P01 (Network)

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Firecycle, a scalable test bed for large-scale LTE security research

LTE (Long Term Evolution) is the latest cellular communications standard to provide advanced mobile services that go beyond traditional voice and short messaging traffic. Mobility networks are experiencing a drastic evolution with the advent of Machine to Machine (M2M) systems and the Internet of Things (IoT), which is expected to result in billions of connected devices in the near future. In parallel, the security threat landscape against communication networks has rapidly evolved over the last few years, with major Distributed Denial of Service (DDoS) attacks and the substantial spread of mobile malware. We introduce Firecycle, a new modeling and simulation platform for next-generation LTE mobility network security research. This standards compliant platform is suitable for large-scale security analysis of threats against a real LTE mobile network. It is designed with the ability to be distributed over the cloud, with an arbitrary number of virtual machines running different portions of the network, thus allowing simulation and testing of a full-scale LTE mobility network with millions of connected devices. Moreover, the mobile traffic generated by the platform is modeled from real data traffic observations from one of the major tier-1 operators in the US. A versatile tool, our test bed is also a valuable resource for designing strong security architectures for future next-generation mobility networks.

P02 (Network)

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Coding for joint energy and information transfer

Abstract—In various wireless systems, such as sensor RFID networks and body area networks with implantable devices, the transmitted signals are simultaneously used both for information transmission and for energy transfer. In order to satisfy the conflicting requirements on information and energy transfer, this paper proposes the use of constrained run-length limited (RLL) codes in lieu of conventional unconstrained (i.e., random like) capacity-achieving codes. The receiver’s energy utilization requirements are modeled stochastically, and constraints are imposed on the probabilities of battery underflow and overflow at the receiver. It is demonstrated that the codewords’ structure afforded by the use of constrained codes enables the transmission strategy to be better adjusted to the receiver’s energy utilization pattern, as compared to classical unstructured codes. As a result, constrained codes allow a wider range of trade-offs between the rate of information transmission and the performance of energy transfer to be achieved.

P03 (Wireless)

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Stevens

Robust Multipath Channel Identification with Partial Transmit-Receive Filter Information

The subspace method is a popular approach for blind channel identification. It assumes the knowledge of the transmit/receive filter response such as the pulse shaping filter and the anti-aliasing filter. In practice, unknown perturbation may cause such knowledge to be only partially available, such as in the presence of I/Q imbalance and distortions of the filter due to environmental factors (temperature, humidity, etc.). To improve the performance of channel identification when such perturbations exist, we introduce blind channel identification algorithms corresponding to two cases, when the perturbations are totally unknown due to lack of prior knowledge and, respectively, some statistical property of the perturbations is available obtained through a prior calibration process. For the first case, we introduce a recursive algorithm which iteratively estimates the channel response and the filter response sequentially. For the second case, we develop a robust channel identification algorithm with enhanced estimation accuracy by exploiting the statistical knowledge of the filer response. We also discuss extensions of these algorithms when the channel is time-varying.

P04 (Network)

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Detection of Transportation Mode Based on Smartphones for Reducing Distracted Driving

Nowadays distracted driving is becoming an alarming epidemic on the roadways. A lot of activities may lead to distracted driving, such as texting, making phone calls, eating, using GPS or road maps, using in-car entertainment systems, etc. As the number of smartphones is rapidly growing year by year, using smartphone is by far the most dangerous driver distraction. This work addresses the problem of detecting transportation mode between public transportations and driving.

We propose and design an app DriveLock on smartphone with various embedded sensors integrated for detecting different transportation modes. DriveLock can run in the background and lock the smartphone screen with no passwords required when it detects that the user is driving. After the user finishes driving, the lock will be removed immediately. Our system can distinguish different public transportation modes among static, on foot, public transit and drive. We describe a DTM algorithm to detect the transportation mode and give the performance analysis of our system. We also give a method on how to distinguish between drivers and passengers. To evaluate our approach, we conduct experiments with several users on various vehicles and smartphones. Our evaluation results show that DriveLock can effectively prevent users from using their smartphones during driving and save more energy than other related applications.

P05 (Wireless)

Kenneth Ezirim

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Title: Opportunistic Spectrum Access amidst Dynamic and Demand-Driven Primary Users

Abstract: While essentially the entire spectrum resources have been allocated to licensed incumbents with long-term contracts, observations show that considerably large portion of these resources is underutilized. The dynamic spectrum access (DSA) paradigm allows unlicensed users, otherwise known as secondary users, to exploit the vacant spectrum bands on a zero-interference basis. The public safety and emergency services are examples of primary users that are mobile and whose spectrum usage in a particular locality is demand-driven. So for most part of the time, the spectrum bands are left idle. We propose a cognitive radio (CR) network that is designed to exploit the idle frequency bands allocated to public safety and emergency services to provide delay-tolerant data transmission services. The cognitive radio network comprises of secondary users equipped with cognitive radio devices and stationed at strategic locations, such as major transit hubs. The cognitive radio network also includes travelling data mules, in form of taxicabs, that help in propagating data transmission between transit hubs. The cognitive radio network architecture is designed to provide alternative communication means to handle the ever-increasing wireless traffic by exploiting mobile nature of the primary users. The network's architecture incorporates robust and reactive measures to adhere to spectrum etiquette and at the same time, maximize spectrum utilization.

P06 (Wireless)

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Code-Aided EM Algorithm for Joint Channel Tracking and Decoding for Sparse Fast-Fading Multipath Channels

In a fast-fading environment, channel estimation and tracking require the availability of a number of pilot symbols that is at least as large as the number of independent channel parameters. Aiming at reducing the number of necessary pilot symbols, this paper proposes a novel technique for joint channel tracking and decoding that is based on the following three ideas. 1) Sparsity: While the total number of channel parameters to be estimated is large, the actual number of independent multipath components is generally small; 2) Long-term vs. short-term channel parameters: Each multipath component is typically characterized by long-term parameters that change slowly with respect to the duration of a transmission time-slot, such as delays or average powers, and by fast-varying fading amplitudes; 3) Code-aided methods: Decision-feedback techniques can optimally leverage past, and partially reliable, decisions on the data symbols to obtain “virtual” pilots via the Expectation Maximization (EM) algorithm. Numerical results show that the proposed code-aided EM algorithm is effective in performing joint channel tracking and decoding even for velocities as high as 350 km/h, as in high-speed railway communications, and with as few as four pilots per OFDM data symbol, as in the IEEE 802.11a/n standards.

P07 (Wireless)

Mehdi Ashraphijuo

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Title: The Role of Cooperation and Feedback in MIMO Interference Channel

Abstract: This work characterizes the approximate capacity region of the two-user MIMO ICs with limited receiver cooperation within a constant gap bits. This approximate capacity region is used to find the DoF region for the two user MIMO ICs with limited receiver cooperation. We also find the maximum amount of cooperation needed to achieve the outer bound of unlimited receiver cooperation. Further, the GDoF region is found for a two-user MIMO IC with equal antennas at all the nodes. With the GDoF region, we find that the “W” curve without cooperation changes gradually to “V” curve with full cooperation. The cooperation improves the GDoF till the capacity of the cooperation link is of the order of ?M logSNR when the GDoF reaches the GDoF with full cooperation. This work gives a specific strategy for Han-Kobayashi message splitting for two-user MIMO IC where the covariance matrices for the public and the private messages are properly designed. Also, we showed this scheme achieves a region that is within a constant gap of the capacity region for MIMO IC with feedback, and MIMO IC with limited receiver cooperation in this work. We believe this strategy can help achieve general results for a variety of other scenarios where Han-Kobayashi message splitting is used. Investigation of these scenarios (such as transmitter cooperation, limited feedback, etc.) is an interesting future problem.

P08 (Wireless)

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Single Sensor Blind Estimation of Time-Frequency Activity of a Mixture of Radio Signals via Block Tensor Decomposition

We consider a scenario where a single sensor receives a mixture of M discontinuously transmitting (in time) and overlapping in frequency radio signal. The signals being observed can be categorized as either using a linear modulation (e.g. PSK) or as a non-linear modulation that can be approximated as a finite sum of linearly modulated signals (e.g. OFDM). The received signals are grouped into time periods with similar activity patterns and the fourth- order cumulant spectra (trispectra) of each group is computed. We then take a particular slice of each group's trispectrum and stack the slices to form a three- dimensional tensor. An analysis of this tensor reveals that it can be decomposed into sum of rank-1 tensors as in the Canonical Decomposition/Parallel Factors (CP) tensor model, however the decomposition is non-unique. By restructuring the tensor so that it is constructed as a rank-(Rm;Rm; 1) block-partitioned tensor we can guarantee the uniqueness of the decomposition. We propose a de- composition strategy using convex optimization incorporating l1 regularization to sparsify a partition matrix which allows us to estimate the partitioning of the factor matrices as well as the (scaled) power spectrum, time (transmitting/non- transmitting) activity of the observed signals, and kurtosis of the modulation. We verify the operation and performance of the decomposition through simulations.

P09 (Network)

Omid Javidbakht and Parv Venkitasubramaniam

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Title: Optimizing the Delay anonymity Trade-off in Data Networks

Abstract:

Communication networks are vulnerable to an unauthorized access of network information which can compromise users’ privacy. Anonymous networks such as TOR provide anonymity to users by hiding their identities using layered encryption but these systems can be compromised by correlating transmission timing of incoming and outgoing packets. Incorporating Chaum Mixes which are intelligent routers or proxy servers that delay and shuffle the incoming packets, packet source and route anonymity from timing analysis are achievable, albeit at the cost of additional delay. The tradeoff between delay and anonymity in a multi-path anonymous network is studied in this work. Specifically the optimal rate allocation which maximizes the anonymity is studied under two traffic regimes- light traffic and heavy traffic regimes. It is shown that the optimal rate allocation yields in a single route transmission under light traffic conditions whereas the maximum anonymity can be achieved independent of rate allocation in heavy traffic. The trade-off between anonymity and end-to-end delay is then investigated analytically and a low complexity algorithm is proposed to derive the optimal routing parameters under light traffic to optimize the desired tradeoff.

P10 (Wireless)

(James) Shridatt Sugrim

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Title: Background Spectrum Classification for Cognitive Radio

Abstract:

 Recent changes in policy regarding the opportunistic use of licensed radio spectrum have paved the way for new innovative technologies like cognitive radio (CR). This technology puts tight demands on systems built to sense spectrum occupancy. Any strategy employed for opportunistic spectrum usage has to consider the tradeoffs between time spent searching for empty channels and time spent using those empty channels. In most cases the spectrum sensing that is employed by a CR system starts with no prior information about the occupancy of the channels it intends to use. A classifier can be run before the CRs attempt transmission to provide the CRs' spectrum sensing sub-systems with a set of occupancy probability categories for some of the channels. By providing priors it may be possible for the CR to reach a transmission strategy in a shorter time frame.

 We propose a novel method of addressing this lack of prior knowledge by employing an efficient strategy that classifies some of the channels the CR intends to use within a fixed time limit. Our classification algorithm is based on multiple sequential probability ratio tests (multi-SPRT) and a heuristic allocation strategy for measurements that considers the completion time of each multi-SPRT. We will show that this strategy will achieve a bounded error by prioritizing channels that give consistent measurement results. We also compare the performance of the proposed system to simpler systems that do not require as many computations.

P11 (Network)

Xiaoyuan Liang

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Deploying Mobile Survivability-Heterogeneous Sensor Networks for Barrier Coverage

Abstract: Barrier coverage is a broadly known coverage model for intruder surveillance application in wireless sensor networks. When sensor nodes are deployed outdoors, they are subject to environmental detriments. One traditional barrier cannot provide barrier coverage under both sunny and rainy weather considering that sensors are not equipped any protections. In this paper, we study the barrier coverage problem in a mobile survivability-heterogeneous sensor network, which is composed of sensor nodes with different environmental survivability to make it robust to environmental damages and with different mobile availabilities to repair the barrier when the barrier cannot be constructed. Our goal is to maintain different barriers to monitor the field under sunny and rainy environment conditions respectively and to prolong the network lifetime as much as possible. We propose a novel greedy barrier construction algorithm to solve the problem. The algorithm adopts weather forecast information to direct the barrier construction for sunny and rainy weather, and so to minimize the energy consumption in each construction. In addition, it is a local algorithm when constructing the barrier in the rain, which could reduce the energy consumption on communication. Simulation results show that our algorithm efficiently solves the problem and outperforms other alternative in many metrics.

P12 (Wireless)

Oner Orhan

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Title: Delay-constrained distortion minimization for energy harvesting transmission over a fading channel.

Abstract:

Distortion minimization for an energy harvesting sensor node communicating over a fading channel is studied. Slotted transmission is considered such that, new source samples and energy packets arrive at the beginning of each time slot (TS), and the fading channel state changes from one TS to the next. A delay constraint is imposed requiring each source sample to be reconstructed at the destination d TSs after its arrival. Assuming independent Gaussian samples with variances changing over TSs, total distortion is minimized under the offline optimization framework, i.e., energy arrivals, source variances and channel gains are assumed to be known non-causally. Optimal compression rates and transmission powers are found and some properties of the optimal strategy are discussed. A two-dimensional water-filling interpretation of the optimal solution is provided for a battery-run node with d = 1.

P13 (Network)

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Title: "Neighbor Discovery in IEEE 802.11"

Abstract:

"In this work is studied a wireless neighbor discovery (ND) process in a linear topology of a high speed train backbone network. A key step that enables communication in such a network is that of topology discovery (TD), or train inauguration, whereby nodes learn in a distributed fashion the physical topology of the backbone network. The first and key step in TD is ND, where each individual node discovers their right and left one-hop neighbors. While the current standard for train inauguration assumes wired links between adjacent backbone nodes, this work investigates the more challenging scenario in which the nodes communicate in wireless-fashion based on IEEE 802.11. The implementation of ND over wireless channels is made difficult by the broadcast nature of the wireless medium, which includes fading and interference. A network simulation using NS-2 software was developed for the 802.11-based wireless ND process. The network simulation was applied to analyze performance metrics, such as time to successful ND and ND success rate as a function of various parameters. Performance is also compared to that of ND in a slotted-Aloha network."

P14 (Wireless)

Raed Alhamad

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Title: Multi-channel Slotted Aloha applied in Reporting to FC

P15 (Wireless)

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Stevens

Title: Single-tone Jamming Mitigation in MC-CDMA and Coordinated Jamming Communications System

P16 (Network)

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Stevens

Title: Cooperative Spectrum-Aware Opportunistic Routing in Cognitive Radio Ad Hoc Networks.

P17 (Network)

Jelena Marasevic

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Title: Max-min Fair Rate Allocation and Routing in Energy Harvesting Networks: Algorithmic Analysis

Abstract: We consider max-min fair rate allocation and routing in energy harvesting networks where fairness is required among both the nodes and the time slots. Unlike most previous work on fairness, we focus on multihop topologies and consider different routing methods. We assume a predictable energy profile and focus on the design of efficient and optimal algorithms that can serve as benchmarks for distributed and approximate algorithms. We first develop an algorithm that obtains a max-min fair rate assignment for any given (time-variable or time-invariable) single-path routing or a routing tree. For time-invariable single-path routing, we also develop an algorithm that finds routes that maximize the minimum rate assigned to any node in any slot. For fractional routing, we study the joint routing and rate assignment problem. We develop an algorithm for the time- invariable case with constant rates. We show that the time- variable case is at least as hard as the 2-commodity feasible flow problem and design an FPTAS to combat the high running time. Finally, we show that finding a max-min fair single-path routing or a routing tree is NP-hard, even for a time horizon of a single slot. Our analysis provides insights into the problem structure and can be applied to other related fairness problems.

P18 (Wireless)

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Poster Title: Field-Programable Interferer-Reflecting LNAs

Abstract:

A field-programmable (FP) low noise amplifier (LNA) with interferer-reflecting (IR) loop is introduced. The user can program its gain, noise figure, linearity and power consumption during operation. The IR loop uses a frequency-selective shunt-shunt feedback around the noise-canceling LNA to reduce the input impedance out of band and to suppress the input voltage swing created by blockers. A notch filter at the desired operation frequency in the feedback path results in selectivity at the RF input so that all out-of-band blockers are suppressed without the need to know blocker locations and the LNA input linearity is improved. 65nm CMOS chip prototypes have been implemented with on-chip LC, bondwire LC or N-path notch filters. The FP N-path IR-LNA operates from 0.2 to 1.6GHz; with the IR disabled, the NF is 2.4dB, B1dB is -15dBm, and the OOB-IIP3 is +2.5dBm with a 13mW power consumption; with the IR on, the NF is 3.6dB, the RF channel input bandwidth is 20MHz, the B1dB is -4dBm and the OOB-IIP3 is +14.5dBm. The LNA dissipates 15.8 to 20.2mW across the operating frequencies. Analog VDD is 1.6V and LO VDD is 1V.

P19 (Wireless)

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Title:

A blocker-tolerant RF front end with harmonic rejecting N-path filter

Abstract:

A 0.2-1GHz RF front end with a harmonicrejecting N-path filter (HR-NPF) features tunable narrow band filtering as well as high attenuation at the 3rd and 5th order LO harmonics at the LNA output. The B1dB-CP is -2.4dBm at a 20MHz offset, and remains high at the 3rd and 5th LO harmonics thanks to the HR-NPF configuration. The reverse isolation of the LNA helps to keep the LO emission below -90dBm. The two-stage harmonic rejection approach offers >51dB harmonic rejection ratio at the 3rd and 5th LO harmonics without calibration. The front end consumes 26-32mA while occupying an area of 0.77mm2.

P20 (Wireless)

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Maximum Likelihood Synchronization for DVB-T2 in Unknown Fading Channels