IEEE ComSoc Newsletter

June 2021

Issue 09

Contents:

Chairman's Message	*3*
5G Technology and Cellular System: Tutorial Series Part 9	*4*
IEEE ComSoc Membership Statistics	*5*
Events Conducted in The Year 2021 (Jan to June 2021)	*5*
Recent Important Events	*7*
The IEEE ComSoc Summer School 2021	*8*
News For Ph.D. And Research Students (International)	*10*
Student Branch Chapters Corner	*13*
Protsahan	*14*
Understanding 5G Beam Management with MATLAB	*15*
Crypto-ML : A Revolutionary Convergence of Two Technologies	*16*
Short Packet Communication for Mission-Critical Applications: Part 1	*17*
Sampling Rate in LTE And 5G-NR Baseband Systems	*18*

EDITOR'S MESSAGE

About IEEE ComSoc Chapter Bangalore Newsletter

The IEEE ComSoc Chapter, Bangalore Newsletter includes news useful to its members, non-members and highlights most important technology developments. It also highlights important concluded and upcoming events. In addition, it also includes openings for Post Doc and PhD positions in universities abroad. Links for few important topics from current issue of *IEEE Communication Magazine are also embedded.*

Editor Message

Dear Readers,

We are delighted to present the 9th edition of ComSoc newsletter, Bangalore Chapter, June 2021 issue. At the outset we would like to thank the chair and ExeCom for giving us the opportunity in bringing the Ninth issue of the newsletter.

The newsletter highlights the activities and achievements which happened in the first half of the year 2021. We have included a snapshot of the significant events conducted by the IEEE ComSoC, Bangalore Chapter and other high-quality technical articles related to advanced topics in 5G. Some nontechnical article in communication community and higher education information relevant to national and international institutes are also provided for benefit to student community.

Inside this issue

This issue continues the journey into the depth of 5G Technology from where we left off in the previous newsletter. The 5G Tutorial series part 9, introduces Massive MIMO and how it exploits Beamforming to overcome propagation losses. Basics of Antenna arrays and their usage in mm-Wave and multiple trade-offs of RF Chains are also motivated. Further along, we have an article from MATLAB which details the various components of Beam Management and studies of various aspects, especially concerning the different use cases like Enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low Latency Communication (URLLC), and Massive Machine Type Communications (mMTC). Further along, we discuss the diverse topic - Crypto-ML, that marries Cryptography and Machine Learning domains. This enables the cryptographic algorithms to generate robust keys which enhance the security of our communication networks. Considering the significance of URLLC and mMTC in 5G that deal with communication for mission-critical applications, we are starting a series on short packet communication from this edition. This series will delve deeper into what is required for supporting exceptionally reliable and low latency communication over unreliable wireless channels. Finally, we also have an article that discusses the basics of how the sampling rates for 5GNR and LTE waveforms have been chosen as a function of sub-carrier spacing and channel bandwidths. This edition also gives a snapshot of the topics covered as part of the recently concluded IEEE ComSoc Summer School 2021 conducted around the theme of "Beyond -5G and IoT: Human-Machine Interaction".

In this newsletter, we also present consolidated reports from Student Branch Chapters related to IEEE ComSoc and future planned technical activities and views, findings, and advancements. We will be happy to receive more articles from various streams in the field of communication, technical research, and social awareness to publish in the next issues.

IEEE ComSoc Bangalore Chapter Newsletter Team:
Anindya Saha, Shobha K R & Navin Kumar

CHAIRMANS MESSAGE

Let me start by congratulating the Execom, student bodies, professional members and all the volunteers for making the 1H, 2021 very eventful. Though, in the early months, we started in a relaxed lockdown mode, we had to retrace to a complete virtual mode for our activities due to the second wave of pandemic. My sincere request to the community is to continue to take great care as the curb gets relaxed again. And ensure vaccination at the earliest possible opportunity!

This newsletter outlines many of our activities. Thanks to the editorial committee. Without getting into the nitty-gritty, I would like to highlight how we are investing our time and energy in three streams of activities. All these initiatives are towards the advancement of technologies and benefits for our members.

For last decade or so, many of our member companies and academia have been researching for 5G wireless communication system: from device to network. This is the apt time to get fruit of all those hard work. Worldwide, over last two years, several deployments of 5G system have happened. New applications are emerging with the true power of high speed for faster communication, low latency for interactive communication and new protocols for machine communication. In India, operators and OEMs are currently gearing up to conduct 5G trials in major cities.

Firstly, in IEEE ComSoc workshops and fora, we have been deliberating on the system architecture, security dimensions, deployment challenges, low-latency applications and other key aspects. Our chapter has hosted the global summer school on “Beyond-5G and IoT: Human-Machine Communication” where the ComSoc students from 25+ countries have been trained to understand the convergence of 5G and IoT technologies. We have also deliberated in a workshop on 6G requirements and plausible use cases. This germinates the idea of an international 6G summit in 2H.

Secondly, we are playing a critical role in research and innovation growth. Our Research Methodology workshop is evergreen; many researchers benefit from such authorship lab. We had an invigorating panel discussion with young researchers on “how to create a research mindset”. Built on the foundation of our last year Patent workshop, I gave an invited talk in IEEE India council on “Intellectual Property: Why, What and How” with ~500 participants. And as part of our Open Innovation promotion, in partnership with Samsung, we are conducting an Open Source mini-conference in early July around 5G, IoT and Edge Computing.

Last but not the least, we value professional and overall growth of our members. In a session, we went into the details of membership upgrade qualifications. We invited members to join an “Ask Us Anything” session addressed by leaders from industry and academia. Many of our student chapters have been organizing training and awareness sessions in their campuses as well as online. We also concluded recently, graduate theses presentations (Grate-7) in conjunction with three other state sections. We have encouraged our members to join IEEE group medical insurance scheme; those who are yet to avail this attractive offering may consider early next year for them and their families.

I wish you a sound health and splendid 2H!

Dr. Aloknath De
Chair—IEEE ComSoc Bangalore
CTO-Samsung India, Bangalore

Dear Reader, we plan to dedicate this page to the 5G Tutorial Series. Starting from the basics, I would like to continue discussing the 5G Cellular System and Technologies in sequence (starting from Part 1, Part 2, etc.). The tutorial will be in continuation of the previous issue. I hope we will go in parallel with ongoing 5G research and development. It is believed that the Reader will gain a better understanding of the 5G Cellular System if they follow the tutorial. In the last part, VIII, we discussed Edge Computing and Multi-Access Edge Computing. In this issue, we are continuing our discussion on Mobile Edge Computing.

- Navin Kumar, Ph.D., Associate Professor, Amrita School of Engineering Bangalore

5G TECHNOLOGY AND CELLULAR SYSTEM TUTORIAL SERIES: PART IX- MMWAVE MASSIVE MIMO SYSTEM

Sheeba Kumari M, Ph.D. Scholar
Navin Kumar, PhD

In the earlier part, part III of the series, we briefly discussed massive MIMO as an enabling technology for 5G. However, considering the significance of massive MIMO in beamforming and the related enhancements provided in the 3GPP releases of 5G New Radio (NR), we explore the technology in detail in this part.

Massive MIMO and mmWave technology complement and converge in many respects. The extremely short wavelength of mmWave carrier frequencies is attractive for massive MIMO as the physical size of the antenna arrays can be considerably reduced, and many antenna elements can be deployed in the same form factor. This enables a massive MIMO antenna array not only at the Base Stations but also at the UEs. Meanwhile, the large beamforming gains offered by massive MIMO are effective in reducing the severe propagation attenuation of mmWave signals. In this context, emerging mmWave-massive MIMO systems can substantially improve the user throughput, spectral and energy efficiencies, network capacity and offer high multiplexing gains. Hence, a rational way of integrating these two approaches will be beneficial to accomplish 5G key performance indicators (KPIs).

MIMO has evolved from passive to active antenna systems, from 2D to 3D array architecture, from few antennas to massive antennas. The maximum number of antennas suggested by 3GPP for mmWave transmission is 1024 and 64 for the BSs and UEs. With many antennas, the BS/UE can concentrate their transmit power into narrow beams. The shape and direction of the transmitted beams can be controlled by dynamically adjusting the phase and amplitude of multiple antenna elements, thus offering beamforming capabilities. Fig.1 shows some of the benefits of massive MIMO beamforming expected in cellular systems. To exploit these benefits, appropriate pre-processing of signals before transmission is required. Three categories of beamforming architectures have evolved: fully analog beamforming, digital beamforming, and hybrid analog-digital beamforming architecture.

As mmWave massive MIMO systems must cater to single and multiple users with several spatial streams, analog beamforming may be inadequate. Also, the need to incorporate a vast number of RF chains in the transceiver will impose tremendous hardware requirements for a fully digital mmWave massive MIMO antenna architecture. The increased cost and energy consumption will make the digital beamforming realization impractical.

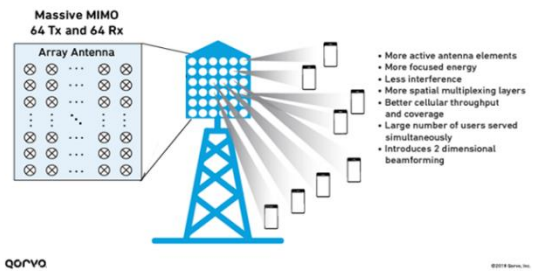


Fig. 1: Benefits of massive MIMO beamforming

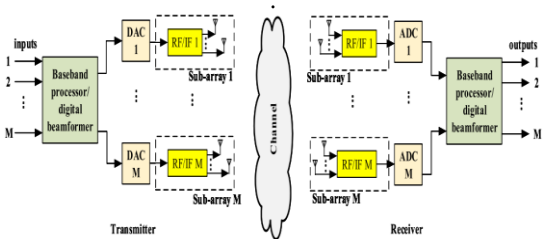


Fig 2: Hybrid antenna array architecture

Hence, the feasible approach for mmWave massive MMO is the hybrid beamforming architecture, as shown in Fig.2. In the massive hybrid array architecture, antenna elements are grouped into analog sub-arrays. Only one phase shifter is dedicated to a single antenna element, and all antenna elements share all other components in each sub-array.

Each sub-array is fed with only one digital input, and all digital signals from all the sub-arrays are jointly processed in a digital processor.

To unleash the potential of mmWave massive MIMO technology, several challenges need to be addressed. The challenges arise primarily due to the differences in the architecture and propagation characteristics of mmWave massive MIMO networks as compared to the existing networks.

The major challenges, as well as scope of exploration, include channel modeling, antenna and RF transceiver architecture design, waveforms and multiple access schemes, information-theoretic issues, channel estimation techniques, modulation, and energy efficiency issues, medium access control (MAC) layer design, interference management, backhaul transmissions, mobility management, system-level modeling, tests, and characterization, and many more.

We will continue this part in the next edition, highlighting beam management techniques in 5G.

The next part continues in the next issue.

IEEE Communication Society Membership Statistics As of June 2021

Total Members: 393 (June 2021)

Fellow + Life Fellow:	**05**	**Graduate Student Member**	**88**
Senior Member	**102**	**Student Member**	**91**
Member	**100**	**Others:**	**07**

EVENTS CONDUCTED (JAN TO JUNE 2021)

	Date	Event
1.	09-01-2021	COMSOC AGM
2.	09-01-2021	EXCOM Monthly meeting
3.	23-01-2021	Workshop on Rural Communication in 5G and beyond Opening remarks by the chair
4.	23-01-2021	Title - Rural Connectivity: The capacity transport and distribution problem
5.	23-01-2021	Rural communication Industry connection program
6.	30-01-2021	Intelligent Reflecting Surfaces: Fundamentals, Applications, Challenges, and Future Trends
7.	30-01-2021	IRS: Part-I
8.	30-01-2021	IRS: Part-II
9.	06-02-2021	COMSOC Execom monthly meeting
10.	20-02-2021	5G URLLC Application workshop: Event Title: URLLC - Overview of Standards, RAN Architecture and Vertical Market Realization Challenges
11.	20-02-2021	URLLC Session 1: URLLC Perspective and Introduction
12.	20-02-2021	URLLC Session 2: Overview of URLLC standard and Radio Access Architecture
13.	20-02-2021	URLLC Session 3: 5G for Healthcare Applications
14.	20-02-2021	URLLC Session 4: Industrial Automation using URLLC

15.	20-02-2021	URLLC Session 5: Applicability of URLLC in Transport & Connected Car
16.	27-02-2021	End to End 5G security
17.	27-2-2021	End to End 5G security - Welcome address
18.	27-2-2021	End to end security perspective in 5G
19.	27-2-2021	5G Device Security
20.	27-2-2021	5G Application Security in Financial Sector
21.	27-2-2021	Cyber Security in the Indian context
22.	06-03-2021	COMSOC Execom monthly meeting - 3
23.	13-03-2021	Data Management in 5G - Welcome address
24.	13-03-2021	Data Management in 5G
25.	13-03-2021	Unified Data Layer
26.	13-03-2021	Data & Automation in Digital Operations
27.	13-03-2021	Data Privacy & Security
28.	13-03-2021	Data Management & Monetization Panel Discussion
29.	12-03-2021	5G Security workshop follow up session with MeiTY
30.	20-03-2021	5G Security in the post-quantum era
31.	20-03-2021	IEEE awareness session at Tejas
32.	22-03-2021	IEEE awareness session at Wipro
33.	24-03-2021	IEEE awareness session at Harman
34.	03-04-2021	Research Methodology
35.	08-04-2021	Communication Research and Research Mindset
36.	10-04-2021	COMSOC Execom monthly meeting - 4
37.	08-05-2021	6G: REQUIREMENTS AND USE CASES
38.	08-05-2021	COMSOC Execom monthly meeting - 5
39.	29-05-2021	Ask Us Anything
40.	29-05-2021	Professional Growth/Membership Drive
41.	05-06-2021	COMSOC Execom monthly meeting - 6
42.	10-06-2021 to 12-6-2021	IEEE ComSoc Summer School: Beyond - 5G and IoT: Human-Machine Communication
43	19-06-2021	ICT Education in India: 2025 and Beyond

RECENT IMPORTANT EVENTS

The world has seen a strong transformation of 5G with respect to Research and Deployment, but the ongoing transformation will eventually give rise to multiple challenges of 5G deployments and supporting use-cases. Thus, researchers must think future networks which virtually has more touchpoint of our daily life, society, and integrating all the industries of the world in general, along with the communication needs of human and intelligent machines. In this webinar, speakers focused more on the requirements & use cases that will drive 6G, IoT applications migrations, and finally, the cellular network deployment features and its Radio Access Network.

The workshop provided insights on 5G networks which require a new approach to the management of data, as the network embraces Cloud-native architecture, Service Orientation. For the next few years, 4G and 5Gwill co-exist, which requires linkage of 4G subscriber data repository and UDM in 5G, which is being standardized now. As 5G encourages ecosystem collaboration, new opportunities arise with IoT and Edge for vertical industry solutions. Data Management becomes very key across domains within operators and the ecosystems for monetization. Cross-domain linkage is very key for handling Zero Touch Operations leveraging AI / ML and automation. As networks are becoming open, it is important to focus on e2e data security, privacy, and governance.

IEEE COMSOC BEST READINGS

https://www.comsoc.org/publications/best-readings/network-localization-and-navigation
http://www.comsoc.org/
http://www.comsoc.org/whitepapers
https://www.comsoc.org/publications/ctn/be-or-not-be-there-person-what-future-technical-conference

The IEEE ComSoc Summer School 2021: Beyond -5G and IoT: Human-Machine Interaction

The IEEE ComSoc Summer School 2021 was the 8th Edition of the Summer School, jointly organized by IEEE ComSoc, Bangalore Chapter & IEEE ComSoc Educational Services Board. The 3-day virtual event from 10th to 12th June 2021 was designed with the central theme being "Beyond -5G and IoT: Human-Machine Interaction". The 3-day virtual event featured lectures by world-leading professors, industry leaders, and executives, focusing on topics addressing the cutting-edge trends within the abovementioned theme. Approximately 140 participants, including the speakers, registered for this event, including students, researchers, and professionals from India and abroad.

The program included an introduction to the basics of 5G, IoT, Machine to Machine Communication, 5G Core network, Radio Systems, Standards, and their research challenges. Following the theme, aspects of Industry 4.0 in IoT and a few demo sessions on the usage of AI in 5G were covered. Finally, security aspects of 5G and trusted processing in 5G IoT systems were included to give completeness to this program to appreciate the importance of real-world deployments.

The event started with the thematic presentation by Dr. Aloknath De, Chair of IEEE ComSoc, Bangalore. The stage was set well to introduce the 5G requirements and standards and

embraced radio and network technologies convergence to enable new services – eMBB, mMTC, and URLLC. The use cases of both Fixed Wireless access and Mobile use cases for access and backhaul were elaborated. The marriage of 5G Connectivity and IoT to enable use cases like Smart city, Vehicle to Vehicle and Vehicle to infra (V2X), immersive experiences for applications like healthcare, video streaming, intelligent navigation, real-time interactive gaming were also highlighted. For the Beyond 5G and IoT scenario, various Machine communication with enhanced intelligence in access plane and Core network plane was envisioned, geared towards handling different types of traffic simultaneously. In addition, it was also highlighted that industry 4.0 would be enabled by Beyond 5G technologies, leading to intelligent manufacturing and human-machine collaboration.

Dr. Sudip's talk carried forward the event's theme by highlighting the need for B5G Technologies and how it can combine with IoT to serve the needs of massively connected devices. Applications like Industrial IoT and Autonomous vehicles need ultra-low latency and ultra-

high-reliability capabilities while simultaneously

satisfying improved energy and spectral efficiency. The

talk discussed various enabling technologies like FD-MIMO and Massive MIMO, enabling IoT and mMTC to evolve to IoE (Internet of everything). Challenges and research directions in this 5G and IoT domain leading to 6G were also motivated. Several future IoT applications were envisioned in the talk, like Massive Access and Massive Machine-type Communication (mMTC), Tele-Operation, Industrial Automations, Smart Energy Systems, Edutainment, Networked Control System, Tactile Robots, Co-operative Automated Driving, and Smart Healthcare. Dr. Sudhindra, Dr. Thinagaran, and Dr. Sean McGrath (video lecture) also delved into the B5G aspects, including the IoT Edge, later.

The sessions by Dr. Srikanth on the 5G NR Key concepts and technology were introductory and aimed at building a solid foundation for the students. It covered detailed aspects of the waveform starting from IMT requirements and how the objectives are realized using Flexible OFDM, scalable numerologies, framing requirements for TDD and FDD leading up to Massive MIMO, and basics of beamforming aspects. He also covered LTE and 5G NR comparisons for MIMO, including the concepts of Bandwidth parts.

Prof Rui Aguiar's talk touched upon aspects of future research beyond 5G. He touched upon the emerging topics covering fundamental techniques for Tb/s communication and associated enabling methods and technologies like operations at higher carrier frequencies, Antenna Selection, and Spatial Modulation, combined with massive MIMO. In addition, his talk also emphasized future aspects of Converged networks, Visible light communication, Dynamic radio infrastructures, including topics of importance like Emergency communication, cellular radar, self-powered devices, and systems.

The topic of 5G Core by Mr. Sankaran was very informative and helped build the concept from the first principles. The talk explained a stepwise approach to the rationale for a new core, key concepts considered in the design, reference architecture, network functions, interfaces, and finally, how it enables Human to machine and machine-to-machine communication.

The aspects of Security in 5G and IoT were covered in sufficient detail, emphasizing the different threat vectors by Dr. Ashutosh. The key pillars of 5G security related to SDN, Cloud RAN, Edge Cloud, Orchestration, and Virtualization were covered. In addition, it also touched on various aspects of Data Security and Privacy, Network Slicing Security, Predictive Security, and Supply Chain security Challenges. Finally, the mitigation aspects and risk severity were also touched upon concerning all the different scenarios. The talk on Trusted Processing for 5G IoT by Dr. Dilip highlighted how the distributed processing techniques could robustly address security aspects.

Prof Sinem Coleri's talk covered innovative research areas which her group is pursuing in Machine to Machine and Machine to infrastructure communications. She covered various aspects of Communication Aware Dynamic Edge Computing, Vehicular Visible Light Communication, Energy Efficient machine to machine communications. Her talk also covered aspects of how the connectivity through 5G networks can be controlling the elements in our environment based on the data collected from these machines.

The talk by Mr. Subodh Gajare titled "Rebooting the 4th Industrial Revolution with IoT" included discussion on architecture aspects of how 5G has evolved to include Massive IoT, including demonstrating the relevant concepts. In addition, the talk covered aspects of how distributed platforms and applications can be used to cater to the Industrial IoT use cases while at the same time adhering to regulatory requirements and not compromising on Security.

Prof RK Ganti spoke about the ongoing work on the 5G Testbed and associated Research Challenges. The 5G Testbed is the first of its kind for India, being developed by DoT, Govt of India, and premier Indian institutes to develop the ecosystem for 5G mobile communication technologies. The project will deliver an end-to-end 5G testbed comprising 5G Base Station and User Equipment nodes that support enhanced mobile broadband (eMBB), Ultra low latency communication (URLLC), and massive MTC, including NB IoT services.

The talk by Mr. Tarun Gupta demonstrated how the NI platform could be used for 5G research. The demonstration included real-time emulation of 5G UE interworking with a gNB. The demonstration gave good visibility of how students and researchers can use these platforms, tools, and frameworks from NI for building prototyping in their chosen domain in 5G.

PH.D. OPPORTUNITY IN TERAHERTZ-BASED WIRELESS DATA CENTRE NETWORKS AT LETTERKENNY INSTITUTE OF TECHNOLOGY, IRELAND.

- We are looking for an excellent, motivated, and self-driven student to engage in Ph.D. studies and research around Terahertz communication networks at the Department of Computing, Letterkenny Institute of Technology, Ireland. The project will mainly focus on designing novel MAC protocols for Data Centre networks using Terahertz frequency bands.
  Please find the project description and supervisor profiles at the following links: Project description:
  https://www.lyit.ie/portals/0/pdf/2021/research/phdsummaries/P.4MACprotocolsforWirelessDataCentreNetwork.pdf

  Supervisors profile:
  Dr. Saim Ghafoor
  https://sites.google.com/view/saimghafoor
  https://www.lyit.ie/portals/0/pdf/2021/research/supervisor/SaimGhafoorSupervisorProfilePRB.pdf
  Dr. Mubashir Husain Rehmani
  https://sites.google.com/site/mubrehmani/home

  Candidate Qualifications/Requirements:
  1. Master's degree in computer engineering or science or equivalent.
  2. Bachelor's degree holders can also apply provided they show strong motivation and proficiency in the following requirements.
  3. Strong mathematical background and understanding. Prior experience in modeling will be preferred.
  4. Prior experience in Machine Learning and mathematical models/tools will be preferred.
  5. Strong programming skills, especially in C++ and Python.
  6. English proficiency with good communication skills.
  7. Previous publications in the related field will be given preference.

  Application Process
  To apply for one of our Ph.D. projects, please complete the following application form and return it to researchoffice@lyit.ie along with all relevant documentation by 5:00 pm, Friday 16th July.

  Application form link:
  https://www.lyit.ie/portals/0/pdf/2021/research/2021PresidentsResearchBursariesPhDapplicationform.docx

  Please ensure that you use the Project Reference Number in the subject of the E-mail. The project reference number is "P.4".
  For more information on our Taught Postgraduate Courses, please click here. Additional information for International Students can be found here. www.lyit.ie

POSTDOC POSITION AT VIRGINIA TECH ECE

The laboratory of research in optimization, learning, and energy (ROLE), led by Dr. Ming Jin in the Bradley Department of Electrical and Computer Engineering at Virginia Tech, has one fully funded postdoctoral research position starting in fall 2021. The position is initially for one year with the possibility of extension.

ROLE lab aims to enable trustworthy learning and control for safety-critical systems by developing fundamental machine learning, control, and optimization methods. The successful candidate should have strong mathematical skills and publication records in these domains.

Please send your CV and three sample publications to email: jinming@vt.edu. Homepage: http://www.jinming.tech/

POST-DOC/RESEARCH FACULTY POSITION AT VIRGINIA TECH

Post-doc/Research Faculty position at Virginia Tech

A post-doc or research assistant professor position is available at Wireless@Virginia Tech, a university-based research center on wireless communications and networking at Virginia Tech, Blacksburg, VA. The incumbent will participate in an active research program in 5G and wireless networks and systems in general. Responsibilities include conducting research in wireless networks, publishing in top conferences and journals, participating in proposal development, and supervising graduate students. Required background includes strong knowledge of wireless communications, MIMO, and optimization. A completed Ph.D. degree in ECE is required by the time of the appointment. Interested applicants should send CVs to Prof. Tom Hou at thou@vt.edu.

POSTDOC RESEARCH FELLOW POSITION ON INDUSTRIAL IOT AT NTU, SINGAPORE

Postdoc Research Fellow Position on Industrial IoT at NTU Singapore A postdoctoral Research Fellow position is immediately available at the HP-NTU Digital Manufacturing Corporate Lab, Nanyang Technological University (NTU), Singapore. The successful candidate will join the Corporate Lab and the NTU IoT Sensing Group (https://ntuiot.xyz) to conduct research in industrial IoT with focus topics of embedded 3D sensing via a combination of RGB cameras,

LIDAR, and/or mmWave radar and the integration with robotics.
The candidates should have obtained a Ph.D. degree in computer science, computer engineering, or relevant disciplines and have demonstrated strong research ability by publications on prestigious venues in the areas of IoT and cyber-physical systems.
The position will provide excellent opportunities to perform basic and applied research closely with high-profile industrial collaborators. Other advantages of the position include (1) stable fund subject to satisfactory performance; (2) various opportunities in Singapore's strategic IoT and AI research clusters; (3) high-quality living and low tax rates in Singapore. Interested candidates can send CVs asap and before August 31, 2020, to Dr. Rui Tan <tanrui@ntu.edu.sg>.
More information about the research group can be found at https://ntuiot.xyz and https://personal.ntu.edu.sg/tanrui/
About NTU and SCSE: NTU is a fast-rising young university. It is No. 1 among universities under 50 years (2021). The computer science of NTU is ranked 7th and 8th in the world according to The US News and The Academic Ranking of World Universities (Shanghai Ranking) in 2021.

IEEE Connecting the Unconnected Challenge Call for Participation

https://ctu.ieee.org/
Contact email: ieee-ctu@ieee.org
Phase 1 submission Deadline
July 16, 2021 (500 words abstract)

The competition has two main tracks:

1. Proof-of-Concept track: This category is intended for individuals or groups who have already demonstrated their innovation with a basic proof-of-concept implementation or a pilot program and can show preliminary results or successful field deployment(s). The submission in this category should include a description of the general design and proposed functionality including implementation of specific features. In addition to implementation, it can include a (small-scale) deployment/exercise to verify the idea's potential and/or illustrate its feasibility. It should be noted that the competition is not looking for well-established programs with a large user base or extremely advanced
initiatives.

2. Concept-Only track: These are individuals or groups with novel ideas that only exist "on paper" with simulation or analytical results, demonstrating potential towards the CTU vision of affordably connecting unconnected populations. Prizes in this will be lower than the POC track.

Why participate?

A minimum of $60,000 will be distributed to winners in the different tracks, and Proof-of-Concept prizes will be higher than Concept-Only prizes. Additionally, this program will provide awardees with opportunities for significant exposure from IEEE Future Networks. Winning contestants will be invited to present their solutions at a global (virtual) IEEE Connecting the Unconnected Summit in November. This event will also include keynote talks, panels, and other presentations from leaders in industry, governments, and NGOs.

Who can apply?
The competition is open to private sector companies or startups, nonprofits and grassroots groups, university projects, students, government organizations, other organizations, or individual participants from anywhere globally. Individual participants must be at least 18 years old. Participants who represent underserved communities from developing/emerging nations and/or the Global South are highly encouraged to apply.
Competition rules and expectations

The competition will be executed in three stages.
In the first stage (Phase 1), participants will submit a short initial submission that includes a 500-word abstract describing their solution. Those who advance to Phase 2 will be asked to complete a second, more detailed online submission, to which applicants may attach additional supporting materials. In Phase 3 (final), a select number of applicants will be invited to present to our Selection Committee in a closed-door, live/virtual session with Q&A. The whole process is expected to last approximately 3 months from start to finish. Winners will be recognized at an awards ceremony during the IEEE Connecting the Unconnected Summit in November 2021, where they will be invited to present their solutions to the summit audience.

● During Phase 2, applicants will have the option to have their submission reviewed by the IEEE Standards Association for potential standardization opportunities within their Rural Communication program. This review is voluntary and has no bearing on the competition judging process.

● All finalists will be required to present their solutions online to the selection committee on September 31, 2021, or October 1, 2021.

● All finalists will be required to undergo a due diligence procedure in October to verify submitted information before the final ranking is determined.

● All winners/awardees will be required to create a video of their solution posted publicly by IEEE. We do not envision this video as requiring any cost burden, and
IEEE will provide recommendations for video creation.

● All winners/awardees will be required to present at the Summit on November 3-5, 2021.

● All winners/awardees will be required to provide updated information about their solution
1 year following the award date. However, IEEE will not conduct any follow-up audit, and participants will not be required to indicate how the award money was used.

Selected submissions may be encouraged or invited to publish in IEEE publications. Selected proposals may also be encouraged or invited to participate in IEEE Standards Association projects.

Award Criteria

The submissions will be assessed based on several technical and societal impact criteria. These will include the novelty/innovation of the idea/project and relevance to the CTU topic and scalability, sustainability (from a business/deployment perspective), and readiness of the proposed solution. The submissions will also be evaluated on their potential for inclusion, impact, efficacy, and risk level.

Challenge Website: https://ctu.ieee.org/ - Visit webpage for more information.
Challenge contact email: ieee-ctu@ieee.org
Deadlines:
Phase 1 submission closing: July 16th, 2021 (500 Words Abstract)
Phase 2 submission: Approximately one month later
Finalist selection: Approximately 5 weeks after Phase 2
Presentation at the CTU Summit: November 3-5, 2021.

CALL FOR CONTRIBUTION TO COMSOC NEWS

Please get in touch with us if you wish to write and to be included in this newsletter (in Communication Technology). The article should be from 300-1000 words in docx, or doc file and separate image files must be provided in jpeg or tiff file format.

You can submit to:

shobha_shankar@msrit.edu , anindya@saankhyalabs.com ,navinkumar@ieee.org

IF YOU WISH TO ADVERTISE

The newsletter is circulated to more than 10,000 members from academia and industry. It has wide reach and slowly getting popularity. Please contact us to advertise in the newsletter. Increase your visibility with us.

Anindya Saha (anindya@saankhyalabs.com)

Navin Kumar (navinkumar@ieee.org)

STUDENT BRANCH CHAPTERS CORNER

1. INDIAN INSTITUTE OF SCIENCE, BANGALORE

The ComSoc Student Branch Chapter was formed on 13th January 2011. The branch has 18 ComSoc members.
Faculty advisor: Prof. T. Srinivas
Student Chair: Varkey M. John

2. AMRITA SCHOOL OF ENGINEERING, BANGALORE CAMPUS

The ComSoc Student Branch Chapter was formed in April 2016. The student branch has largest number of student members over 120 and perhaps the largest Student ComSoc Members. They conduct lot many activities and are highly active.
Faculty advisor: Sagar Basavaraju
Student Chair: Anushka Tripathi

3. CMRIT, BANGALORE

The ComSoc Student Branch Chapter was started in late 2012 but was inactive for a short period. It was restarted on 30 April 2019.
Faculty advisor: Mahesh Kumar Jha
Student Chair: Rashmi T

4. RVCE, BANGALORE

The ComSoc Student Branch Chapter was formed in July 2016.
Faculty advisor: Shushrutha K S
Student Chair: Anushka Subramanian

5. RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE

The ComSoc Student Branch Chapter was formed in 9th Dec 2019. The branch has 30 ComSoc members.
Faculty advisor: Dr . Shobha K R
Student Chair: Vibha Narayan

6. ST JOSEPH ENGINEERING COLLEGE, MANGALURU

The ComSoc Student Branch Chapter was formed on 28 April 2018.
Faculty advisor: Dr Rohan Pinto
Student Chair: Valona Mandonca.

7. MALNAD COLLEGE OF ENGG, HASSAN

The ComSoc Student Branch Chapter was formed in Oct 2019.
Faculty advisor: Triveni.C.L
Student Chair: Pooja H M.

8. REVA UNIVERSITY, BANGALORE

The ComSoc Student Branch Chapter was formed on **25th** September 2020.
Faculty advisor: Abdul Haq N
Student Chair: Bhoomika M

9. MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL

The ComSoc Student Branch Chapter was formed on **27th August 2020 and inaugurated on 19th September 2020.**
Faculty advisor: Dr Ujjwal Verma
Student Chair: Krithika M Pai

ALL THE STUDENT BRANCHES ARE CONDUCTING VERY GOOD TECHNICAL EVENTS INDIVIDUALLY AS WELL AS IN COLLABORATION WITH STUDENT BRANCHES.

PROTSAHAN: RECOGNITION OF RESEARCH PUBLICATIONS

The Bangalore ComSoc chapter, Protsahan drive is to recognize contributions in the Communication Sector by granting awards to any paper published / Tutorial offered in recognized conference / journals (during Jan 2020 - Sep 2021) by IEEE student member / member / non-member (as first author to be IEEE member, non-Member in the jurisdiction of IEEE Bangalore Section).

Publications can be part of fundamental research or industry aligned research in the Communications sector. Broad criteria include,

1. **Academic Research (fundamental)**
   a. **Novelty**
   b. **Analysis & Insights**
   c. **Superiority of proposed technique vis-a-vis state of art**
2. **Industry Research (having potential for Commercialization)**
   a. **Innovation**
   b. **Social Impact**
   c. **Commercialization**

Select and award Top 5 in each of following 4 categories:

Categories	Target Groups	Award
I	IEEE member + ComSoc member	Book(s) in communication area
II	IEEE member, ComSoc non-member	One-year ComSoc membership
III	IEEE student members	One-year ComSoc membership + a book / gift
IV	IEEE Non-member <Professional / Student>	One-year ComSoc membership, provided IEEE membership is taken

Jury Chair & Core Panel

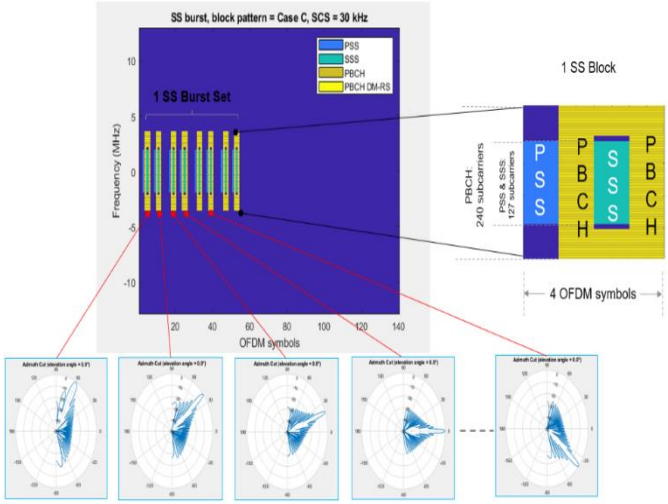
- **Dr Dilip Krishnaswamy (Chair)**
- **Dr Ganesan Thiagarajan**
- **Dr. Navin Kumar**
- **Gnanapriya Chidambaranathan**
- **Dr. Sanjeev Gurugopinath**

UNDERSTANDING 5G BEAM MANAGEMENT WITH MATLAB:

The use cases for 5G, such as Enhanced Mobile Broadband (eMBB), Ultra-Reliable and Low Latency Communication (URLLC), and Massive Machine Type Communications (mMTC), will need technical innovations, and 5G beam management becomes indispensable.

With 5G millimeter wave (mmWave) enabling directional communication with a larger number of antenna elements and providing an additional beamforming gain, efficient management of beams—where the user equipment (UE) and gNodeB (gNB) regularly identify the optimal beams to work on at any given point of time—has become crucial. Read this white paper to learn about:

- The components of beam management and 3GPP-defined beam management procedures
- Various beam management techniques and their importance in maintaining a healthy communication link
- The method to design and simulate efficient 5G NR beam management procedures using MATLAB® and add-on toolboxes



Key components of Beam Management:

- Beam Sweeping
- Beam Measurement and Determination
- Beam Reporting
- Beam Recovery
- Beam Switching

Learn more:
https://www.mathworks.com/campaigns/offers/5g-nr-beam-management.html
Explore more on Wireless Communications -videos, white papers, and examples:
https://explore.mathworks.com/wireless-communications-development-library
Simulate, analyze, and test satellite communications systems and links using Satellite Communications Toolbox:
https://www.mathworks.com/products/satellite-communications

Explore 5G wireless technology development: *mathworks.com/5g*

CRYPTO-ML: A REVOLUTIONARY CONVERGENCE OF TWO TECHNOLOGIES

Ananya K, Meghana S, Rashmi Harish, Sameeksha Kamath
Department of Electronics and Telecommunications,
Ramaiah Institute of Technology

Cryptography is the process of protecting information and communications by converting ordinary plain text into unintelligible ciphertext and vice-versa.

Although cryptography has been in use for a long time, its primary focus was secrecy in communication, such as spies, military personnel, diplomats, and other confidential war reports and information. Modern cryptography is now an amalgamation of various disciplines of computer science, mathematics, electrical engineering, communication science, and physics, thus shifting the focus to multiple other aspects of information security, including data confidentiality, data integrity, authentication, and non-repudiation.

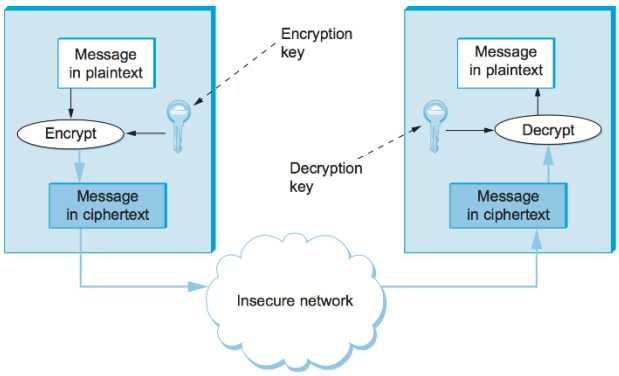


Fig 1: Working of a basic cryptographic system

Machine Learning is the most promising and easiest way to enhance the performance of machines through experience and using more data.
Machine Learning and cryptography have a lot of things in common. The most apparent one is processing large amounts of data and large search spaces.

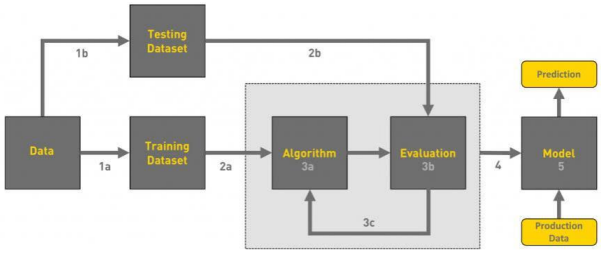


Fig 2: Machine learning workflow

Applications

Here are examples of a few challenges machine learning and cryptography can address together.

1. **Ensure the privacy of people and data**- The power of ML comes from people (data from big tech firms like Facebook and Twitter), so cryptography ensures privacy during data collection and model training to give "power to people."
2. **Models should not be tampered with nor introduce bias for profit or control**-Develop methods to restrict the introduction of maliciously chosen training data to affect the model in such a way that it is in favour of one party
3. **Adversarial ML** - Clever manipulations of input by an adversary can cause misclassifications and fool applications where the consequences emerge as a real threat. E.g. self-driving cars, virus detection
4. **Trace the unauthorized use of data and model** - Introduction of encrypted data with several layers of Security, so it is easier to weed out unnecessary access to data and the training and prediction model, allowing only people who have access to use data the right way
5. **Fairness, accountability, interpretability, and de-biasing** - Cryptography, along with ML and DL, can ensure that proper rules are applied to tech firms exploiting data of users
6. **Proper use of proper randomness** - Randomness seems key to the training phase in DNN and aspects such as key generation in cryptographic algorithms. Randomness affects stability.
7. **Define specialized cryptographic functionalities which are ML complete** - Focus on efficient reductions between known ML classifiers and cryptographic functions.
8. **Replace current ML algorithms with cryptographic friendly ones** - Present a new theory for cryptography motivated by ML

Conclusion:
With machine learning, cryptographic algorithms can now generate stronger keys, enhance secure encryption, generate better encoding functions, and do much more, along with higher efficiency and accuracy.
Thus, communication systems are now more secure, reliable, and robust due to safer data transmission.

Short Packet Communication for Mission-Critical Applications: Part 1 (Introduction)

Dr. Parthajit Mohapatra
Indian Institute of Technology Tirupati, India

Besides providing support for the increasing demands of mobile broadband traffic, 5G technology is envisioned to support *machine-to-machine (M2M) communication* with minimal or without human intervention. The M2M plays a significant role in many mission-critical applications such as autonomous vehicles, smart factories, and unmanned aerial vehicles (UAV). It is required to support highly reliable and low latency communication over unreliable wireless channels for mission-critical applications.

To meet the stated requirements, 5G technology is expected to provide two important modes: (a) *Ultra-Reliable Low Latency Communication (URLLC)*; and (b) *massive Machine Type Communication (mMTC)* [1], [2]. URLLC mode is expected to provide services in the scenarios where throughput requirement is moderate, but it is required to provide high reliability under stringent delay constraints. Some practical scenarios where URLLC is relevant are inter-vehicular communication, connectivity to the cloud, and communication between UAV and ground stations. On the other hand, mMTC is expected to support a vast number of devices in each area. This will be important for distributed cyber-physical systems (CPS). For both the modes, it is required to support high reliability under stringent delay constraints. According to Shannon's channel coding theorem, the transmission rate should be less than the channel capacity to drive the error probability to zero. To achieve this result, it is required to use a long codeword. However, using a long codeword (or packet of large size) can increase the latency in communication. To reduce the latency, one can use a short packet, but it can reduce the reliability. Hence, many of the existing communication techniques used in LTE or Wi-Fi cannot be used for such scenarios as they are designed for large packet sizes. This requires the development of methods for short packet communication, and the following challenges arise:

(a) When packet size is small, the distortion introduced by the propagation channel is not averaged out.
(b) Metadata (preamble and header) size is comparable to the data. One cannot neglect the metadata size compared to the data and its requirement for proper encoding for the metadata.
(c) Many information-theoretic results developed in existing literature are not applicable as these results are based on the law of large numbers, which assume that the packet size is large.

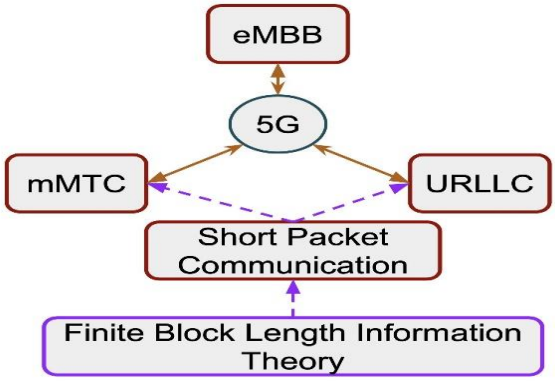


Fig 1: Relevance of Finite Block Length Information Theory for 5G (eMBB: enhanced Mobile Broadband, URLLC: Ultra-reliable Low Latency Communication and mMTC: massive Machine Type Communication).

Hence, the short packet communication brings new research challenges in channel encoder/decoder design, resource allocation, and network-level protocol development. In recent years, progress has happened in understanding fundamental tradeoffs between rate, error, and block length [1, 2]. The developed results allow us to study for a given block-length and error performance, the best possible rate or target rate and error performance, and the size of block-length needs to be used. Although these results are applicable for point-to-point scenarios, there has been progress in understanding such tradeoffs for multi-user scenarios such as Non-Orthogonal Multiple Access (NOMA). The finite block length information theory can give valuable insights on developing techniques for short packet communication and in the design of latency-aware communication. This article will continue, and future articles will focus on the recent advances in finite block length information theory and secure communication with short packets.

References:

[1] Y. Polyanskiy, H. V. Poor and S. Verdú, Channel coding rate in the finite blocklength regime, *IEEE Trans. Inf. Theory*, vol. 56, no. 5, pp. 2307-2359, May 2010.
[2] M. Bennis, M. Debbah and H. V. Poor, Ultrareliable and Low-Latency Wireless Communication: Tail, Risk, and Scale, *Proceedings of the IEEE*, vol. 106, no. 10, pp. 1834-1853, Oct. 2018.
Acknowledgment: The author would like to thank you for the support provided by the project from SERB, India.

SAMPLING RATE IN LTE AND 5G-NR BASEBAND SYSTEMS

Kiran C Marathe, Founder, dtri.in

For LTE practitioners, it is common knowledge that for a baseband signal bandwidth (BW) of 20MHz, the minimum sampling rate for converting this signal to a digital domain is 30.72MHz. This number of 30.72MHz appears in the 3GPP LTE specifications document, for example, in TS 36.101.

The sampling rate of 30.72MHz is not intuitive, and 2 questions may arise in the first-time reader's mind. Firstly, how can a signal with a bandwidth of 20MHz be sampled at 30.72MHz? Does it not violate the fundamental Nyquist sampling theorem that states that the sampling rate should be at least twice the signal bandwidth? Secondly, why 30.72MHz, and why not use a rather well-rounded number like 30MHz or 40MHz?

The answer to the first question is 'quadrature sampling.' An LTE transceiver is a quadrature system, as shown in Figure-1.

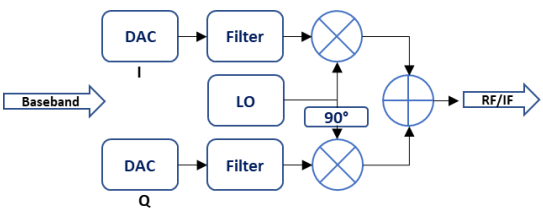


Figure-1: Quadrature Transmitter System

The I and Q paths in a quadrature system have their mixers, filters for processing the signal. An LTE signal of BW 20MHz refers to this quadrature or complex signal bandwidth where individual I and Q paths have a bandwidth of 10MHz each and provide the total 20MHz bandwidth. For each of the paths with 10MHz bandwidth, the sampling rate of 30.72MHz very well exceeds (3x) the Nyquist sampling rate.

The second question can be addressed by recalling the LTE transmitter and receiver design based on OFDM and how the sub-carriers are generated. Consider the case of the OFDM transmitter. The inverse discrete Fourier transform (IDFT) or the efficient form of DFT, the inverse fast Fourier transform (IFFT), generates multiple sub-carriers. Consider the IDFT equation shown in Equation-1.

$$x(n) = \frac{1}{N}\sum_{m=0}^{N-1} X(m) e^{\left(\frac{j2\pi mn}{N}\right)}$$

Equation-1: IDFT Equation

Here x(n) represents a discrete time-domain signal formed from N discrete frequencies represented by X(m) and the exponential term. The value N and the sampling rate (fs) of signal x(n) give an essential relationship, as shown in Equation-2.

$$f_{spacing} = \frac{mf_s}{N}$$

Equation-2: Frequency spacing calculation

$f_{spacing}$ in Equation-2 gives the spacing between 2 neighboring frequencies in an N frequency system. m is an integer that goes from 1 to N, which gives the index of each frequency point.

Consider an LTE signal with BW=20MHz and sub-carrier spacing (SCS) of 15kHz. The number of sub-carriers within 20MHz BW spaced at 15kHz is calculated by dividing the BW by SCS, giving 1333.33 sub-carriers. This value is higher than the actual number of subcarriers specified by 3GPP specifications for LTE (1200 sub-carriers) and 5G-NR (1272 subcarriers). Equation-1 is used to generate these sub-carriers, but the actual implementation uses radix-2 FFT, where the number of frequency points in FFT should be a power of 2. Thus, to generate 1200 sub-carriers, 2^{11} FFT is used. Hence, we derive the value of N as 2^{11} or 2048 sub-carriers.

Rearranging Equation-2 as below:

$$f_s = \frac{f_{spacing}N}{m}$$

Equation-3: Sampling rate calculation

In OFDM transceiver, identifying $f_{spacing}$ as SCS, which is 15kHz, N=2048, and m=1 (always use one since there is no indexing in this context), the sampling rate is f_s=30.72MHz, which answers the second question.

Equation-3 can be applied to calculate sampling rates for other LTE and 5G-NR BW and SCS cases, as shown in Table-1.

SCS (kHz)	BW (MHz)	N	f_s (MHz)
60	100	2048	122.88
15	5	512	7.68
15	40	4096	61.44

Table-1: Sampling rates for different SCS and BW cases


IEEE
COMMUNICATIONS
MAGAZINE
May 2021, vol. 59, no. 5
Special Issue: Nano-Networking for Nano-, Micro-, Macro-Scale Applications
Series: Data Science and Artificial Intelligence for Communications
IEEE
IEEE ComSoc
IEEE Communications Society
A Publication of the IEEE Communications Society
www.comsoc.org