2018 Twenty Fourth National Conference on Communications (NCC 2018)

Hyderabad, India
25-28 February 2018

Program

Sun-Tutorial-1: Building IoT Solutions with Edge Intelligence (by) Mr. Anand Joshi, Dr. N. Govinda Rao and Mr. Karthik Suryadevara, Redpine Signals

Room: Auditorium
Chair: Abhinav Kumar (Indian Institute of Technology Hyderabad, India)

An emerging trend in the IoT is a focus on a better utilization of available communication bandwidth and battery by performing intelligence at the edge. AI algorithms are compute and power intensive and that has prevented AI from being adapted in edge devices. In this session, we will be providing information in depth on building IoT applications with device intelligence. We will also be presenting a new platform that enables running AI applications on the edge. We will be discussing hardware and software tradeoffs necessary to achieve acceptable performance and power. A use case that utilizes the complete platform along with a cloud component will also be presented.

Sun-Tutorial-2: Modeling and Analysis of mmWave Networks (by) Dr. Abhishek Kumar Gupta, IIT Kanpur

Room: LH1
Chair: Sumohana Channappayya (Indian Institute of Technology Hyderabad, India)

This tutorial will focus on mathematical models and analytical techniques for millimeter wave (mmWave)cellular systems. As upcoming cellular standard (5G) has put very high requirements, it has been evident that just trivial changes in current 4G standard will not be sufficient to achieve these high expectations. The use of mmWave frequencies in cellular services is one of the few unconventional features being proposed in the 5G standard. The two fundamental physical differences of mmWave from conventional Sub-6GHz communication are (i) vulnerability to blocking, and (ii) the need for significant directionality at the transmitter and/or receiver, which is achieved through the use of large antenna arrays of small individual elements. This tutorial will cover distinguishing features of mmWave systems and various techniques to model these features. An analytical approach based on stochastic geometry that allows the computation of the statistical distributions of the downlink SINR and also the per link data rate will be presented. Tutorial will also cover various design insights that can be derived from the analysis including possible infrastructure and spectrum sharing, self-backhauling and optimal network deployment.

Sun-Tutorial-3: An Introduction to Bitcoin (by) Dr. Saravanan Vijayakumaran, IIT Bombay

Room: LH2
Chair: Kotaro Kataoka (Indian Institute of Technology Hyderabad, India)

The objective of this tutorial is to describe the functioning of the Bitcoin cryptocurrency. The problem of double spending in decentralized digital currencies will be used to motivate the need for a blockchain. The process of Bitcoin mining will be described and its role in achieving consensus with respect to the validity of transactions will be described. The Bitcoin block format, transaction format, and scripting language will be described to give attendees an inside look into the construction of a cryptocurrency. Finally, the escrow smart contract which is enabled by the current Bitcoin scripting language will be described.

Sun-Tutorial-4: SDN/NFV within a telecommunications access network (by) Dr. Marc Kimpe and Mr Chris Thompson, ADTRAN

Room: Auditorium
Chair: Antony Franklin A (Indian Institute of Technology Hyderabad, India)

Software Defined Networks (SDN) and Network Function Virtualization (NFV) are transforming the telecommunications network landscape similarly to the introduction of the Windows operating system in the Personal Computer (PC) industry of the 80's. SDN separates and standardizes the control plane of a network from its data plane. Doing so enables the abstraction of the underlying network elements and the creation of management/control/application software which can be centralized and run across equipment from different manufacturers. NFV ports traditional embedded application software onto commodity servers located in a data center. SDN and NFV combined with the advent of open source and micro-service architecture enables developers to innovate and deploy services in a network at an accelerated rate. This tutorial defines SDN and NFV in the context of an access telecommunications

network explaining the disaggregation of functionality. The tutorial will delve into standardization and explain how various open source projects aim to create deployable solutions. An end-to-end copper g.Fast and optical NGPON2 system will be used as a use case of SDN/NFV deployment. A Machine Learning use case will be shown to demonstrate the ease of innovation within SDN/NFV.

Sun-Tutorial-5: Using SDR based testbeds to accelerate real-time prototyping (by) Mr. Raghunandan N V, National Instruments

Room: LH1
Chair: Lakshmi Prasad Natarajan (Indian Institute of Technology Hyderabad, India)

Modern communications systems present a wide variety of challenges and trade-offs at different stages in the system design process. There is a constant need to bridge the gap between theoretical results and practical deployment cases. Testbeds bridge this gap by enabling researchers to prototype their systems and validate their theoretical findings. In this tutorial we discuss how software defined radios can be used to build scalable, state of the art testbeds that enable communications system prototyping, evaluation and testing. Software defined implies flexibility, agility and extensibility - all desirable attributes for communications researchers. These software defined testbeds can be used in prototyping of research applications such as cognitive radios, coding and signal processing techniques for PHY enhancements, Massive MIMO, mmWave, Coexistence and so on.

Sun-Tutorial-6: Online Learning with Dynamic Convex Optimization (by) Dr. Ketan Rajawat, IIT Kanpur

Room: LH2
Chair: Srijith P. k. (Indian Institute of Technology Hyderabad, India)

Convex optimization is a well-known mathematical tool that has been widely adopted to solve problems in machine learning, control theory, wireless communications, signal processing, financial engineering, robotics, etc. The conventional optimization problem consists of a fixed objective function that must be min- imized subject to a set of fixed constraints. However, practical problems arising in control theory, machine learning, and signal processing are often dynamic, where the objective function and/or the constraints vary over time. Examples include multi-agent target tracking, adaptive filters, sequential estimation, etc. The recent trend is to formulate and solve these dynamic convex optimization problems using low-complexity single-iteration algorithms. In this tutorial, we take a fresh look at some of the recently proposed algorithms from the lens of online learning and dynamic regret. By allowing the optimum to drift over time, we develop bounds on the worst-case performance of these algorithms. Several real-world applications, such as dynamic network latency prediction, video denoising, dynamic matrix completion, multi-agent target tracking, and multi-robot formation control will also be discussed in detail.

Sun-Tutorial-7: Demystifying Deep Learning - a Hands-On MATLAB Tutorial (by) Dr. Amod Anandkumar & Dr. Rishu Gupta, MathWorks

Room: 220
Chair: Sri Rama Murty Kodukula (Indian Institute of Technology Hyderabad, India)

Deep learning achieves human-like accuracy for many tasks considered algorithmically unsolvable with traditional machine learning. It is frequently used to develop applications such as signal classification, image recognition, and automated driving. In this hands-on tutorial , you can learn how MATLAB simplifies and accelerates: Accessing popular pretrained networks and performing transfer learning Training and fine-tuning deep neural networks Using visualizations and other techniques for understanding network behaviour Generating portable CUDA Code for optimized implementation This tutorial will be run using R2017b version of MATLAB, Neural Network Toolbox, Computer Vision System Toolbox, Image Processing Toolbox, and Parallel Computing Toolbox. You can download a free trial at http://www.mathworks.com/trial.

Mon-1-Com1: Cognitive Radio I

Room: Auditorium
Chair: Rahul Vaze (TIFR Mumbai, India)

9:30 *Spectrum Sensing and Collision with Primary Users in MIMO Cognitive Radio*   *1*
Vijay Viswanath (Qualcomm India Pvt Ltd, India); Shahzad Alam (Qualcomm India Private Limited, India); Rakhesh Singh Kshetrimayum (Indian Institute of Technology Guwahati, India)

9:50 *Optimization of Majority Rule Threshold in Double Threshold Based Cooperative Cognitive*

Radio Network *7*
> Priyanka Maity (National Institute of Technology, Rourkela, Odisha, India); Siddharth Deshmukh (National Institute Of Technology, Rourkela, India)

10:10 ***Optimal Sequential Channel Sensing for Cognitive Radios for IID and Non-Identical Channels*** *13*
> Aaqib Patel (Indian Institute of Technology Hyderabad)

10:30 ***Generalized Statistical Spectrum Occupancy Modelling and Its Learning Based Predictive Validation*** *18*
> Anirudh Agarwal (The LNM Institute of Information Technology, Jaipur, India); Ranjan Gangopadhyay (The L.N.Mittal Institute of Information Technology, India)

10:50 ***Cooperative Sensing of OFDM Signals Using Heterogeneous Sensors*** *24*
> Akhil Singh (International Institute of Information Technology, Hyderabad, India); Prakash Gohain (International Institute of Information Technology Hyderabad, India); Sachin Chaudhari (International Institute of Information Technology, India)

Mon-1-NW: Sensor Networks

Room: LH1
> Chair: Mohan Dhawan (IBM Research, India)

9:30 ***Balanced Use of Battery Power in Ad-hoc Wireless Sensor Networks*** *30*
> Hema Aggarwal (The LNM Institute of Information Technology, India); Santosh Shah (The LNM Institute of Information Technology, Jaipur India, India)

9:50 ***Range Free Localization in Anisotropic Networks Using Unbiased Distance Model*** *36*
> Meera Bharathan, Mridula. K. M. and Ameer P M (National Institute of Technology Calicut, India)

10:10 ***A New Combinatorial Design Based Data En-Route Filtering Scheme for Wireless Sensor Networks*** *42*
> Alok Kumar (National Institute of Technology Karnataka, Surathkal, India); Alwyn Roshan Pais (NITK, Suratkal, Mangalore India, India)

10:30 ***Energy-Efficient Air Pollution Monitoring with Optimum Duty-Cycling on a Sensor Hub*** *48*
> Mayukh Roy Chowdhury (Indian Institute of Technology Delhi, India); Narendra Kumar Shukla (Shiv Nadar University, India); Swades De (Indian Institute of Technology Delhi, India); Ranendra Biswas (Shiv Nadar University, India)

10:50 ***Improved Energy Efficient Architecture for Wireless Sensor Networks with Mobile Sinks*** *54*
> Prashanth Lingala, P Rajalakshmi and Soumil K Heble (Indian Institute of Technology Hyderabad, India)

Mon-1-SP: Speech Processing and Understanding

Room: LH2
> Chair: Preeti Rao (IIT-Bombay, India)

9:30 ***Approaches to Codec Independent Speaker Identification in VoIP Speech*** *60*
> Anil Chilli (Centre for AI and Robotics, India); K R Prasanna Kumar (Centre for Artificial Intelligence and Robotics, India); Hema A Murthy (Indian Institute of Technology Madras, India); Chandra Sekhar Chellu (IIT Madras, India)

9:50 ***Improved Epoch Extraction Using Variational Mode Decomposition Based Spectral Smoothing of Zero Frequency Filtered Emotive Speech Signals*** *65*
> Govind D and Pravena D (Amrita Vishwa Vidyapeetham, India); Ajay Ganesan (Amrita School of Engineering & Amrita Vishwa Vidyapeetham, India)

10:10 ***A Novel Feature for Nasalised Vowels and Characteristic Analysis of Nasal Filter*** *71*
> Debasish Jyotishi (IIT, GUWAHATI, India); Suman Deb (Indian Institute of Technology, India); Samarendra Dandapat (IITG, India)

10:30 *Manner of Articulation Based Split Lattices for Phoneme Recognition*   *76*
Pradeep R (Indian Institute of Technology, Kharagpur, India); K. Sreenivasa Rao (IIT KGP, India)

10:50 *Exploiting Parts-of-Speech for Improved Textual Modeling of Code-Switching Data*   *82*
Ganji Sreeram (IIT Guwahati, India); Rohit Sinha (Indian Institute of Technology Guwahati, India)

Mon-1-Com2: Antennas & Propagation

Room: 220
Chair: Amalendu Patnaik (Indian Institute of Technology, Roorkee, India)

9:30 *Graphene Plasmonic Bowtie Antenna for UWB THz Application*   *88*
Sasmita Dash (IIT Roorkee, India); Amalendu Patnaik (Indian Institute of Technology, Roorkee, India)

9:50 *Design of Enhanced Gain Two Element Linear Microstrip Antenna Array*   *92*
Prahlada Rao (Gulbarga University & Gulbarga University, India); Prabhakar Hunugund and Vani M (Gulbarga University, India)

10:10 *An Optically Transparent Microwave Broadband Absorber Using Resistive Sheet*   *98*
Harsh Sheokand, Gaganpreet Singh, Saptarshi Ghosh and Mondeep Saikia (Indian Institute of Technology Kanpur, India); Kumar Vaibhav Srivastava (Indian Institute of Technology, Kanpur, India); J Ramkumar (Indian Institute of Technology Kanpur, India); Anantha Ramakrishna (IIT kanpur, India)

10:30 *Broadband Simultaneously Dual Circularly Polarized Planar Monopole for Single Antenna Diversity Reception and Transmission*   *102*
G Bharath Reddy (National Institute Of Technology, Tiruchirappalli, India); D. Sriram Kumar (National Institute of Technology, Tiruchirappalli, India)

10:50 *A Compact Dual-Band Resonator for Negative Permittivity Metamaterial at Microwave Regime*   *106*
Dushyant Marathe (Visvesvaraya National Institute of Technology, VNIT, Nagpur, India); Kishore Kulat (Visvesvaraya National Institute of Technology, VNIT, Nagpur)

Mon-2-Plenary: Srinivasa Ramanujan and Digital Signal Processing (by) Prof P. P. Vaidyanathan, CalTech, USA

Room: Auditorium
Chair: Sumohana Channappayya (Indian Institute of Technology Hyderabad, India)

The great Indian mathematician Srinivasa Ramanujan introduced a summation in 1918, called the Ramanujan-sum. For many years this summation was used by mathematicians to prove important results in number theory. In recent years, some researchers have found applications of this sum in digital signal processing, especially in identifying periodic components of signals buried in noise. In our recent work we have generalized the Ramanujan- sum decomposition in several directions, and this has opened up some new theory as well as applications in the representation and identification of structured signals such as periodic signals. Many beautiful properties are enjoyed by such representations, thanks to the genius and vision of Ramanujan. Our new developments include Ramanujan dictionaries, Ramanujan filter banks, and the Ramanujan MUSIC algorithm, and applications of these in the study of DNA and protein sequences among others. In this talk we will give an overview of the theory and show some applications.

Mon-3-Com1: Information Theory & Applications

Room: Auditorium
Chair: Sibi Raj B Pillai (IIT Bombay, India)

2:00 *Universal Compression of a Piecewise Stationary Source Through Sequential Change Detection*   *112*
Dheeraj Kumar Chittam (Honeywell Tech. Solutions Lab Pvt. ltd.); Rakesh K. Bansal (Indian Institute of Technology Kanpur & India, India); Ritvik Srivastava (Independent, India)

2:20 *Gaussian MAC with Feedback and Strictly Causal State Information* *118*
   Haseen Rahman (Indian Institute of Technology Bombay, India); Sibi Raj B Pillai (IIT Bombay, India); Kumar Appaiah (Indian Institute of Technology Bombay, India)

2:40 *On the Equivalence of Projections in Relative α -Entropy and Rényi Divergence* *124*
   Periyapatna Narayana Prasad Karthik and Rajesh Sundaresan (Indian Institute of Science, India)

3:00 *Communication and State Estimation over a State-Dependent Gaussian Multiple-Access Channel* *130*
   Viswanathan Ramachandran (Indian Institute of Technology Bombay, India); Sibi Raj B Pillai (IIT Bombay, India); Vinod M Prabhakaran (Tata Institute of Fundamental Research, India)

Mon-3-NW: Data Center Networking and Network Security / Invited Talk by Dr. Mohan Dhawan, IBM Researach

Room: LH1
   Chair: Swades De (Indian Institute of Technology Delhi, India)

2:00 *Caching Policies for Transient Data* *136*
   Santosh Fatale (Indian Institute of Technology Bombay, India); R Sri Prakash (IIT Bombay, India); Sharayu Moharir (Indian Institute of Technology Bombay, India)

2:20 *ML-based Admission Control of Cloud Services: Centralized Versus Distributed Approaches* *142*
   Abul Bashar (Prince Mohammad Bin Fahd University, Saudi Arabia)

2:40 *Inferring the Deployment of Source Address Validation Filtering Using Silence of Path-Backscatter* *148*
   Samant Saurabh (Shiv Nadar University, India); Ashok Singh Sairam (Indian Institute of Technology Guwahati, India)

Mon-3-SP: Speech and Audio Applications / Invited Talk by Dr. Amod Anandkumar, MathWorks

Room: LH2
   Chair: Sri Rama Murty Kodukula (Indian Institute of Technology Hyderabad, India)

2:00 *Energy-Weighted Multi-Band Novelty Functions for Onset Detection in Piano Music* *154*
   Krishna Subramani, Srivatsan Sridhar and Rohit M Ananthanarayana (Indian Institute of Technology Bombay, India); Preeti Rao (IIT-Bombay, India)

2:20 *Mridangam Artist Identification from Taniavartanam Audio* *160*
   Krishnachaitanya Gogineni and Jom Kuriakose (IIT Madras, India); Hema A Murthy (Indian Institute of Technology Madras, India)

2:40 *Improving the Noise Robustness of Prominence Detection for Children's Oral Reading Assessment* *166*
   Kamini M Sabu (Indian Institute of Technology, Bombay, India); Kanhaiya Kumar (IIT Bombay, India); Preeti Rao (IIT-Bombay, India)

3:00 *Cell-Phone Identification from Recompressed Audio Recordings* *172*
   Vinay Verma, Preet Khaturia and Nitin Khanna (Indian Institute of Technology Gandhinagar (IITGN), India)

Mon-3-Com2: Optical & Visible Light Communications

Room: 220
   Chair: Gvv Sharma (Indian Institute of Technology Hyderabad, India)

2:00 *Optimum Power Allocation for Uniform Illuminance in Visible Light Communication*   *178*
   G V S S Praneeth Varma (IIT Hyderabad, India)

2:20 *Comparative Analysis of Different Performance Enhancement Techniques in 2-D Atmospheric OCDMA System*   *184*
   Ajay Yadav and Prateek Yadav (Indian Institute of Technology Delhi, India); Subrat Kar (Indian Institute of Technology, Delhi, India); V K Jain (IIT Delhi, India)

2:40 *Generation of Perfectly DC Balanced Codes for Visible Light Communications*   *190*
   Uday Thummaluri, Abhinav Kumar and Lakshmi Prasad Natarajan (Indian Institute of Technology Hyderabad, India)

3:00 *Bi-Directional Indoor VLC System with Backhaul Solution*   *195*
   Akash Gupta (Netaji Subhas Institute of Technology, India); Parul Garg (Netaji Subhas Institute of Technology, New Delhi, India)

Mon-4-Keynote: Making 5G NR a Commercial Reality: A unified, more capable 5G air interface (by) Dr Rohit Kapoor, Qualcomm

Room: Auditorium
   Chair: Adrish Banerjee (Indian Institute of Technology, Kanpur, India)

5G will provide a unifying connectivity fabric to connect new industries/devices, empower new services, utilize new spectrum bands/types and bring new levels of cost/energy efficiency. 5G will empower many new connected services across an array of world-changing use cases across Enhanced mobile broadband, Mission-critical services and Massive IoT. This talk will discuss some of the drivers for 5G and give a glimpse on the innovations that will provide the technical platform to support these new and diverse types of applications in a single unified air-interface.

Mon-5-Com1: Cognitive Radio II and Relay Networks

Room: Auditorium
   Chair: Bharath Bettagere (IIT Dharwad, India)

5:10 *Low Complexity Two-Stage Sensing Using Energy Detection and Beamforming*   *200*
   Madhuri Latha (International Institute of Information Technology, India); Prakash Gohain (International Institute of Information Technology Hyderabad, India); Sachin Chaudhari (International Institute of Information Technology, India)

5:30 *A Cognitive Opportunistic Fractional Frequency Reuse Scheme for OFDMA Uplinks*   *206*
   Subbarao Boddu (Mahindra Ecole Centrale, India); Venkata Sudhakar Reddy Bandi (Rajiv Gandhi University of Knowledge Technologies, R K Valley, India)

5:50 *Multihop FD Relaying with Fixed and Random Phase Errors*   *212*
   Prabhat Kumar Sharma (Visvesvaraya National Institute of Technology, India); Kamal Agrawal (Indian Institute if Technology Delhi, India); Parul Garg (Netaji Subhas Institute of Technology, New Delhi, India)

Mon-5-NW: Optical Networks

Room: LH1
   Chair: Abhishek K Gupta (Indian Institute of Technology Kanpur, India)

5:10 *Offline Scheduling Schemes to Transfer Voluminous Deadline Complying Data in Elastic Optical Networks*   *218*
   Sridhar Iyer (Jain College of Engineering, India); Shree Prakash Singh (NSIT, India)

5:30 *Performance Analysis of Non-Converged and Converged Medium Access Control Protocols for Radio-over-Fiber Networks*   *224*
   Kshitiza Singh (Indian Institute of Technology Delhi, India); Abhishek Dixit (Indian Institute of Technology Delhi & IBBT, India); V K Jain (IIT Delhi, India)

5:50 *Control and Management of Optical Networks Using Optical Network Description Language*   *230*

Nitin K. Lohar (Indian InstituteI of Technology Delhi, India); Subrat Kar (Indian Institute of Technology, Delhi, India)

Mon-5-SP: Speech Processing

Room: LH2
Chair: Jiji Charangatt Victor (College of Engineering, Trivandrum, India)

5:10 *Robust Offline Trained Neural Network for TDOA Based Sound Source Localization*   *235*

Srikanth Raj Chetupalli (Indian Institute of Science, India); Ashwin Ram (National Institute of Technology Tiruchirappalli, India); Thippur V. Sreenivas (Indian Institute of Science, India)

5:30 *Disambiguation of Source and Trajectory Non-Stationarities of a Moving Acoustic Source*   *240*

Sai Gunaranjan Pelluri (Indian Institute of Science, Bangalore, India); Thippur V. Sreenivas (Indian Institute of Science, India)

5:50 *Grouping Subarray for Robust Estimation of Direction of Arrival*   *246*

Tejaswini Dudyala, Srivally Munnangi and Senthil Kumar Mani (Meeami Technologies, India)

Tue-1-Com1: Communications Theory I

Room: Auditorium
Chair: Abhinav Kumar (Indian Institute of Technology Hyderabad, India)

9:30 *Performance Analysis of a Gauss-Optimal Receiver for a Receive Diversity PLC System in Nakagami-m Noise Environment*   *251*

Soumya Prakash Dash (Indian Institute of Technology Delhi, India); Ranjan K. Mallik (Indian Institute of Technology - Delhi, India); Saif Khan Mohammed (Indian Institute of Technology Delhi, India)

9:50 *Multiuser Communication Using Chirp Signals of Equal Chirp Rate*   *257*

Arijit Roy and Sharmistha Sen (Indian Institute of Technology Guwahati, India); Harshal Nemade (Indian Institute of Technology, India); Ratnajit Bhattacharjee (Indian Institute of Technology, Guwahati, India)

10:10 *Fading-Averaged Symbol Error Probability Analysis of Full Duplex Amplify-and-Forward Relaying over Rayleigh Fading Channels*   *263*

Rahul Shrotey (BITS Pilani, Rajasthan, India); B. Sainath (BITS Pilani, India); Gaurav Sharma (BITS Pilani, Rajasthan, India)

10:30 *BER Performance of Multi User Scheduling for MIMO-OFDM and MIMO-SCFDMA Broadcast Network with Imperfect CSI*   *269*

Vinay Kumar Trivedi and Preetam Kumar (Indian Institute of Technology Patna, India)

10:50 *Error Rate of MIMO OSTBC Systems over Mixed Nakagami-m/ Rice Fading Channels*   *275*

Dharmendra Dixit (Indian Institute of Technology Bhubaneswar & REC Sonbhadra, India); Pravas Ranjan Sahu (Indian Institute of Technology Bhubaneswar, India); George K. Karagiannidis (Aristotle University of Thessaloniki, Greece)

Tue-1-NW: Cellular Networks

Room: LH1
Chair: Subhash Bhalla (University of Aizu, Japan)

9:30 *Throughput Optimal Scheduling for Wireless Downlinks with Reconfiguration Delay*   *280*

Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India)

9:50 *Optimal Association of Wireless Devices to Cellular and Wi-Fi Base Stations*   *286*
Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India); Chandramani Singh (Indian Institute of Science, India)

10:10 *Modeling MME Residence Time in LTE Based Cellular Networks*   *292*
Ushasi Ghosh (NIT Durgapur, India); Pranay Agarwal (Indian Institute of Technology, Hyderabad, India); Abhinav Kumar (Indian Institute of Technology Hyderabad, India)

10:30 *Channel Allocation for Multiple D2D-Multicasts in Underlay Cellular Networks Using Outage Probability Minimization*   *298*
Ajay Bhardwaj and Samar Agnihotri (Indian Institute of Technology Mandi, India)

10:50 *Spectrum Sharing for LTE-A Network in TV White Space*   *304*
Meghna Khaturia (IIT Bombay, India); Sweety Suman (IIT Bombay); Abhay Karandikar and Prasanna Chaporkar (IIT Bombay, India)

Tue-1-SP: Signal Processing

Room: LH2
Chair: Mrityunjoy Chakraborty (Indian Institute of Technology., Kharagpur, India)

9:30 *Power System Frequency and Amplitude Estimation Using Variational Mode Decomposition and Chebfun Approximation System*   *310*
Neethu Mohan and Soman K P (Amrita Vishwa Vidyapeetham, India)

9:50 *Co-Prime Sampling and Cross-Correlation Estimation*   *316*
Usham Dias and Seshan Srirangarajan (Indian Institute of Technology Delhi, India)

10:10 *State-Space Digital Filters with Minimum Weighted Round-off Noise and Pole Sensitivity Subject to l_2-Scaling Constraints*   *322*
Yoichi Hinamoto (National Institute of Technology, Kagawa College, Japan); Akimitsu Doi (Hiroshima Institute of Technology, Japan)

10:30 *Batch Look Ahead Orthogonal Matching Pursuit*   *327*
Muralikrishnna G. s. (National Institute of Technology, Tiruchirappalli, India); Sooraj K. Ambat and K. v. s. Hari (Indian Institute of Science, India)

10:50 *Functorial Signal Representation: Foundations and Redundancy*   *332*
Salil Samant and Shiv Dutt Joshi (Indian Institute of Technology, Delhi, India)

Tue-1-Com2: Microwave Communications

Room: 220
Chair: Lakshmi Prasad Natarajan (Indian Institute of Technology Hyderabad, India)

9:30 *A Polarization-Independent Tunable Microwave Absorber with Wide Tuning Range*   *338*
Saptarshi Ghosh and Harsh Sheokand (Indian Institute of Technology Kanpur, India); Kumar Vaibhav Srivastava (Indian Institute of Technology, Kanpur, India)

9:50 *A Simple Robust Equal-Split T-Junction Power Divider at Three Frequencies*   *342*
Deepayan Banerjee and Antra Saxena (IIITD, India); Mohammad Hashmi (Nazarbayev University, Kazakhstan & IIIT Delhi, India)

10:10 *A Polarization-Insensitive Miniaturized Element Frequency Selective Surface Using Meander Lines*   *346*
Varuna A b, Saptarshi Ghosh and Harsh Sheokand (Indian Institute of Technology Kanpur, India); Kumar Vaibhav Srivastava (Indian Institute of Technology, Kanpur, India)

10:30 *A Novel Meandered Coupled-Line Tri-Band Impedance Matching Network*   *350*
Antra Saxena and Deepayan Banerjee (IIITD, India); Mohammad Hashmi (Nazarbayev University, Kazakhstan & IIIT Delhi, India)

Tue-2-5G: Special Session on 5G Initiatives in India and Telecom Standardization: Role of TSDSI (by) DoT and TSDSI

Room: Auditorium
Chair: Neelesh B. Mehta (Indian Institute of Science, India)

Tue-2-Keynote: A Platform Approach to 5G: Design, Prototyping and Test (by) Mr. Satish Mohanram, National Instruments

Room: Auditorium
Chair: Sibi Raj B Pillai (IIT Bombay, India)

For many, 5G represents that next major standard for cellular connectivity, but 5G is significant beyond just the next cell phone standard. It will have huge implications for connectivity that will take use beyond the smart phone to vehicles, hospitals, medical devices, factories, and smart cities. In the case of vehicle design, systems that used to operate independently are increasingly designed such that mechanical and electrical systems operate within a holistic system of an autonomous vehicle.

Highlights of this session will include:

- The challenges of testing new devices and systems, and how this could be a major bottleneck for organizations,

- How every standard follows a progression that starts with research and prototyping, and then moves to the design and development of the enabling semiconductor technology,

- The test challenges that lie ahead and the architectural requirements needed, and then lastly,

- How we will look to the past and apply systems thinking to a connected world from beam steering, synchronization to lowering the cost of millimeter wave measurement within the industries highlighted.

This talk will review the background and history of these explorations, lessons learned, and the future challenges that lie ahead. .

Tue-2-SP: Signal Processing / Invited Talk by Mr Anand Joshi, Redpine Signals

Room: LH2
Chair: Gvv Sharma (Indian Institute of Technology Hyderabad, India)

12:15 *Enhanced Convergence Distributed Arithmetic Based LMS Adaptive Filter Using Convex Combination* *354*
Tasleem Khan and Shaik Rafi Ahamed (Indian Institute of Technology Guwahati, India)

Tue-3-Com1: Communications Theory II

Room: Auditorium
Chair: Ranjan K. Mallik (Indian Institute of Technology - Delhi, India)

2:00 *Training-Based Joint Antenna and Relay Selection in Multiuser Downlink Cellular Network with RF Impairments* *360*
Anoop Kumar Mishra (National Institute of Technology Rourkela, India); Poonam Singh (National Institute Of Technology, Rourkela, India)

2:20 *Modeling and Outage Analysis of DF Relay Assisted Mixed PLC-VLC System* *366*
Manan Jani and Parul Garg (Netaji Subhas Institute of Technology, New Delhi, India); Akash Gupta (Netaji Subhas Institute of Technology, India)

2:40 *Performance Evaluation and Optimization of Multiantenna Two-Way Relaying System with CCI* *371*
Imtiyaz Khan (NIT ROURKLA, India); Dhulipudi Krishna Kanth (NIT Rourkela, India); Poonam Singh (National Institute Of Technology, Rourkela, India)

3:00 *Impact of Underlaid Multi-antenna D2D on Cellular Downlink in Massive MIMO Systems* *377*
Amit Agarwal (Indian Institute of Technology Delhi (IITD), India); Sudarshan Mukherjee (Daegu Gyeongbuk Institute of Science & Technology (DGIST), Korea); Saif Khan Mohammed (Indian

Institute of Technology Delhi, India)

3:20 *Closed-form Approximations for Coverage and Rate in a Multi-tier Heterogeneous Network in Nakagami-m Fading* *383*
G V S S Praneeth Varma (IIT Hyderabad, India); Gvv Sharma and Abhinav Kumar (Indian Institute of Technology Hyderabad, India)

Tue-3-NW: Wireless Networks / Invited Talk (by) Prof. Subhash Bhalla, University of Aizu

Room: LH1
Chair: Vineeth Bala Sukumaran (Indian Institute of Space Science and Technology, Trivandrum, India)

2:00 *A Frequency Assignment Technique for Effective SINR and Throughput Management in a Battlefield* *389*
Athindran Ramesh Kumar (Center for Excellence in Wireless Technology & Indian Institute of Technology Madras, India); Navinnath Palanisamy and Klutto Milleth (Centre of Excellence in Wireless Technology, India)

2:20 *Optimal Rate Control in a Quasi-Static Wireless Fading Channel with Throughput and Power Constraints* *395*
Rahul R and Utpal Mukherji (Indian Institute of Science, India)

2:40 *Dynamic Beam Assignment in Narrow Beamforming and mmWave Systems* *401*
Arzad Kherani (Indian Institute of Technology, Bhilai, India); Karthik Rm (Aruba Networks, India)

Tue-3-SP: Image Understanding

Room: LH2
Chair: Prithwijit Guha (IIT Guwahati, India)

2:00 *A Deep Learning Based Technique for Anomaly Detection in Surveillance Videos* *407*
Prakhar Singh (IIT Roorkee, India); Vinod Pankajakshan (Indian Institute of Technology Roorkee, India)

2:20 *Weighted Nuclear Norm and TV Regularization Based Image Deraining* *413*
Baiju P S and Deepak P (National Institute of Technology Calicut, India); Sudhish N George (National Institute of Technology, Calicut, India)

2:40 *Multiview 3D Reconstruction of Underwater Scenes Acquired with a Single Refractive Layer Using Structure from Motion* *419*
Parvathi VS (College of Engineering Trivadrum, India); Jiji Charangatt Victor (College of Engineering, Trivandrum, India)

3:00 *Forgery Detection in Digital Images Through Lighting Environment Inconsistencies* *425*
Aniruddha Mazumdar, Jefin Jacob and Prabin Kumar Bora (Indian Institute of Technology Guwahati, India)

3:20 *Spatio-Spectral Compression and Analysis of Hyperspectral Images Using Tensor Decomposition* *431*
Renu R K (Amrita University, India); V Sowmya (Amrita Vishwavidyapeetham, India); Soman K P (Amrita Vishwa Vidyapeetham, India)

Tue-3-Com2: Coding Theory & Applications

Room: 220
Chair: Prasad Krishnan (IIIT Hyderabad, India)

2:00 *A Rate-Optimal Construction of Codes with Sequential Recovery with Low Block Length* *437*
Balaji Srinivasan Babu (IISc, India); Ganesh Kini (Indian Institute of Science, India); P Vijay Kumar

(Indian Institute of Science & University of Southern California, India)

2:20 *On Maximally Recoverable Codes for Product Topologies* **443**
D. Shivakrishna (IIIT Hyderabad, India); V. Arvind Rameshwar (BITS Pilani, Hyderabad Campus, India); V. Lalitha (International Institute of Information Technology, India); Birenjith Padmakumari Sasidharan (Indian Institute of Science, India)

2:40 *Rewrite Cost Optimal Rank Modulation Codes in S_4 and S_5* **449**
Arijit Dutta and Saravanan Vijayakumaran (IIT Bombay, India)

3:00 *Permutation Polynomial Representatives and Their Matrices* **455**
Megha Kolhekar (Electrical Engineering Department IIT Bombay); Harish Pillai (Indian Institute of Technology Bombay, India)

3:20 *Determining the Generalized Hamming Weight Hierarchy of the Binary Projective Reed-Muller Code* **461**
Vinayak Ramkumar and Myna Vajha (Indian Institute of Science, India); P Vijay Kumar (Indian Institute of Science & University of Southern California, India)

Tue-4-5G: Paving the Way to 5G: Where we are & What we need to do? (by) Mr. Farris Alhorr, National Instruments

Room: Auditorium
Chair: Ranjan K. Mallik (Indian Institute of Technology - Delhi, India)

5G wireless will allow us to overcome the challenges that come with a more connected world. Gain insight from NI on how the standards being defined will shape everything from healthcare and automation to autonomous vehicles and smart factories. Also see how leading wireless researchers are utilizing the NI platforms in approaching these challenges and adapting to the new 5G landscape.

Highlights of this session will include:

- 5G NR Standardization and latest results
- Building high channel count wireless communication systems.
- Addressing the gaps to have mmWave frequencies as part of 5G deployments.
- National Instruments'/ involvement in 5GPPP projects and future possibilities
- Q&A session

Tue-4-SP: Image Processing

Room: LH2
Chair: Vinod Pankajakshan (Indian Institute of Technology Roorkee, India)

4:10 *Full Reference Quality Assessment of Full HD Images Using Combined Saliency Priors in Multi-Scale* **466**
Sameeulla Khan MD (Indian Institute Of Technology Hyderabad, India)

4:30 *Symmetric Chaos-Based Image Encryption Technique on Image Bit-Planes Using SHA-256* **471**
Abhilash Bhadke (Visvesvaraya National Institute of Technology, India); Surender Kannaiyan (Visvesvaraya National Institute of Technology); Vipin Kamble (Visvesvaraya National Institute of Technology, India)

4:50 *An Irrotationality Preserving Total Variation Algorithm for Phase Unwrapping* **477**
Bhargav Ghanekar and Dipak Narayan (Indian Institute of Technology Madras, India); Uday Khankhoje (Indian Institute of Technology Madras)

Tue-5-Com1: Communication Systems

Room: Auditorium
Chair: Parul Garg (Netaji Subhas Institute of Technology, New Delhi, India)

5:10 *Hybrid Satellite-Terrestrial Cooperative Communication with Mobile Terrestrial Nodes* **483**
Neeraj Varshney and Aditya K Jagannatham (Indian Institute of Technology Kanpur, India)

5:30 *System Design Aspects of Ka-Band High Throughput Satellite (HTS) for Indian Region* **489**
Neha Mehra (Space Applications Centre, ISRO, India); Abhishek Kakkar and Subhash Bera (Space Applications Centre & ISRO, India)

5:50 *A Study on Pathloss Model for UAV Based Urban Disaster and Emergency Communication Systems* **495**
Alok Ranjan (National Institute Of Technology, Rourkela, India); Bighnaraj Panigrahi and Hemant Kumar Rath (Tata Consultancy Services, India); Prasant Misra (TATA Consultancy Services, India); Anantha Simha (Tata Consultancy Services, India); H Sahu (NIT Rourkela, India)

Tue-5-NW: Potpourri - Networks

Room: LH1
Chair: Arzad Kherani (Indian Institute of Technology, Bhilai, India)

5:10 *Deterministic Evolution Through Indexed Leaf Node Based Attachment in Complex Networks* **501**
Gautham Suresh, Abhishek Chakraborty and Manoj Bs (Indian Institute of Space Science and Technology, India)

5:30 *PPoS: A Novel Sub-flow Scheduler and Socket APIs for Multipath TCP (MPTCP)* **507**
Abhijit Mondal (IIT Kharagpur, India); Aniruddh Rao Kabbinale, Samar Shailendra, Hemant Kumar Rath and Arpan Pal (Tata Consultancy Services, India)

5:50 *Fraction of Connections Among Friends of Friends as a New Metric for Network Analysis* **513**
Kumar Gaurav (Indian Institute of Technology, Kanpur, India); Sateeshkrishna Dhuli and Yatindra Nath Singh (Indian Institute of Technology Kanpur, India)

Tue-5-SP: Machine Learning and Applications

Room: LH2
Chair: Sumohana Channappayya (Indian Institute of Technology Hyderabad, India)

5:10 *Dictionary Learning Based Fingerprinting for Indoor Localization* **519**
Chirag Kumar (IIT Kanpur, India); Ketan Rajawat (Indian Institute of Technology Kanpur, India)

5:30 *Human Activity Classification in Smartphones Using Shape Descriptors* **525**
Ankita Jain and Vivek Kanhangad (IIT Indore, India)

5:50 *Progressively Balanced Multi-class Neural Trees* **531**
Ameya Godbole, Spoorthy Bhat and Prithwijit Guha (IIT Guwahati, India)

Tue-5-Com2: Communication Networks & IoT

Room: 220
Chair: Swades De (Indian Institute of Technology Delhi, India)

5:10 *The Effect of Introducing Redundancy in a Probabilistic Forwarding Protocol* **537**
Vinay Kumar B. R. (Indian Institute of Science, India); Roshan Antony (Qualcomm India, India); Navin Kashyap (Indian Institute of Science, India)

5:30 *Energy-Delay-Distortion Problem* **543**
Rahul Vaze (TIFR Mumbai, India); Akshat Choube (IIT-Palakkad, India); Shreyas Chaudhari (IIT-Madras, India); Nitin Aggarwal (IIT-Roorkee, India)

5:50 *Minimizing Energy Theft by Statistical Distance Based Theft Detector in AMI* **549**
Sandeep Kumar Singh (Indian Institute of Technology Delhi, India); Ranjan Bose (Indian Institute

of Technology, India); Anupam Joshi (UMBC, USA)

Wed-1-5G: 5G: What is missing and what it should be? (by) Mr. Satish Jamadagni, Reliance Jio & TSDSI

Room: Auditorium
Chair: Bheemarjuna Reddy Tamma (IIT Hyderabad, India)

It has been a few years since we have seen large scale LTE deployments worldwide. Key issues that have come in the way of realizing full LTE potential are the following: Backhaul limitations (fiber penetration), spectrum scarcity in key geographies, lack of open Service deployment architectures and other such issues. In 5G discussions including the ongoing standards efforts, there is little effort to address these issues from the LTE era BUT the focus is more on a next generation air interface to provide gigabit throughput, impose non coherent use cases (URLCC and eMBB as an example) on to a single air interface (or a class of unified air interface as they are called). The result is that 5G is a set of technologies that may not be easy to implement. As an example one can easily question that when the LTE based (strictly not correct but I will use it anyway) IOT technologies like NB-IOT itself is yet to see deployments in scale; 3GPP is working on URLCC (Ultra Reliable Low Latency Communications) and there seems be no smooth path from the existing NB-IOT (or even the HRLCC - which is Highly Reliable Low Latency Communication) to URLCC. The NFV/SDN or the Network Slicing specification is hard to realize for LTE networks (and subsequently for 5G) and it is unclear what markets will look at green field 5G deployments where these specifications could be useful. In this presentation we take a critical view of the manner in which the 5G specifications are evolving and address the below issues:

- New "interoperability" challenges given this non coherent standards development; new technologies that may provide some relief

- The IOT roadmap challenge - from LTE (eMTC or NB-IOT) to 5G (URLCC)

- The 5G Air-interface (Waveform design) challenges due to overlapped application requirements like eMBB and URLCC and the inefficiencies that it leads to (not to talk of deployment challenges)

Wed-1-SDN: Terabit SDN Router: Design and Development (by) Prof. Ashwin Gumaste, Indian Institute of Technology Bombay

Room: LH1
Chair: Kotaro Kataoka (Indian Institute of Technology Hyderabad, India)

We report a terabit cross connect router that was built at IIT Bombay. The terabit transport cross connect (T2C2) is an SDN capable whitebox that has 10G and 100G capable interfaces with WDM features. The cross connect was designed to consider OTN, IPv4, IPv6, MAC based routing but whose architecture is also seen as a complete SDN capable box that potentially conforms to all OpenFlow support. We discuss the design and development of this box as well as its analysis from a deployment perspective. We discuss the bitstream protocol that was proposed as an alternate SDN protocol for better programmability and forms the core of the SDN version of the cross connect. Bitstream is compared to OpenFlow as well as POF. A detailed overview of the architecture of the platform as well as use cases in which this platform can be deployed are presented. The controller architecture and user interface is also showcased. The use cases include provider networks, packet-optical integration, 5G backhaul as well as enterprise and HPC networks. The products' benchmarks are presented. The talk concludes with an overview of some of the carrier-class products developed and deployed by our lab in providers, enterprises and key networks.

Wed-1-Keynote: Beyond Software Defined Networking: When Software Isn't Fast Enough (by) Dr. David A. Maltz, Microsoft USA:

Room: Auditorium
Chair: Bheemarjuna Reddy Tamma (IIT Hyderabad, India)

The success of cloud computing stems from the ability to take extremely large pools of physical servers, connect them by a massive shared network, and then carve up those resources into separate virtual networks assigned to different tenants. For years, the ability to give each tenant an isolated virtual environment, configured exactly the way they want it, has depended on Software Defined Networking (SDN). In turn, Software Defined Networking has depended on software-based virtual switches running on the servers to modify each tenants' packets in ways that create the isolation. This worked fine when servers had 10 Gbps network interfaces, but as network speeds have increased to 40G and above, the Software in SDN has become a bottleneck to stable performance. In this talk, I will explain how computing clouds like Azure use SDN to virtualize network resources and the limits of that approach. I will then explain how and why Microsoft deployed FPGAs into nearly all our servers, so that programmable hardware offloads can be used to create blazingly fast and predictable networks while still providing the flexibility of software-based solutions. I will end by sketching some of the other things that become possible once FPGAs are present on every server, such as machine-learning and deep neural networks of unprecedented scale. This talk will be of interest to those that want to learn how cloud hosting platforms work, the state of the art in cloud networking, or how FPGAs provide a way to overcome the performance bottlenecks of software-only solutions.

Wed-2-Plenary: Generative Sensing: Transforming Unreliable Sensor Data for Reliable Recognition (by) Prof Lina Karam, Arizona State University (ASU), USA

Room: Auditorium
    Chair: Vineeth Balasubramanian (Indian Institute of Technology Hyderabad, India)

This talk introduces a deep learning enabled generative sensing framework which integrates low-end sensors with computational intelligence to attain a high recognition accuracy on par with that attained with high-end sensors. The proposed generative sensing framework aims at transforming low-end, low-quality sensor data into higher quality sensor data in terms of achieved classification accuracy. The low-end data can be transformed into higher quality data of the same modality or into data of another modality. Different from existing methods for image generation, the proposed framework is based on discriminative models and targets to maximize the recognition accuracy rather than a similarity measure. This is achieved through the introduction of selective feature regeneration in a deep neural network (DNN).

Wed-3-Com1: Network Coding

Room: Auditorium
    Chair: V. Lalitha (International Institute of Information Technology, India)

2:00 *Optimal Index Codes via a Duality Between Index Coding and Network Coding*   *554*
    Ashok Choudhary (IIIT Hyderabad, India); Vamsi Krishna Gummadi (IIIT HYDERABAD, India); Prasad Krishnan (IIIT Hyderabad, India)

2:20 *On Linear Codes for Broadcasting with Noisy Side Information*   *560*
    Suman Ghosh (IIT Hyderabad, India); Lakshmi Prasad Natarajan (Indian Institute of Technology Hyderabad, India)

2:40 *Index Coding: Rank-Invariant Extensions*   *566*
    Vamsi Krishna Gummadi (IIIT HYDERABAD, India); Ashok Choudhary and Prasad Krishnan (IIIT Hyderabad, India)

Wed-3-NW: SDN/NFV

Room: LH1
    Chair: Kotaro Kataoka (Indian Institute of Technology Hyderabad, India)

2:00 *Analysis of Computational Complexity and Power Consumption in Cloud Based Heterogeneous RAN*   *572*
    Ramakrishnan S and Subrat Kar (Indian Institute of Technology, Delhi, India); Dharmaraja Selvamuthu (IIT Delhi, India)

2:20 *Providing Resiliency for Service Function Chaining in NFV Systems Using a SDN-based Approach*   *578*
    Karthik Karra (Indian Institute of Technology, Madras, India); Krishna M. Sivalingam (Indian Institute of Technology Madras, India)

2:40 *A Machine Learning Approach for Detecting DoS Attacks in SDN Switches*   *584*
    Abhiroop T (Indian Institute of Space Science and Technology, India); Sarath Babu (Indian Institute of Space Science and Technology (IIST), India); Manoj Bs (Indian Institute of Space Science and Technology, India)

Wed-3-SP: Biomedical Signal Processing

Room: LH2
    Chair: P Rajalakshmi (Indian Institute of Technology Hyderabad, India)

2:00 *Identification of Coronary Artery Diseased Subjects Using Spectral Features*   *590*
    Pranab Samanta (IIT Kharagpur); Akanksha Pathak (IIT Kharagpur, India); Kayapanda Mandana

(Fortis Healthcare Limited, India); Goutam Saha (IIT Kharaghpur, India)

2:20 *Subspace Based CS-MUSIC for Diffuse Optical Tomography*   596
 B p v Dileep (IIT KHARAGPUR, India); Tapan Das and Pranab K. Dutta (IIT Kharagpur, India)

2:40 *Region Selective Information Augmentation for Retinal Images*   601
 Vineeta Das (Indian Institute of Technology, Guwahati, India); Samarendra Dandapat (IITG, India); Prabin Kumar Bora (Indian Institute of Technology Guwahati, India)

3:00 *Nonlinear State Estimation Technique Implementation for Human Heart Model*   606
 Amit Waghmare and Pradhnya Priyadarshi (Visvesvaraya National Institute of Technology, India); Surender Kannaiyan (VNIT, Nagpur, India); Vipin Kamble (Visvesvaraya National Institute of Technology, India)

3:20 *Fully Automatic Segmentation of Intima Media Complex in Common Carotid Artery Using Adaptive Wind Driven Optimization*   612
 Pardhu Madipalli, Sandeep Kotta and Harish Dadi (National Institute of Technology Karnataka, India); Nagaraj Y and Asha C. S. (National Institute of Technology, Karnataka, India); V Narasimhadhan A (NITK, India)