THE ELISHA YEGAL BAR-NESS CENTER FOR WIRELESS INFORMATION PROCESSING (CWiP) ACTIVITY REPORT

AY2016/2017 TO PRESENT

NJIT
New Jersey Institute of Technology

ABOUT THE CENTER

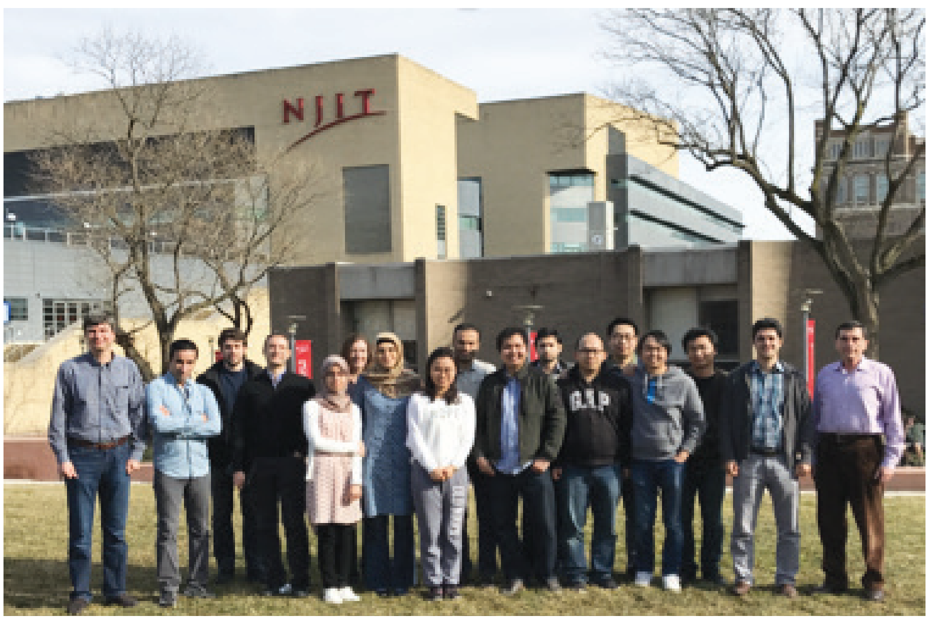
The Elisha Yegal Bar-Ness Center for Wireless Information Processing (CWiP) engages in a broad range of research, including wireless communications, radar, sensor networks, cloud radio, information theory, and signal processing. A unifying theme of the Center's research is that of 5G wireless mobile networks.

There are five faculty members associated with the Center and over 20 graduate students, most of them pursuing their Ph.D. degree.

The Center routinely hosts visiting researchers, post-docs, and students from other countries. Several students pursue double Ph.D. programs according to agreements between NJIT and other universities.

The Center seeks new collaborations with the wireless communications industry.

For more information, please contact Alexander Haimovich, Center Director, 973-596-3534 or alexander.m.haimovich@njit.edu.



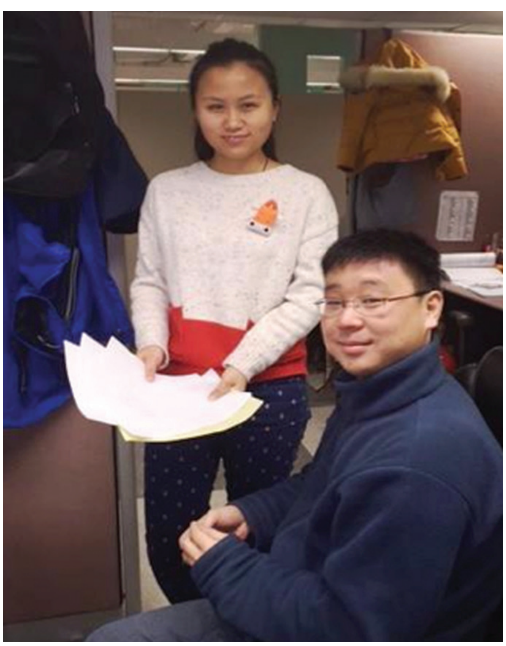
VISION OF THE CENTER

Primary Goal:

To serve as the focal point in the Department of Electrical and Computer Engineering for research in wireless, communications and signal processing.

Activities carried out by participants:

- Initiate and pursue research in the fields of wireless communications and signal processing
- Search collectively as well as individually for possible sources of financial support for participating Center researchers and their affiliates (graduate students or visiting faculty)
- Establish contacts in the electronics industry in the Newark-metropolitan area and throughout New Jersey, learn about their needs, and suggest methods of collaboration
- Assume responsibility for teaching graduate courses in the fields of communications and signal processing, propose and plan new courses and monitor graduate courses taught by adjunct faculty
- Undertake initiatives to recruit highly qualified graduate students, research associates and visiting faculty members and support the efforts of the department chairman to recruit new faculty
- Suggest, design, prepare and deliver short courses as part of the New Jersey Institute of Technology's continuing education program
- Organize seminars on topics of interest to Center members, the Department of Electrical and Computer Engineering, and local industry



RESEARCH INTERESTS OF CENTER FACULTY

Vector Acoustic Communication Technology for High-Speed Underwater Modems

Faculty: Ali Abdi
Ph.D. student: Erjian (Eric) Zhang, researcher: Yuewen Wang
Sponsor: National Science Foundation

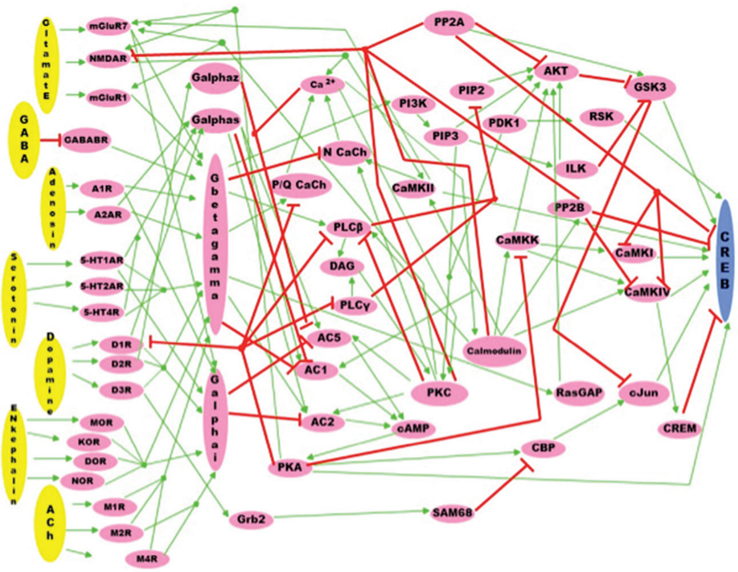
Advanced Communication and Signal Processing (aCASP) Lab setup at NJIT for underwater communication research and development

Over 75% of the earth's surface is covered with water that overlays many resources upon which our lives depend. High-speed wireless underwater data communication between underwater sensors, deepwater moored instruments, autonomous underwater vehicles, and surface vessels is of crucial importance in many applications of national interest. However, the achievable data rates by the conventional technologies are much smaller than what is needed for effective communication and management. To have high-speed communication links in underwater environments, the transformative concept of communication via the vector components of the acoustic field was proposed and developed by Ali Abdi in a prior project supported by the National Science Foundation.

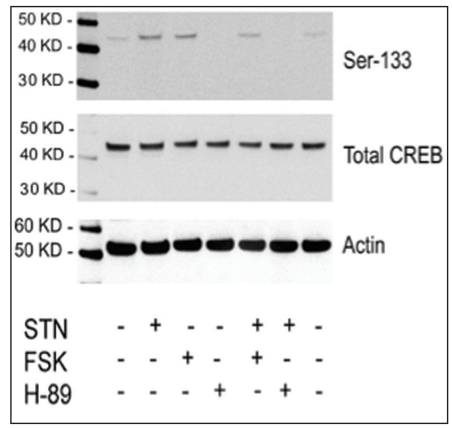
In this new project, a prototype modem will be developed, based on the vector field concept. The key difference between the new modem and other existing modems is that it uses vector transducers, which are compact multichannel devices, to transmit several data streams via multiple particle velocity vector channels. This is while other modems use scalar transducers, which can modulate the data only on the scalar acoustic pressure.

FAULT DIAGNOSIS AND THERAPEUTIC TARGET DISCOVERY IN HUMAN SIGNAL TRANSDUCTION NETWORKS

Faculty: Ali Abdi
Graduate Student: Iman Habibi (Ph.D. graduate)



The CREB signal transduction network



Western blot analysis for experimental verification

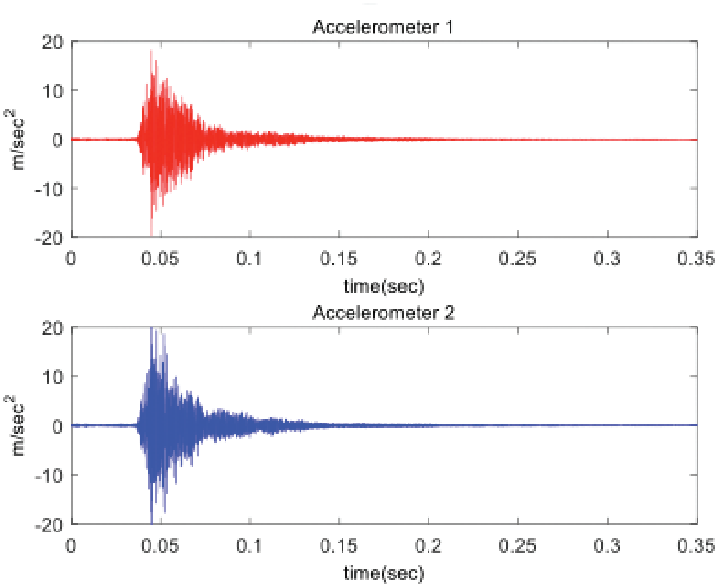
Failure analysis of signal transduction networks is an important topic in systems and molecular biology and has many applications in target discovery and drug development. In this work, some advanced methods for fault diagnosis in signaling networks are developed. The goal is to understand how, and to what extent, the dysfunction of molecules in a network contributes to the failure of the entire network. Network dysfunction is defined as failure to produce the expected outputs in response to the input signals. Vulnerability level of a molecule is defined as the probability of the network failure, when the molecule is dysfunctional. In this study, a method to calculate the vulnerability level of single molecules for different combinations of input signals is developed. Furthermore, a more complex yet biologically meaningful method for calculating the multi-fault vulnerability levels is suggested, in which two or more molecules are simultaneously dysfunctional. Additionally, a method is developed for fault diagnosis of networks based on a ternary logic model, which considers three activity levels for a molecule, instead of the previously published binary logic model. This study suggests that by increasing the number of activity levels the complexity of the model grows; however, the predictive power of the ternary model does not appear to be increased proportionally.

BOREHOLE COMMUNICATION VIA STEEL PIPES IN OIL WELLS

Faculty: Ali Abdi
Ph.D. Student: Ali Alenezi
Sponsor: National Science Foundation

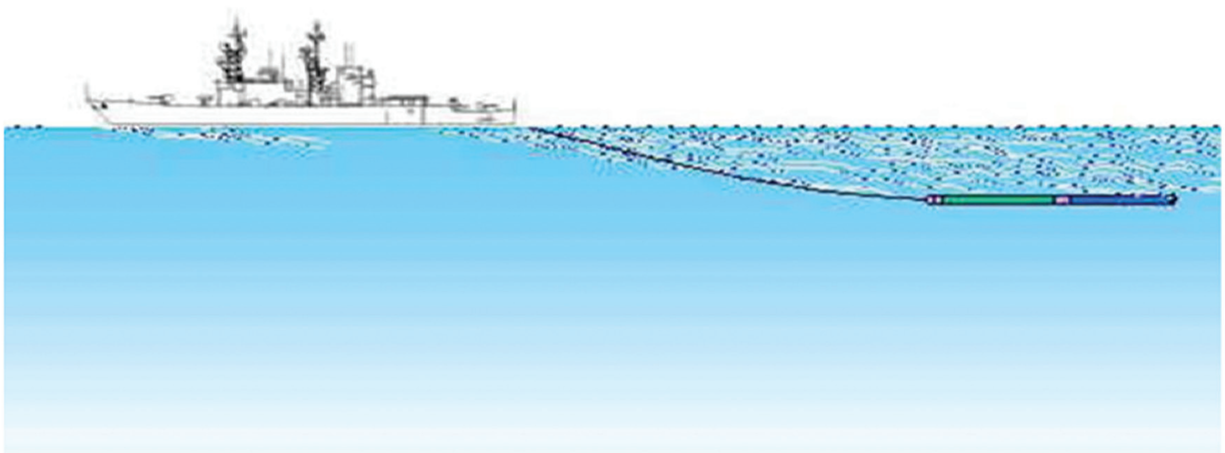
Since boreholes in oil wells are typically very deep, several thousand feet or more, wired communication is very expensive and prone to failure. On the other hand, wireless electromagnetic-based and mud-based methods can provide only very low data rates, typically a few bits per second. Acoustic transmission, however, offers higher data rates. In this research, new high rate communication schemes will be developed by utilizing the physics of sound propagation in steel pipes.

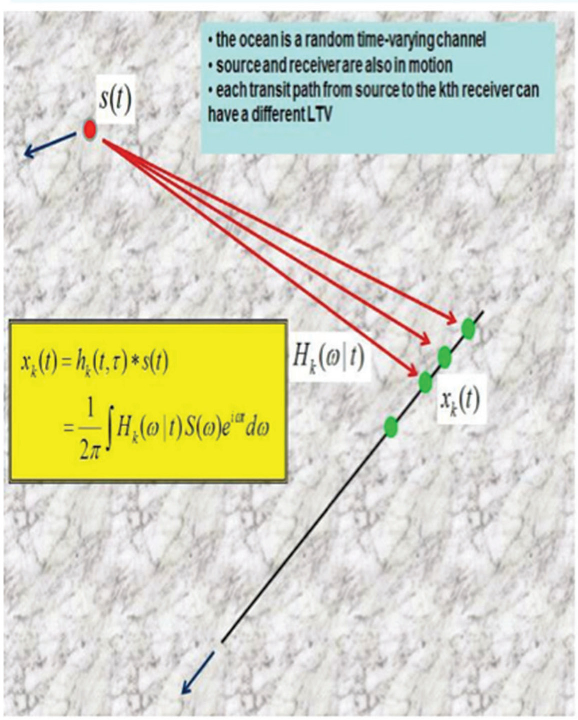
Advanced Communication and Signal Processing (aCASP) Lab testbed at NJIT for communication via steel pipes

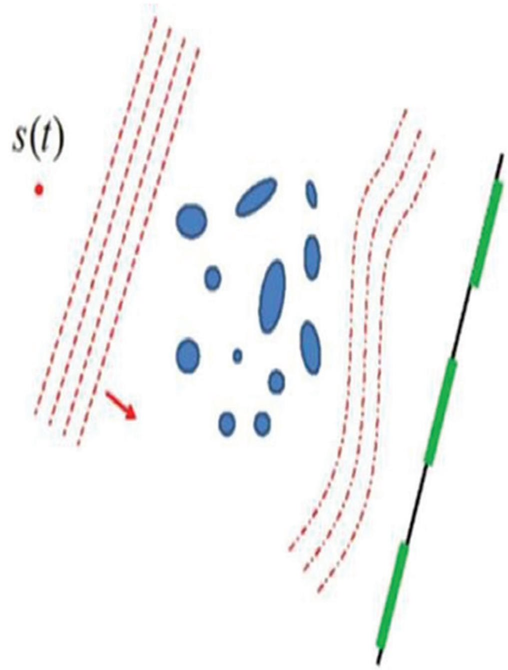


PASSIVE RANGING USING DISTRIBUTED ARRAYS IN UNDERWATER ACOUSTIC ENVIRONMENTS SUBJECT TO SPATIAL COHERENCE LOSS

Faculty: Hongya Ge
Collaborators: Ivars P. Kirsteins (NUWC, Newport, RI)
Sponsor: U.S. Office of Naval Research (ONR), Naval Sea Systems Command (NAVSEA) and Naval Undersea Warfare Center (NUWC)







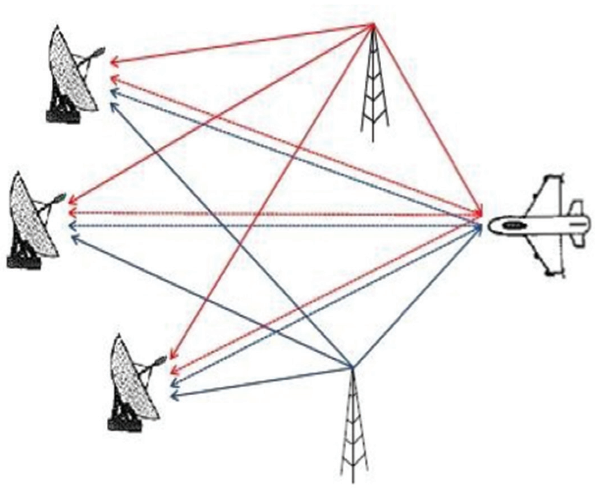
Passive ranging in challenging underwater environments is an important problem in many naval applications, ranging from national defense to disaster recovery and environmental monitoring. Large aperture and/or moving aperture array systems have been designed and redesigned to enable the performance gain in passive methods to source detection, localization and tracking.

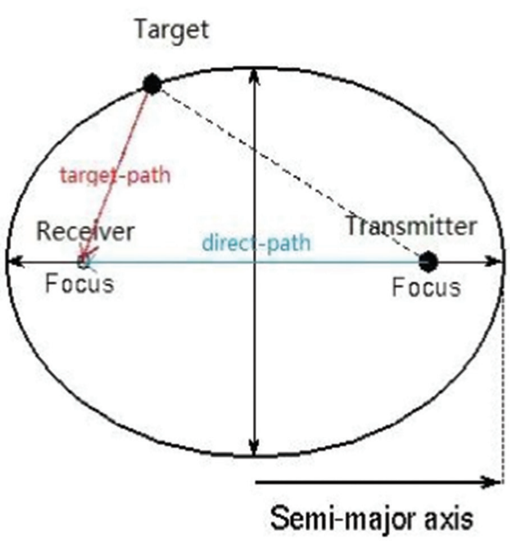
Through data-driven adaptive signal processing, our research explores statistical as well as tempo-spatial-spectral features of acoustic data collected by towed array systems comprised of multiple distributed volumetric array modules. Large amounts of space-time data are collected during different sea trials under the sponsorship of ONR, NAYSEA and NUWC. The goal is to design real-time solutions to passively localize (detection and estimation), classify and track distant emission sources undersea. Due to the turbulent nature and random media effects of underwater acoustic channels, an emission source's spherical or plane wavefronts are partially distorted when arriving at the receiving arrays of large/moving aperture. The relative motion between the source of interest and receiving arrays makes data and the associated parameters highly time varying (a typical high-dimension and sample poor scenario). All of these will result in performance degradation to the wavefront curvature ranging systems equipped with very long aperture. We developed maximum likelihood multi-stage and multi-rank wavefront curvature passive ranging solutions to the problem of localizing and tracking distant sources of interest.

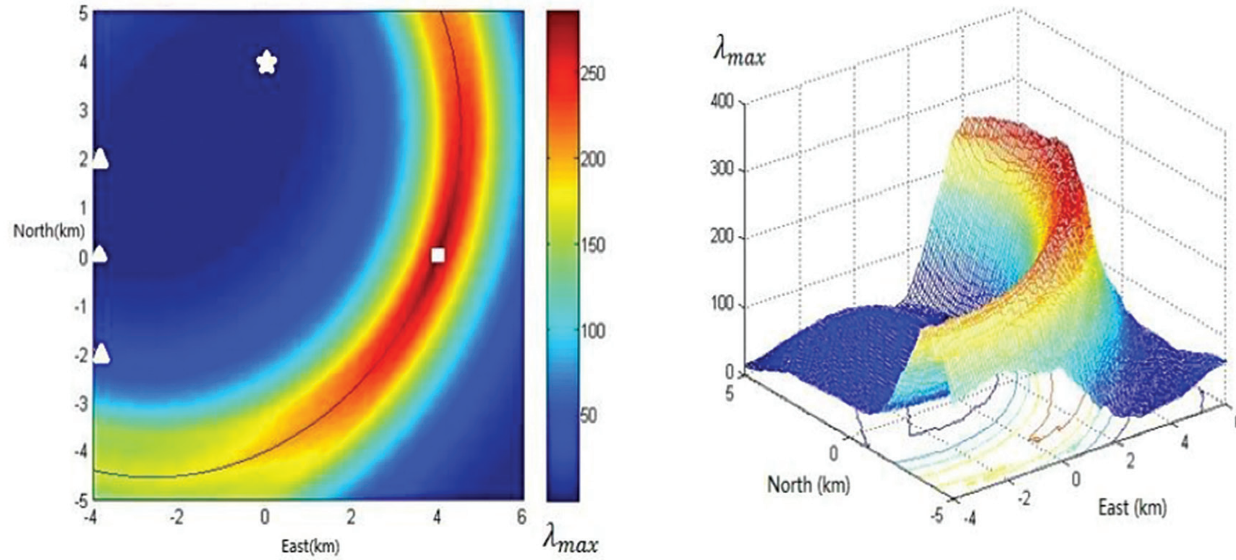
PASSIVE MIMO-RADAR FOR TARGET DETECTION

Faculty: Hongya Ge
Graduate Student: Enlong Hu

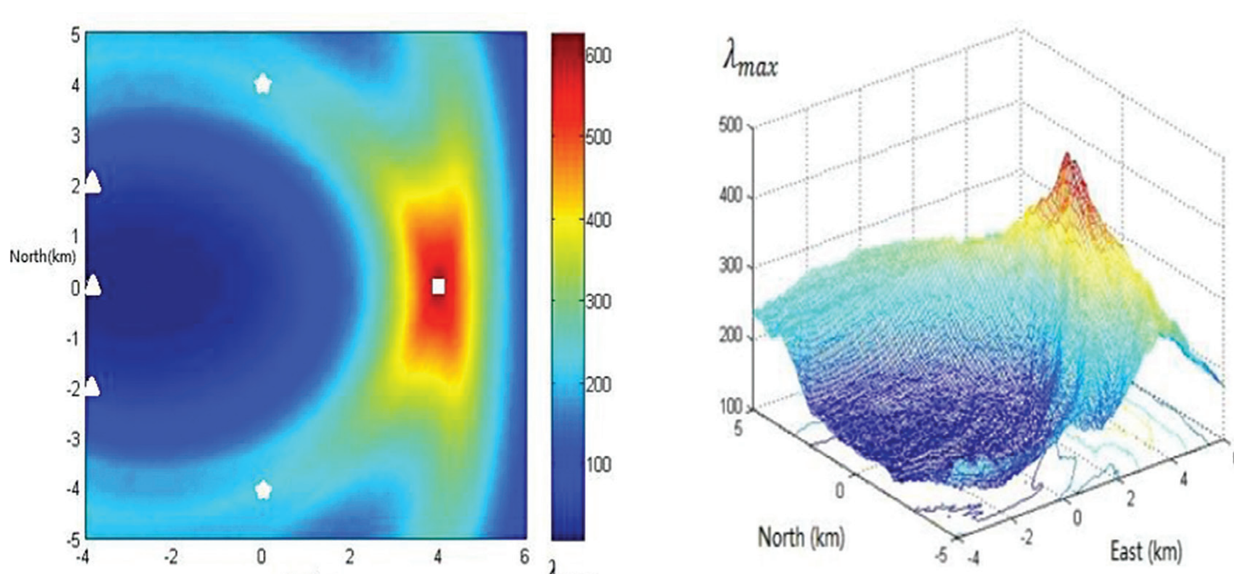
In passive MIMO-Radar system, the RF transmission from existing radio towers along with the reflected RF signals from a target are utilized by low-cost radar antennas. Such primary and secondary multi-channel data can be used to build low-cost MIMO radars for surveillance applications. We studied the performance gain in detection using multiple RF towers as well as reference channel data.







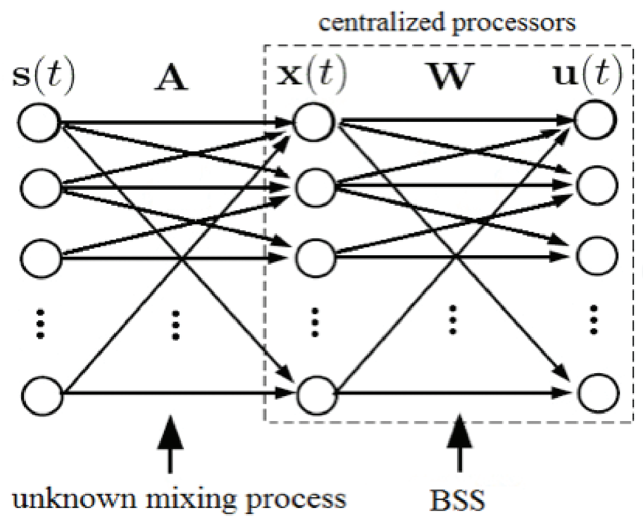
Results obtained by using the transmission from a single RF tower and the target reflection



Results obtained by the using transmissions from two RF towers and the target reflection

BLIND SOURCE SEPARATION

Faculty: Alexander Haimovich, Osvaldo Simeone
Graduate Student: Annan Dong
Sponsor: U.S. Office of Naval Research (ONR)/Booz Allen Hamilton

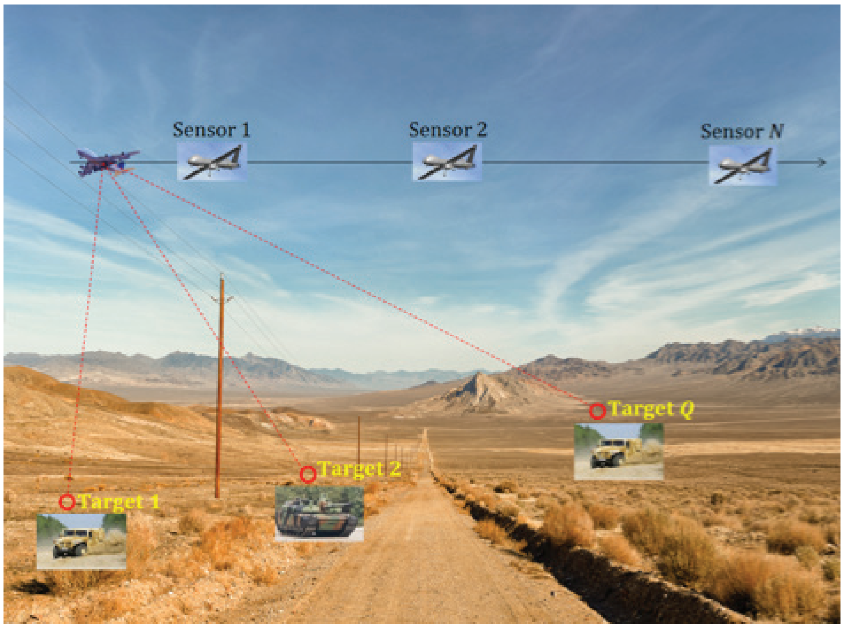


The problem of blind source separation (BSS) is most commonly solved by independent component analysis (ICA). The term "blind" means both the signals from each source and the pattern of how the signals are mixed are unknown. ICA is a probabilistic method that takes a mixture as input and finds components that are maximally independent and non-Gaussian. In contrast to classical multivariate statistical methods, which often invoke Gaussianity of the data, the non-Gaussianity assumption is required for ICA.

Our focus is BSS in a sparse framework. The goal can be achieved by seeking the sparsest representation of the observed signals in a dictionary. The dictionary is a set of basis functions spanning the observed signals, and is assumed to be overcomplete and unknown. To address the sparse BSS problem, a dictionary learning approach is adopted, in which a dictionary is learned from the observed signals. There are two steps in dictionary learning algorithms: a sparse representation step and a learning step. We propose an algorithm that improves the accuracy of the sparse representation step by adding a state-change penalty term to a traditional LASSO algorithm. Moreover, a forwards-backwards algorithm is applied post-processing to further increase the source separation accuracy. Numerical results demonstrate good separation accuracy. For example, with 20 dB SNR, the detection probability is close to 1 at a false alarm probability of 0.13.

DISTRIBUTED RADAR GROUND MOVING TARGET INDICATOR

Faculty: Alexander Haimovich
Graduate Student: Phuoc Vu
Sponsor: Air Force Research Lab/Matrix Research



Ground moving target indicator (GMTI) detects and localizes moving targets in the presence of ground clutter and other interference sources. Space-time adaptive processing (STAP) implemented with antenna arrays has been a classical approach to clutter cancellation in airborne radar. One of the challenges with STAP is that the minimum detectable velocity (MDV) of targets is a function of the baseline of the antenna array: the larger the baseline (i.e., the narrower the beam), the lower the MDV. Unfortunately, increasing the baseline of a uniform linear array (ULA) entails a commensurate increase in the number of elements. An alternative approach to increasing the resolution of a radar is to use a large, but sparse, random array. The proliferation of relatively inexpensive autonomous sensing vehicles, such as unmanned airborne systems, raises the question whether is it possible to carry out GMTI by distributed airborne platforms. A major obstacle to implementing distributed GMTI is the synchronization of autonomous moving sensors. For range processing, GMTI processing relies on synchronized sampling of the signals received at the array, while STAP processing requires time, frequency and phase synchronization for beamforming and interference cancellation. An additional fundamental assumption in array processing is exact knowledge of the sensor locations. Distributed sensors have independent oscillators, which are naturally not synchronized and are each subject to different stochastic phase drift. Moreover, in the proposed distributed GMTI system, sensors are airborne, thus their locations are known with only finite precision. This project develops techniques for phase calibration and frequency synchronization in distributed radar systems. Our goal is to jointly estimate the relative phases and the locations of the sensors, and subsequently to use these estimates to perform ground moving target detection by space-time adaptive processing (STAP).

DISTRIBUTED RADAR MULTIPLE TARGET TRACKING

Faculty: Alexander Haimovich
Graduate Student: Wei Jiang/ Phuoc Vu

This project focuses on developing a direct tracking approach to multiple targets by distributed radar sensors. We present a challenging scenario of a distributed multi-input multi-output (MIMO) radar system (as shown above), in which relatively simple moving sensors send observations to a fusion center where most of the baseband processing is performed. The sensors are assumed to maintain time synchronization, but are not phase synchronized. The conventional approach to localization by distributed sensors is to estimate intermediate parameters from the received signals, for example time delay or the angle of arrival. Subsequently, these parameters are used to deduce the location and velocity of the target(s). These classical localization techniques are referred to as indirect localization. Recently, new techniques have been developed capable of estimating target location directly from signal measurements, without an intermediate estimation step. Our objective is to develop a direct tracking algorithm for multiple moving targets. We aim to develop a direct tracking algorithm of targets' state parameters using widely distributed moving sensors for multiple moving targets. Potential candidates for the tracker include Extended Kalman Filter and Particle Filter.

MEASURING AND MODELING INFORMATION FLOW ON THE BRAIN-RESPONSE CHANNEL

Faculty: Joerg Kliewer
Graduate Student: Ketan Mehta, New Mexico State University (NMSU)
Sponsor: National Science Foundation (NSF)
Collaborators: Chuck Creusere (NMSU), Jim Kroeger (NMSU)

We use mutual information (MI) as a measure to quantify the subjective perception of audio quality by directly measuring the brainwave responses of human subjects using a high-resolution electroencephalogram (EEG). Specifically, we propose an information theoretic model to interpret the entire "transmission chain" comprising stimulus generation, brain processing by the human subject and EEG measurements as a nonlinear, time-varying communication channel with memory. In the conducted experiments, subjects were presented with audio whose quality varies between two quality levels. The recorded EEG measurements can be modeled as a multidimensional Gaussian mixture model (GMM). In order to make the computation of the MI feasible, we have derived a novel approximation technique for the differential entropy of the multidimensional GMM. The obtained mutual information results are shown in Figure 1 for each human subject and different music type.

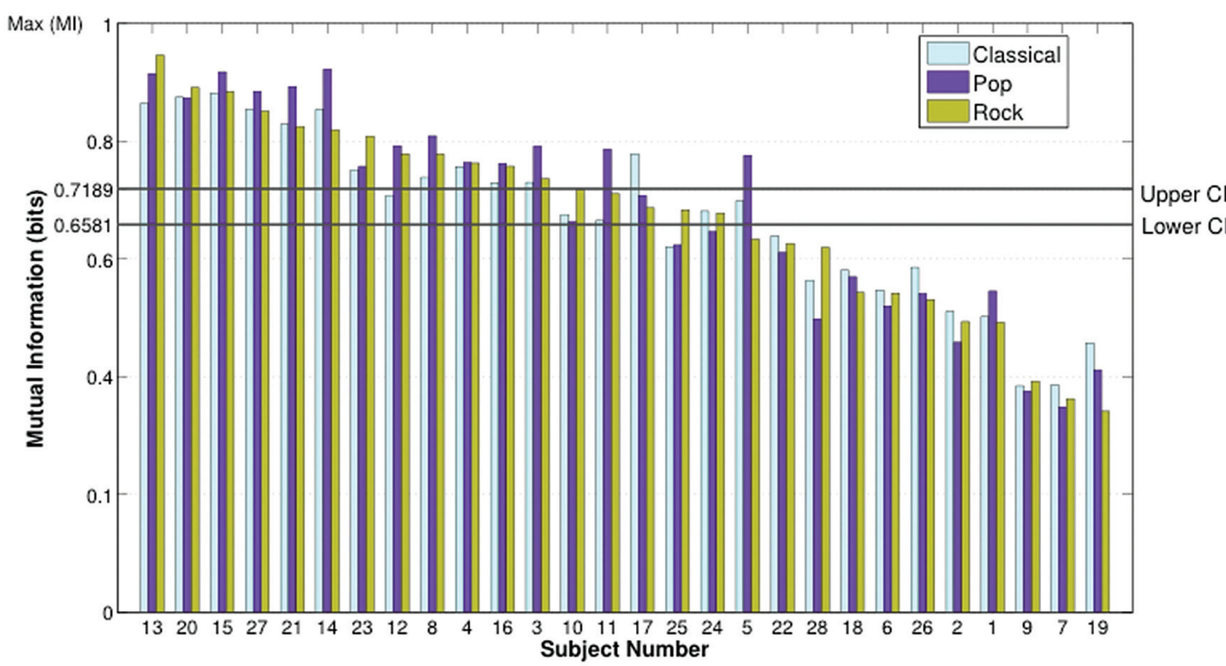


Figure 1: The median mutual information estimates for each of the 19 test subjects when presented with the same set of trial-sequences, across the two different distortion-types.

We have extended the above results to the analysis of directed MI measures between different regions of EEG sensors and to determine whether these measures are useful to exhibit different information flows for different audio stimuli between these regions. A new causal bi-directional information (CBI) measure is proposed which quantifies the information flow between EEG electrodes by appropriately grouping them into specific regions of interest (ROIs) over the cortex. It is shown that CBI can be intuitively interpreted as a causal bi-directional modification of directed information applied to a generalized cortical network setting, and inherently calculates the divergence of the observed data from a multiple access channel with feedback. The proposed measure is used to analyze and compare the information flow between ROI pairs for the case when the subject listens to high-quality audio as opposed to the case when the subject listens to low-quality audio. The connectivity results inferred by using CBI indicate a much stronger change in the rate of information flow between ROIs as the subject listens to the different audio qualities, compared to using standard directed information measures (see Figure 2(b) below).

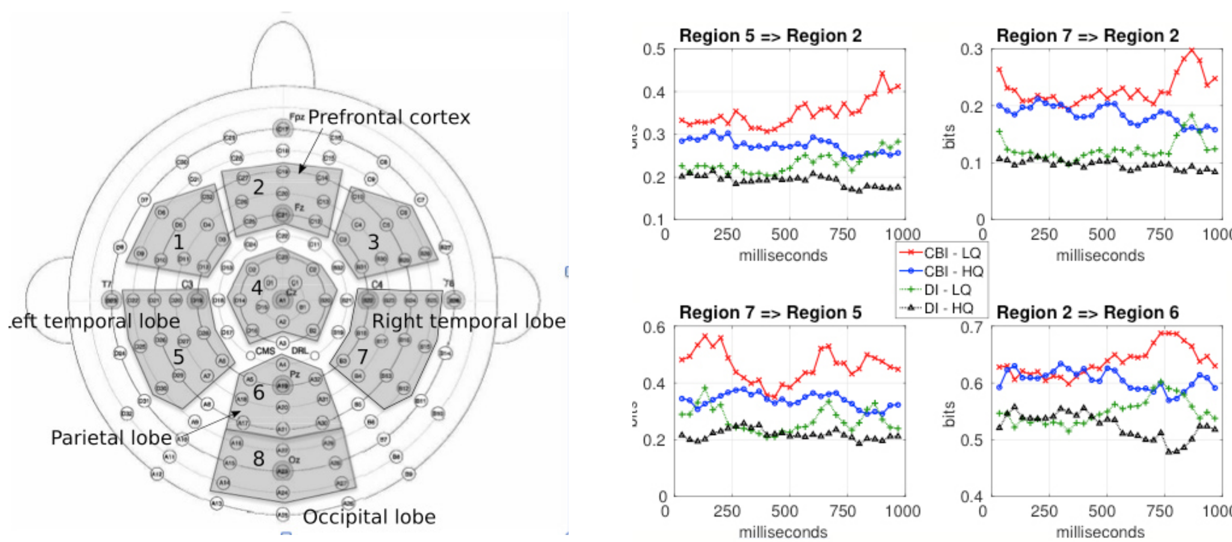


Figure 2: (a) The 128 electrodes are grouped into eight ROIs to effectively cover the different cortical regions (lobes) of the brain. (b) The instantaneous information transfer rates for the proposed CBI measure calculated between four different ROI pairs, for a second of the trial data after stimulus onset. Also included for comparison purposes are the causally conditioned Massey directed information (DI) rates for the same set of trial data.

LOW-COMPLEXITY WIRELESS SENSOR ARCHITECTURES BASED ON ASYNCHRONOUS PROCESSING

Faculty: Joerg Kliewer
Graduate Student: Chen Yi Chen
Sponsor: National Science Foundation (NSF)
Collaborators: Wei Tang, New Mexico State University (NMSU)

In recent years, integrated wireless sensors have emerged in a wide range of applications, including health care, surveillance, smart buildings, disaster mitigation, and environment monitoring, and therefore have significantly benefited society due to alleviating certain monitoring tasks associated with these applications. However, new applications with implantable biopotential sensors or submersible sensors for measuring mechanical stress require further miniaturization of existing state-of-the-art sensor hardware while having a significantly increased transmission data rate due to the need to perform multichannel processing, i.e., to aggregate the data of multiple single sensors on the same chip over a single communication link. Thus, these approaches require the design of very low-power sensor hardware architectures, including novel low-complexity modulation and coding schemes which can support reliable and secure transmission over these high-speed data links. Our suggestion to solve this problem is to devise asynchronous delta modulation on the sensor interface in combination with asynchronous ultra-wideband transmission on the wireless radio interface in order to significantly decrease the power consumption of the sensor hardware.

The goal of this project is to find and study forward error correction strategies that are tailored to this emerging class of low-power integrated wireless sensors nodes based on asynchronous modulation (see the system block diagram in Figure 3). We have proposed a forward error correction scheme for asynchronous sensor communication, where a continuous-time sparse waveform signal is asynchronously sampled (see Figure 4(a)) and communicated over a noisy channel via Q-ary frequency-shift keying (FSK). The presented concatenated code employs outer systematic convolutional codes and inner embedded marker codes, which effectively preserve the timing information along with a protection against symbol insertions and deletions. For this scheme, we have shown that by iteratively decoding marker and convolutional codes along with interleaving a short block of parity bits, a significant reduction in terms of the expected end-to-end distortion between original and reconstructed signals can be obtained compared to non-iterative processing (see Figure 3(b)).

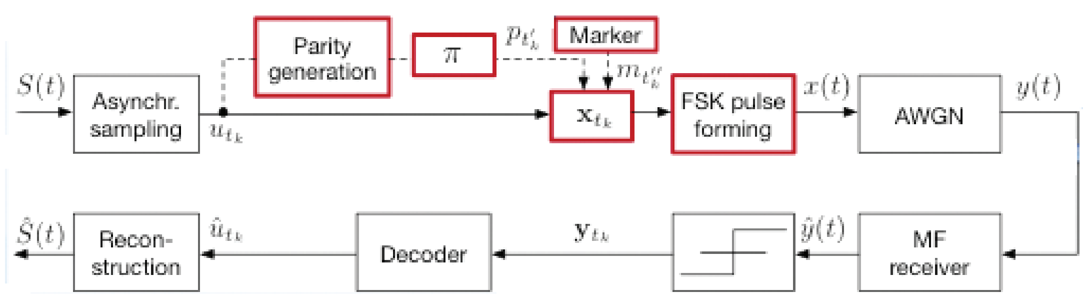
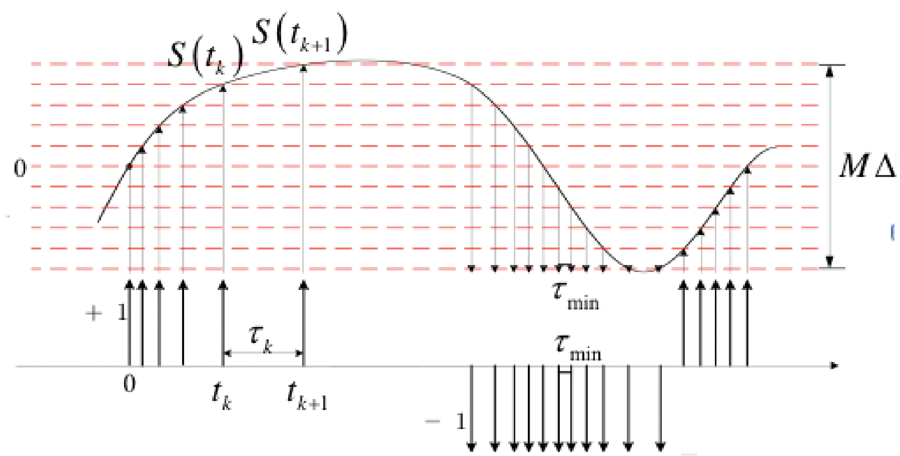


Figure 3: Block diagram of the wireless sensing transmitter and receiver



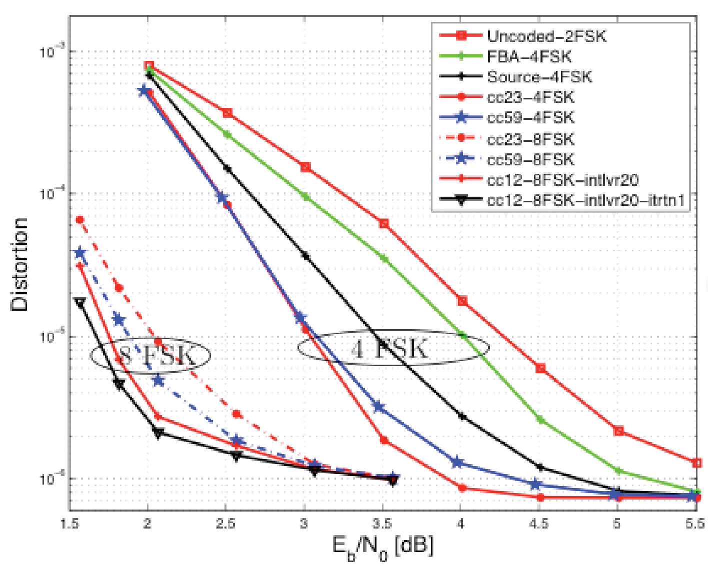


Figure 4: (a) Asynchronous sampling via level crossing sampling. (b) Reconstruction signal-to-noise ratio (SNR) versus channel SNR for the proposed coded asynchronous communication system.

COORDINATION AND COOPERATION IN NETWORKED MULTI-AGENT SYSTEMS

Faculty: Joerg Kliewer
Graduate Student: Sarah Obead
Postdoctoral Researcher: Badri Vellambi
Sponsor: National Science Foundation (NSF)

One fundamental problem in decentralized networked systems is to coordinate activities of different nodes so that they reach a state of agreement. This global objective is typically obtained by local operations, for example, by employing gossip algorithms to achieve consensus over a set of agents, where several data exchanges are iteratively carried out between pairs of adjacent nodes. In contrast, we are interested in a generalization of this problem where consensus is meant in a broader sense of achieving coordinated actions by the network nodes, and therefore can be seen as an instance of distributed control in networks. This cooperative behavior is useful in a host of applications, for example, in multi-agent systems for exploration of an unknown terrain, distributed surveillance applications, autonomous vehicles, load balancing with divisible tasks in a large computer networks or power grids and in distributed games.

Given this importance of coordination between autonomous agents the goal of our work is to study the fundamental communication limits of coordination and extend these limits to the network setting. We have analyzed the problem of coordination of the actions of two agents X and Y that communicate over a noisy communication channel such that the actions follow a given joint probability distribution (see Figure 5). We have proposed two novel schemes for a noisy strong coordination problem, and derive inner bounds for the respective strong coordination capacity region. The first scheme is a joint coordination-channel coding scheme that utilizes the randomness provided by the communication channel to reduce the local randomness required in generating the action sequence at agent Y. The second scheme exploits separate coordination and channel coding where local randomness is extracted from the channel after decoding. We obtain the surprising result that the joint scheme is able to outperform the separate scheme in terms of coordination rate, which breaks Shannon's classical source channel separation theorem for strong noisy coordination. This has significant implications for the design of such coordination schemes.

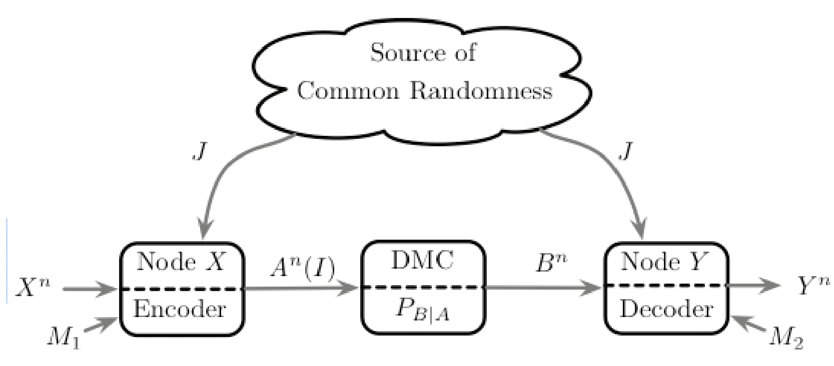
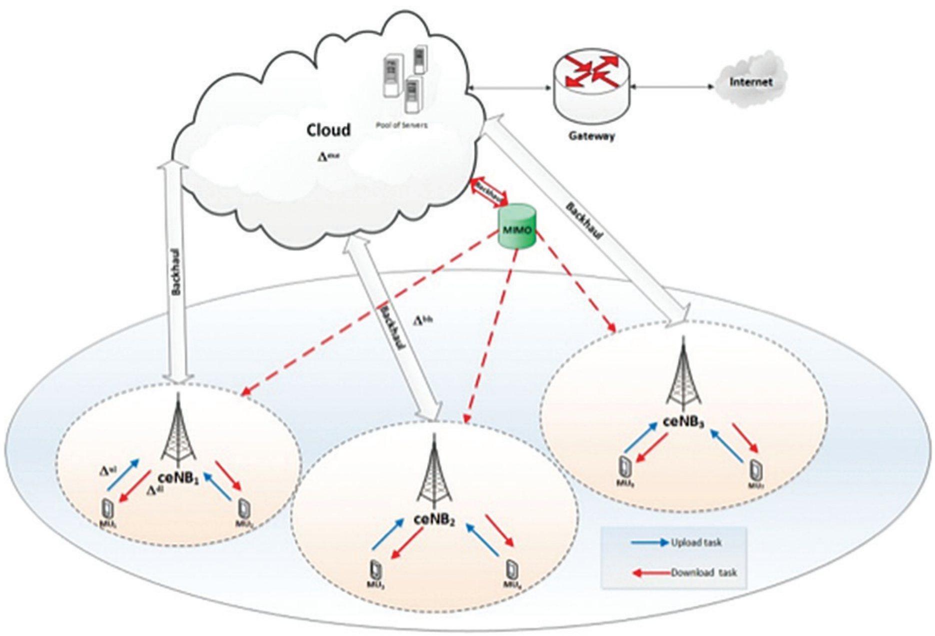


Figure 5: Point-to-point strong coordination over a discrete memoryless channel (DMC)

MOBILE FOG COMPUTING

Faculty: Osvaldo Simeone
Graduate Students: Alireza Bagheri, Ali Najdi
Collaborator: Gesualdo Scutari (Purdue University)
Sponsor: National Science Foundation (NSF)

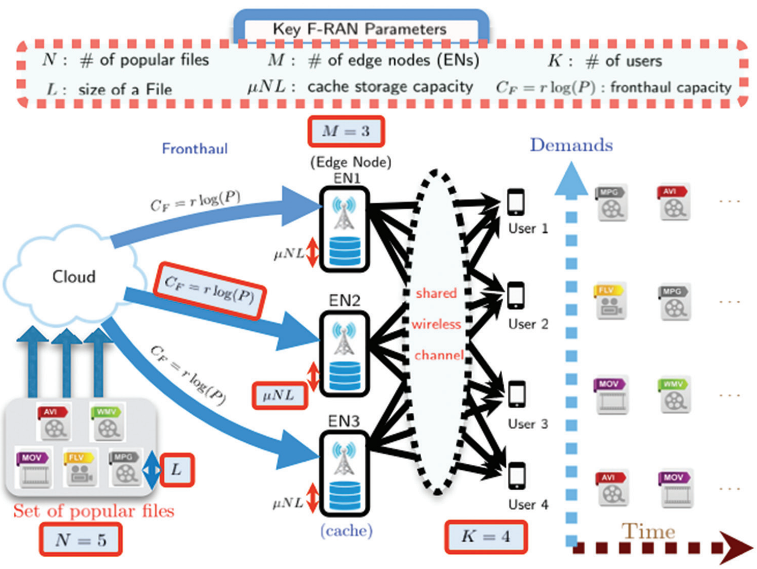


While the number of computation-intensive applications that users expect to run on mobile devices– including video processing, object recognition, gaming, automatic translation and medical monitoring– continues to grow, the devices' computing capabilities are ultimately limited by the battery lifetime. Barring breakthroughs in battery technology, the only potential solution to this challenge appears to be mobile cloud computing; that is, the offloading of computation-intensive tasks to a cloud service provider, such as for speech recognition with Google Voice Search and Apple Siri. However, accessing the cloud through a wireless network entails the energy and latency required for uplink and downlink transmissions, as well as the delay caused by routing on the backhaul network, hence potentially offsetting the gains of mobile cloud computing.

This research project proposes to tackle the above problem by introducing the fog mobile computing architecture, in which the small-cell base stations of a cellular system are endowed with computing capabilities to offer proximate wireless access and computing. The key objective of the project is to develop effective, low-complexity, scalable and flexible offloading strategies based on the inter-layer optimization of computation and communication resources, with the aim of ensuring Quality of Experience (QoE) constraints in terms of minimal mobile energy expenditure and latency.

FOG RADIO ACCESS NETWORKS: CLOUD AND CACHE-AIDED WIRELESS SYSTEMS

Faculty: Osvaldo Simeone
Graduate Students: Mohammadreza Azimi, Avik Sengupta (Virginia Tech)
Collaborator: Ravi Tandon (University of Arizona)

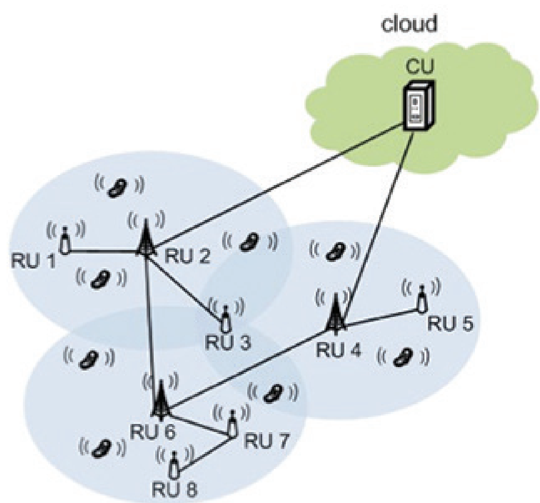


Virtualization and edge processing are among the most promising and transformative trends in the evolution of wireless network architectures. Virtualization of radio access, also known as Cloud Radio Access Network (C-RAN), prescribes the centralization of baseband and higher-layer processing, with the aim of boosting spectral and cost efficiency in interference-limited dense wireless deployments. In contrast, edge processing leverages local content reuse by means of edge caching, with the goal of catering to hot-spot or proximate traffic of popular multimedia content. In order to accommodate the broad range of use cases that are envisioned to be within the scope of 5G systems and beyond, a hybrid architecture, referred to as Fog-RAN (F-RAN), which harnesses the benefits of, and the synergies between both technologies, has been recently advocated and is the subject of this project. In an F-RAN, edge nodes may be endowed with caching capabilities, so as to serve local data requests of popular content with low latency, while at the same time being controllable from a central cloud processor, in order to serve arbitrary data requests with stronger interference management properties and less stringent delay constraints.

The optimal operation of an F-RAN architecture poses a complex design problem that is characterized by the interaction between the policies used for caching, for transmission over the fronthaul links connecting cloud and edge nodes, and for wireless delivery. The policies operate at heterogeneous time scales and under different conditions in terms of channel state information and knowledge of users' requests. In order to tackle this complex design problem and obtain insights into the main trade-offs between performance and resources, namely caching and fronthaul capacities, a novel information-theoretic model for F-RAN is introduced along with a fundamental performance metric that quantifies the worst-case delivery latency needed to support the users' requests. The delivery latency encompasses the delays associated with the transfer of information on the fronthaul network and on the wireless segment. Novel information-theoretic achievability and converse arguments will be developed to obtain tight characterizations of the tradeoff between latency, on the one hand, and fronthaul and edge caching capacities on the other hand. Through this information-theoretic analysis, fundamental insights into optimal design choices will be revealed. The theory will be complemented by means of system-level simulations that will be carried out in collaboration with industrial and academic partners.

CLOUD RADIO ACCESS NETWORKS

Faculty: Osvaldo Simeone
Graduate Students: Jinkyu Kang, Korea Advanced Institute of Science and Technology (KAIST), Seongah Jeong (KAIST), Eunhye Heo (KAIST),
Wonju Lee (KAIST)
Collaborators: Shlomo Shamai (Technion), Onur Sahin (InterDigital), Joonhyuk Kang (KAIST), Marco Levorato, (University of California-Irvine), Wei Yu (University of Toronto)
Support: Vienna Science and Technology Fund



Next-generation wireless cellular systems are expected to undergo a radical paradigm shift, which is akin to the revolution brought forth by clouding computing in computer networks. As cloud computing prescribes the physical separation of user-centric data input/output and remote computing, cloud radio access networks (C-RANs) separate distributed and localized radio transmission/reception units from centralized information processing nodes.

In a basic C-RAN, radio units (RUs), such as macro-, pico- and home-base stations, provide the wireless interface between the operator's network and the mobile devices. However, unlike conventional cellular systems, the RUs do not implement the information processing functionalities needed to encode and decode information on the wireless channel. Instead, information processing is carried out remotely within the "cloud" of the operator's network. This migration of computing to the cloud is enabled by a network of backhaul links that connect the radio units both among themselves and to control units (CUs) within the cloud.

The centralization of information processing afforded by C-RANs enables effective interference management at the geographical scale covered by the distributed radio units. Moreover, C-RANs in principle simplify the deployment of dense heterogeneous networks. Both advantages promise to be key components of the solution to the so called "spectrum crunch" problem. However, the main roadblock to the realization of the potential benefits of C-RANs hinges on the effective integration of the wireless interface provided by the radio units with the backhaul network that links the radio units and information processing nodes within the cloud. The goal of this research is to investigate advanced integration strategies based on network information theoretic principles.

CENTER Ph.D. STUDENTS AND VISITING SCHOLARS

First	Last	Advisor
Ali	Alenezi	Ali Abdi
Erjian (Eric)	Zhang	Ali Abdi
Mustafa	Ozen	Ali Abdi
Enlong	Hu	Hongya Ge
Annan	Dong	Alexander Haimovich
Haley	Kim	Alexander Haimovich
Phuoc	Vu	Alexander Haimovich
Wei	Jiang	Alexander Haimovich
Chen	Yi	Joerg Kliewer
Sarah	Obead	Joerg Kliewer
Salman	Habib	Joerg Kliewer
Malihe	Aliasgari	Joerg Kliewer
Ali	Al-Shuwaili	Osvaldo Simeone
Alireza	Bagheri	Osvaldo Simeone
Seyyed Mohammadreza	Azimi	Osvaldo Simeone
Jeongwan	Koh	Osvaldo Simeone

CENTER MASTER’S DEGREE AND BACHELOR’S DEGREE STUDENTS WORKING ON PROJECTS

First	Last	Advisor
Sudha	Namburi	Ali Abdi
Jinzhen	Wang	Ali Abdi
Yichen	Lin	Ali Abdi

CENTER FACULTY AND STAFF

First	Last	Advisor
Ali	Abdi	Faculty
Yeheskel	Bar-Ness	Faculty Emeritus
Hongya	Ge	Faculty
Alexander	Haimovich	Faculty
Joerg	Kliewer	Faculty
Osvaldo	Simeone	Faculty
Kathy	Bosco	Staff

LIST OF PROJECTS AND FUNDING

Abdi, Ali (PI) "PFI: AIR–TT: A novel vector acoustic communication technology for high speed underwater modems," U.S. NSF, $199,985. (August 2015–January 2018)

Associate Investigator: H. Ge, NUWC ILAR Research Proposal (PI: Dr. Ivars P. Kirsteins, NUWC) on team effort to study "Lucky ranging in underwater acoustic environments subject to spatial coherence loss," ($220K for FY 2017 and FY2018) with a goal of obtaining detailed results on various real data collected (provided by the NUWC, and Scripps-UCSD) as well as simulated data with internal waves (provided by WHOI-MIT) to be presented to ONR for future long-term funds. (Awarded in Mid-Sept. 2016)

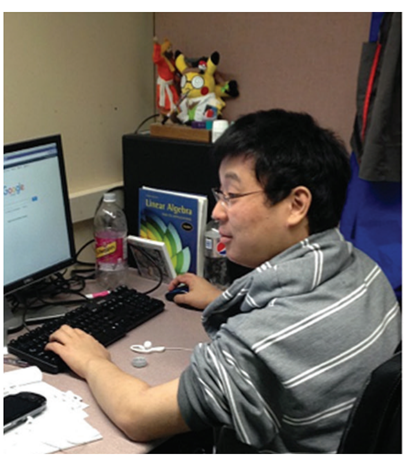
Haimovich, Alexander M. (PI), "GMTI by Multi-platform airborne distributed MIMO," Sponsored by U.S. Air Force/Matrix Research, $307,767.00. (August 2015-August 2018)

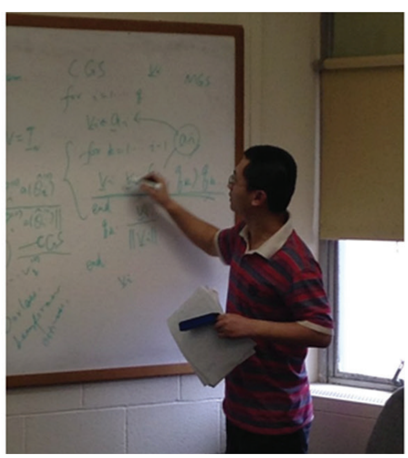
Haimovich, Alexander M. (PI), "Tactical signals intelligence (SIGNIT) technology blind source separation," Sponsored by U.S. ONR/Booz Allen Hamilton, $280,712. (June 9, 2016–December 23, 2017)

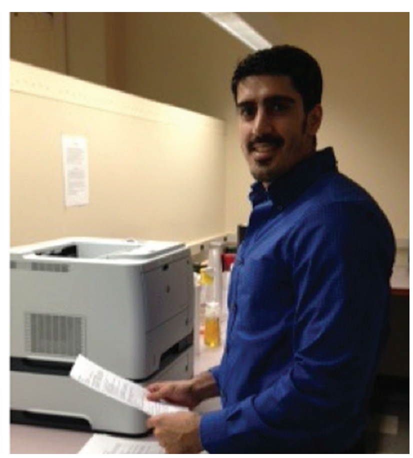
Haimovich, Alexander M. "Development, Integration, Testing, and Training (DITT) of Systems and Processes for Systems & Facilities Optimization Mod 4," Sponsored by U.S. Army–Picatinny, $4,820,943. (September 1, 2016–September 1, 2017)

Kliewer, Joerg (PI), "Collaborative Research: Spatially Coupled Sparse Codes on Graphs – Theory, Practice, and Extensions, Sponsored by U.S. National Science Foundation, Federal, $153,989. (July 2012-June 2017). Awarded to New Mexico State University, transferred to NJIT

Kliewer, Joerg (PI), "Collaborative research: Coordination and cooperation in networked multi-agent systems," Sponsored by U.S. National Science Foundation, Federal, $246,157. (Sept. 2014-Aug. 2017). Awarded to New Mexico State University, transferred to NJIT







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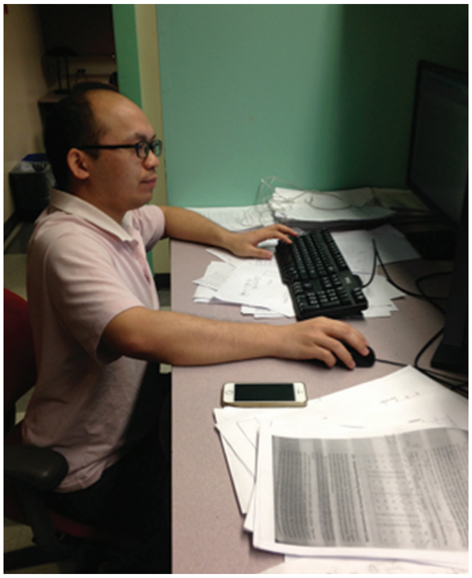

Kliewer, Joerg (PI), “Collaborative research: Low-complexity wireless sensor architectures based on asynchronous processing,” NSF, $194,898. (September 2014-August 2017)

Kliewer, Joerg (PI), “TWC: Small: Communication under adversarial attacks in complex networks-fundamental limits and secure coding strategies”, NSF, $338,193. (September 2015-August 2018)

Simeone, Osvaldo (Co-PI), “TINCOIN,” Sponsored by Vienna Science and Technology Fund, Other, $50,000.00. (November 2012–Present)

Matz, G. (TU Wien) (PI), Simeone, Osvaldo (Co-PI), “TINCOIN,” Vienna Science and Technology Fund, $40,000.00. (March 2014–March 2017)

Simeone, Osvaldo (PI), “CIF: Small : Collaborative research: Communicating while computing: Mobile fog computing over wireless heterogeneous networks,” U.S. NSF, $249,848.00. (September 2015-August 2018)

PUBLICATIONS

Refereed Journal Articles Published:

I. Habibi, R. Cheong, T. Lipniacki, A. Levchenko, E. S. Emamian, and A. Abdi, “Characterization and measurement of cell decision making processes using single cell data.” (2nd revision to be submitted in Jan. 2017. One reviewer has asked for few minor changes.)

W. Huang, M. Langberg, J. Kliewer, J. Bruck, “Communication efficient secret sharing.” IEEE Transactions on Information Theory, vol. 62, no. 12, pp. 7195-7206, December 2016

A. Al-Shuwaili, O. Simeone, J. Kliewer, P. Popovski, “Coded network function virtualization: Fault tolerance via in-network coding.” IEEE Wireless Communication Letters, vol. 5, no. 6, pp. 644-647, December 2016

B. Amiri, A. Reisizadehmobarakeh, H. Esfahanizadeh, J. Kliewer, L. Dolecek, “Optimized design of finite-length separable circulant-based spatially-coupled codes: An absorbing set-based analysis.” IEEE Transactions on Communications, vol. 64, no. 10, pp. 4029-4042, October 2016

E. En Gad, Y. Li, J. Kliewer, M. Langberg, A. Jiang, J. Bruck, “Asymmetric error correction and flash memory rewriting using polar codes,” IEEE Transactions on Information Theory, vol. 62, no. 7, pp. 4024-4038, July 2016

M. Varasteh, B. Rassouli, O. Simeone and D. Gündüz, “Zero-delay joint source-channel coding with a 1-bit ADC front end and receiver side information,” 2016 IEEE Information Theory Workshop (ITW), Cambridge, 2016, pp. 449-453. doi: 10.1109/ITW.2016.7606874

A. Al-Shuwaili, O. Simeone, J. Kliewer and P. Popovski, “Coded network function virtualization: Fault tolerance via in-network coding,” in IEEE Wireless Communications Letters, vol. 5, no. 6, pp. 644-647, Dec. 2016. doi: 10.1109/LWC.2016.2611510

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S. H. Park, O. Simeone and S. S. Shitz, "Time-asynchronous robust cooperative transmission for the downlink of C-RAN," in IEEE Signal Processing Letters, vol. 23, no. 10, pp. 1444-1448, Oct. 2016. doi: 10.1109/LSP.2016.2601113

S. Khalili; O. Simeone, "Uplink HARQ for cloud RAN via separation of control and data planes," in IEEE Transactions on Vehicular Technology, vol. PP, no. 99, pp. 1-1. doi:10.1109/TVT.2016.2604119

R. Tandon and O. Simeone, "Harnessing cloud and edge synergies: toward an information theory of fog radio access networks," in IEEE Communications Magazine, vol. 54, no. 8, pp. 44-50, August 2016. doi: 10.1109/MCOM.2016.7537176

S. Jeong, O. Simeone, A. Haimovich and J. Kang, "Optimal fronthaul quantization for cloud radio positioning," in IEEE Transactions on Vehicular Technology, vol. 65, no. 4, pp. 2763-2768, April 2016. doi: 10.1109/TVT.2015.2431491

S. Khalili; J. Feng; O. Simeone; J. Tang; Z. Wen; A. M. Haimovich; M. Zhou, "Code-aided channel tracking and decoding over sparse fast-fading multipath channels with an application to train backbone networks," in IEEE Transactions on Intelligent Transportation Systems, vol. PP, no. 99, pp. 1-12. doi: 10.1109/TITS.2016.2549544

S. H. Park, O. Simeone, O. Sahin and S. Shamai, "Multihop backhaul compression for the uplink of cloud radio access networks," in IEEE Transactions on Vehicular Technology, vol. 65, no. 5, pp. 3185-3199, May 2016. doi: 10.1109/TVT.2015.2436991

B. Azari, O. Simeone, U. Spagnolini and A. M. Tulino, "Hypergraph-based analysis of clustered co-operative beam-forming with application to edge caching," in IEEE Wireless Communications Letters, vol. 5, no. 1, pp. 84-87, Feb. 2016. doi: 10.1109/LWC.2015.2500895

S. M. Azimi, O. Simeone, O. Sahin and P. Popovski, "Ultra-reliable cloud mobile computing with service composition and superposition coding," 2016 Annual Conference on Information Science and Systems (CISS), Princeton, N.J., 2016, pp. 442-447. doi: 10.1109/CISS.2016.7460543

A. Sengupta, R. Tandon and O. Simeone, "Cache aided wireless networks: Trade-offs between storage and latency," 2016 Annual Conference on Information Science and Systems (CISS), Princeton, N.J., 2016, pp. 320-325. doi: 10.1109/CISS.2016.7460522

R. Tandon and O. Simeone, "Cloud-aided wireless networks with edge caching: Fundamental latency trade-offs in fog Radio Access Networks," 2016 IEEE International Symposium on Information Theory (ISIT), Barcelona, Spain, 2016, pp. 2029-2033. doi: 10.1109/ISIT.2016.7541655

A. N. Al-Shuwaili, A. Bagheri and O. Simeone, "Joint uplink/downlink and offloading optimization for mobile cloud computing with limited backhaul," 2016 Annual Conference on Information Science and Systems (CISS), Princeton, N.J., 2016, pp. 424-429. doi: 10.1109/CISS.2016.7460540

PAPERS PUBLISHED IN CONFERENCE PROCEEDINGS:

E. Zhang and A. Abdi, "Experimental results on underwater communication using vector transducers," in Proc. Meetings on Acoustics, vol. 23, Apr. 2016, pp. 1-7

A. Alenezi and A. Abdi, "A comparative study of multichannel and single channel accelerometer sensors for communication in oil wells," accepted for presentation and publication in IEEE International Conference on Communication and Signal Processing, India, pp. 1-4 (accepted Jan. 2017)

H. Ge, "Canonical correlation analysis for distributed signal processing and communications," Invited Speaker, Presented in the 25th Annual Wireless and Optical Communication Conference (WOCC), Chengdu, China, May 2016

H. Ge, and I. P. Kirsteins, "Lucky ranging using distributed towed arrays in underwater environments subject to non-stationary spatial coherence loss," Proc. of the IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Shanghai, China. March 2016

H. Ge, and I. P. Kirsteins, "Lucky ranging in underwater environments subject to spatial coherence loss," Proc. of the IEEE Asilomar Conf. on Signals, Systems and Computers, Pacific Grove, CA. Nov. 2015

H. Ge, and I. P. Kirsteins, "Lucky ranging in underwater acoustic environments subject to spatial coherence loss," (by invitation) presented in the IEEE Workshop on Underwater Acoustic Signal Processing (UASP), West Greenwich, RI. Oct. 2015

H. Ge, and I. P. Kirsteins, "Lucky ranging in underwater acoustic environments subject to spatial coherence loss," The 169th Meeting Proceedings of the Acoustical Society of America, Pittsburgh, PA. May, 2015

D. Cohen, D. Cohen, Y. C. Eldar and A. M. Haimovich, "Sub-Nyquist collocated MIMO radar in time and space," 2016 IEEE Radar Conference (RadarConf), Philadelphia, PA, 2016, pp. 1-4.
doi: 10.1109/RADAR.2016.7485160

W. Jiang and A. M. Haimovich, "Cramer-Rao bound and approximate maximum likelihood estimation for non-coherent direction of arrival problem," 2016 Annual Conference on Information Science and Systems (CISS), Princeton, N.J., 2016, pp. 506-510. doi: 10.1109/CISS.2016.7460554

W. Jiang, A. M. Haimovich and Y. C. Eldar, "Direction of arrival by non-coherent arrays," 2016 IEEE Radar Conference (RadarConf), Philadelphia, PA, 2016, pp. 1-6. doi: 10.1109/RADAR.2016.7485274

M. Yangg, A. M. Haimovich, B. Chen and X. Yuan, "A new array geometry for DOA estimation with enhanced degrees of freedom," 2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), Shanghai, 2016, pp. 3041-3045. doi: 10.1109/ICASSP.2016.7472236

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H. H. Kim and A. M. Haimovich, "Design of CFAR radars using compressive sensing," 2016 IEEE Radar Conference (RadarConf), Philadelphia, PA, 2016, pp. 1-6. doi: 10.1109/RADAR.2016.7485280

L. Ong, B. Vellambi, J. Kliewer, P. L. Yeoh, "An equalence between secure network and index coding." Proc. IEEE Globecom, Washington, DC, December 2016

C. Yi, J. Kliewer, "On error correction for asynchronous communication based on iterative processing." Proc. Asilomar Conference on Signals, Systems and Computers, Pacific Grove, CA, Nov. 2016

A. Golmohammadi, J. Kliewer, D. G. M. Mitchell, D. J. Costello, Jr., "On the windowed encoding complexity of SC-LDGM codes for lossy source compression." Proc. International Symposium on Information Theory and its Applications (ISITA 2016), Monterey, CA, Nov. 2016

B. Vellambi, J. Kliewer, "Sufficient conditions for the equality of exact and Wyner common information." Proc. Fifty-Fourth Annual Allerton Conference on Communication, Control, and Computing, Monticello, IL, September 2016

O. Kosut, J. Kliewer, "Network equivalence for a joint compound-arbitrarily-varying network model." Proc. IEEE Information Theory Workshop (ITW 2016), Cambridge, U.K., Sept. 2016

C. Yi, J. Kliewer, "Error correction for asynchronous communication." International Symposium on Turbo Codes and Iterative Information Processing (ISTC 2016), Brest, France, Sept. 2016

B. Vellambi, J. Kliewer, M. Bloch, "Lossy compression with near-uniform encoder outputs." Proc. IEEE Int. Symp. on Information Theory (ISIT 2016), Barcelona, Spain, July 2016

O. Kosut, J. Kliewer, "On the relationship between edge removal and strong converses." Proc. IEEE Int. Symp. on Information Theory (ISIT 2016), Barcelona, Spain, July 2016

A. Golmohammadi, D. G. M. Mitchell, J. Kliewer, D. J. Costello, Jr., "Windowed encoding of spatially coupled LDGM codes for lossy source compression." Proc. IEEE Int. Symp. on Information Theory (ISIT 2016), Barcelona, Spain, July 2016

L. Ong, B. Vellambi, P. L. Yeoh, J. Kliewer, J. Yuan, "Secure index coding: Existence and construction." Proc. IEEE Int. Symp. on Information Theory (ISIT 2016), Barcelona, Spain, July 2016

J. Zhao, O. Simeone, D. Gunduz and D. Gomez-Barquero, "Non-orthogonal unicast and broadcast transmission via joint beamforming and LDM in cellular networks," in Proc. IEEE GLOBECOM 2016, Washington, DC, Dec. 48, 2016

M. Azimi, O. Simeone and R. Tandon, "Fundamental limits on latency in small-cell caching systems: An information-theoretic analysis," in Proc. IEEE GLOBECOM 2016, Washington, DC, Dec. 48, 2016

M. Varasteh, B. Rassouli, O. Simeone and D. Gunduz, "Zero-delay joint source-channel coding with a 1-Bit ADC front end and receiver side information," in Proc. IEEE Information Theory Workshop (ITW 2016), Cambridge, UK, Sep. 1114, 2016

A. Sengupta, R. Tandon and O. Simeone, "Cloud RAN and edge caching: Fundamental performance trade-offs," in Proc. IEEE Int. Workshop on Signal Proc. Advances in Wireless Commun. (SPAWC 2016), Edinburgh, UK, Jul. 36, 2016

S.H. Park, O. Simeone and S. Shamai (Shitz), "Joint cloud and edge processing for latency minimization in fog radio access networks," in Proc. IEEE Int. Workshop on Signal Proc. Advances in Wireless Commun. (SPAWC 2016), Edinburgh, UK, Jul. 36, 2016

R. Tandon and O. Simeone, "Cloud-aided wireless networks with edge caching: Fundamental latency trade-offs in fog radio access networks," in Proc. IEEE Int. Symp. Inform. Theory (ISIT 2016), Barcelona, Spain, Jul. 1015, 2016

S.H. Park, O. Simeone and S. Shamai (Shitz), "Joint optimization of cloud and edge processing for fog radio access networks," in Proc. IEEE Int. Symp. Inform. Theory (ISIT 2016), Barcelona, Spain, Jul. 1015, 2016

M. Varasteh, O. Simeone and D. Gündüz, "Joint source-channel coding with one-bit ADC front end," in Proc. IEEE Int. Symp. Inform. Theory (ISIT 2016), Barcelona, Spain, Jul. 1015, 2016

W. Lee, O. Simeone, J. Kang and S. Shamai (Shitz), "Multivariate front-haul quantization for CRAN downlink: Channel-adaptive joint quantization in the cloud," in Proc. IEEE Int. Conf. Communications (ICC), Kuala Lumpur, Malaysia, May 2327, 2016

A. Sengupta, R. Tandon and O. Simeone, "Cache aided wireless networks: Trade-offs between storage and latency," in Proc. Conference on Information Science and Systems (CISS), Princeton, N.J., Mar. 16-18, 2016

A. Najdi, A. Bagheri, and O. Simeone, "Joint uplink/downlink and offloading optimization for mobile cloud computing with limited backhaul," in Proc. Conference on Information Science and Systems (CISS), Princeton, N.J., Mar. 16-18, 2016

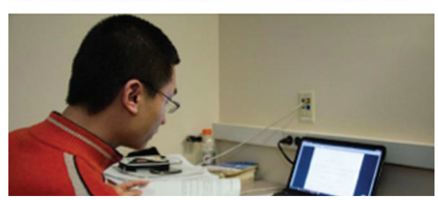
M. Azimi, O. Simeone, O. Sahin and P. Popovski, "Ultrareliable cloud mobile computing with service composition and superposition coding," in Proc. Conference on Information Science and Systems (CISS), Princeton, N.J., Mar. 16-18, 2016

S. Khalili and O. Simeone, "Control-data separation in Cloud RAN: The case of uplink HARQ," in Proc. IEEE Information Theory and Applications (ITA), San Diego, CA, January 31-February 5, 2016

NEWS

Three Doctoral Students Present Research at Annual NJIT Center Showcase
NJIT's Elisha Yegal Bar-Ness Center for Wireless Communications and Signal Processing Research recently showcased the research of three doctoral students. The students' work was featured in presentations and posters displayed for the showcase. The annual event gives doctoral students and their advisers from the Center a chance to exchange current information about ongoing work.

Patents Awarded/Filed
W. Huang, M. Langberg, J. Kliewer, J. Bruck, "Communication Efficient Secret Sharing". United States Patent Application 20170017581. 2017



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New Jersey Institute of Technology