker: Mark Beach, Univerity of Bristol, UK

Abstract: The use of directional antenna facets, such as an antenna array and beamformer, to provide boresight gain to mitigate the additional line-of-sight path loss at millimetre wave frequencies when compared with sub-6GHz spectrum is widely accepted by those engaged in 5G R&D. Real-world channel measurements addressing diffraction and reflection of millimetre wave signals has also identified significant differences in the characteristics of these mechanisms as well as the impact of surface roughness and the electrical properties (permittivity and conductivity) of the materials within the environment. This, alongside the directional properties of the transmitting and receiving antennas selectively illuminating a specific addressed volume, thus creates a significantly different realisation of the physical processes describing the composite or joint antenna and channel model for the design of 5G systems at millimetre wave. Hence, an accurate representation of the spatial channel at millimetre wave and the support of mobility is thus essential to aid both planning and testing of devices. Further, conformance testing of products will necessitate a cost-effective means for emulating these complex mechanisms. This presentation will summarise the measurements, models and approaches taken to emulate the millimetre wave channel by researchers at the University of Bristol (UK).

S2.T1. mmWave Transceiver Architecture Research for Massive MIMO. Sheffield's new mmWave Antenna & Device Measurement Facility
Speaker: Athanasios Vasileiadis. University of Sheffield, UK

Abstract: RF 30 GHz ray-tracing simulation results are presented from a conceptual, Massive- Multiple Input Multiple Output (M-MIMO) propagation model in an urban canyon. The usage of Constant Envelope (CE) RF signals is evaluated in both propagation ray-rich and ray-sparse scenarios. Multiple mobile terminals are simulated, each employing single carrier Phase Shift Keying (PSK). It is found that once an operational link budget is achieved, CE transmitters have negligible effect on a received Error Vector Magnitude (EVM). Finally, it is found that the EVM is a function of both richness of propagation rays as well as the relative proximities of mobile users. A worst-case EVM of circa 25% is observed when terminals are separated by 1m, reducing to circa 5% when terminals are separated by more than 4m. We will also discuss the new mmWave measurement facility that is in the process of being commissioned at the Communications Research Group, at the University of Sheffield. This new facility will be available for all industrial and academic researchers to use. The facility consists of a 110GHz 3D antenna measurement system (for wafer or assembled device level tests), 4 port Vector Network Analyser and mmWave wafer probe station.

S2.T2. Moving from 5 GHz to 60 GHz: Opportunities and challenges of integrating mmWave technology
Speaker: Pieter Demuytere, Televic, Belgium

Abstract: As a provider of both wired and wireless conference systems, Televic Conference is active in some of the world's most renowned institutions such as the United Nations office, the European Parliament, the new NATO building. Our clients demand the highest quality and reliability. This talk discusses what mm-Wave brings as opportunities, but also what the challenges are when integrating this technology in mission-critical equipment. Differences with 5 GHz, from both a technological, a system architectural and a deployment point-of-view, are discussed.

S2.T3. ***5G New Radio Planning in the Built Environments***

Speaker: Jie Zhang, RANPLAN Wireless, UK

Abstract: The fifth generation (5G) mobile network promises to create a platform and an eco-system to provide ubiquitous access to a wide range of applications and services such as eMBB, URLLC and mMTC. It will support both the mobile industry and verticals such as automotive, industry automation and public safety. In this talk, we will first discuss the challenges and opportunities associated with 5G new radio (NR) planning in the built environments, in particular, at the mmWave bands. Then we will present the performance of 5G NR networks in typical built environments such as urban outdoor and large venues.

Session 3: Rising upper bounds in frequencies above 40GHz

15:45-17:30 Tuesday 15-Jan

Chair: Sana Salous, University of Durham, UK

S3. T1. Key characteristics of millimeter-wave channels, their models and implications on antenna gains

Speaker: Katsuyuki Haneda, Aalto University, Finland

Abstract: This talk first summarizes key findings from above-6GHz channel sounding and modeling activities, particularly frequency depependency of angular/delay dispersion, diffuse scattering, depolarization, human body blockage and outdoor-to-indoor penetration. Analysis methods and tools for antenna-human interaction is then briefly covered. Finally, examples of mobile handset antenna designs and gain comparison are introduced to consolidate the obtained models and analysis methods.

S3.T1. ***Frequency Trends of Radio Wave Propagation in the range 1-100 GHz***

Speakers: Satyam Dwivedi, Jonas Medbo, Ericsson, Sweden

Abstract: Next generation of mobile communications, 5G, is planned for utilizing a very wide range of radio spectrum from below 1 GHz up to about 100 GHz. Most of this spectrum will be allocated at radically higher frequencies than the spectrum used in current mobile networks. The higher frequencies are needed for providing sufficient amount of spectrum for the required bitrates and network capacities of 5G. In order to optimize 5G radio networks it is crucial to know well the radio propagation characteristics, and corresponding frequency dependence, over the full 5G frequency range. This presentation summarizes the current understanding of radio wave propagation frequency trends in terms of 3GPP, ITU-R and mmMAGIC models. Both propagation loss, and, delay and angle spread characteristics are covered. The propagation loss results are essentially coherent between the different models, showing some weak to strong frequency trends depending on propagation scenario. Regarding angle and delay spread the substantial frequency dependence of the 3GPP model is challenged based on the mmMAGIC results which show that there is no clear frequency dependence.

S3.T2. ***1-100 GHz Deterministic and Experimental Indoor Channel Modeling***

Speaker: Jose M. Molina, Universidad Politécnica de Cartagena, Spain

Abstract: This work presents experimental analysis of Line-of-Sight experimental data from 1 to 100 GHz based on a VNA using three different set-ups in the same indoor scenario. The received power, RMS delay spread, K-factor and correlation are computed from experimental data, providing an insight of how propagation behaves in all possible 5G frequency bands.

S3. T4. 300 GHz Channel Measurements in a Real Data Centre

Speaker: Johannes Eckhardt, TU Braunschweig, DE

Abstract: In this presentation a measurement campaign in a real Data Centre at 300 GHz and recent results are presented. The measurements are performed with a UWB sub-mmWave channel sounder and classified in general characterisation, top-of-rack and intra-rack measurements. The individual measurement setups as well as the methodology are explained. In a first step, the measurements are evaluated regarding the path attenuation, the power delay profile (PDP) and the power angular spectrum (PAS). The PDP as well as the PAS give comprehensible results, which are explained by the scenario's geometry. The path attenuation shows reasonable results compared to the free space path loss and demonstrates that wireless communication at 300 GHz in a Data Centre is possible.