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 - [vTools Tutorials](#)
 - [Engage](#)
 - [eNotice](#)
 - [Events](#)
 - [Nominations](#)
 - [Officer Reporting](#)
 - [Student Branch Reporting](#)
 - [Surveys](#)
 - [Voting](#)
 - [WebInABox](#)
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- [My Events](#)
- [Manage Events](#)
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Wave-Controlled Metasurface-Based Reconfigurable Intelligent Surfaces

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Reconfigurable Intelligent Surfaces (RISs) are programmable metasurfaces that can adaptively steer received electromagnetic energy in desired directions by employing controllable phase shifting cells. Among other uses, an RIS can modify the propagation environment in order to provide wireless access to user locations that are not otherwise reachable by a base station. Alternatively, an RIS can steer the waves away from particular locations in space, to eliminate interference and allow for co-existence of the wireless network with other types of fixed wireless services (e.g., radars, unlicensed radio bands, etc.). The novel approach presented in this talk is a wave-controlled architecture that properly accounts for the maximum

possible change in the local reflection phase that can be achieved by adjacent RIS elements. It obviates the need for dense wiring and signal paths that would be required for individual control of every RIS element, and thus offers a substantial reduction in the required hardware. We specify this wave-controlled RIS architecture in detail and discuss signal processing and machine learning methods that exploit it in both point-to-point and multi-cell MIMO systems. Such implementations can lead to a dramatic improvement in next-generation wireless, radar, and navigation systems where RIS finds wide applications. They have the potential to improve the efficiency of spectrum utilization and coexistence by orders of magnitude.

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Co-sponsored by University of Oulu, Centre for Wireless Communications

Speakers

Ender Ayanoglu

Biography:

Ender Ayanoglu received the Ph.D. degree from Stanford University, Stanford, CA in 1986, in electrical engineering. He was with the Communications Systems Research Laboratory, part of AT&T Bell Laboratories, Holmdel, NJ until 1996, and Bell Labs, Lucent Technologies until 1999. From 1999 until 2002, he was a Systems Architect at Cisco Systems, Inc., San Jose, CA. Since 2002, he has been a Professor in the Department of Electrical Engineering and Computer Science, University of California, Irvine, Irvine, CA, where he served as the Director of the Center for Pervasive Communications and Computing and held the Conexant-Broadcom Endowed Chair during 2002-2010. His past accomplishments include invention of the 56K modems, characterization of wavelength conversion gain in Wavelength Division Multiplexed (WDM) systems, and diversity coding, a technique for link failure recovery in communication networks employing erasure coding introduced in 1990, prior to the publication of the first papers on network coding. During 2000-2001, he served as the founding chair of the IEEE-ISTO Broadband Wireless Internet Forum (BWIF), an industry standards organization which developed and built a broadband wireless system employing Orthogonal Frequency Division Multiplexing (OFDM) and a Medium Access Control (MAC) algorithm that provides Quality-of-Service (QoS) guarantees. This system is the precursor of today's Fourth and Fifth Generation (4G and 5G) cellular wireless systems. From 1993 until 2014, Dr. Ayanoglu was an Editor, and since January 2014 is a Senior Editor of the IEEE Transactions on Communications. He served as the Editor-in-Chief of the IEEE Transactions on Communications from 2004 to 2008. From January 2015 until December 2016 he served as the Editor-in-Chief of the IEEE Journal on Selected Areas in Communications - Series on Green Communications and Networking. This series published three special issues with record number of papers. He led the efforts to start the IEEE Transactions on Green Communications and Networking and served as its Founding Editor-in-Chief from August 2016 to August 2020. From 1990 to 2002, he served on the Executive Committee of the IEEE Communications Society Communication Theory Committee, and from 1999 to 2002, was its Chair. Dr. Ayanoglu is the recipient of the IEEE Communications Society Stephen O. Rice Prize Paper Award in 1995, the IEEE Communications Society Best Tutorial Paper Award in 1997, and the IEEE Communications Society Communication Theory Technical Committee Outstanding Service Award in 2014. He has been an IEEE Fellow since

1998. He is an IEEE Communications Society Distinguished Lecturer in 2002 and 2023.

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