IEEE ComSoc Newsletter – Bangalore Chapter

June 2022

Issue 11

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EDITOR'S MESSAGE

ABOUT IEEE COMSOC CHAPTER BANGALORE NEWSLETTER

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

EDITOR MESSAGE

Dear Readers,

We are delighted to present the 11th edition of the ComSoc newsletter, Bangalore Chapter, June 2022 issue. At the outset, we would like to thank the chair and ExeCom for giving us an opportunity to bring out the Eleventh issue of the newsletter.

The newsletter highlights the activities and achievements which happened in the first half of the year 2022. We have included a snapshot of the significant events conducted bythe IEEE ComSoC, Bangalore Chapter, and other high-quality technical articles related to advanced topics in 5G. Some articles in the communication community and higher education information relevant to national and international institutes are also provided to benefit the student community.

INSIDE THIS ISSUE

This issue covers various topics ranging from aspects of Beam management in Massive Mimo Radios (as part of 5G tutorials) to Security aspects, innovative usage of Blockchain, the significance of Network Synchronization, and Chaotic Communication. In 5G NR, massive MIMO has become a key technology in the FR1 (sub-6Ghz) and FR2 (24Ghz to 53GHz) range. The article highlights the aspects of Beam sweeping, beam measurements, beam determination, beam reporting, and failure recovery. Regarding futuristic and fully-fledged technology, Blockchain and 5G are the most discussed technologies hitting the marketplace. From the article titled "Communication Reimagined through Blockchain," it is interesting to figure out how Blockchain can impact the telecommunication industry and the challenges that technology will face while transforming. Synchronization is one of the most critical functions of a communication system. Timing and synchronization standards for mobile networks prevent messages from interfering with one another and enable smooth cell-to-cell transfers. The increased stringency of timing and synchronization requirements for 5G is driven by exponentially faster speeds, lower latency, and increased densification. An article that highlights the importance of Synchronization and RAN Transport is covered in this edition. 6G Communication systems are expected to face new security challenges while opening up new frontiers toward context awareness in the wireless edge. The workhorse behind this projected technological leap will be a new set of sensing capabilities predicted for 6G devices and edge and device embedded intelligence. Combining these enhanced traits can give rise to a new breed of adaptive and context-aware security protocols, following the quality of security (QoSec) paradigm. The article on Context-Aware Secure Communication examines how physical layer security solutions can provide context-aware security schemes. We also introduce the subject of Chaotic Communications in this edition, which is touted as one of the exciting methods that will become popular in the future. We strongly urge readers to write back to us on what type of articles theywould like us to address in future editions. This newsletter also presents reports from Student Branch Chapters related to IEEE ComSoc and future planned technical activities, views, findings, and advancements. We will be happy to receive more articles from various streams in communication, technical research, and social awareness to publish in the following issues.

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

CHAIRMAN'S MESSAGE

Congratulations to the ExCom members, industry captains, academic community, young professionals, and student volunteers for an excellent start to 2022, despite the constraints posed by the pandemic. We have already conducted many events and started new initiatives boosting the student chapter activities and interactions apart from the professional education.

Through IEEE ComSoc workshops and forums, we have deliberated on many salient and upcoming technologies such as Satellite communication, Private 5G networks, machine learning for 5G networks, edge computing, and context-aware resource allocation. As a few examples of the events, I can highlight the following. We had a detailed seminar on part 1 of the two-part series on Private 5G features, security, and architectures. Two DLT talks by Prof. Melike Kantarci from the University of Ottawa and Dr. Majid Butt from Nokia Bell labs explored the details of optimizing the 5G networks. The webinars by Mr. Kannan Babu and Dr. Tinku Acharya detailed the nuances of edge computing and analytics.

With the pandemic restrictions fading away, we are encouraging physical meetings and talks at various student branches and ComSoc execom meetings. We had a physical execom for June in Saankhya Labs premises. Four new student branches are approved and inaugurated. We celebrated World telecom day along with IETE in a physical format.

We value professional growth, and accordingly, we are happy to see member strength getting closer to the membership we had in December 2021, despite the drop of 20% at the beginning of the year. We focused on membership upgrade qualifications and membership benefits packages. Three new senior membership elevation was achieved in the first half of 2022. Nine of our student branches have been re-ignited for the activities, and four new student branches have been approved and initiated. Graduate theses presentations (Grate-7) just got completed, and PhD EDITS preparations have started, which are the two popular programs for graduate and Ph.D. students.

The upcoming events for this year are a virtual student internship program where industry veterans will guide students as mentors. We started "Codify" – the first edition of a student 24-hour hackathon event this year along with BNMIT, which will be held during the 1st week of July. In July, we are technical co-sponsoring two flagship conferences for IEEE ComSoc Bangalore, CONECCT, and SPCOM. The new scheme we launched last year —' Protsahan,' which awards the first authors for good research publications- will also be continued this year.

With global chapter award reception in 2021 and social media promotion, the society has created international visibility. Via LinkedIn, we promoted our events and shared our video presentations on our YouTube channel. The YouTube channel subscriptions have increased to >500 as of June 2022. Our telegram channel subscription, which we started this year, has been growing steadily over the few months along with our events. Our website has been updated, presenting all information for easy access by members. Our finance base is comfortable for initiating new activities in student chapters.

As we embark on the second half of 2022, I am confident we will execute our annual plan as planned and introduce new social impact programs. I wish you another exciting half year ahead!

Dr. Ganesan Thiagarajan
Chair—IEEE ComSoc Bangalore

Dear Reader, we plan to dedicate this page to the 5G Tutorial Series. Starting from the basics, I would like to discuss 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 parallel with ongoing 5G research and development. It is believed that the Reader will better understand the 5G Cellular System if they follow the tutorial. In the last part, X, we discussed Beam management as an enabling technology for 5G. In this issue, we are continuing our discussion on Beam Management in part XI.

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

5G TECHNOLOGY AND CELLULAR SYSTEM TUTORIAL SERIES: PART XI- BEAM MANAGEMENT

Navin Kumar, PhD
Sheeba Kumari M, Ph.D

Cont'd from previous: Directional links, especially very narrow beams, require accurate alignment of transmitted and received beams. To achieve beam pair alignment and the necessary end-to-end performance with the desired delay, beam management operations are used in the 5G NR (as mentioned in the previous tutorial Part X). Beam management operations are essential during Initial Access (i.e. IDLE mode) when UE is not in connection with gNB and during tracking (i.e. CONNECTED mode) when UE is exchanging data with the gNB (i.e. network).

The beam management procedure is used in 5G NR to acquire and maintain a set of the transmission-reception point (TRxP(s)) and UE beams which can be used for downlink (DL) and uplink (UL) transmission/reception.

The following operations are performed in the 5G NR beam management procedure (for both modes, i.e. SA and NSA).

- ***Beam Sweeping***: It can cover a spatial area with a set of beams transmitted and received according to pre-specified intervals and directions.
- ***Beam measurement***: It is based on the quality of the received signal at the gNB or the UE. Different metrics could be used, such as reference signal received power (RSRP), reference signal received quality (RSRQ), and signal to interference ratio (SINR) or signal to noise ratio (SNR) for this purpose.
- ***Beam determination***: It refers to selecting the suitable Beam or beams either at the gNB or at the UE, according to the measurements obtained with the beam measurement procedure.
- ***Beam reporting***: In this procedure, UE sends beam quality and beam decision information to the Radio Access Network (RAN).

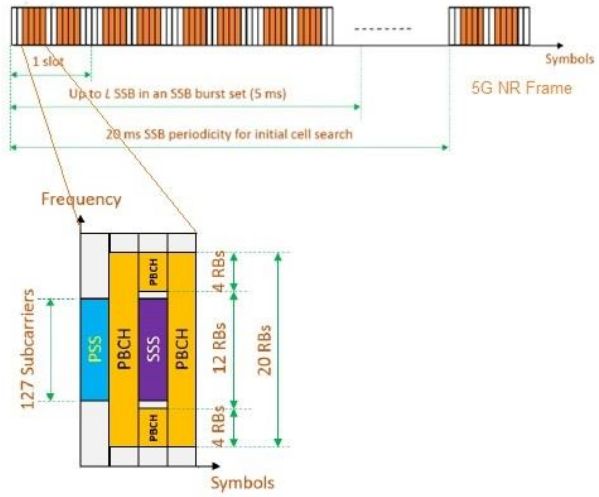
Implementation of Beam Management in 5G NR

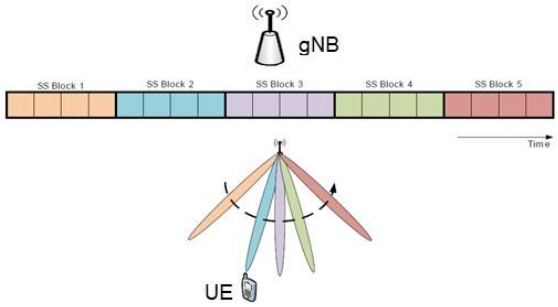
We discuss the downlink (from gNB to UE) and uplink (from UE to gNB) of the 5G NR system. The system uses different reference signals for beam management. Page | 5

- It uses a primary synchronization signal (PSS)/ Secondary Synchronization Signal (SSS)/Physical Broadcast Channel synchronization signal block (SSB)) during IDLE mode.
- It uses Channel State Information Reference Signal CSI-RS (in the downlink) and Sounding Reference Signal (SRS) (in the uplink) during the CONNECTED mode.

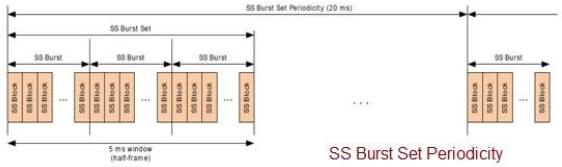
DL Signal Measurement-Using SS Blocks:

- In the 5G NR downlink frame, SS blocks are transmitted towards UEs at regular intervals based on the periodicity set (i.e. 5/10/20/40/80/160ms).
- SS blocks are carried in a SS burst.
- A single SS block spans 4 OFDM symbols on the time axis and 240 subcarriers on the frequency axis.
- SS block carries PSS, SSS, and PBCH with DMRS.
- The SS blocks are grouped into the first 5ms of the SS burst.
- The maximum number (L) of SS blocks in a single burst is frequency-dependent. There can be about 64 blocks per burst at frequencies above 6GHz (i.e. mmWave frequencies).





In this, DMRS (Demodulation Reference Signal) associated with the PBCH channel is used to estimate RSRP (Reference signal received power) is calculated from the received SS blocks at the UE.



The figure shows periodic transmission of SS burst (carrying SS blocks) from gNB to UE at every 20ms interval.

- **Using CSI-RS:**
- In LTE, connected UEs estimate channel conditions regularly and report CQI (Channel Quality Information) to their serving eNBs.
- Like LTE, in 5G NR, these signals are used for RRM measurements for mobility management purposes in CONNECTED mode.
- CSI-RS spans N = 1/2/4 OFDM symbols. There are two transmission modes of CSI-RS viz. periodic and semi-persistent/aperiodic.
- We have to continue this for UL …

IEEE Communication Society Membership Statistics as of JULY 2022

Total Members: 477(Jul 2022)

Affiliate	02	Graduate Student Member	55
Associate Member	01	Student Member	218
Fellow + Life Fellow:	06	Member	84
Senior Member + Life Senior	111		

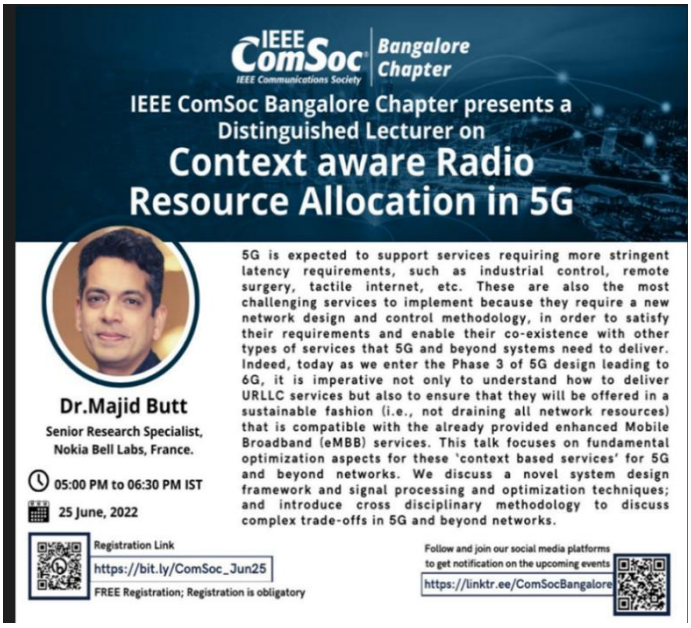
MAJOR EVENTS CONDUCTED FROM JAN TO JUNE 2022

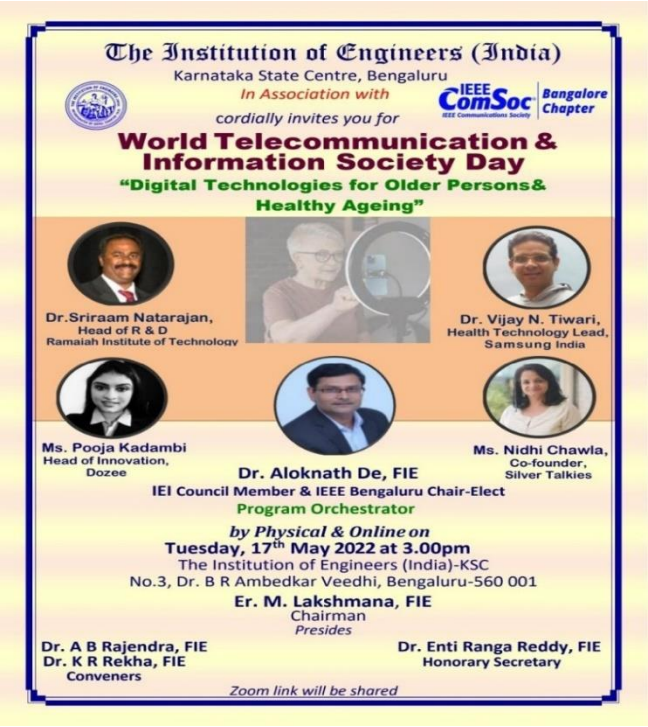
Sl. No.	Date	Event
1.	08-01-2022	DLT - Deep and Reinforcement Learning in 5G and 6G
2.	22-01-2022	Seminar - Introduction to Satellite-IoT Systems
3.	12-02-2022	Introduction to Edge computing and green computing features
4.	19-02-2022	Artificial Intelligence, Video IoT, and their applications in Smart Cities
5.	25-02 2022	5G Evolution - Ushering Massive IoT Acceleration.
6.	05-03-2022	Private 5G Enterprise Use Cases, Deployment Models, and Challenges
7.	10-03-2022	IC3IoT - COMMUNICATION, COMPUTING & INTERNET OF THINGS
8.	27-05-2022	DLT- Software Market place
9.	17-05-2022	Digital technologies for older Persons and Healthy Ageing
10.	20-05-2022	CODIQ- 24 hours hackathon
11.	21-05-2022	Private 5G workshop series - 1 of 2
12.	07-06-2022	Private 5G - tech talk
13.	18-06-2022	DLT "Introduction to Software Defined Radio, 5G, and Functional Split for Virtual RAN
14.	25-06-2022	DLT “Context-aware Radio Resource Allocation in 5G”

IMPORTANT UPCOMING EVENTS

Sl. No.	Event
1.	One day workshop on Quantum Technologies
2.	5G Deployment Challenges
3.	NTN - Talk on Satellite (Thales/Inmarsat/ISRO)
4.	6G AI / ML
5.	Private 5G Enterprise Use Cases, Deployment Models, and Challenges
6.	Research Methodology
7.	Ph.D. Edits

RECENT IMPORTANT EVENTS





News for Ph.D. and Research Students (International)

1. Funded Post Doc At University Of Québec, Montréal, Canada

Fully funded postdoc position is available in the Department of Electrical Engineering at *École de Technologie Supérieure (*ETS*)*, the University of Québec, Montréal, Canada. The candidate will conduct research on wireless networks, resource allocation, machine learning, and their applications to tactical and wireless communications.

Candidates for this position are expected to have the following qualifications:

1) Excellent oral and written communication skills in English.
2) A Ph.D. degree in electrical engineering or a closely related field.
3) Requirements and qualifications (in descending order of importance):
   - A strong background in digital/wireless communications,
   - Experience in optimization and/or machine learning,
   - A solid academic record.

Application: Interested candidates should send a detailed CV, graduate transcript(s), list of publications, statement of research and interests, TOEFL/GRE test scores, and a cover letter to **Prof Georges Kaddoum @ <georges.kaddoum@etsmtl.ca>** .

1.

2. Amrita School Of Engineering Bengaluru,

Department of ECE urgently requires

- 2 PostDoc and 2 Ph.D. scholars to work on 5G and Beyond (development and proving use cases).
- 2 M Tech (ECE/CSE) to work on the 5G Communication area.
- 4 B Tech graduate (ECE) to work in 5G and advanced Communication areas, including LiFi
- 2 B Tech ECE to work on Signal processing
- 3 B Tech/M Tech as Lab Engineer.

Contact -k_navin@blr.amrita.edu

3. The Network Communications And Economics Lab (NCEL) Of CUHK Shenzhen

The Network Communications and Economics Lab (NCEL) of CUHK Shenzhen has several postdoc openings in the areas of:

- Mechanism design for crowd decision making.
- Data and machine learning model trading.
- Federated learning and multi-agent reinforcement learning.
- Distributed optimization of large-scale energy networks.
- Mechanism design and optimization for the carbon market.

Interested candidates can send CVs and three representative publications to **jianweihuang@cuhk.edu.cn**.
For details (in Chinese), please see https://mp.weixin.qq.com/s/8LFUtrixhdIz6r0aPgh2Qw

4. Postdoc Opportunity In 5G/NextG Wireless At George Mason University

The College of Engineering and Computing at George Mason University (GMU) is seeking a motivated postdoctoral fellow to conduct high-quality experimental wireless research under the direction of Prof. Vijay K. Shah at NextG Wireless Lab@Mason. More information here: https://mason.gmu.edu/~vshah22/
The successful candidate will contribute to the recently NIST-funded project on the 5G/NextG wireless project and will also have the opportunity to collaborate with other teammates at NextG Wireless Lab@Mason, and our academic and industry partners on the exciting topics of 5G/NextG communications, Open AI Cellular (OAIC), mmW beamforming, and spectrum sharing.

Project Description

This project proposes designing, prototyping, and demonstrating a highly precise 5G-based Indoor Positioning System (5G-IPS). The project addresses three long-standing and complex challenges in emergency environments (i) global navigation satellite systems (GNSS) and traditional global positioning systems (GPS) do not work reliably in an indoor setting, and (ii) reliable communication infrastructure may not always be available, and (ii) accurate mapping and visualization of the building map may not be available. UAVs mounted with 5G base stations or user equipment [UEs]) will be utilized for enabling cellular-based

(viz. 5G NR) positioning along with specific enhancements to precisely localize firefighters within a building. Then, an essential 5G capability, called network slicing, will be utilized to securely, reliably, and timely disseminate the time-critical position information (and other important audio/video or sensor information) from firefighters to the safety stakeholders that need to know it. Following this, a mapping and visualization tool will be prototyped to accurately track the position of firefighters within the visual 3D map of the building. The 5G-IPS system will be demonstrated in the lab using NextG Wireless Lab@Mason's 5G O-RAN testbed, followed by an in-field building test setting in collaboration with Arlington County Fire Department.

Qualifications

- Ph.D. degree in Electrical Engineering, Computer Engineering, Computer Science, Telecommunications, or related areas.
- Excellent knowledge of 5G/NextG wireless. Knowledge of machine learning will be a plus.
- Hands-on experience with at least one of the SDR platforms and FPGA programming.
- Excellent publication record in top academic conferences and journals
- Fantastic team player and has good communication skills while working independently.

Your application must include:

- A research statement (max. 2 pages) indicating your research interests, achievements, plans, and how these fit with the above position requirements and our ongoing research
- Curriculum vitae, including the list of publications, R&D skills, awards, fellowships, grants, etc.
- Names of at least two references

How to apply?

Send the required documents as a single pdf file directly to vshah22@gmu.edu, with Subject="Postdoc-application-FirstName-LastName" by July 31, 2022.

The College of Engineering and Computing (CEC) at George Mason University comprises the Volgenau School of Engineering and a new School of Computing.

The College is a fast-growing force for innovation in research and education. Ranked nationally in the top 100 in undergraduate and graduate education, the College boasts more than 9,100 students in 37 undergraduate, master's, and doctoral degree programs, including several first-in-the-nation offerings. Of the 271 full-time faculty who comprise the College, 91 are tenured, 59 are tenure-track, 89 are instructional faculty, and 32 are research faculty. As part of a nationally ranked research university, its research teams expended more than $75 million in sponsored research awards in the past year and have projects with over $400 million in current and anticipated awards. The College stands out for its leading research in areas such as artificial intelligence, data analytics engineering, cybersecurity engineering, biomedical imaging and devices, community-based healthcare, autonomous systems, 5G/Next G communications, systems architectures, computational biomedicine, advanced materials, and manufacturing, sustainable infrastructure, and more. The College encourages multidisciplinary research and provides ample opportunity for faculty to work with other disciplines.

George Mason University is the largest and most diverse public research university in Virginia, with an enrollment of over 39,000 students studying in over 200-degree programs. Mason is an innovative, entrepreneurial institution with national distinction in various academic fields. It was classified as an R1 research institution in 2016 by the Carnegie Classifications of Institutes of Higher Education. Mason has campuses in Fairfax, Arlington, and Prince William. Its proximity to Washington, D.C., provides unmatched geographical access to several federal agencies and national laboratories. Northern Virginia is also home to one of the nation's largest concentrations of high-tech firms, giving excellent opportunities for interaction with industry. The region is consistently rated as among the best places to live in the country and has an outstanding local public school system.

STUDENT BRANCH CHAPTERS CORNER

1. **INDIAN INSTITUTE OF SCIENCE, BANGALORE**
   The ComSoc Student Branch Chapter was formed on January 13, 2011. This student branch conducts a lot of activities.
   Faculty advisor: Prof. T. Srinivas Student Chair: Ananta Kant Rai

2. **AMRITA SCHOOL OF ENGINEERING, BANGALORE CAMPUS**
   The ComSoc Student Branch Chapter was formed in April 2016. They conduct lot many activities and are highly active.
   Faculty advisor: Dr. Salija
   Student Chair: Haritha J

3. **CMRIT, BANGALORE**
   The ComSoc Student Branch Chapter was started in late 2012 but was inactive for a short period. It was restarted on April 30, 2019. Currently, they have the largest number of students.
   Faculty advisor: Prof. Harsha Student Chair: Gaurav Srivastava

4. **RVCE, BANGALORE**
   The ComSoc Student Branch Chapter was formed in July 2016. They conduct a lot of activities each year.
   Faculty advisor: Dr. Shushrutha K S
   Student Chair: Shamanth S Bhat

5. **RAMAIAH INSTITUTE OF TECHNOLOGY, BANGALORE**
   The ComSoc Student Branch Chapter was formed on December 9, 2019. They conduct a lot of activities each year.
   Faculty advisor: Dr. Shobha K R Student Chair: Ranjitha D P

6. **ST JOSEPH ENGINEERING COLLEGE, MANGALURU**
   The ComSoc Student Branch Chapter was formed on April 28, 2018.
   Faculty advisor: Prof Chaitra U R Student Chair: Samyak Chandra

7. **MALNAD COLLEGE OF ENGG, HASSAN**
   The ComSoc Student Branch Chapter was formed in Oct 2019.
   Faculty advisor: Dr. Triveni. C.LStudent Chair: Guruprasad G H

8. **REVA UNIVERSITY, BANGALORE**
   The ComSoc Student Branch Chapter was created on **September 25,** 2020.
   Faculty advisor: Abdul Haq NStudent Chair: Bhoomika C M

9. **MANIPAL INSTITUTE OF TECHNOLOGY, MANIPAL**
   The ComSoc Student Branch Chapter was formed on August 27, 2020, and inaugurated on September 19, 2020**.**
   Faculty advisor: Dr. Pramod Kumar
   Student Chair: Pallavi M

10. **CENTRAL UNIVERSITY OF KARNATAKA, KALABURGI**
    The ComSoc Student Branch Chapter was formed on February 23, 2022, and inaugurated on 23rd March 2022
    Faculty advisor: Dr. Paramesha
    Student Chair: Bhargav SRS

11. **JNN COLLEGE OF ENGINEERING, SHIVAMOGGA**
    The ComSoc Student Branch Chapter was formed on April 13, 2022, and inaugurated on 30th May 2022
    Faculty advisor: Dr. S V Sathyanarayana
    Student Chair: V N Gokul Krishna

12. **PES UNIVERSITY**
    The ComSoc Student Branch Chapter was formed on April 23, 2022, and inaugurated on May 31, 2022
    Faculty advisor: Dr. Sanjeev
    Student Chair: Aditya Sangli

GLIMPSES OF STUDENT BRANCH ACTIVITIES

CENTRAL UNIVERSITY OF KARNATAKA, KALABURGI STUDENT BRANCH INAUGURAL

JNN COLLEGE OF ENGINEERING, SHIVAMOGGA STUDENT BRANCH INAUGURAL

PES UNIVERSITY, BANGALORE STUDENT BRANCH INAUGURAL

Communication Reimagined Through Blockchain

V N Gokul Krishna
J N N College of Engineering.

I. What is Blockchain?

What Makes Blockchain Powerful? Blockchain is the concept that commenced it all – it's what makes hundreds of thousands of transactions processed via peer-to-peer cryptocurrency networks each year. And now, it's making its way into one of the essential components of everyone's life – communication. But what makes Blockchain so powerful, and what should it do with how we speak to others? Cryptocurrency networks determine the actual state of their blockchains using consensus mechanisms, which confirm the legitimacy of data stored within the blocks and decide which blocks belong alongside a selected blockchain. If nodes inside a cryptocurrency network disagree on a blockchain's true state, then protocols specific to each network automatically settle the dispute and decide the correct Blockchain. Because that is done automatically, it is challenging for an attacker to commit fraudulent transactions. Consensus mechanisms contribute to some other appealing function of blockchains, that being their immutability. Data stored within blockchains can't be retroactively modified or reversed without majority consensus. 51% or greater of all nodes within a cryptocurrency network have to conform to change the state of a blockchain. As a chain grows, it will become harder and harder for a single entity to control 51% of the network. Because of this, prominent cryptocurrencies and services like Bitcoin and Ethereum ensure the integrity of transactions. This enables people and companies to accept that their funds are safe.

II. Blockchain implementation visualized through TokLok

TokLok is a growing messaging app using similar technology to revolutionize online communication. TokLok uses a decentralized and encrypted peer-to-peer network to send secure communications directly between parties, guaranteeing private conversations. When messages are shot from one user to another, they're first wrapped in layers of encryption. Then, they travel throughout the network to their meant destination. Only devices with the correct secret codes can decrypt and read them to ensure they aren't intercepted. Anyone who tries to enter between senders and receivers will be unable to read the contents of the messages due to the encryption and secret codes. As a result, users can feel confident that their conversations are secure, unfiltered, and uncensored. While numerous encrypted messaging apps are available, no other app is going to such lengths to defend user data. Because TokLok sends messages directly between phones, those messages in no way contact a 3rd-party data provider, skipping cell networks and ISPs. This is important because messages that travel via third-party networks are vulnerable on the way to their destination. Without knowing what occurs between a message's start and cease point, it's impossible to determine whether they're being spied upon or altered. This problem isn't unfounded. The well-known PRISM documents, leaked by Edward Snowden in 2013, revealed that the National Security Agency (NSA) in the United States had back-door access to several of the largest internet platforms. Microsoft, Google, Facebook, and Apple were all named – either voluntarily or by force; those agencies enabled the US authorities to spy on anybody using their services. No information sent via a third party is safe between authorities' surveillance and hackers. Even without something to hide, information privacy is essential. Data sent via third-party services can be saved indefinitely and utilized in a plethora of nefarious ways.

Personal information can be used to profile people to persuade their beliefs, track their movements, impersonate them, steal their identity, and more. Although TokLok has already been developed, maintaining the most secure messenger is no easy feat. Cyber security threats evolve every other day. As such, TokLok has determined to move public thru an ICO or Initial Coin Offering. Sold TOL tokens will be disbursed via the Ethereum blockchain, and the funds generated from that income will be placed towards continuous updates and the development of the service's features. There will be three rounds, each round offering the token for a higher price than the last; since TokLok is one of the messaging apps that provides complete protection, investors from across the cryptocurrency space are leaping in. Other platforms exist, like Secretum, built on Ethereum and Solona blockchain, where messages are exchanged through the brand's tokens, and the users are rewarded for using the platform. Privacy is guaranteed by providing a signup process containing their crypto wallet address.

III. Conclusion

Innovation in messaging and file sharing space through the internet is now primarily focused on non – conventional approaches, primarily on the Blockchain. With Blockchain future seems secure and private. The future of privacy in all domains looks up for blockchain implementation.

ComSoc Initiatives

Protsahan: Call For Paper Submission

The Bangalore ComSoc chapter has launched a drive titled "Protsahan" to recognize contributions in the Communication Sector. The "Protsahan" drive grants awards to papers published, or Tutorials offered in recognized conferences or journals(during 1st October 2021 – 30th Sep 2022) by IEEE student member/member/non-member (the first author can be an IEEE member/ non-Member in the jurisdiction of IEEE Bangalore Section).

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

1. **Academic Research (fundamental)**
   a. **Novelty**
   b. **Analysis & Insights**
   c. **The superiority of the proposed technique vis-a-vis state of the art**

2. **Industry Research (having potential for Commercialization)**
   a. **Innovation**
   b. **Social Impact**
   c. **Commercialization**

The last date for submission of papers will be **15th October 2022**. The details process for submission will be communicated shortly

Student Internship

IEEE Comsoc has, for the first time, initiated a Student internship, " IGNITE" which will be the Bridge for students to ace the 'Campus to Corporate' journey. This program ensures exposure to theoretical and practical aspects of Innovation, Business Architecture and Technology. It will also be the compass to align their skills to industry expectations.

This program is open only for ComSoc members in the 2nd and 3rd year of Engineering of Electrical sciences. The recommended group size is 3 to 4 students per team; each student branch can have 2/ 3 teams. This internship will be in virtual mode for 2 months. Comsoc excom members and mentors from industry and academia will suggest problem statements. At the end of the internship, Comsoc will issue a certificate after evaluation in terms of outcomes achieved. The details of the internship will be communicated to the Student branch chairs and branch counselors shortly

NUTS & BOLTS OF SYNCHRONIZATION AND RAN TRANSPORT

Chengappa Munjandira,
Hewlett Packard Enterprise
Secretary, IEEE Bangalore Section
Execom Member, IEEE ComSoc Bangalore Chapter

NEPs are doing ***sync turnkey***, so few operators have enough competence to design sync e2e independently. So here we discuss some of them briefly; before which, we shall look into some of the jargon definitions.

TDD: Time Division Duplexing, a technique to multiplex uplink and downlink transmission on radio interface using same RF frequency, just separating UL and DL in time. TDD became prevalent in higher spectrum bands of 4G and 5G compared to FDD (frequency division duplexing – where UL and DL are transmitted simultaneously over different frequencies) because the spectrum in the higher frequency range is typically unpaired (so there is no way to separate UL and DL in frequency), and also because some of the antenna techniques of MIMO and beamforming is easier to do in TDD than in FDD (with UL and DL transmitted over same frequency we can rely on RF channel quality indicators reported by phone in UL for DL transmission beamforming, in FDD it is not possible because UL and DL are transmitted over different frequencies, hence RF propagation characteristics for UL and DL are different)

PRC: Primary Reference Clock, a terminology from old ITU-T G.811 specifications describing synchronization in telecommunication networks. PRC is an autonomous centralized clock serving the whole telecommunication network – typically a Cesium-based independent atomic clock sitting somewhere in the core network and distributing sync to all nodes which need it. PRC concept was created to serve as a primary time reference for the first synchronous techniques of transport –e.g., SONET/SDH. Then was reused for the first generations of mobile RAN in cellular networks (2G/3G typically, where we have centralized PRC and then distribute sync from it through transport network via relatively low precision protocols such as NTP). 2G, 3G, and first iterations of LTE could operate off that architecture because they had fairly relaxed sync requirements; the RF interface in those technologies does not require precise sync.

PRTC: Primary Reference Time Clock, a newer concept in telco synchronization, described in ITU-T G.8272. DL Transmission is a relatively high-powered signal radiated from RRU. It is a localized clock providing high accuracy sync, disciplined by a reference signal from GNSS (Global Navigation Satellite System). PRTC concept appeared for the new generation of mobile technologies. PRTC required tight sync not only in frequency but also in phase and was used for advanced features of LTE and for the first TDD-based LTE deployments where phase synchronization is essential because DL and UL transmissions from all base stations should coincide. In the absence of this, the DL transmission of one base station will interfere with the UL reception of a neighboring one.

PRTC implementation is costly, and, at times, it could be impossible to provide that high precision frequency and phase sync from a centralized PRC because we need to upgrade all transport nodes between PRC and consumer of sync (e.g., LTE base station). Many operators have chosen the route of clock de-centralization. They have inserted PRTC closer to base stations (or right at the base station like many US operators) to serve as the primary sync source while delivering lower precision sync from PRC over long-haul transport network as a fallback option. At the same time, UL reception at Base Station comes from a measly smartphone RF transmitter, so guess which one wins when they overlap in time and frequency.

LTE Advanced or TDD-based system won't work if PRTC fails, but at least 2G/3G/basic 4G will still be going. In that model, Cell Site Router will have PRTC functionality and the ability to ingest and re-distribute secondary sync sources from a centralized PRC. In case the primary source fails, as well as a local oscillator to keep the heartbeat going for some limited time (say, 24 hours) if both sync sources fail.

GNSS: Global Navigation Satellite System – the constellation of satellites providing globally-synchronized Time-of-Day timestamps to everyone who wants to receive those on Earth. GPS is the US version of GNSS; Galileo is the EU version, Glonass is the Russian version, QZSS is the Japanese one, BDS is the Chinese one, and NavIC is the Indian one (though Japanese, Chinese, and Indian GNSS systems are not that global - their satellites mainly cover homeland,

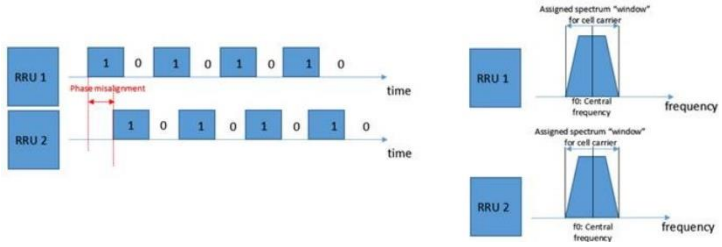
more of an insurance policy against the US turning off GPS for them in case of a conflict rather than some global expansion plan). We can use the Time-of-Day timestamps for navigation purposes (comparing delays in ToD timestamps coming from 3-4 satellites and knowing the speed of light (and correcting for relativistic effects) we can calculate our polar coordinates on Earth), or for accurate phase and frequency synchronization – typically used for telecommunication networks, for banking infrastructure synchronizing financial operations and for other applications requiring super high accuracy in time – e.g., our smartphone clock. So, when people say, "*Does your NIC support GNSS receiver*," we need to ask which constellations they will tune to – some of the receivers do not support regional GNSS constellations, e.g., ***Indian NavIC support is missing from many receivers*** because the constellation is new. Typically, US operators care only about GPS, European ones about GPS+Galileo as a fallback, Russia and its friends about GPS+Glonass as a fallback, Japan is GPS+QZSS as a fallback, etc.

PTP/SyncE: Precision Time Protocol/Synchronous Ethernet. PTP and SyncE are protocols to distribute high-accuracy sync over the packet network. IEEE 1588 series of specs standardize PTP protocol (hence it also goes some time by "1588 sync"); ITU-T, in partnership with IEEE, develops SyncE standard (ITU-T G.8261, 8262, and 8264 are the main specs for SyncE). The critical problem PTP and SyncE are addressing is that our typical packet network is not synchronous. Ethernet packets come and go at whatever pleases them and have variable lengths (unlike legacy SDH/SONET, where all time frames are strictly synchronous, so one could extract sync right from the transport stream). PTP addresses that with the transfer of timestamps inside packets and techniques to remedy all jitter/inaccuracies/latencies brought by packet switching nodes. SyncE goes closer to the legacy SDH/SONET route with its physical layer highly synchronized so that one can extract sync from edges of pulses (which are Ethernet packets, just unlike regular Ethernet, they have a rigid time structure).

PTP and SyncE are used to re-distribute sync from PRTC at the edge of the network to final consumers (in O-RAN, those are RRUs) – hence we have to have PTP/SyncE Master functionality somewhere close to RRUs. RRUs do not care where sync comes from, as long as it is accurate enough (50ppb in the frequency domain and 1.5usec in phase is baseline sync accuracy for TDD-based system). So, what do we mean by Phase sync? Does it mean syncing the UL and DL of all phases of transmission?

RF transmission between RRU and phone could be synchronized either in frequency only or in both frequency and phase.

Frequency synchronization means two neighboring radios have the same (very close) central frequency for the signal they radiate on air. The picture below illustrates what two signals synchronized in frequency will look like in time and frequency domains. Time being, we can skip the complexity of the actual RF physical layer in time frequency and give a simple 1-0-bit pattern transferred over a single central frequency – just to illustrate a general idea.

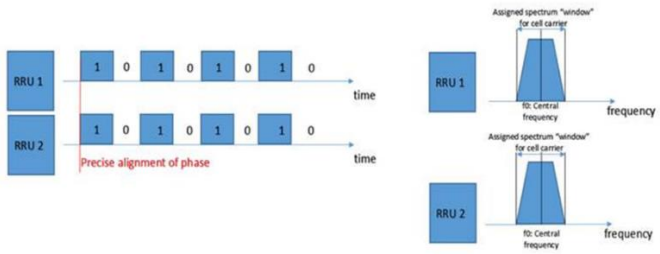


Synchronization in frequency is needed to ensure neighboring RRUs emit a signal only in the assigned spectrum "window," limiting noise outside the given spectrum. So, in the frequency domain, f0 is the same for both RRUs – which in the time domain translates to the same pace of "1s" and "0s". However, with frequency-only synchronization, nothing is known about the phase of signals – meaning in the time domain "1" and "0" pattern of one radio is phase-shifted compared to another radio (note "phase misalignment" on the picture – it stays constant for all bits because the central frequency is identical).

Frequency synchronization of RRUs in a network is a must for all cellular technologies from 2G onwards; 3GPP demands network-wide accuracy of frequency sync of 50 parts-per-billion (so if we have 1800MHz as a central frequency for RRU, the actual frequency of RRU should not deviate more than 50x1800MHz/1 billion = 90Hz).

Frequency synchronization is relatively easy since no awareness of the signal's phase is required. Historically, it's done via a centralized reference clock (PRC), delivering sync to RRUs via a simple NTP protocol.

2. **Phase and frequency synchronization** mean two radios have the same (very close) central frequency and time alignment–the picture below illustrates what that looks like for the same 1-0-bit pattern. So not only is the pace of "1s" and "0s" the same, but they are being emitted precisely simultaneously.



This time alignment is essential for several scenarios:

a. TDD is the primary duplexing mechanism for LTE and 5G for frequencies above 3GHz, which is all the narrow band's mid-band and higher capacity scenarios. Any system with TDD between UL and DL MUST have tight phase synchronization because two neighboring cells MUST switch between UL and DL transmission simultaneously. If they cannot adhere to this, then a cell emitting high power DL signal at the same time as the neighboring one tries to listen to weak UL transmission from the phone – and since they talk at the same frequency, DL emission will destroy this neighbor UL channel with noise.

b. Some LTE-Advanced and 5G features in systems with FDD will also demand phase synchronization. Those features target tight time alignment between neighboring cell transmission: e.g., for aggregating transmissions from neighboring RRUs for a single phone (known as "inter-cell carrier aggregation") or coordinating scheduling to limit mutual noise (e.g., coordinated multipoint, cross-sector beamforming, etc.)

Phase sync is more complex to deliver to RRUs because there is a time element– sync signal from remote sync source becomes subject to latencies brought by transport network, which are random and different for different transport routes. NTP as a protocol won't work because it has no mechanisms to handle variable latency on transport. Also, the centralized PRC clock is too far in a network – so we need to remedy latency and jitter impact from too many transport nodes, even if the protocol we use knows how to do that.

To address that situation:

a. ***New sync delivery protocols*** were brought in either high accuracy PTP (known as PTP "telecom profile") or SyncE – both have built-in mechanisms to remedy variable latency brought by intermediate transport nodes (which is the primary function of the "Boundary Clock" feature in PTP and SyncE protocols)

b. ***New sync source architecture was created where instead of a single remote centralized PRC, we will have a lot of decentralized PRTCs globally synchronized with each other by the GNSS reference clock***. That way, we minimize the number of transport hops between RRU and sync source, so overall accuracy improves

3GPP mandates end-to-end network-wide phase alignment to be < 1.5usec for TDD and even below for some FDD coordination scenarios. For example, cross-sector beamforming would require alignment of <0.5usec, which is why it's not used today – the phase sync accuracy requirement is very stringent.

PTP/Sync-E functionality in the NIC cards distributes the PRTC to the edge components, So now the question would be, where does the PRTC itself run? Is this an OXCO clock that is on some of the FPGAs? Like Xilinx?

PRTC is how ITU-T sync standard calls decentralized synchronization source with GNSS as primary reference input. PTP/SyncE Grandmaster, listening to GPS as direct input with OCXO crystal as a fallback is an implementation example of the PRTC concept. ***So, the new NIC cards with those PTP / SyncE grandmasters with GPS receiver and OCXO onboard become PRTC from the point of view of ITU-T synchronization standard.***

Context-Aware Secure Communication: Physical Layer Secrecy Perspective

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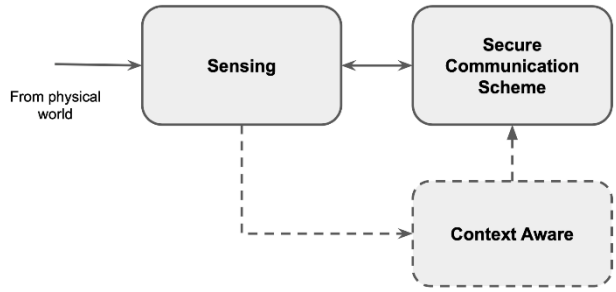
With 5G deployment in the real world not very far, academic and industry research has already started focusing on 6G communication. Joint communication and sensing have been envisioned as critical aspects of 6G communication. Security is another crucial aspect of current and future wireless technologies such as 6G. Some prominent attacks are jamming and false base station attacks, which existing security schemes cannot mitigate. As we move away from the client-server architecture, it is required to provide end-to-end quality of service. In the future wireless network, it will be necessary to provide Quality of Security (QoSec) as a part of the service level agreement. The proposed security mechanisms need to be dynamic and should be able to adapt based on the threat level or the threat model. There is no consensus on how to define QoSec, and it is still under research or investigation. This brings an important question on how to define security and quality of security based on the environment or the threat model. As joint communication and sensing are expected to play a vital role in 6G communication, it will be possible to develop context-aware communication, which can include the network's topology, the capability of the communication device, and the freshness of information. It is natural to consider integrating context awareness in QoSec, which can help to adopt the security mechanism based on the threat level. This will have significant implications for mission-critical applications such as autonomous vehicles.

For many future applications, it will be required to develop context-aware security protocols with QoSec guarantees. In this regard, physical layer secrecy can play an important role as these schemes are not very computationally intensive and can be adapted based on the physical world's attributes. Physical layer secrecy (PLS) has its root in information theory and uses the randomness present in the physical world, such as thermal noise in devices and wireless channels. In the last decade, significant progress was made in the theoretical aspects of PLS. Many testbeds based on physical layer secrecy have been developed in academic institutes. One of the key aspects of physical layer security is the secret key generation from the correlated randomness between the users, which can be incorporated into joint communication and sensing. A high-level framework for context-aware security is shown in the figure. The development of context-aware secure transmission based on physical layer secrecy is a non-trivial problem, and some of the critical issues that need to be addressed are as follows:

1. Design of physical layer-based schemes based on the type of threat model. For example, the threat model can be jamming, spoofing, or eavesdropping.
2. It will also be essential to consider communication delay and security and reliability requirements.
3. Another important aspect will be how to incorporate the freshness of information in the design of security protocols.



For joint communication and sensing, sensing can enable a better security system design. However, this raises another important question: how to protect the device from attack while sensing. The answer to these questions is not easy, and time can only tell how the future network evolves.

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CHAOTIC COMMUNICATION

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Pseudo-Noise (PN) Sequences and/or Spreading sequences are used in applications that demand reliability, such as transmitting control information in LTE/5G. The need for random sequences that offer enhanced robustness to propagation impairments and uncertainty in decoding information transmission is increasing. Chaotic signals are a class of random signals that exhibit robustness to multipath fading [1-3]. In addition to robustness, the high sensitivity of chaotic systems to their initial conditions and parameters, the un-correlation, random-like nature, and unpredictability of the chaotic signals, combined with the fact that they are easily reproducible, improve the security at the physical layer. A typical chaotic communication system is shown below.

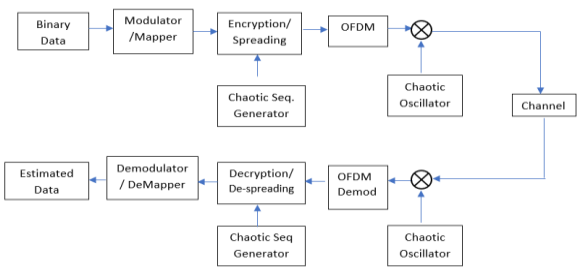

Fig. 1 Chaotic-Communication system [3,5]

Chaotic sequences and the Logistic map

The chaotic sequences can be generated using 1D chaotic maps like Lorenz Map and Chebyshev Map, or higher dimension chaotic maps [4]. Conventionally, a chaotic system can be described by state space equations,

$$X_{n+1} = f(X_n)$$

Where X_n is the state, and $f(.)$ is the mapping function. The chaotic sequences of two systems are the same if the initial conditions and state parameters used by the two chaotic systems are the same. Any minor difference between initial states and/or parameters will lead to uncorrelated sequences. This low cross-correlation is the essential requirement for the sequences used as encryption sequences or spreading sequences etc., The most well know logistic map is given as

$$X_{n+1} = rX_n(1 - X_n)$$

The bifurcation parameter r is chosen such that the Lyapunov exponent is strictly positive.

The chaotic map-based sequence generators are used at the transmitter to encrypt/spread the information.

However, it has been observed that the characteristics of chaotic systems cannot be perfectly preserved if chaotic maps are implemented on digital signal processing platforms. Despite this limitation induced by quantization, the randomness quality of chaotic signals can be enhanced by increasing its periodic loop or alternately using a chaotic oscillator. One of the most fundamental and popular Oscillators is the Chua's circuit. The data can be retrieved at the receiver without ambiguity if the chaotic oscillator and the chaotic seq generator match those used at the transmitter. In the case of de-spreading, the Chaotic sequence generator used at the receiver consists of integration, dump filter, and the threshold detector [5].

Unlike conventional signals, it is shown that the generated chaotic signal's information capacity is independent of the underlying physical wireless channel properties and depends on the Lyapunov exponents of the signal [7].

Chaotic Optical Communication

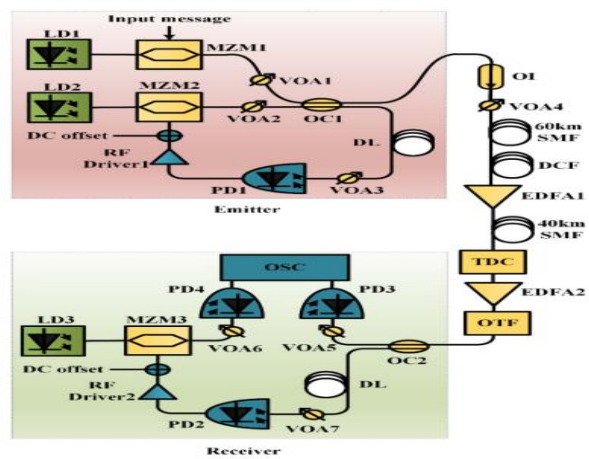

Fig 2. Optical Chaos Communication Schematic [6]

As we move towards the THz communication, it is interesting to revisit the use of chaotic signals in optical communications. In [6], researchers have discussed the experimental setup of a chaotic optical communication system. A continuous-wave (CW) light from 1545-nm lasers is passed through Non-linear Mach-Zehnder Modulators (MZM) to obtain a chaotic carrier. Additionally, variable optical amplifiers (VOA) control the mixture ratio between the chaotic carrier and the message. The encrypted signal is transmitted through 60 Km long single mode optical fiber. To compensate for the dispersion induced by the SFM, a dispersion compensation filter (DCF) has been used at the end of 60 Km SMF. The output of DCF is then amplified and transmitted through 40 Km

long SMF. At the receiver, a combination of non-linear MZMs is used for the chaos republication.
To retrieve the message without ambiguity, the physical parameters of the RF driver, Photodiode, and MZMs are ensured to be the same as those used at the transmitter. The output of PD3 and PD4 is collected at the oscilloscope and analyzed for the message transmitted [6].

Current trends in Chaotic communication

Chaotic communication has found its practical/real-time applicability in conventional optical communication links (free-space optics or fiber-optic). It is being investigated/extended for its use in THz communication links. Recent trends have seen a resurgence in exploring the following research applications.

i) Deep learning-based chaos synchronization
ii) Multiantenna-based chaotic communication
iii) Network coding
iv) Power line communications
v) THz Chaotic Sources

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