EVOLUTION OF AIR INTERFACE TOWARDS 5G

PROF. SUVRA SEKHAR DAS
School of Telecommunications
IIT Kharagpur

PRE-REQUISITES : Digital communications, Mobile Communications / Wireless Communications
INTENDED AUDIENCE : Senior undergraduate students, graduate level students, MS and PhD students, in the broad domain of telecommunications engineering who are interested to work further or even gather the latest developments in the domain of wireless communication technology leading to 5G air interface. The course is also suitable for practicing engineers in the domain of wireless communications who want to be familiar with the new technology changes that are expected to be engines of 5G air interface / radio access technology so that they can equip themselves with the new knowledge in a composite manner.
INDUSTRIES APPLICABLE TO : All wireless telephony service providers and equipment manufactures.

COURSE OUTLINE :
Air Interface is one of the most important elements that differentiate between 2G, 3G, 4G and 5G. While 3G was CDMA based, 4G was OFDMA based; this course reveals the contents of air interface for 5G. While 4G brought in a deluge of infotainment services, 5G aims to provide extremely low delay services, great service in crowd, enhanced mobile broadband (virtual reality being made real), ultra reliable and secure connectivity, ubiquitous QoS, and highly energy efficient networks. The above mentioned requirements are expected to be met by several advancement in technologies such as (i) new waveforms (termed as 5G NR, the new radio), (ii) millimeter wave technology, (iii) massive multiple antenna technologies (iv) non orthogonal multiple access (v) heterogeneous networks such as small cells and device to device communications (vi) energy savings in radio access network and (vii) ubiquitous quality of service among others. In this course we aim to provide insight into the fundamentals of the above mentioned methods, which are essential components of 5G Air Interface. We will begin with an overview of 5G technology aspects. Then we will discuss 5G new radio waveform, its genesis and variants. Thereafter we will introduce non orthogonal multiple access scheme. Next we will discuss various aspects of mmwave communication technology. Massive MIMO will be presented next, wherein we will discuss the essential building blocks and design challenges. While all these will be discussed that propagation models which are essential for performance analysis will also be briefly presented. This will be followed by performance analysis of heterogeneous networks including small cells and device to device communication. Then we will present energy saving methods for radio access network through multi objective optimization. The final part of the course will touch upon performance characterization of QoS for delay sensitive traffic for radio access networks.The intended audience includes research scholars who are interested to pursue 5G and beyond technologies to bring improvement in performance, which can make these technologies even more commercially viable. It is also expected to provide practicing engineers an opportunity

ABOUT INSTRUCTOR :
Prof. Suvra Sekhar Das is currently serving as associate professor at the G. S. Sanyal School of Telecommunictions in Indian Institute of Technology Kharagpur. He has completed Ph.D. from Aalborg University, Aalborg, Denmark. He has worked as Senior Scientist with the Innovation Laboratory of Tata Consultancy Services. His research interests include cross-layer optimization of mobile broadband cellular networks, 5G, Broadband Mobile Communications, 5G Waveform design GFDM FBMC UFMC, heteogeneous networks Femto Cells Device to Device communication, Multi objective optimization for radio access networks, Green radio network design Packet Scheduling and radio resource allocation with link adaptation, MIMO communications, base-band transceiver design for broadband wireless communication systems.

COURSE PLAN :
Week 1 : Overview of 5G communication technology, (operating scenarios, mm wave technology, propagation models),
Week 2 : Waveform in 5G, (W-OFDM, F-OFDM, UFMC, FBMC, GFDM, adaptive OFDM)
Week 3 : Modulation and coding in 5G
Week 4 : Propagation Characteristics of 5G Channel models
Week 5 : MIMO communication essentials
Week 6 : Massive MIMO in 5G (massive MIMO, pilot contamination, Beam forming)
Week 7 : Heterogeneous Ultra Dense networks in 5G, (Small cells, D2D, MIMO-NOMA)
Week 8 : Ubiquitous Quality of Service Provisioning for real time traffic.