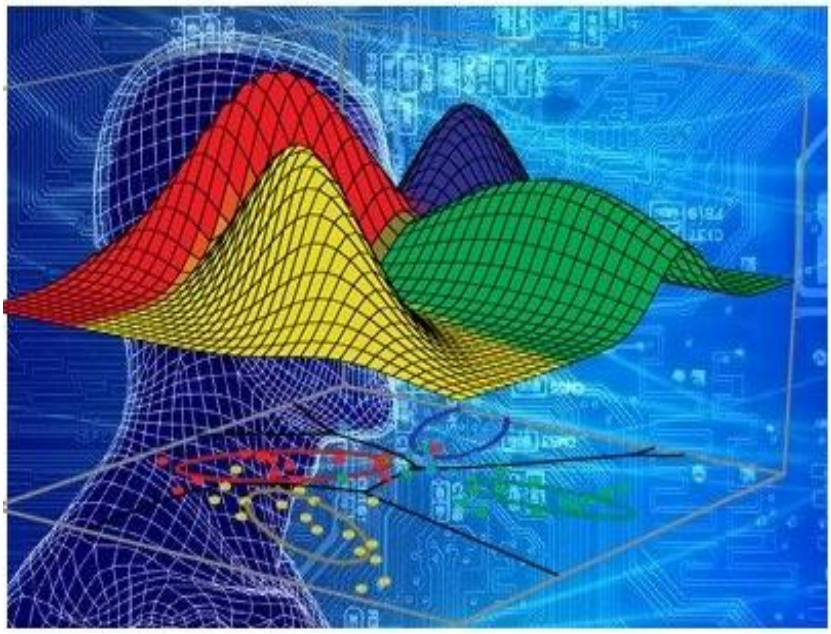
IEEE ComSoc Newsletter- Bangalore Chapter

December 2021

Issue 10



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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 10th edition of ComSoc newsletter, Bangalore Chapter, December 2021 issue. At the outset we would like to thank the chair and ExeCom for giving us the opportunity in bringing the Tenth issue of the newsletter.

The newsletter highlights the activities and achievements which happened in the second 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 beyond 5G and examines diverse topics covering the use of Machine learning in networks, network security, and some basics of network coding. Machine learning technology has developed rapidly in recent years. One of the articles introduces how machine learning methods can be used in SDN to improve network management efficiency and parameters like Quality of Experience (QoE) and Quality of Service (QoS). Machine Learning is thus helping solve problems that traditional methods cannot solve. Taking off from the previous newsletter where we discussed how cryptographic algorithms are used for generating robust keys to enhance the security of our communication networks, this issue gives a primer on Quantum Key Distribution. It remains to be seen if, with the advent of a feasible quantum computer, the existing public-key cryptosystems will become obsolete and threaten key distribution protocols. It appears that some of the same principles that empower quantum computers also offer an unconditionally secure solution to the key distribution problem. This edition also contains a primer on Network Coding. We can only reveal that Network Coding (NC) is a new concept that breaks with the end-to-end communication paradigm and allows for distributed coding within the network for those unfamiliar with this subject. We strongly urge readers to dive deep into this subject and write back to us on what type of articles they would like us to address in future editions.

Amongst some of the essential topics covered in the latter part of 2021: One of the talks which were very popular was the overview on the 5Gi Standard titled **Implementation nuances of 5Gi**. In addition to this, the **5G Understanding** talk organized in 3 parts by Dr. Saptarshi was especially appealing to students to gain insight into this complex 3GPP Standard. The links to these talks on our YouTube Channel are also shared in this newsletter for easy reference.

This newsletter also presents 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 communication, technical research, and social awareness to publish in the following issues.

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

CHAIRMAN'S MESSAGE

Congratulations to the ExCom members, industry captains, academic community, young professionals and the student volunteers for making the 2021 a grand success. A year that is very eventful and impactful. We have pursued a plethora of initiatives towards the advancement of technologies and benefits for our members. A hat-trick winning performance ensued at the Asia-Pacific region of ComSoc chapters. This year, for the very first-time, the Bangalore ComSoc chapter has received 'Chapter of the Year Award' (CoYA) among 200+ ComSoc chapters globally. Kudos!

Through IEEE ComSoc workshops and forum, we have been deliberating on the system architecture, security nuances, interactive applications and, deployment intricacies along with other dimensions. We had a detailed seminar on 5Gi features that recently got absorbed in the global 3GPP standard. The global summer school on "Beyond-5G and IoT: Human-Machine Communication" highlighted convergence of long and short-range communications as well as human and machine collaborations. The Nokia workshop on 'Sustainable Technologies' has been a fruitful event. Earlier in the year, we have had a workshop on 6G requirements and plausible use cases. AI in Communication has been the theme of our track of IEEE CONECCT 2021.The year ended with 'Synthetic-Aperture Radar system' seminar by former Director of Space Application Center, ISRO.

The second stream has focused on research and innovation growth. Our Research Methodology workshop provides benefit to researchers through authorship lab. Creating a research mindset among the young professionals has been a key objective. A presentation by me on "Intellectual Property: Why, What and How" had drawn ~500 participants in India Council forum. And as part of our Open Innovation promotion, in partnership with Samsung, we have conducted an Open Source mini-conference with themes around 5G, IoT and Edge Computing where IEEE-SA, Linux Foundation, Red Hat and many others participated.

We value professional growth and accordingly, we are happy to see member strength crossing 500 as on end-Dec. We focused on membership upgrade qualifications and membership benefit package. Nine of our student branches have been organizing training and awareness sessions in their campuses or online. Graduate theses presentations (Grate-7) and PhD EDITS are two popular programs among graduate students. This year, we have also launched a new scheme—'Protsahan' with awards to first authors for good research publications.

With global chapter award reception and social media promotion, the society has been able to create an international visibility. LinkedIn has promoted our events and YouTube has shared video presentations. Organizing events to capturing details in vTools has been system-automated by our volunteers; this has resulted in a prompt and accurate reporting. The website is presenting all information for easy access by members. Our finance base has grown 3X in the last two years, giving a comfortable position. One of the major milestones in 2021 for ComSoc Bangalore has been to have an approved Bye-Law for the society; the registration of the society is the next natural step.

As we embark on 2022, I am confident that the new ExCom team will consider adding Distinguished International Lecture series as well as introducing social impact programs in Bangalore vicinity. May the chapter reach even a greater height! Wish you all a safe, healthy and prosperous 2022 ahead!

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

AWARDS WON IN THE YEAR 2021

The year 2021 was a momentous year for IEEE ComSoC Bangalore Chapter. We were selected as the Asia-Pacific (APAC) Region winner of the year's **Communications Society Chapter Achievement Award**. For the second time in a row, the Bangalore Chapter has won this award amidst 200+ chapters. The aspect that made this win sweeter was that our Chapter also bagged the prestigious **ComSoc Chapter of the Year Award** for 2021 amongst the best chapters in the four regions across the globe. The Chapter of the Year winner award was announced at the Awards Ceremony during the ComSoc GLOBECOM conference. The CoYA plaque transcribes "for achieving the Highest Excellence in chapter activities and for Outstanding Contributions furthering the objectives of the society."

Further details are available at **https://www.comsoc.org/membership/chapters/chapter-awards**

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, IX, we discussed massive MIMO as an enabling technology for 5G. In this issue, we are continuing our discussion on Beam Management.

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

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

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

In earlier part, part IX of the series, we briefly discussed beam forming in 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 beam management in this part.

As we know, beamforming is a signal processing technology that lets base stations send targeted beams of data to users, reducing interference and making more efficient use of the radio-frequency spectrum. MIMO beam beamforming and steering are essential to delivering the 100x data rates and the 1000x capacity goals specified in the International Mobile Telecommunications-2020 (IMT-2020) vision. 5G boosts throughput in multiple ways:

- Wider overall channel bandwidths enable sending more data through the air interface
- Spatial multiplexing sends multiple independent streams of data through multiple antennas at a given time and frequency. The use of enhanced channel feedback enables 5G to better exploit this technique and achieve higher data rates than previous technologies.

In 5G, conventional wide beam-based cell sector coverage concept is not use rather beams-based cell sector coverage is used. This increases the link budget and overcomes the disadvantages of the mm-wave high loss channel. In other words, all the data transmissions and key signaling transmissions are beam-formed (directional).

Beam steering and beamforming are additional techniques that use multiple antennas to create directional transmissions that must accurately point at the receiving device. Beam steering is a set of techniques used to focus the direction and width of a radiation pattern. s shown in Fig.1, new initial access techniques use beam sweeping to have the base station transmit multiple beams and then identify the strongest beam and establish a communication link.

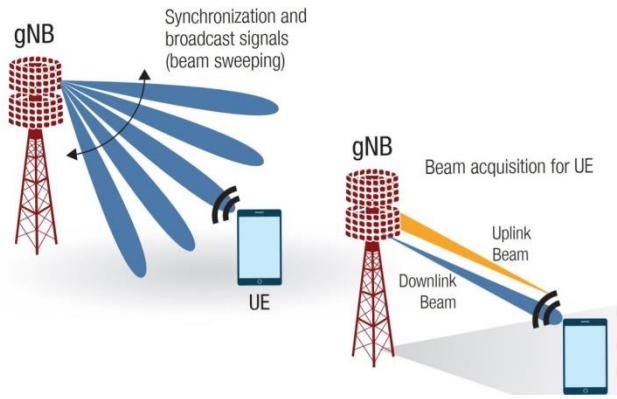

Fig.1: Beam Sweeping and Acquisition

Fig.2 illustrates the 20 beams massive MIMO systems. That is, the massive MIMO system will transmit 20 different beams to cover the 120 degrees cell sector. The Nokia article, for example, has a system with 128 antennas all working together to form 32 beams, so the Nokia system is a 32 beams massive MIMO system.

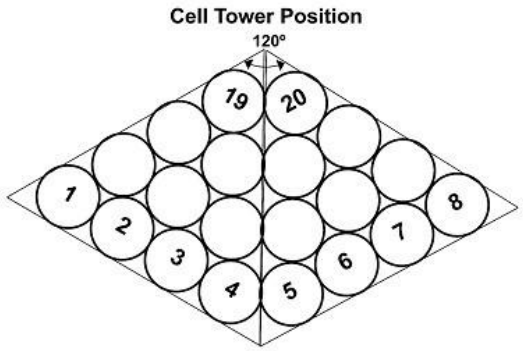

Fig.2: 20 Beam MIMO for 120 degree coverage

In 5G NR, these beams are formed by analog beamforming technique, but for the data transmissions, 5G system dynamically uses analog or digital or the combination of analog and digital beam-forming called Hybrid beam-forming technique. As the cell coverage is beams-based, a mobile terminal in the 5G cell will sync, attach and report from a beam. The mobile terminal will only connect to a single beam, multi-beam connection is not supported in 3GPP Release 15.

5G NR Rel.15 specifies new procedures for initial access and attach when establishing the wireless link connection. Since neither the device nor the base station knows the other's location, the base station uses beam sweeping to transmit channel information in sync blocks across the spectrum as shown in Fig.3. The UE determines the strongest match and transmits back to the base station. Once the base station knows the direction of the UE, it establishes a communication link.

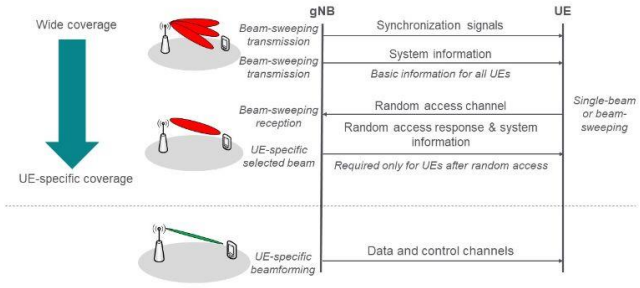

Fig.3: 5G initial access and beam management

We will continue this part in the next edition where we will highlight beam management techniques in 5G.

IEEE Communication Society Membership Statistics as of DEC 2021

Total Members: 508 (Dec 2021)

Fellow + Life Fellow:	**08**	**Graduate Student Member**	**79**
Senior Member	**110**	**Student Member**	**173**
Member	**133**	**Others:**	**05**

MAJOR EVENTS CONDUCTED DURING JUL TO DEC 2021

Sl. No.	Date	Event
1.	03/07/2021,	Workshop on Open Source
2.	10/07/2021	IEEE CONNECT 2021 Communication Track
3.	27/08/2021	ECE Career Roadmap: Panel Discussion
4.	28/08/2021	Workshop: Implementation nuances of 5Gi 5Gi Standards Overview
5.	17/09/2021	Corporate and Startup: A Symbiotic Relationship
6.	03/10/2021	5G Understanding: From Theory to Practice- Part 1
7.	09/10/2021	5G Understanding: From Theory to Practice- Part 2
8.	23/10/2021	Nokia-IEEE Webinar-Sustainable Technologies To Transform People and Enterprises
9.	23/10/2021	5G Understanding: From Theory to Practice- Part 3
10.	20/10/2021	Scenario Aware Scalable Digital Architectures for Communication Systems
11.	29/10/2021	Connecting Space Assets to the Internet: Challenges and Solutions
12.	13/11/2021	Reflecting Intelligent Surfaces for 5G and Beyond 5G
13.	13/11/2021	IEEE PhD EDITS-PhD Colloquium
14.	19/11/2021	The Challenge of calibrating Video Surveillance Cameras
15.	11/12/2021	Radar Systems and Synthetic Aperture Radar

RECENT IMPORTANT EVENTS

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

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

1. HuangLab, Sun Yat-Sen University (SYSU), Guangzhou, China

Two Research Assistant positions (Postdoctoral research assistants or general research assistants) are immediately available at the HuangLab (http://xintelligence.pro), Sun Yat-Sen University (SYSU), Guangzhou, China. The successful candidate will join HuangLab to conduct research in the area of distributed computing and systems. The candidates should have obtained a PhD degree in computer science, computer engineering, or the relevant disciplines, and have strong research background and system implementation skills. Research experiences with machine learning or distributed machine learning are preferable. The positions will provide excellent scientific research support. Other advantages of the positions include:

- Participate in frontier research in the field of distributed machine learning.
- Competitive talent treatment: research start-up fee, talent allowance, and urban bonus

Please send your CV with the full publication list to Prof. Huawei Huang at huanghw28@mail.sysu.edu.cn if you are interested in joining our Lab.

HuangLab (http://xintelligence.pro) is a research team based in the School of Computer Science and Engineering, SYSU. We focus on designing new mechanisms, protocols, and scheduling algorithms in blockchain and distributed systems. Our research team has two main directions in blockchain and distributed machine learning systems. For the first direction, we study high-performance blockchain systems. For the second direction, we study the scheduling of computational and network resources in distributed machine learning systems. Our research works have been published by top-tier conferences such as INFOCOM, ICDCS, IWQoS, and ACM/IEEE Transactions journals, including JSAC, TPDS, TMC, TC, and TDSC. We invite candidates with great passion to join us!

2. HP-NTU Digital Manufacturing Corporate Lab, Nanyang Technological University (NTU), Singapore

A postdoctoral Research Fellow position is immediately available at the HP-NTU Digital Manufacturing Corporate Lab (https://www.ntu.edu.sg/hp-ntu-corp-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 and the integration with industrial robots. The candidates should have obtained a PhD degree in computer science, computer engineering, or relevant disciplines, and have strong research background and system implementation skills. Research experiences with depth cameras, LIDAR, and mmWave radar are pluses.

The position will provide excellent opportunities to perform applied research in close collaboration with Hewlett-Packard. Other advantages of the position include:

- Stable multi-year fund subject to satisfactory performance.
- Various opportunities in Singapore's strategic IoT and AI research clusters.
- High-quality living and low tax rates in Singapore.

Interested candidates can send CV with full publication list to Dr. Rui Tan at tanrui@ntu.edu.sg

NTU IoT Sensing Group (https://ntuiot.xyz) is a research team based in the School of Computer Science and Engineering (SCSE), NTU. We focus on the research, design, and evaluation of networked, energy-efficient, and secure sensing systems found in the Internet of Things (IoT) and its AI-empowered generation (AIoT). Our research has two main sub-directions of IoT sensing systems/applications and the security/privacy of AIoT sensing. In the first sub-direction, with a strong experimental focus, we study several sensing modalities (e.g., powerline radiation, radio frequency, acoustics, image, thermal, and energy), exploit them to construct system functions and applications. In the second sub-direction, we study the security and privacy of AIoT sensing systems that use machine learning to process the sensed data. Due to the immediate application potential, our research has been funded externally by government authorities and companies in the ICT, energy, and manufacturing sectors. Our research works have won

multiple best paper awards and runner-up recognitions at various prestigious conferences. We invite candidates with great passion for systems research to join us!

8th in the world according to The US News and The Academic Ranking of World Universities (Shanghai Ranking) in 2021.

Tenure Track Assistant Professor - Electrical and Computer Engineering

https://wd1.myworkdaysite.com/en-US/recruiting/scu/scu/job/Santa-Clara-CA/Tenure-Track-Assistant-Professor---Electrical-and-Computer-Engineering_R1987

Fresher, 2-3 years experienced and Interns required

ECE Department, Amrita School of Engineering, Bangalore Campus

Contact – Dr. Navin Kumar, k_navin@blr.amrita.edu

Lab-in-charge/Engineer (04)- Fresher and Experienced

- Project Assistant (5G/6G Innovation) (02)– Fresher and Experienced
- Interns – 5G/6G Innovation, IoT, and many (Full time availability at least for 3 days/week).

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 4th and

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

navinkumar@ieee.org

(anindya@saankhyalabs.com)

If you wish to advertise

The newsletter is circulated to more than 10,000 members from academia and industry. It has a 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.

Network Coding: Application of XOR function to improve network throughput

Raghavendra M A N S, Abhijith B G,
Saankhya Labs Pvt Ltd.

Abstract: This article describes network coding, an application that fundamentally uses XOR to solve the issue of communication network throughput. The main principle of network coding is to employ nodes that transmit XOR (linear combination) of data packets.

Introduction

From connecting users to connecting intelligent devices, communication technology is evolving in a momentous way. The 5G communication technology is likely to achieve the objective of connecting everything and everyone. The parallel objective is to connect intelligent devices and live up to the user demands of high data speeds and throughput in dense networks. Traditionally, the demand for high data speeds was primarily met by L1-layer techniques (PHY layer) such as modulation, multiplexing, non-orthogonal access, and broadcast strategies. However, the increase in interference restricts the dependency on higher-order modulation, multiplexing, and non-orthogonal access strategies in dense networks.

On the other hand, with increased user demand for unicast service, the broadcast has not reached its meaningful applicability in increasing network throughput. Alternately, communication theorists and network theorists proposed an attractive XOR solution to move away from the traditional way. The solution considers a communication network as a network of devices and intermediate nodes that fundamentally uses XOR to address the issue of meeting high data rates and throughput. The approach is termed Network coding.

Network coding is based on this far-reaching yet straightforward idea. In a packet network, intermediate nodes may compute and transmit functions of the packets that they receive rather than simply routing or transmitting packets. The concept of transmitting a linear combination of data dates to 1978, when Celebiler et al. proposed linearly combining data at satellite repeater before transmitting data to the devices [1,2]. This helps increase the downlink capacity of a Regenerative satellite Repeater in point-to-point communications. Unlike satellite repeater, network coding is achieved by using routers in the case of computer communication networks. Routers are the heart of communication networks that route the packets from source to destination. Routers can handle the network inflow and outflow to avoid collision and successful delivery. The arrival of a vast number of packets at the router can increase the network's throughput and serve multiple users at a time.

The 'Butterfly' effect

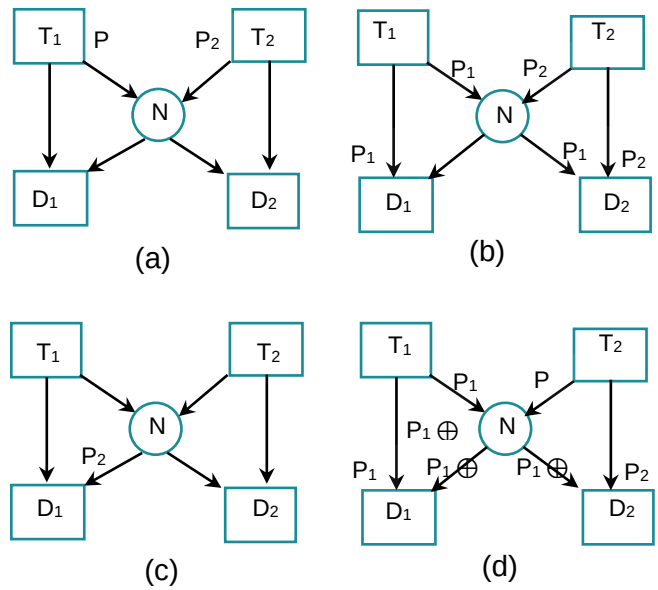

Fig. The Butterfly Networks

The directed graph is shown in Fig. (a)—the so-called "butterfly network"—models a packet network [3]. T_1 and T_2 are the signal sources that intend to multicast/ broadcast packets P_1 and P_2 respectively, to the two destinations D_1 and D_2 via the intermediate node (routers) N. Each directed edge between transmitters and destinations represents an error-free packet channel that can deliver a single packet of m bits per channel. A conventional collision-free "routing solution" to this problem is shown in Fig. (b), (c). In time slot 1, the sources T_1 and T_2 sends out corresponding packets P_1 and P_2 . Assuming zero relative delays between direct edges and edges via node N, in time slot one packet P_1 arrives at D_2 from N and packet P_2 arrives at D_2 from T_2. Simultaneously D_1 receives packet P_1 from T_1. Thus, in time slot 1 D_2 receives both packets P_1 and P_2 and D_1 receives only P_1. It is in time slot 2 that D_1 receives packet P_2. This implies that the throughput of the packet is one packet per channel use.

Using a simple XOR operation, a "network coding solution" that can achieve an improved multicast

throughput of 2 packets per channel use—is shown in Fig. 1 (d). Here, in time slot 1, instead of routing one (and blocking the other), node N transmits the modulo-two sum of P_1 and P_2 (i.e., $P_1 \oplus P_2$). Destination D_1 now receives P_1 and $P_1 \oplus P_2$ and can recover both P_1 and P_2. Simultaneously D_2 receives P_2 and $P_1 \oplus P_2$ and can recover both P_1 and P_2 at the same time. Thus, at the expense of an encoding operation at an internal node N of the network and decoding operations at the sink nodes, the multicast throughput has improved beyond what can be achieved by routing alone.

Advantages of Network Coding

In addition to throughput enhancement, network coding can enhance communication's robustness and increase network tomography's accuracy. The main disadvantage of network coding is that it is vulnerable to pollution attacks and eavesdropping [1]. However, secure network coding techniques are being proposed in the literature to overcome this bottleneck [4].

Types of Network coding

i. Physical Layer Network Coding: Used in wireless relay networks like satellite networks [2]

ii. Random Linear Network Coding: Random linear network coding is used to linearly combine many packets and send the linear combination of packets. This principle is applied in digital fountain codes.

iii. Opportunistic Network Coding: Used in wireless broadcast networks [5].

The above developments led to rapid advancements in network coding and spurred new mathematical tools in algebra, geometry, graph theory, combinatorics, and optimization theory.

Applications

Though network coding offers theoretical gains in throughput and data rate, compared with the conventional networking schemes, its use in practice is restricted due to the computational complexity involved and network impairments. In general, network coding can find applications in scenarios requiring video on demand, live media broadcast in wireless networks [5], Instant Messaging (IM), and High-speed, high-capacity file downloads. However, there are a few practically applicable solutions of network coding: COPE [6] and Microsoft Avalanche [7,8].

References

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COMSOC INITIATIVE PROTSAHAN: RESULTS

The Bangalore ComSoc chapter launched a drive titled "Protsahan" to recognize contributions in the Communication Sector. The "Protsahan" drive granted awards to papers published, or Tutorials offered in recognized conferences or journals (during Jan 2020 - Sep 2021) by IEEE student member/member/non-member (as the first author to be IEEE member, non-Member in the jurisdiction of IEEE Bangalore Section). Thanks to all authors who submitted their nominations.

Publications were in categories, 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 the art**

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

Our Jury panel evaluated the entries, and the results are published below. Congratulations to all the winners! You will receive separate mailers regarding the awards.

Categories	Target Groups	Name of Winners	Affiliation
I	**IEEE member + ComSoc member**	Dr. Jagadeesha R Bhat	Indian Institute of Information Technology, Dharwad
		Barun Kumar Saha	Hitachi ABB Power Grids
		Chengappa M R	Hewlett Packard Enterprise
		Mahendra Pratap Singh	National Institute of Technology Karnataka
		Dr. Rajendra Prasad P	Sri Venkateshwara College of Engineering, Bangalore
II	**IEEE member, ComSoc non-member**	Shrikant Tangade	REVA University
		Annapurna P Patil	M S Ramaiah Institute of Technology
		Veena	NITK and MIT, Manipal
III	**IEEE student members**	Purushottama Lingadevaru	National Institute of Technology Karnataka
		Harini G S	Research Scholar, IIT Dharwad
		Abhilasha Sharma	VIT University, Chennai
		Harshil Bhatt	Manipal Institute of Technology
		Shashidhar R	Sri Jayachamarajendra College of Engineering, JSS Science and Technology University
IV	**IEEE Non-member <Professional / Student>**	Vijayaraghavan Vardharajan	Infosys

Short Packet Communication for Mission-Critical Applications: Part II

Dr. Parthajit Mohapatra
Indian Institute of Technology Tirupati, India

In the first part of the article, the focus was on the development of new technologies for communication involving machine to machine (M2M), where the packets are of short length. In mission critical applications involving M2M communication, it is required to ensure low latency along with reliable communication. As most of the communication happens over wireless medium, which is prone to attack, security is another major concern in such scenarios. Ensuring secure and reliable communication with guarantees on latency is a challenging task.

The unique aspects of M2M communication bring new challenges for ensuring secure communication. Due to the lack of a centralized controller or trusted third party, ensuring secure communication is a challenging task in M2M scenarios. Many existing security mechanisms, such as cryptography methods, may not be suitable due to the low computing power available at the devices or the need for a trusted third party. In the last decade, physical layer secrecy has emerged as a promising solution for ensuring secure and reliable communication over wireless mediums. Physically layer-based security techniques generally harness the randomness present in the communication system, such as noise and fading, to enable secure communication. The root of physical layer security lies in information theory and can simultaneously ensure secure and reliable communication. Generally, it does not require any centralized controller or trusted third party to enable secure communication. Hence, it is an attractive choice for enabling secure communication in the case of M2M scenarios.

In the last decade, there has been significant progress in understanding the fundamental limits of physical layer secrecy and developing communication techniques at the physical layer that can guarantee secure communication. Most of the existing results in physical layer secrecy (PLS) assume that the block-length used is large, and hence, most of the results are not applicable in the case of M2M scenario. It is also essential to design communication techniques that resist active attacks such as jamming. One of the most common denial of service attacks is jamming, and it is challenging to design communication techniques that will be robust to such attacks when devices are constrained to use a small block length. For example, in drone communication, it is essential to ensure reliable communication between drones under jamming attacks with delay constraints. In such scenarios, tools from finite block length information theory can be useful.

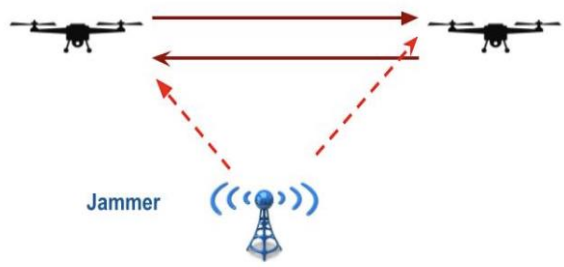

Fig: Reliable Communication between drones under jamming attack

In M2M scenarios, the traffic characteristics are heterogeneous, and most of the existing works in PLS assume that users always have data to send. Hence, it is required to study these networks and develop new schemes that can consider the heterogeneous nature of traffic, underlying channel model, and security issues. Although PLS-based techniques have emerged as a promising approach to secure wireless systems, several challenges need to be overcome, such as low-latency communication with security constraints, energy constraints at devices, and integration of PLS with higher layers. This motivates to develop a cross-layer framework for security by exploiting abundant sources of randomness in the physical world along with attributes of the network layer such as random arrival of data and congestion in the network. The developed framework can explore the interplay between reliability, security, throughput, and delay and thus can enable the development and analysis of various services based on IoT.

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Machine Learning for Traffic Management in Software Defined Networks (SDN)

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Effective network traffic management mechanisms are essential for network efficiency and performance. These mechanisms aim towards reducing network traffic congestion, efficient use of network resources, load balancing over multiple paths, and traffic-aware routing. With increasing network traffic and node mobility, contemporary networks have become highly dynamic, leading to the constant change in traffic patterns and routes. Hence, these networks need to use automated traffic control mechanisms that can adapt to changing network traffic behaviors and map the usage of network resources to maintain expected Quality of Service (QoS) and Quality of Experience (QoE). Introducing such control requires including specific inbuilt intelligence in the network devices.

SDN is being adapted by many networking platforms and organizations to deal with the constantly changing network demands. Unlike in traditional networks where network devices such as routers and switches need to be configured manually, in SDN, the network controller can be programmed and configured to respond to changes in the communication network such as traffic load and network topology. The SDN network controller has a global view of the network and can make decisions about resource allocation based on changing network requirements. SDN separates control plane (the decision-making plane, mostly implemented in software) from data plane (the data transfer plane, mostly implemented in hardware). The application plane comprises of the applications configured by the network operator such as load balancer, access control and bandwidth allocation. The SDN architecture is presented in Figure 1.

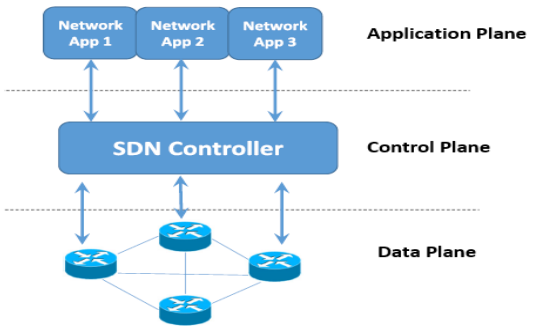

Figure: Simplified SDN Architecture

Machine Learning (ML) is considered a valuable technique to make the networks more intelligent by learning from changing network patterns, adapting according to network dynamics, and thus acting against network congestion, failures, and vulnerabilities. ML techniques can bring intelligence to the SDN controller present in the control plane when applied to SDN. Using ML techniques, the SDN controller can make decisions based on past traffic patterns, forecast future network traffic behavior, and allocate network resources, thus avoiding network congestion and failures. With this, the network operators can classify network traffic based on required QoS and carry out traffic aware routing to handle different network services, thus enhancing network efficiency and performance.

Traffic classification is essential for traffic management in SDN. Traditionally, port-based approach and deep packet inspection (DPI) techniques have been used for traffic classification. However, with exponential growth in network traffic over the years, use of dynamic ports by the applications, and inability to update application patterns, these techniques are no longer considered appropriate for traffic classification. Hence, ML-based algorithms are now being considered to classify the network traffic. A considerable amount of traffic flows is first collected, and ML techniques are implemented to extract the required information. The network traffic is classified based on three characteristics:

1. **Flow-aware:** The traffic is classified based on their bandwidth requirement and the delay tolerance (e.g., elephant and mice flow) using ML algorithms. The SDN controller then uses this information for traffic flow optimization and resource allocation.
2. **Application-aware:** The traffic is classified based on the application data carried. It is prioritized based on the application requirement, and resources are allocated accordingly. Mobile-application aware traffic classification is particularly challenging due to the mobility of traffic sources.
3. **QoS - aware:** The traffic is classified based on the QoS requirements such as data rate, latency, and jitter. This traffic classification method is more efficient than application-aware classification as many applications may belong to the same QoS class.

Based on the information on these traffic classifications, the SDN controller can optimize traffic flows, balance loads, and allocate resources to maintain required QoS and QoE. Some of the ML algorithms used for traffic classification and management are:

1. Support vector machine (SVM)
2. Decision tree
3. k-nearest neighbors (k-NN)
4. Deep Neural Networks (DNN)
5. Semi-supervised learning

Conclusion: Applying ML-based techniques for classification and thus traffic management is essential in contemporary networks due to their dynamic nature and exponentially increasing traffic. This article briefly presents the role of ML techniques in SDN.

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THE FUTURE OF SECURE COMMUNICATION SYSTEMS: QUANTUM KEY DISTRIBUTION

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Communication technology is an evergreen field that is undergoing many changes in recent times, what with the development of 5G, 6G technologies, ORAN and optical communication, etc. But in this global race to secure first place, we can never ignore the security aspect of communication systems. The telecom industry and the governments worldwide need to work hand in hand to ensure that data integrity and privacy are always protected. One emerging technology that has caught our attention is QKD – Quantum Key Distribution.

Quantum key distribution is a secure communication technology that uses quantum mechanics to create a cryptographic protocol. Based on quantum mechanics fundamentals like Heisenberg's uncertainty principle and No-cloning theory, it allows two parties to generate a shared secret key that is only known to them and can be used to encrypt and decrypt messages

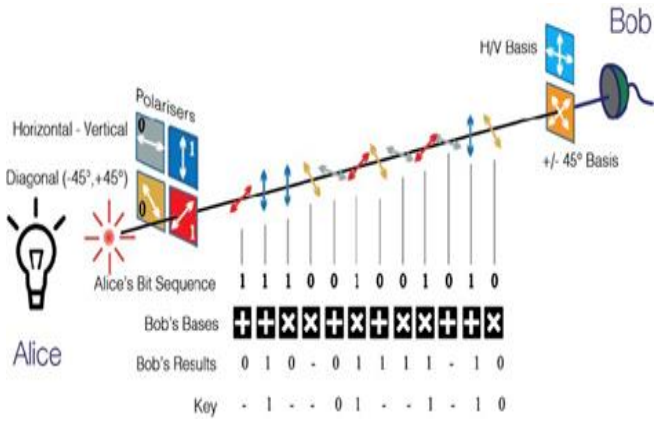

Fig: QKD System

The capacity of the two communicating users to identify the presence of any third party attempting to obtain knowledge of the key is a crucial and unique aspect of quantum key distribution.

This is due to a fundamental characteristic of quantum mechanics: measuring a quantum system affects the system in general. A third party attempting to eavesdrop on the key must measure it somehow, resulting in noticeable irregularities.

Importance of QKD

A communication system that detects eavesdropping can be created by using quantum superposition or quantum entanglement and transferring information in quantum states.

If the level of eavesdropping is below a specified threshold, a secure key can be generated (i.e., the eavesdropper does not know of it); otherwise, no secure key can be generated, and communication is terminated.

Quantum key distribution is only used to generate and distribute a key, not send data. This key can then be used to encrypt (and decrypt) a message, which can then be transmitted over a standard communication channel using any encryption algorithm. In real-world scenarios, it is frequently employed with encryption utilizing symmetric key techniques like the Advanced Encryption Standard algorithm.

Working of QKD

QKD works by transmitting millions of polarized light particles (photons) over a fiber optic cable from one entity to another. Each photon has a random quantum state, and

collectively all the photons create a bitstream of ones and zeros.

When the photons arrive at the endpoint, the receiver uses beam splitters (horizontal/vertical and diagonal) to read the polarization of each photon. The receiver does not know which beam splitter to use for each photon and guess which one to use. After the receiver tells the sender which beam splitter was used for each photon in the sequence they were sent, the sender then compares that information with the sequence of polarizers used to send the photons. The photons that were read using the wrong beam splitter are discarded, and the resulting sequence of bits becomes a unique optical key that can be used to encrypt data.

Advantages and Disadvantages

The security of QKD stems from its ability to detect any intrusion in the QKD transmission. Any third party that tries to read or copy will change the photons' state due to their unique and fragile properties. Moreover, since the keys are randomly generated, they are also protected from future hack attempts

The fundamental disadvantage of quantum key distribution is that it usually requires a verified classical communication connection. As a result, QKD performs the same function as a stream cipher but at a much higher cost. Without employing QKD, one can accomplish authenticated and secure communications by using the Advanced Encryption Standard's Galois/Counter Mode.

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