SUMMER**SIM**'19

2019 Summer Simulation Conference

2019 SYMPOSIUM ON PERFORMANCE EVALUATION OF COMPUTERS AND TELECOMMUNICATION SYSTEMS (SPECTS 2019)

TRACK SPEAKER

Title: Using any Surface to Realize a New Paradigm for Wireless Communications, through Software-controlled Metasurfaces.

Speaker: Andreas Pitsillides

TALK SUMMARY:

Wireless communications is undeniably becoming ubiquitous in everyday life, with user demands growing at a very fast pace. Despite impressive breakthroughs in almost every part of our wireless systems-from antennas to hardware to operating software-this demand is getting increasingly challenging to address. The humongous scale of research effort and investment in the upcoming 5th generation of wireless communications (5G) reflects the scale of the challenge. This talk will introduce a valuable and unnoticed resource, which could be exploited to tackle these increasing challenges.

Wireless communication environments, i.e., the set of physical objects (such as walls, doors, desks, and humans) that stand between two wireless communicating devices, are unaware of the ongoing data exchange efforts within them. Moreover, their effects on the communication quality are intractable in all but the simplest cases. These ensuing effects are degenerative, due to such phenomena as the path loss, the multi-path scattering, and the Doppler Effect, exacerbated as operating frequencies scale up, e.g. mm-wave solutions for 5G. Existing proposals for mitigating these effects generally tackle the problem by adopting device-side approaches, treating the environment as an uncontrollable factor that does not participate into the communication process. Examples include device-oriented (e.g. MIMO techniques, real-time adaptation of signal modulation and coding), and retransmitter-oriented (e.g. intelligent placement of passive or active amplifiers) techniques. These effects, as well as different approaches to minimize them, and their inability to tackle the problem at its root, will be briefly overviewed.

Next, the talk will introduce a new approach that could control these effects, producing a wireless environment with software-defined electromagnetic behavior. The novel idea of HyperSurfaces*, which are software-controlled metamaterials embedded in any surface in the environment (e.g. by coating walls, doors, furniture, poles, and other objects) will be motivated. HyperSurfaces are envisioned to realize a new generation of applications, as for example programmatically controlled wireless environments, realizing application related functionalities such as perfect absorption, beam steering via anomalous reflection, or polarization control. These materials can interact with electromagnetic waves in a fully software-defined fashion, even unnaturally. Thus, the electromagnetic behavior of the environment as a whole can become deterministic, controlled and tailored to the needs of mobile devices within it. HyperSurfaces have inter-networking capabilities, allowing for the first time the participation of electromagnetic properties of materials into control loops, leading to the concept of the Internet of Smart Materials. Our solution will be briefly contrasted with closer in concept approaches, such as phased antennas and reflect arrays, which can only support coarse EM steering, e.g., for beamforming applications in wireless devices.

Beyond the conceptual introduction of the topic, a specific application scenario of a Programmable Wireless indoor Environment (PWE) will be presented, from inception to design to evaluation in 2.4 and 60 GHz setups.

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In conclusion, the talk will highlight the substantial gains in communication quality, communication distance and battery savings of mobile devices, and even in security and privacy, will discuss open problems and plausible research directions, as well as outline its potential application in diverse areas, as e.g. highly efficient energy harvesting photovoltaics, and thermophotovoltaics, ultra-high resolution medical imaging, sensing, quantum optics and military applications. Open discussion with the audience will be encouraged.

SHORT BIO:

Andreas Pitsillides is a Professor in the Department of Computer Science, University of Cyprus, heads NetRL, the Networks Research Laboratory, and is appointed Visiting Professor at the University of the Witwatersrand (Wits), School of Electrical and Information engineering, Johannesburg, South Africa. His broad research interests include communication networks (fixed and mobile/wireless), Nana networks and Software Defined Metamaterials, the Internet- and Web- of Things, Smart Spaces (Home, Grid, City), and Internet technologies and their application in Mobile e-Services, especially e-health, and security. He has a particular interest in adapting tools from various fields of applied mathematics such as adaptive non-linear control theory, computational intelligence, game theory, and nature inspired techniques, to solve problems in communication networks. Published over 270 referred papers in flagship journals (e.g. IEEE, Elsevier, IFAC, Springer), international conferences and book chapters, 2 books (one edited), participated in over 30 European Commission and locally funded research projects as principal or co-principal investigator, received several awards, including best paper, presented keynotes, invited lectures at major research organizations, short courses at international conferences and short courses to industry, and serves/served on several journal and conference executive committees.

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