BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT
(Autonomous Under VTU)

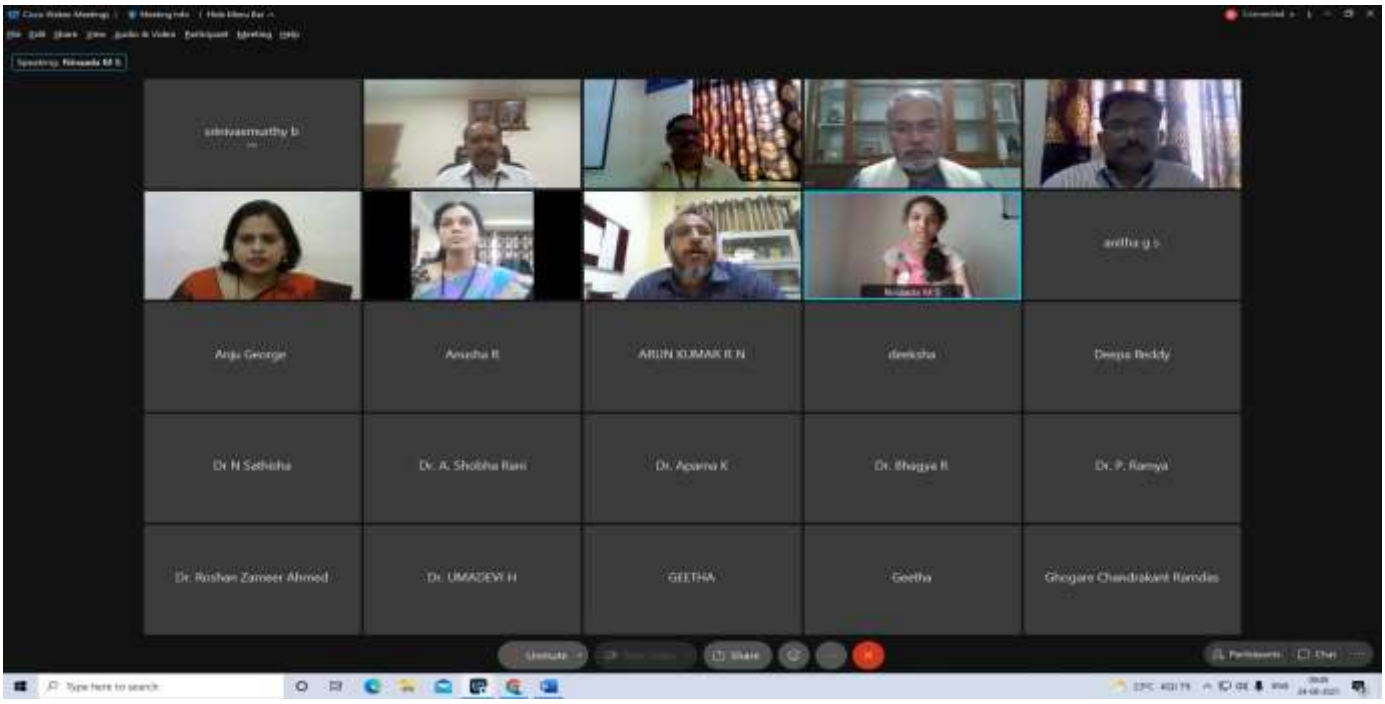
Avalahalli, Doddaballapur Main Road, Bengaluru – 560064

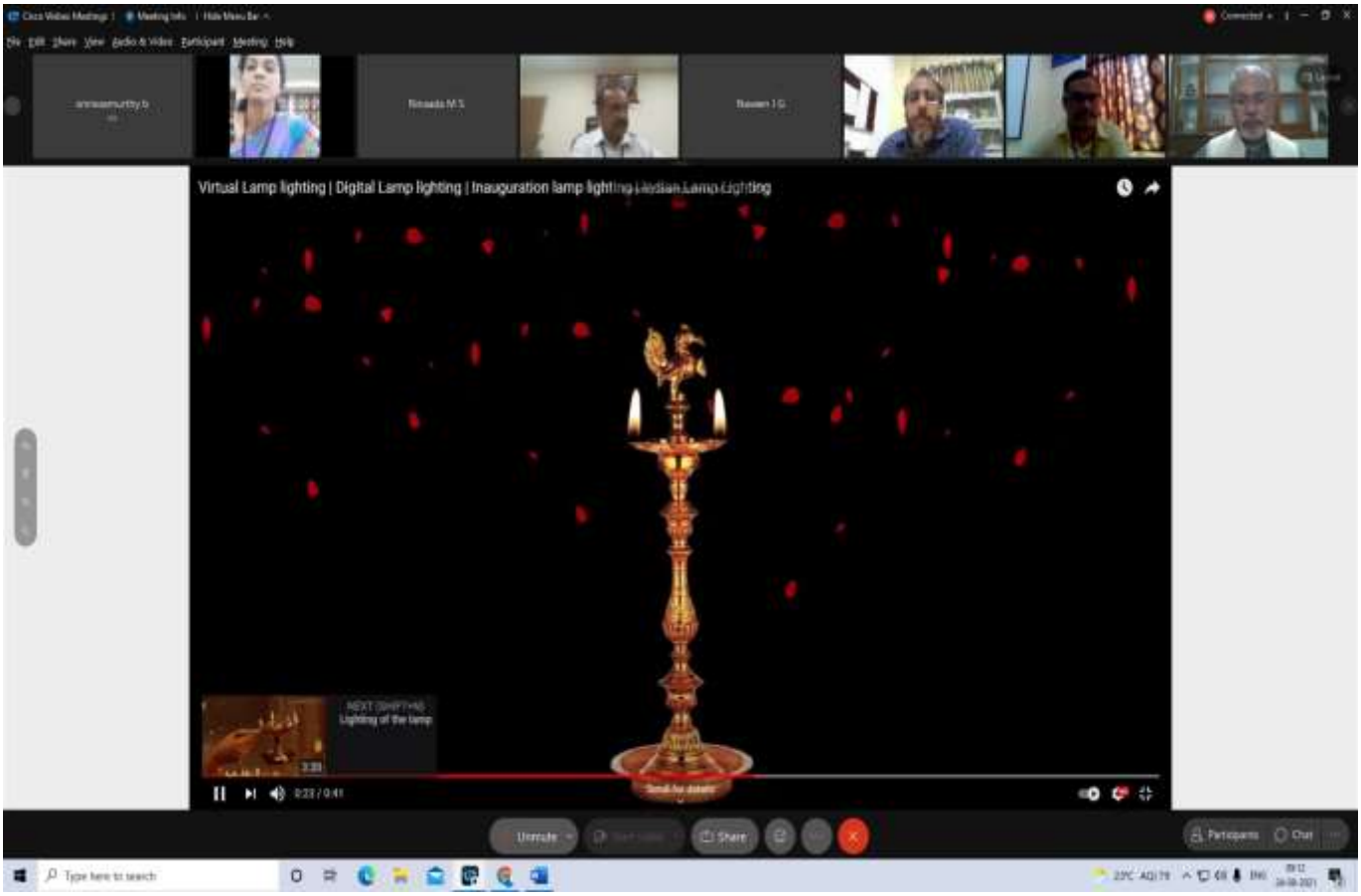
DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING(ETE)

TOPIC

AICTE **Sponsored ATAL FDP on "GREEN COMMUNICATION", August 24th- 28th 2021.**

BMS Institute of Technology and Management, Bengaluru, the department of Electronics and Telecommunication Engineering organized one week AICTE Sponsored online ATAL FDP on "Green Communication" from August 24th – 28th 2021. Inaugural function of the faculty development program held on 24.08.2021 from 9:00 am to 9:15 am, Dr. M. H Kori, Technical Director (Retd.), ALCATEL LUCENT Technologies, Bengaluru, was the chief guest and graced the occasion by sharing his expertise and views on the need for "Green communication", evolving trends, and translating academic research into impactful applications. Our beloved principal, Dr. Mohan Babu G. N given the presidential address by stressing upon the importance of the development of technologies for the sustainable development of the eco system and expressed his gratitude to all the AICTE ATAL FDP officials for considering our institute to coordinate this online faculty development program. Dr. Raju Hajare, HoD of ETE, expressed the importance of upgrading of the faculty members with the change in technologies and in-turn to disseminate to the student community. Prof. Mallikarjuna Gowda C. P., Associate Professor, dept. of ETE, ATAL FDP Coordinator briefed about the content of the faculty development program and its importance, Inaugural function concluded by giving vote of thanks by Dr. Sumathi. M, Asst. Prof, dept. of ETE.



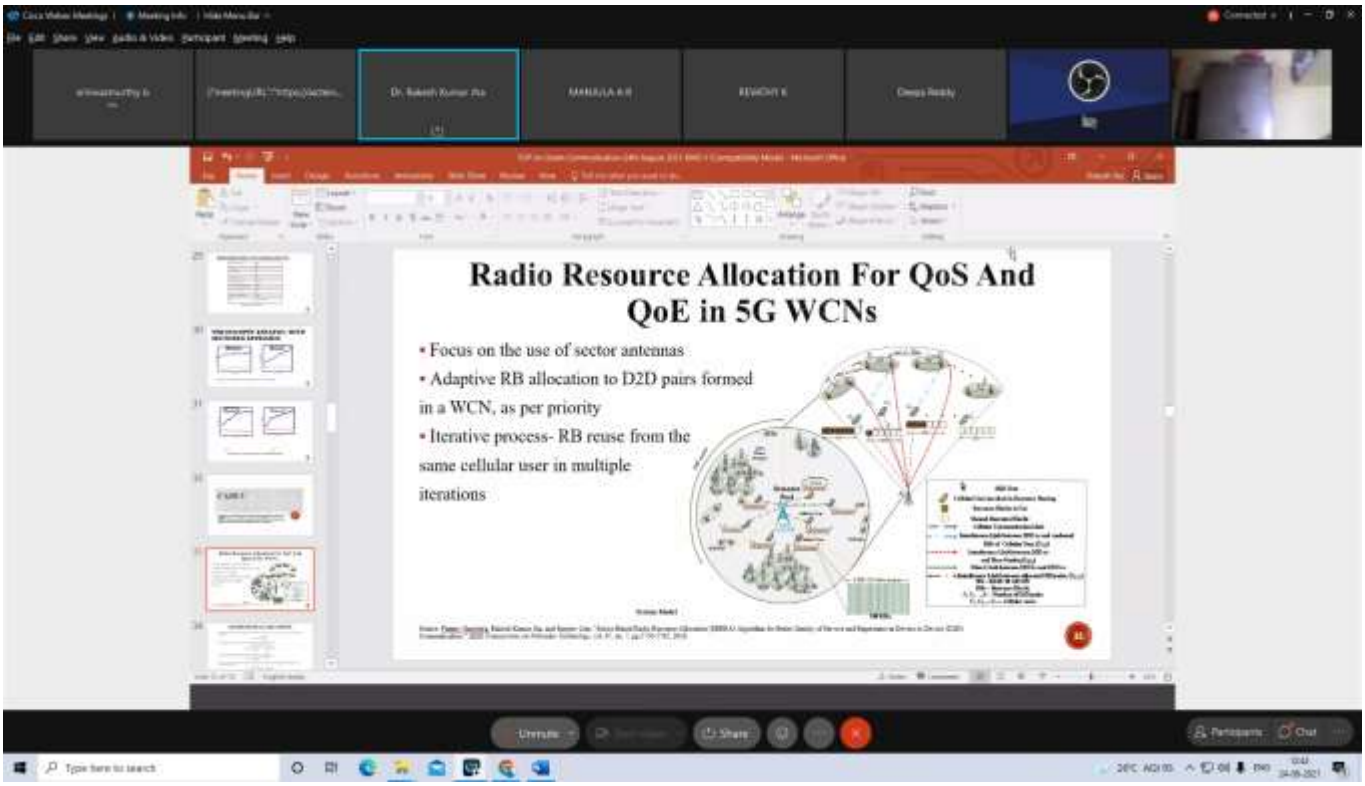


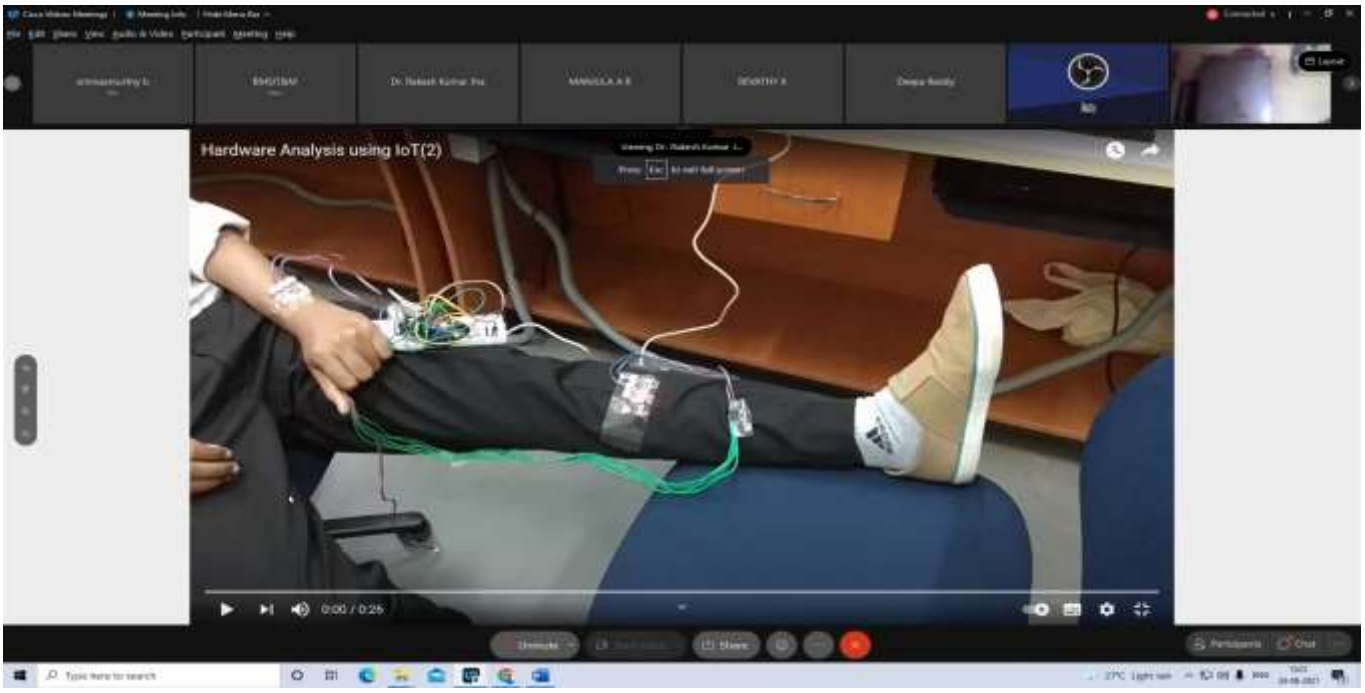
The meaning of **Green Communication, i.e., e**nergy-efficient communication technologies primarily developed for addressing the environmental impact of traditional communication systems and networks.

Day 1: 24.08.2021: Session 1: Started with deliberating on **"Energy Efficiency in 5G and beyond 5G"** by **Dr. Rajarshi Mahapatra**, Associate Prof. and Dean (Academics), IITNR. The speaker shared his knowledge and experience about the meaning of Energy Efficiency its understanding, Benefit – Cost analysis, energy efficient network required tradeoffs and possible solutions, like small cell, massive MIMO, Dense, sleep mode techniques, etc. Also he touched upon the green communication frame work for heterogeneous network, cell Zooming for load balancing, traffic offloading with respect to Multi-Tier network.

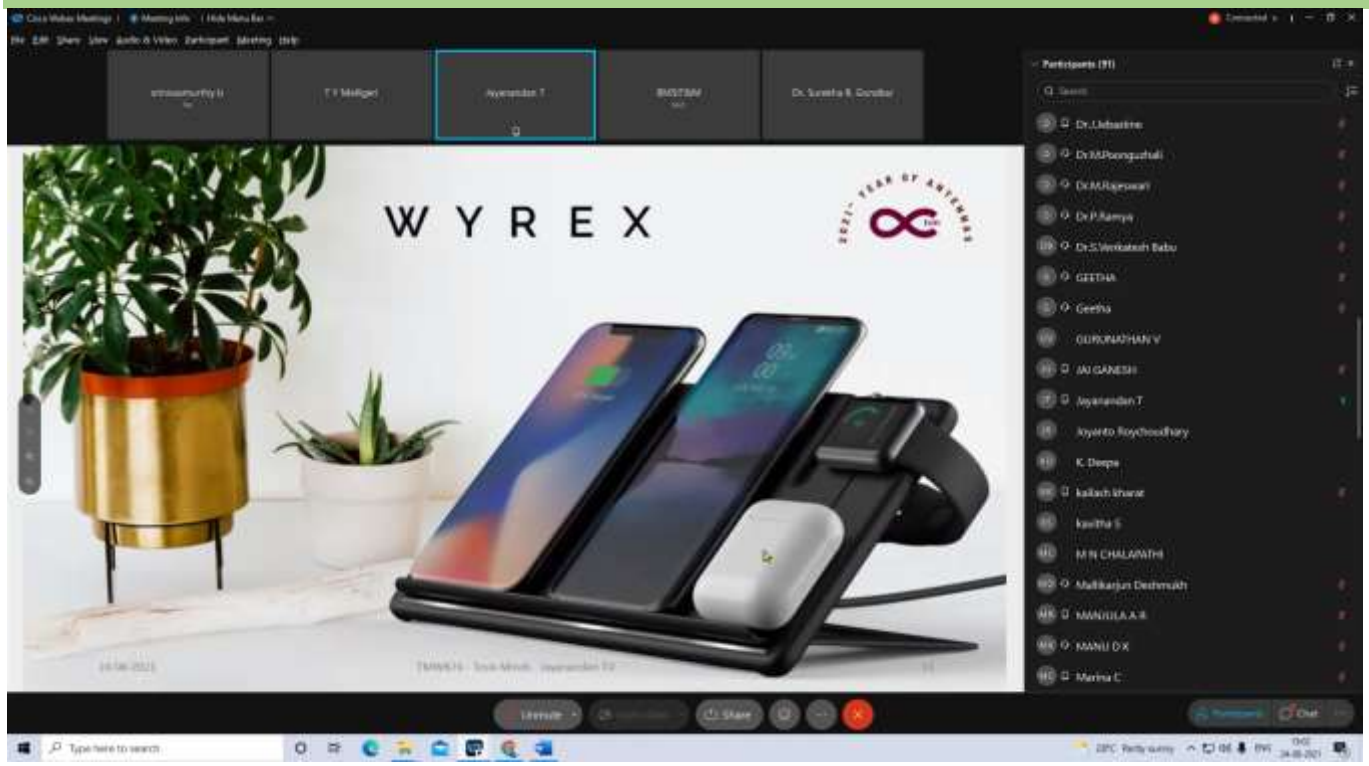
Session 2: Dr. Rakesh Jha, Associate Prof, Dean R&D, dept. of E&C, Shri Mata Vaishno Devi University, J&K, shared his experience by considering four cases: first one on architecture for green communication using

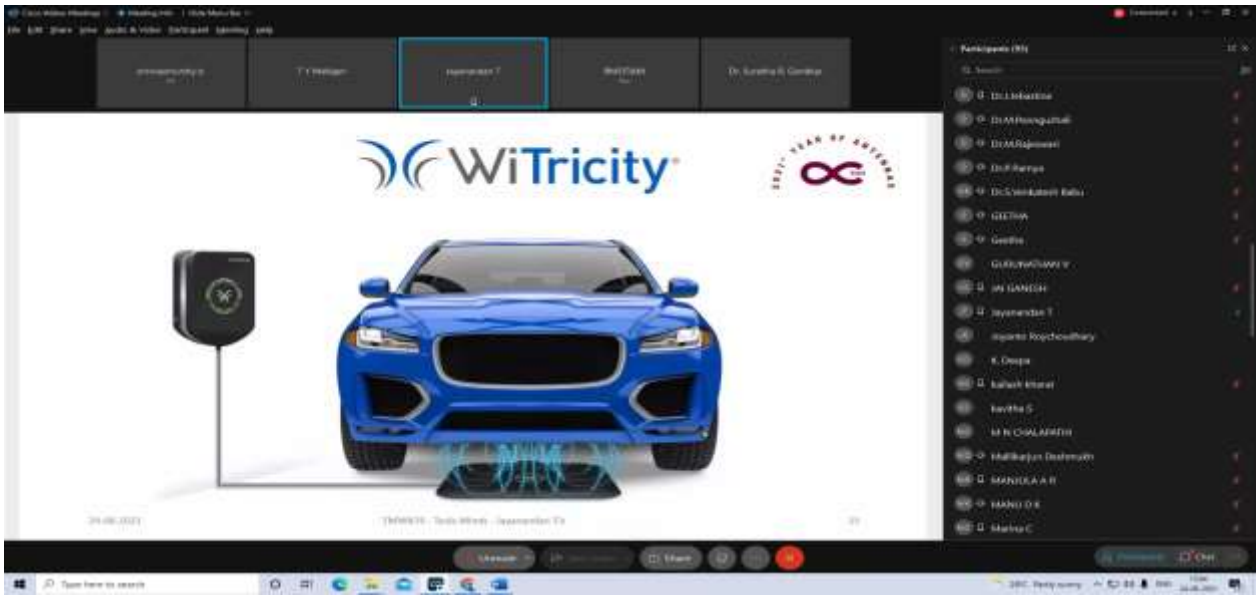
sector based resource allocation scheme for assured QoS & QoE in D2D communication. Second one on novel beam breathing approach for reliable D2D communication. Third one on zonal based green communication algorithm for augmenting the battery life in spectrum shared networks via D2D communication. Fourth one is on green and safe 5G and beyond 5G wireless networks.

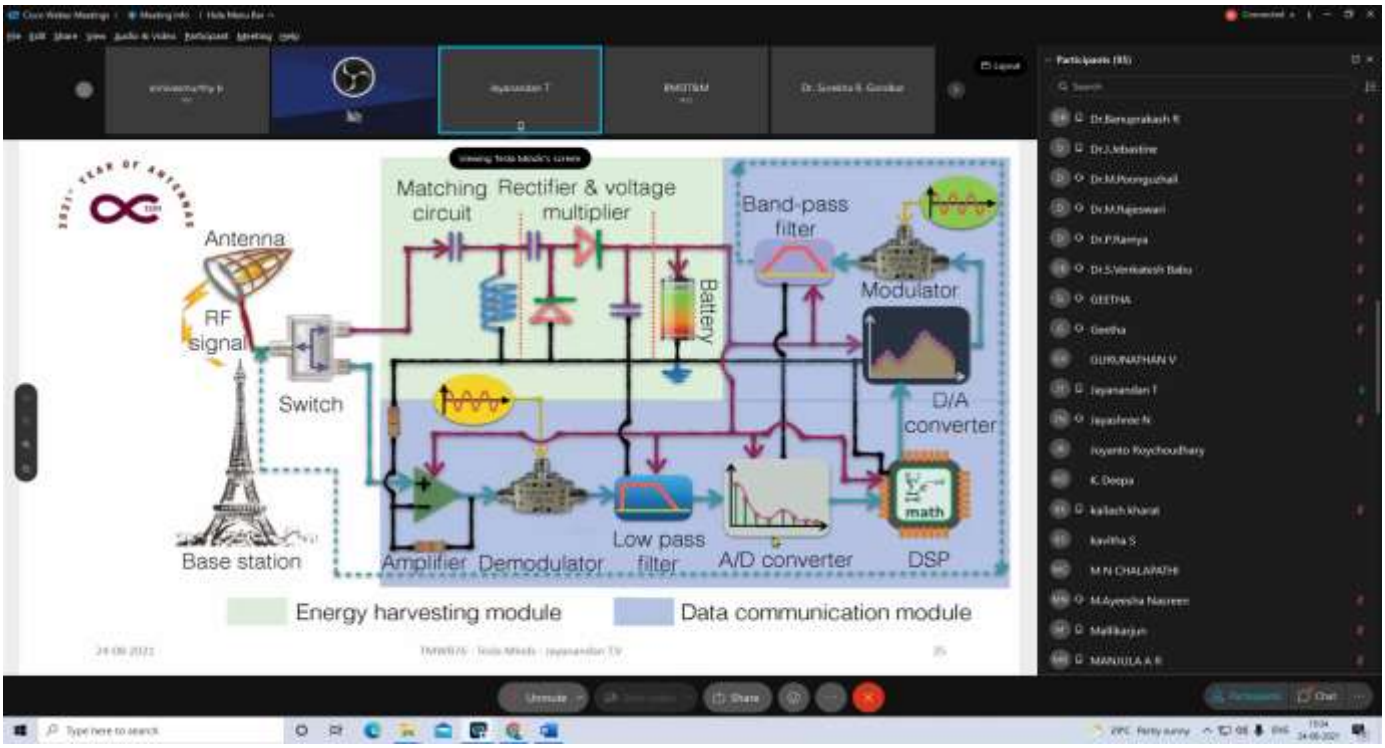




Session 3: Mr. T. Jayanandan, Fouder/CEO, Tesla Minds, India, discussed about "Receiver Architecture of RF energy Harvesting", The speaker explained the Global wireless charging market, which is projected to reach $3.28 billion by 2024 and the challenges and opportunities of Global Wireless Charging Market (GWCM). Also the applications of wireless charging and RF energy harvesting were discussed. The significance of reconfigurable antennas and rectifiers was also discussed. The future is only reconfigurable devices, as without changing the physical structure the desirable frequency can be obtained.

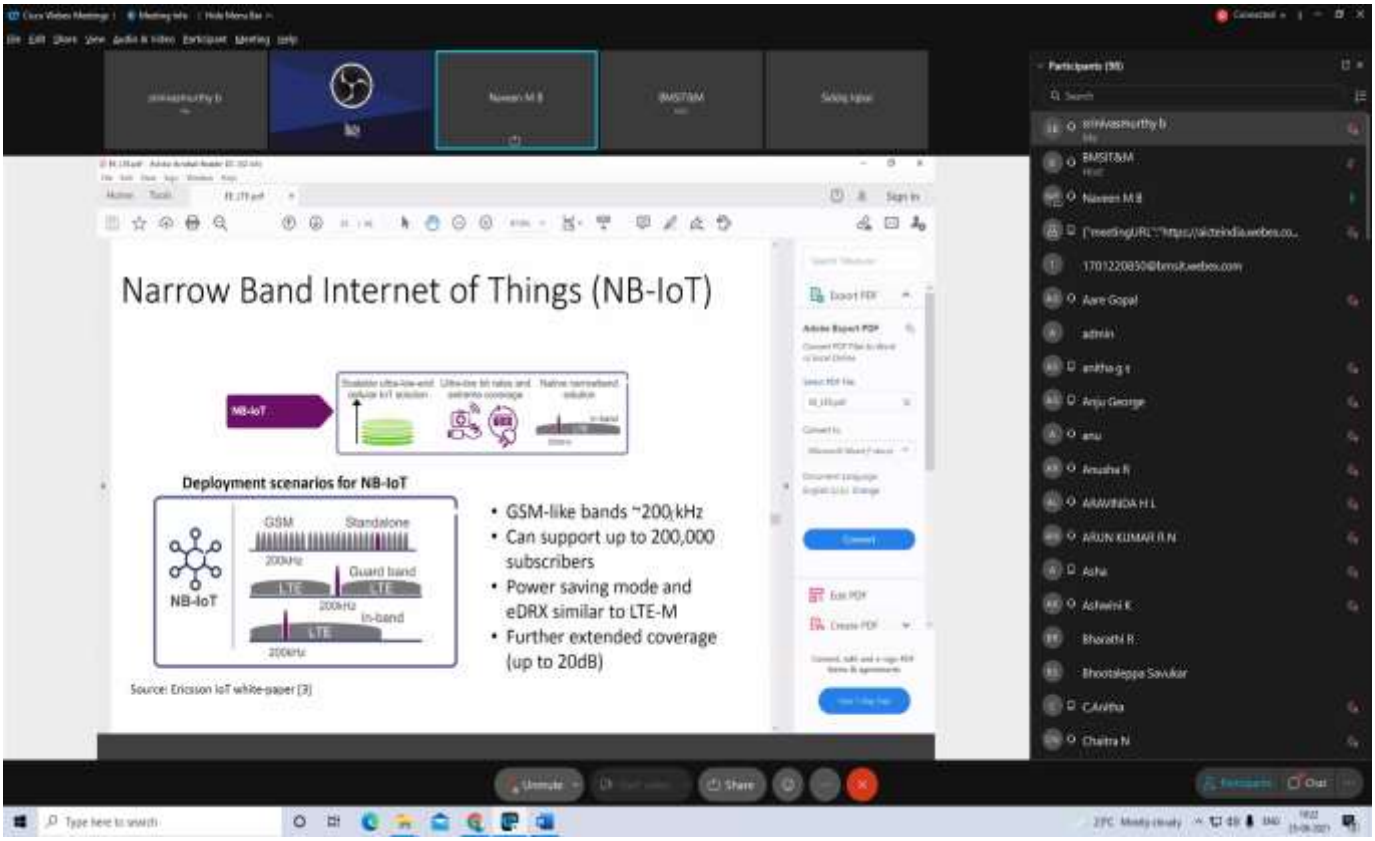






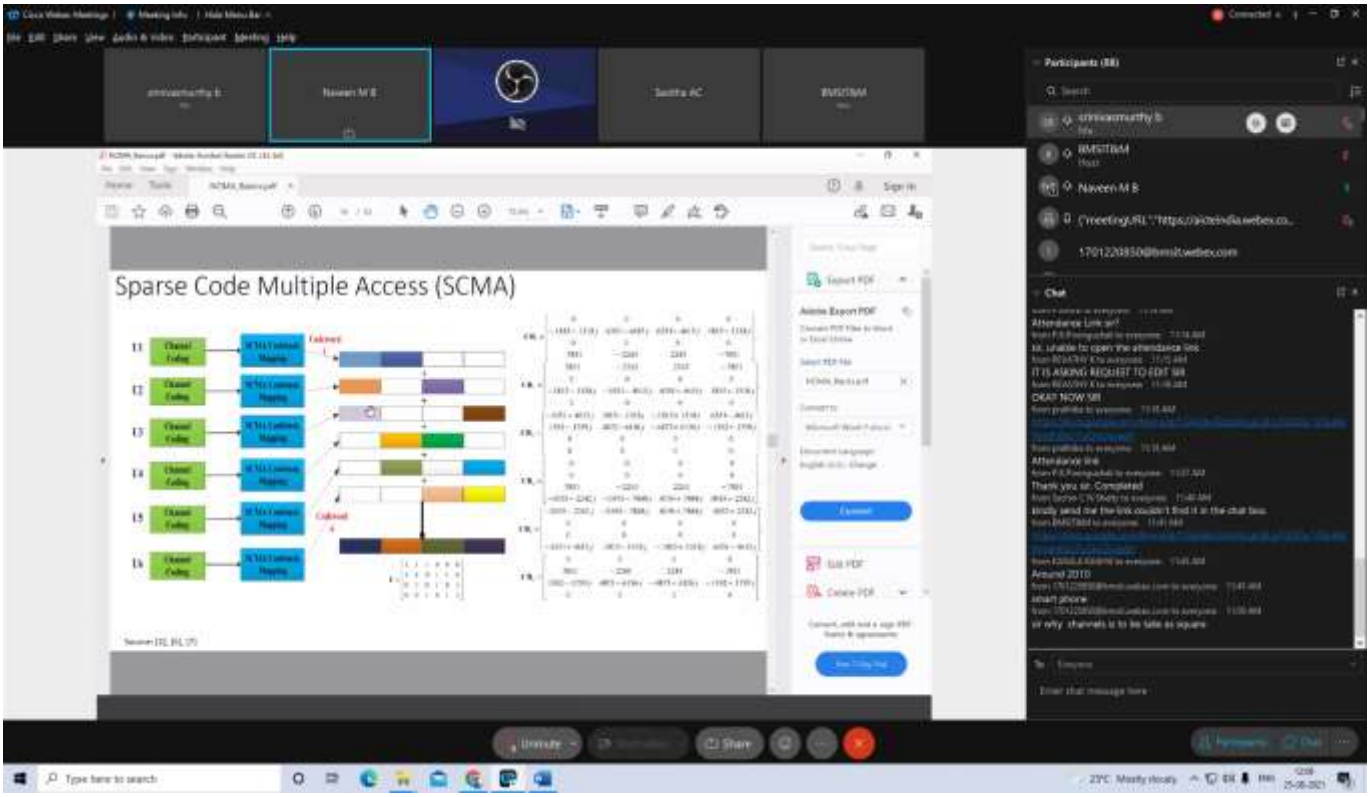
Day 2: Session 1 & 2: Dr. Naveen M B, Asst. Prof. Dept. of Electrical Engineering, Indian Institute of Technology (IIT) Dharwad, Karnataka, shared his knowledge and experience on "Energy and spectral efficient radio transceivers and access technologies: Energy efficient IOT using LTE".

Speaker deliberated on Low power wide area (LPWA) Technologies and standards, like LoRa, eMTC and NB-IoT are attracting a lot of attention primarily because of their ability to offer affordable connectivity to the low-power devices distributed over very large geographical areas. In realizing the vision of the Internet of Things, LPWA technologies complement and sometimes supersede the conventional cellular and short range wireless technologies in performance for various emerging smart city and machine-to-machine applications.



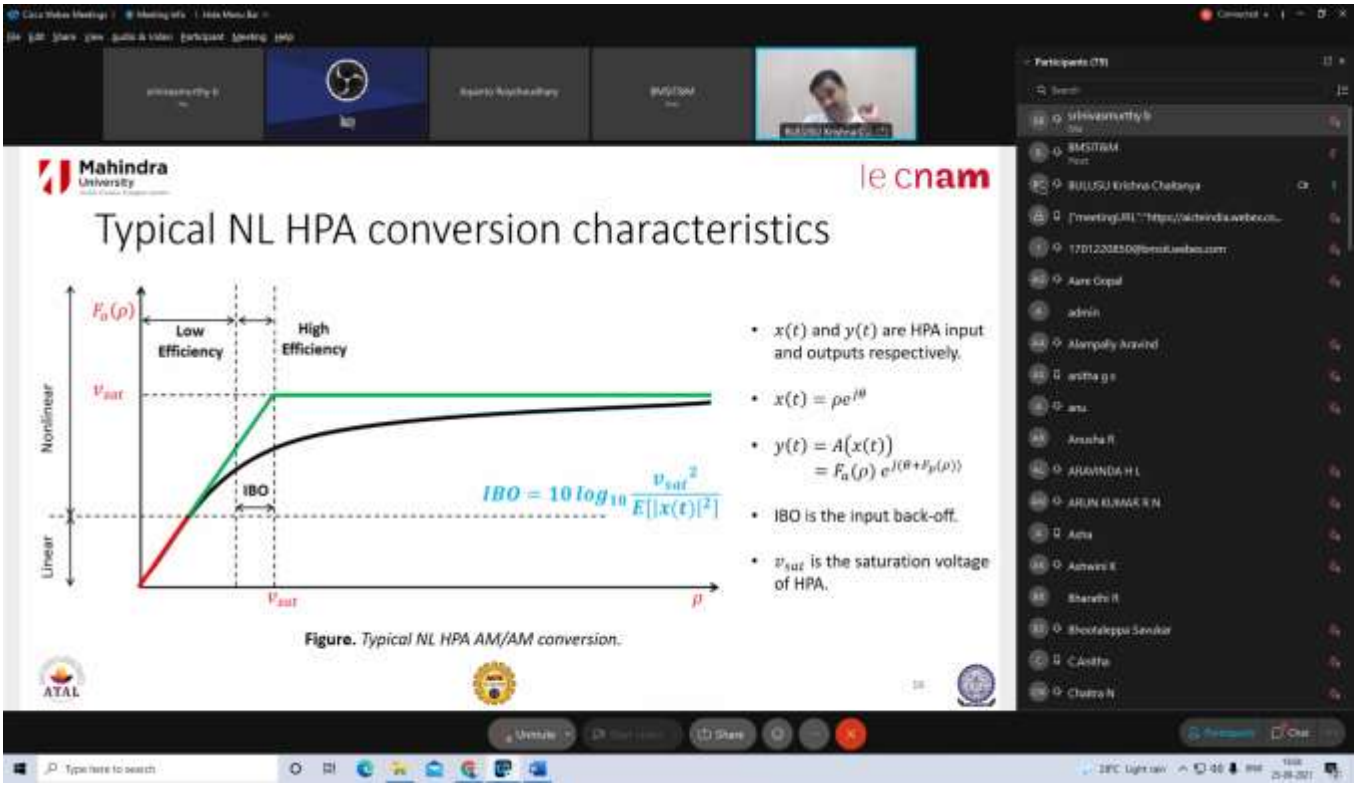
Non-Orthogonal Multiple Access (NOMA) and Grant-Free(GF) access for improved energy efficiency in 5G and beyond

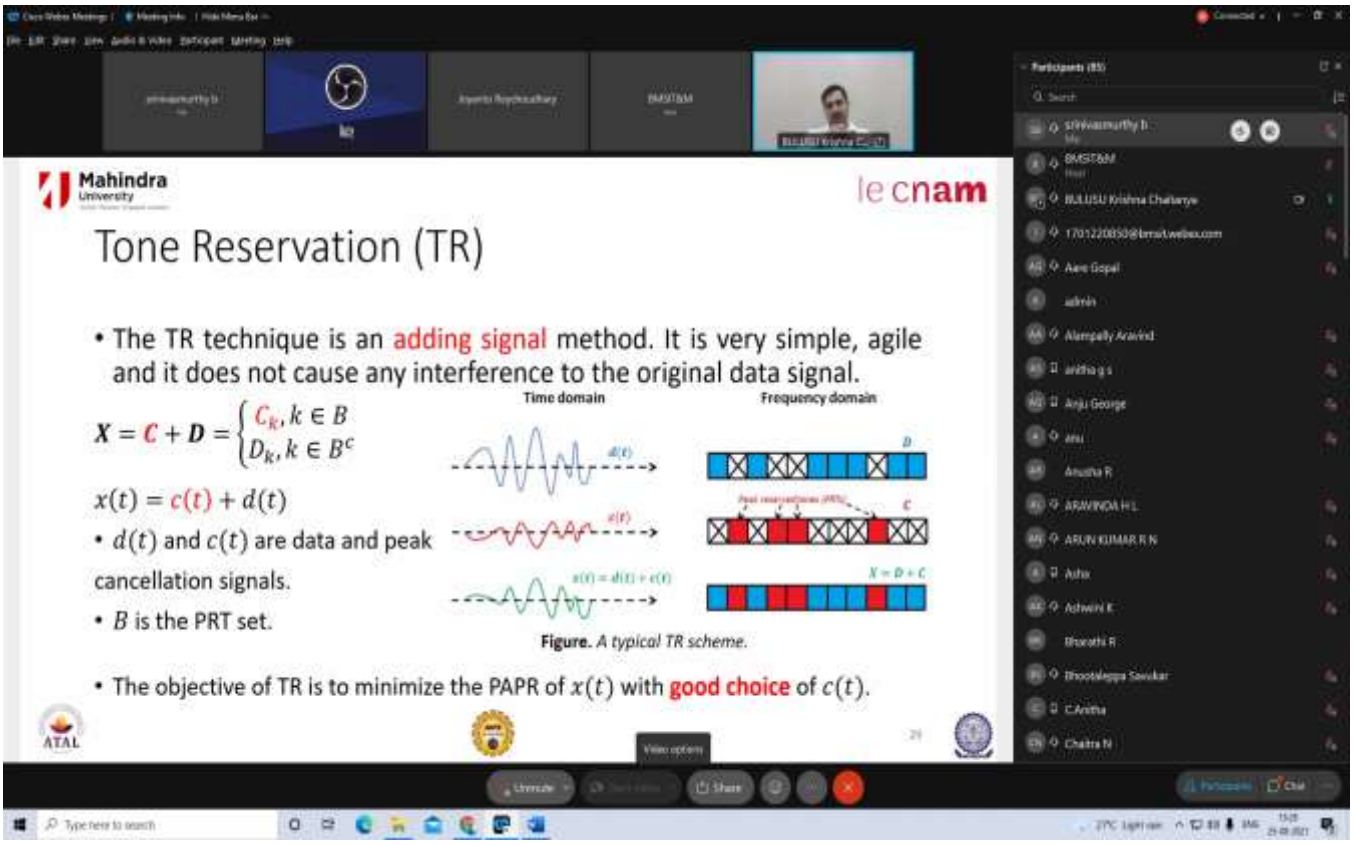
The idea of Non-Orthogonal Multiple Access (NOMA) and its rapid advancements were discussed. Non-orthogonal multiple access (NOMA) is one of the most promising radio access techniques in next-generation wireless communications. Compared to orthogonal frequency division multiple access (OFDMA), which is the current de facto standard orthogonal multiple access (OMA) technique, NOMA offers a set of desirable potential benefits, such as enhanced spectrum efficiency, reduced latency with high reliability, and massive connectivity. The baseline idea of NOMA is to serve multiple users using the same resource in terms of time, frequency, and space.



Session 3: Dr. ***S. S. Krishna Chaitanya Bulusu, Asst. Prof. Dept. of EEE, Mahindra University, Telangana, shared his experience on*** "Improving energy efficiency by mitigating RF nonlinear effects due to High Power Amplifiers."

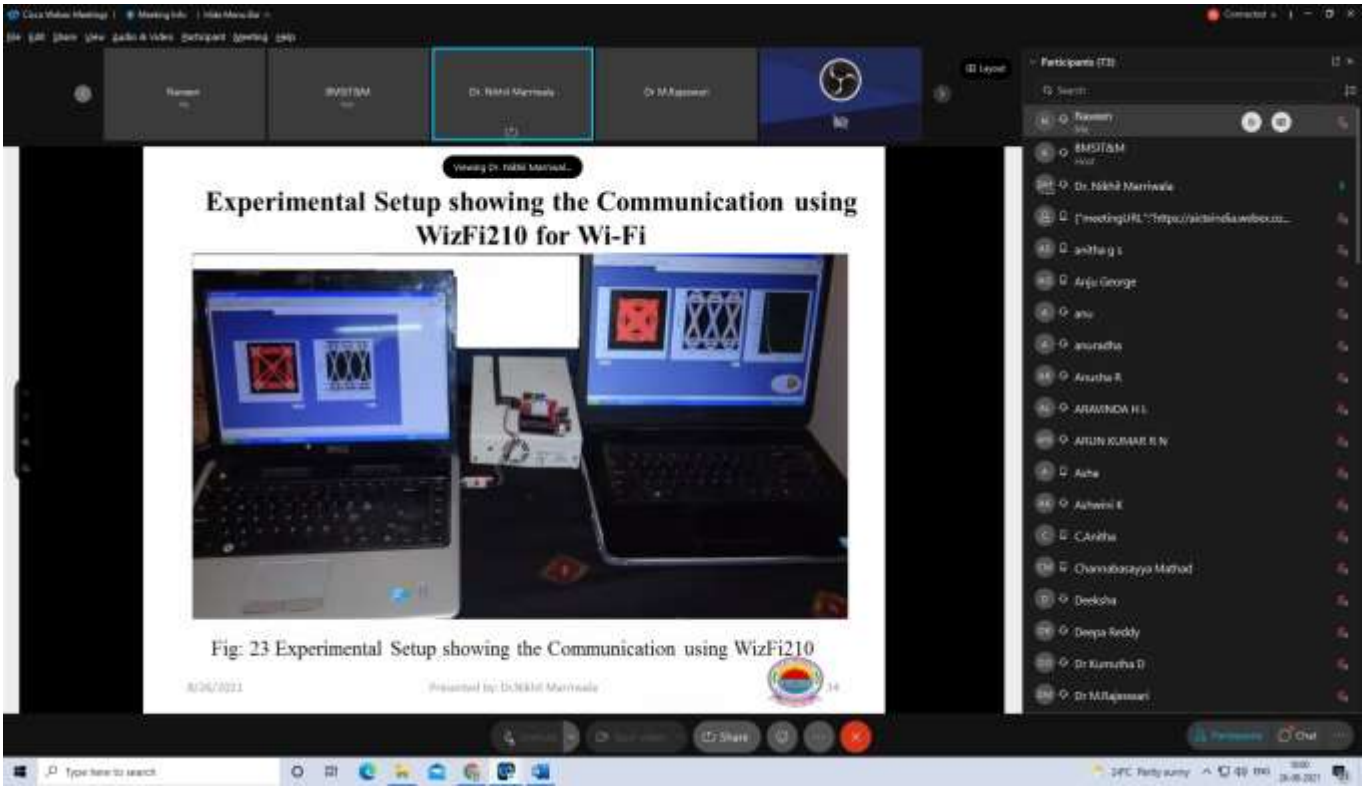
Speaker discussed about the mitigation of NL effects of HPA, i.e., PAPR reduction and HPA linearization. Also he had the opinion of for a better future, an energy-efficient green communication is the need of hour.



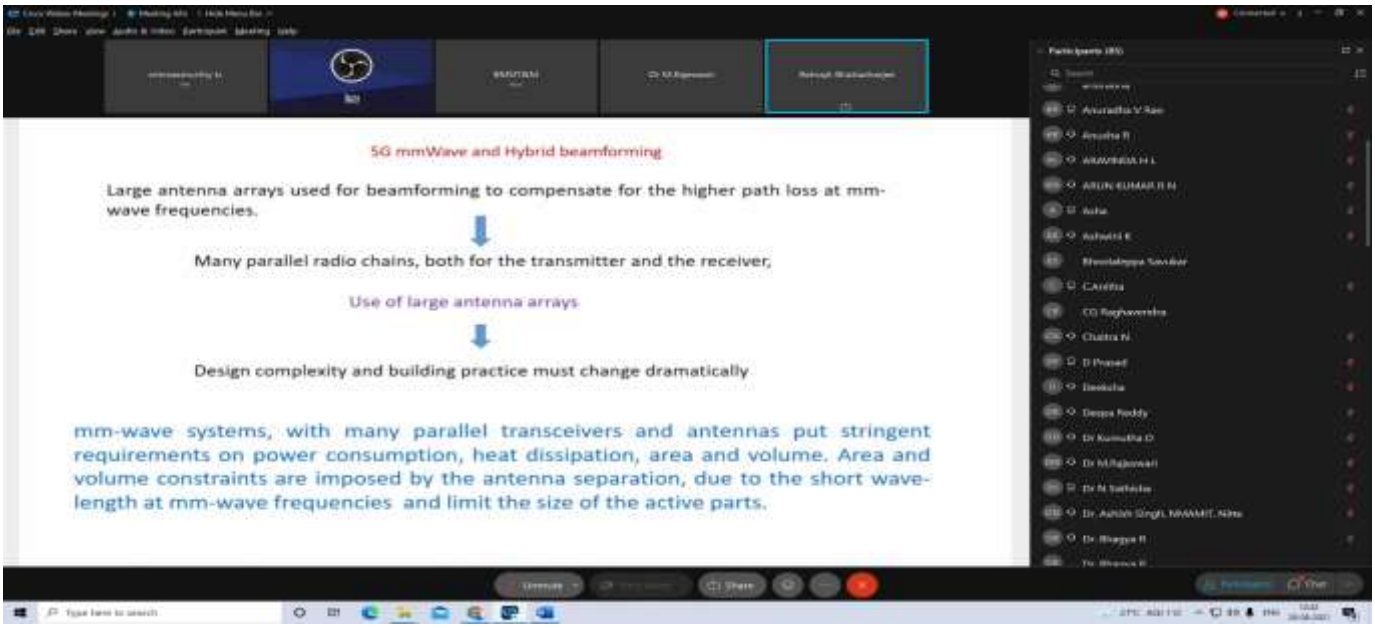


Day 3: Session 1: **Dr. Nikhil Marriwala,** Asst. Prof. dept. of E&CE, University Institute of Engineering and Technology, Kurukshetra University, Kurukshetra, **shared his experience on "Energy –Efficient Transceiver**

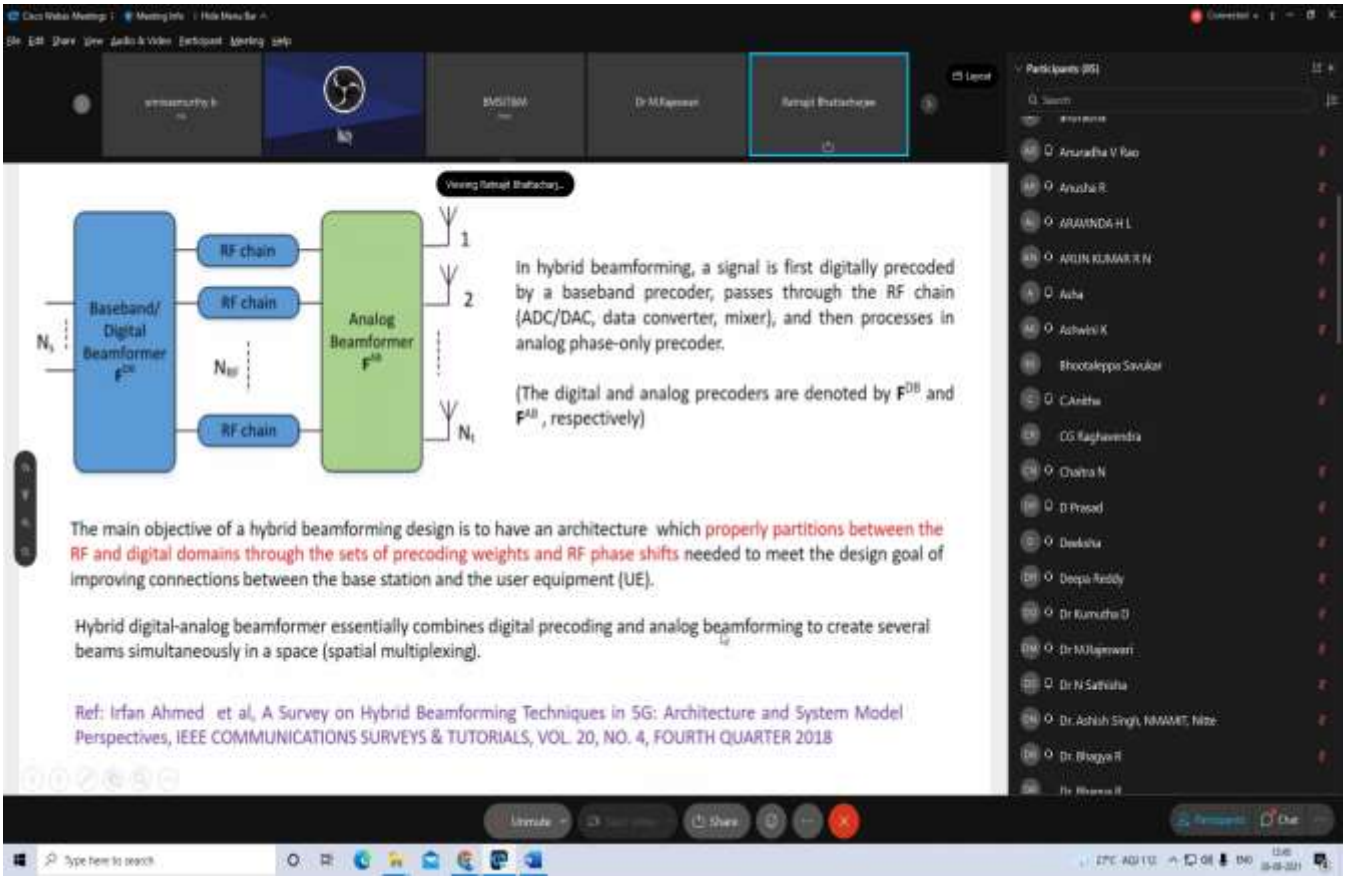
Design" discussed about "Software Defined radio" and how hardware has been minimized by using software to implement the different blocks of transceivers.

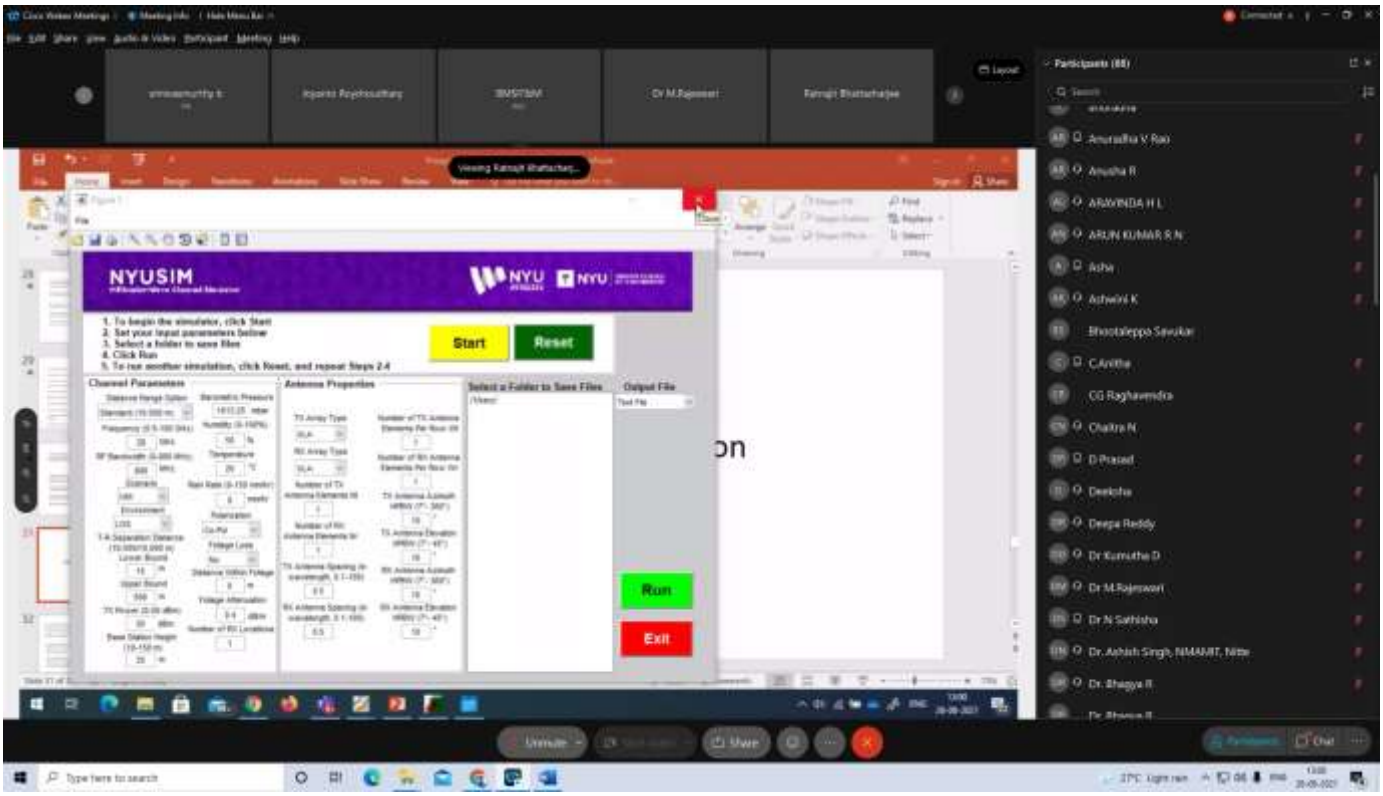


Session 2: Dr. Ratnajit Battacharjee, professor, Indian Institute of Technology (IIT) Guwahati, Guwahati, shared his knowledge on prospects of AI/ML in green communication: An overview. Speaker discussed about AI/ML in wireless communication with some case studies and applications of AI/ML in energy efficient wireless communication and wireless energy harvesting. Also the role of AI in beyond 5G wireless communication, i.e., green 6G.



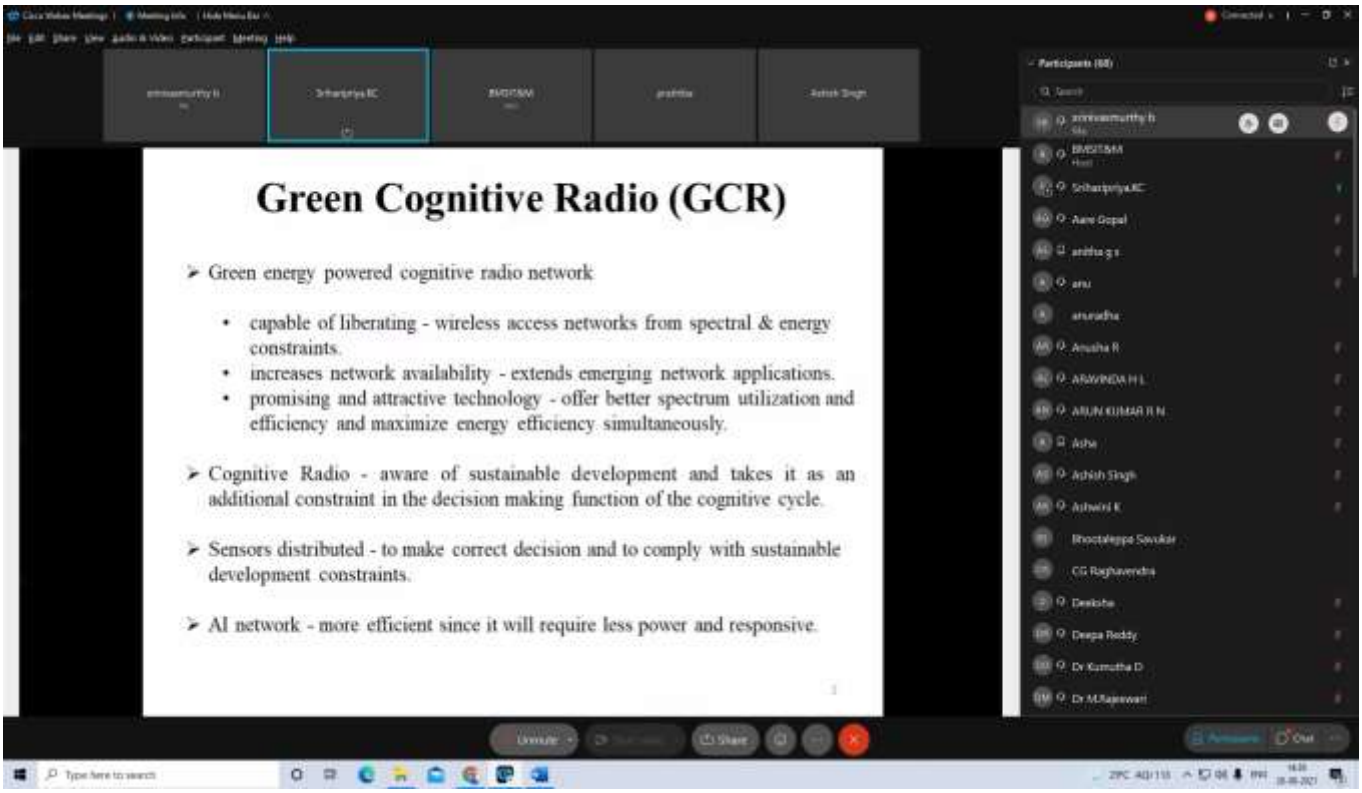

AI ML Basics
Artificial Intelligence
Any technique which enables computer to imitate human behaviour
Machine learning
Algorithms use statistical techniques to allow the machines to improve with experience
Applications 5G/B5G
Deep learning
Multilayer NN
Based computation
Traditional Programming
Supervised Learning
Unsupervised Learning
Reinforcement Agent
Reinforcement Environment
M. E. Morocho-Cayamcela et al.: "Machine Learning for 5G/B5G Mobile and Wireless Communications", IEEE Access 2019


Baseband/ Digital Beamformer
RF chain
RF chain
RF chain
Analog Beamformer
In hybrid beamforming, a signal is first digitally precoded by a baseband precoder, passes through the RF chain (ADC/DAC, data converter, mixer), and then processes in analog phase-only precoder.
(The digital and analog precoders are denoted by F^BB and F^AB, respectively)
The main objective of a hybrid beamforming design is to have an architecture which properly partitions between the RF and digital domains through the sets of precoding weights and RF phase shifts needed to meet the design goal of improving connections between the base station and the user equipment (UE).
Hybrid digital-analog beamformer essentially combines digital precoding and analog beamforming to create several beams simultaneously in a space (spatial multiplexing).
Ref: Irfan Ahmed et al, A Survey on Hybrid Beamforming Techniques in 5G: Architecture and System Model Perspectives, IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 20, NO. 4, FOURTH QUARTER 2018



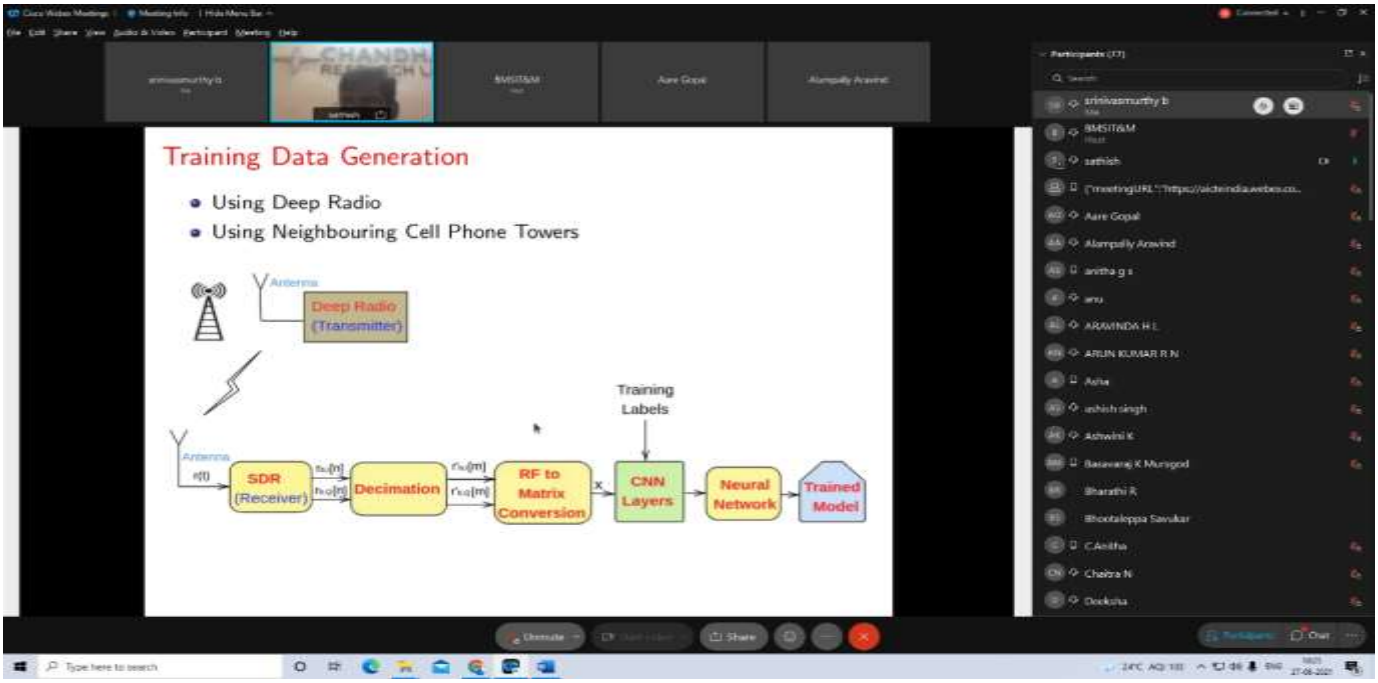
Session 3: Dr. K.C Sriharipriya, Associate Prof, VIT, shared her experience on "Understanding Cognitive Radio for Green Communication".

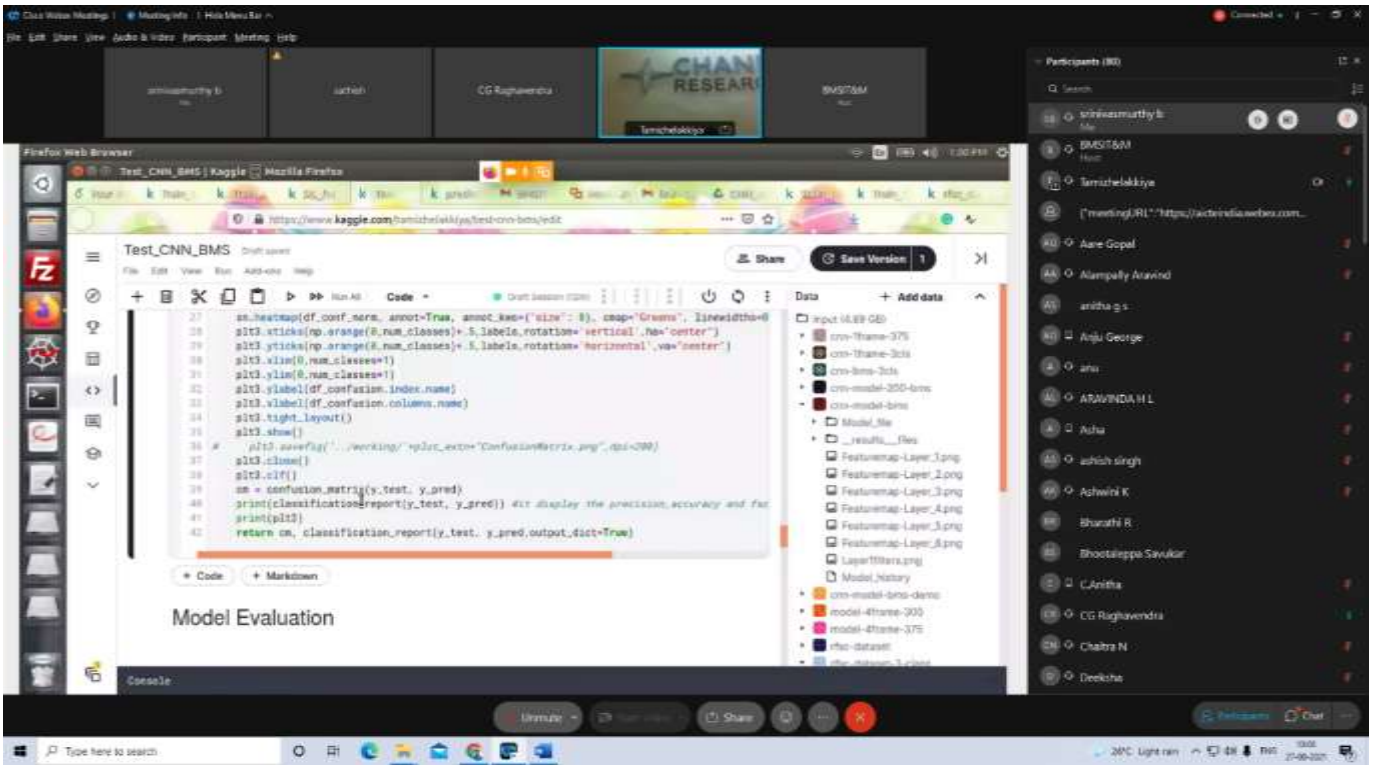
The Speaker discussed about the concepts of Green Cognitive Radio(GCR). The Green energy and awareness of Cognitive radio. Also, deliberated on the concept of saving power, Smartness and Alertness of cognitive radio, Spectrum awareness, Policy, Channel and user awareness.



Day 4: Session 1&2: **Dr. S. Satish Babu, Senior Researcher, (Dr. Prabhu C , Director), Chandhar Research Labs Pvt Ltd, Chennai, shared his knowledge about "Hands on Training on Deep Learning based RF Signal Classification for Cognitive Green Communication"**

The Speaker deliberated on the concepts of AI, ML and DL. Also discussed the difference between AI, ML and DL. The Transition of AI to DL. Importance of deep learning for wireless communication was made clear. ML for 5G and beyond with ITU initiatives were discussed. SINR in typical scenario were also discussed. A typical cellular network example was taken and discussed.





The Speaker deliberated on the Data generation, decimation and convolutional layer dimensions. Flatten and dense layer was explained. This session was continued with hands on session on deep Learning based RF signal classification. CNN Architecture for KERA was discussed along with the formulas used for metric calculation. Experimental setup for Predication was discussed. Hands on Simulations were carried out. CNN Test model evaluation was discussed.

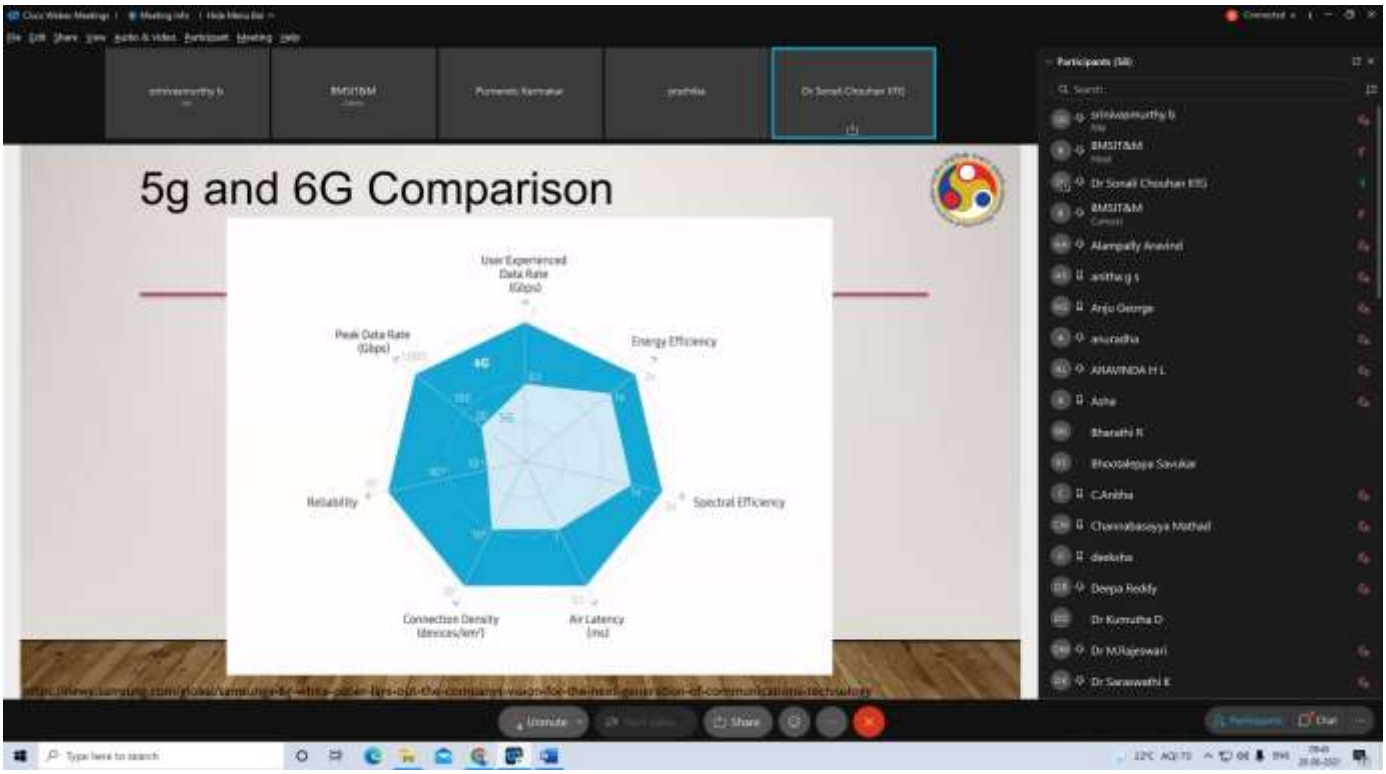
Session 3: Mr. A T Kishore, CEO, Vidhyasangha Pvt. Ltd. Bengaluru, topic: " UAV As BASE STATION: FUNCTIONAL SPLIT ANALYSIS".

Speaker started with UAV as a communication system. The speaker explained the components of a Drone as a part of communication system. Working principle of drone was explained in detail. The advantages of 5G communication was discussed in detail. The necessity of faster transmission, faster response w.r.t 5G narrated clearly. The advantage of beam forming in antenna aspect was highlighted.

Speaker focused on Satellite Access-for the communication and also explained about low earth orbit satellites. The scenario for satellite communication in India was explained. The scenario for UAS was also discussed. The cellular support for UAV was focused in the session along with the requirements for 5G operation with block diagram was discussed in detail. The challenges for 6G communication was also highlighted in the session. At the end speaker explained about the collaborative work he is into, any researcher is interested, he can approach him.

Day 5: 28.08.2021: Session 1 Dr. Sonali Chouhan, Associate Professor, Department of EEE, IIT Guwahati.
Topic: "Energy efficient edge computing for green 6G networks."

The Speaker explained the concepts of **Energy efficient edge computing for green 6G networks** with the definition and history. Topics on Communication transformation relating Fifth generation networks (5G) as it is not just another radio technology, it opens the opportunities for Mobile Network Operators to drive a transformation of the mobile industry. With the advancement of complementary technologies in the same time frame, the scale of industrial transformation is expected to be high, with many leading thinkers describing it industrial revolution. 5G is central to this, acting as the catalyst for the fusion of technologies such as Artificial Intelligence, robotics, 3D-printing, and Internet of the Things (IoT) societal advancement, industrial oriented transformation, 5G and 6G transformation, enabling technology, paradigm shift, multi access edge computing, MEC applications like connected cars, edge video orchestration, data offloading, short distance energy consumption, proposed framework relating application, energy model, mobile device and server energy and mobile device architecture. The effects of data size were also made very clear.



28.08.2021: Session 2: Topic: "Stress Management"

Speaker: Dr. Hema Nandasamy, Dentist, Art of living (TAOL), Bengaluru

The Speaker explained the basics of stress like Physical, Emotional and mental stress. To overcome these stresses, meditation and pranayama should be incorporated in daily life. She highlighted on the chain reactions of stress. One major effect of stress is Acidity increases; chemical effects will lead to emotional imbalances. She briefed out in details all seven levels of existence like body, breath, mind, intellect, memory, ego and self. On way of unblocking technique is meditation. The goal is to have disease free body. she even explained about the physical changes which happens when emotions changes. To control the variations in the breath, the main thing is to mediate and some asana. She demonstrated about the stretching exercises. The exercises started from head, then to neck, shoulders, back to ankle, toes and heels. She highlighted on breathing during the exercises. 96% of toxins in the body is going out through the breath. She demonstrated on exercise for Lungs also. These exercises are very simple and very effective. The session was very informative.

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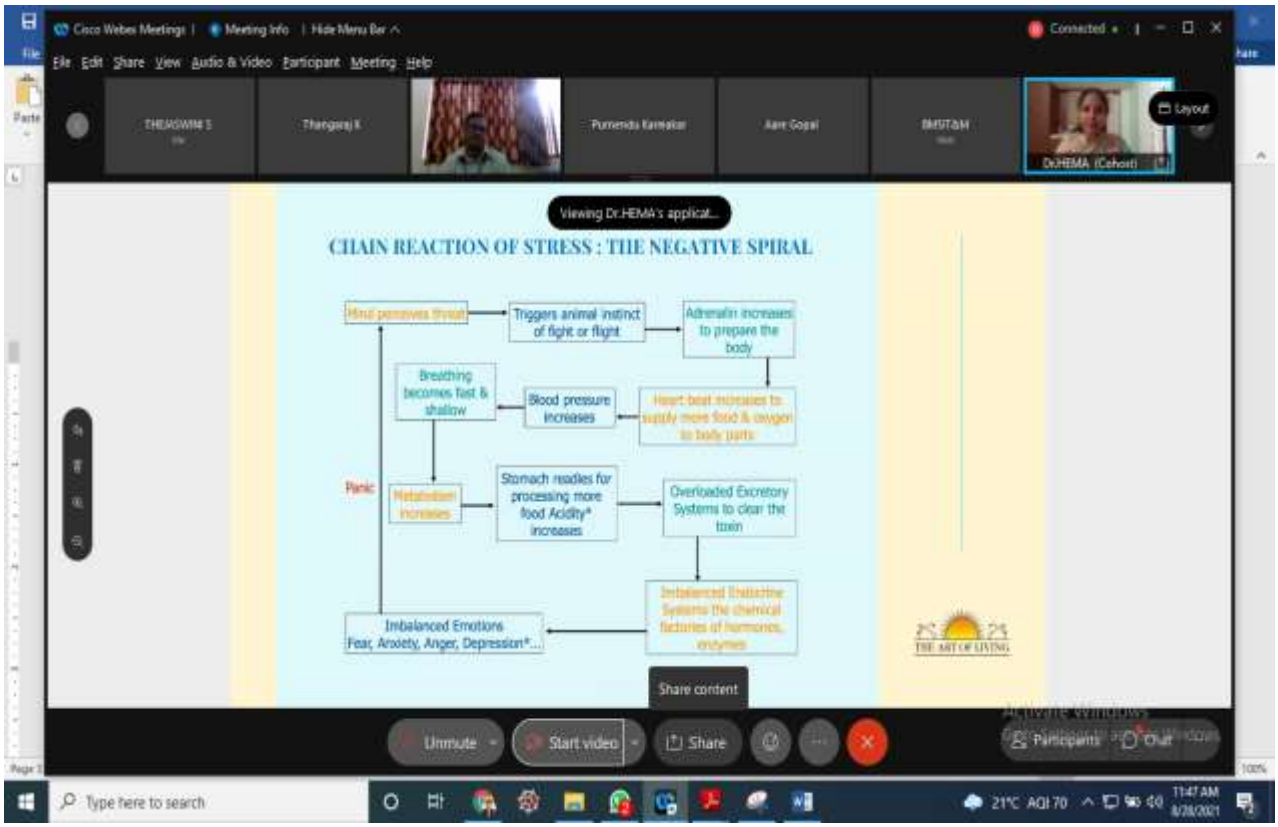

Session 3: Valedictory, oral feedback from the participants and online test conducted.

Participants expressed their learning outcomes and thanked the AICTE ATAL FDP officials, and organizing institute for providing this platform to enhance their knowledge in the domain of green communication.

I take this opportunity to thank wholeheartedly all AICTE ATAL FDP officials for considering our application and giving me an opportunity to coordinate this online faculty development program.

Report prepared by:

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