1) Title of the tutorial:
Joint MIMO-Radar-MIMO-Communications

2) Instructors name and affiliation:
Kumar Vijay Mishra, United States Army Research Laboratory
M. R. Bhavani Shankar, University of Luxembourg
Athina P. Petropulu, Rutgers University

3) a 300 word abstract describing the proposed topic and including an outline of the contents
As the wireless community moves closer to finalizing the 5G standard and radars are deployed for high-bandwidth applications such as autonomous driving, physiological sensors, and short-range weather monitoring, the millimeter-wave (mmWave) band (30-300 GHz) is the new frontier for spectral coexistence research. However, the approaches for joint spectrum utilization cmWave solutions usually rely on opportunistic access via cognitive sensing of the spectrum, conventional antenna arrays, interference management, and radar or communications-centric solutions. These techniques do not easily extend to multiple-input multiple-output (MIMO) configurations in communications and radar. In communications, small-scale MIMO technology has existed for decades. But its practical gains to yield an order-of-magnitude higher spectral efficiency has been made possible only recently with the use of a massive number of antenna elements. This is especially helpful at mmWave, where massive MIMO beamforming compensates path and propagation losses. In radar, MIMO arrays are used to illuminate the entire target scene simultaneously by exploiting waveform diversity.
While extremely topical to current user needs at mmWave, a joint MIMO-radar-MIMO-communications (MRMC) spectrum sharing is considerably more complex with several variables to optimize. Unlike conventional JRC, the antenna positions of radar and communications are shared with each other in an MRMC solution. Both systems may share information with each other to benefit from increased number of design degrees- of-freedom (DoFs). This tutorial provides a detailed overview of the emerging MRMC technology.
Outline
Part I: Introduction to MIMO radar and MIMO communications (60 mins)
[I.1]. Fundamentals of MIMO radar
[I.2]. Fundamentals of MIMO communications
[I.3]. MRMC motivation, mm-Wave channel characteristics and its impact on design
[I.4]. MRMC scenarios and architectures
Part II: MRMC Co-existence (70 mins)
[II.1]. Optimization-based designs: Matrix-completion based colocated MIMO radar and point-to-point MIMO communications
[II.2]. Radar sequence design for P2P MIMO communications and collocated MIMO
[II.3]. Communications LLR design for OFDM systems
Part III: MRMC Co-design
[III.1]. Monostatic radar with new MRMC waveforms
[III.2]. Bi-static MRMC with new and existing waveforms (PMCW, OFDMA and 802.11ad)
[III.3]. Hardware prototype design and evaluation
Part IV: Summary and Open Challenges

4) target audience and assumed knowledge
The target audience includes graduate students, researchers, and engineers with general interests in radar remote sensing, wireless communications with mobility, signal processing, and autonomous vehicles. The tutorial assumes no specific technical expertise on the part of audience except basic knowledge of wireless communications and statistical signal processing. The topic is relevant for scientists at government laboratories – defense, space, and civilian – wishing to integrate more functionalities in their current state-of-the-art. The tutorial is useful to industry participants from automotive, remote sensing, and wireless segments who are looking to incorporate latest mathematical tools into their products.