Message from General Chairs

It is a great pleasure to welcome you to the maiden edition of IEEE International conference on Microwaves, Antennas and Propagation (MAPCON) being held at Hotel The Leela Bhartiya City, Bengaluru, India. MAPCON is a joint flagship conference of IEEE AP-S and IEEE MTT-S in India and organized, this year, by the IEEE MTT/AP Society Bangalore Joint Chapter. IEEE MAPCON was conceived by merging two flagship conferences InCAP and IMaRC of Indian Antenna Community and IEEE MTT-S respectively. MAPCON provides an opportunity for academic researchers, students, practicing engineers, and industry experts to interact and exchange ideas on topics relevant to the current trends in Antenna Technology. Experts from India, USA, Canada, Europe, Isreal, Japan, Taiwan and other countries will be attending MAPCON 2022.

The conference received huge number of submissions and the TPC has selected a good collection of papers that will be presented during the conference with43 oral sessions and 4 poster sessions. The conference also has invited eminent speakers for Plenary, Keynote and TEDx Talks, who will share the excitement of their new findings. Focus of the conference is on Innovations in Antennas, Microwaves and Propagation with special focus on Space and Defence related technologies. Dedicated sessions and a workshop is arranged on the same. An industry exhibit is also organized in which more than 30 industries and 4 selected startups are participating to showcase their product and recent developments in antenna and microwave technologies. 8 Special sessions on6GTechnology,Antenna Arrays, Defence Radar Technology, Measurements, GaN MMIC, SIGHT, YP and WiEM are organized with an aim to provide the latest information on future technologies and encourage participants to develop technologies for the benefit of Humanity. We are pleased that 700+delegates will be able to congregate andshare their knowledge and expertise at a single platform.

It would not be possible to organize a conference of such a magnitude without the help of some committed individuals. MAPCON 2022 is particularly indebted to the Chief Patrons, Patrons, MAPCON EC Co-Chairs, TPC Chairs, Reviewers,

Chairs and members of Finance, Publicity, Publications, Sponsorship, Web and several other committees. We convey our gratitude to the eminent Plenary, Keynote, TEDx, workshop and panel speakers. Last, but not the least, our sincere thanks to MAPCON Executive Committee and IEEE AP/MTT Joint Chapter ExeComfor all their support.

MAPCON2022 has initiated several path breaking initiatives for the benefits of Students/YPs/WiE/Members/Startups/Members viz. (1) M.Tech/B.Tech Student Connect Program, (2) Student Authors Travel Grant, (3) Start-up Initiative, (4) Mentor-Mentee Initiative, (5) Job Opportunities portal, (6) upto 50% subsidized registration fees for Students/AP-S/MTT-S/IEEE Members, (7) upto 20% Early Submission advantage discount to authors who have submitted their manuscript well ahead of paper submission deadline to helped TPC to perform quality review and (8) Free Accommodation to all the Student Delegates, (9) Identifying Academic and Media Partner, (10) Establishment of Centre of Skill Development in Antennas and Microwaves

The conference has been made possible due to the generous support of our sponsors, ANSYS, APC Technology/Wolfspeed, Renesas, MVG, Paras, Anritsu, Micross, DMC, Centum, Sabic, R&S, JV Micoronics, ICON Electromatic, Airbus, Albatross, Maury Microwave, Fastech, Fine-line, Pacemaker Solutions,Satcome Technologies , SSD Polymers, WavePro, IEEE AESS, Cadence, Jyoti Electronics, AMP, IEEE AP-S and IEEE MTT-S. We sincerely thank all of them for their invaluable support.

We sincerely hope that all the delegates will have a wonderful time in the conference where each one will be able to make new friends, re-new old acquaintances and get technically enriched in this wonderful garden city of Bengaluru. Please make time to visit several historical sites with your friends and family that are around Benguluru. The organizing committee will make sure that your stay during the conference is pleasant and comfortable and see you all soon!

Puneet Kumar Mishra

Mrinal Kanti Mandal

General Chairs, IEEE MAPCON 2022

Challenges and Opportunities of Decarbonization in the Global Electric Power Sector

Saifur Rahman, 2023 IEEE President & CEO and Professor,
Director, Virginia Tech, USA
Dec 13, 2022, GBR-1, 18.30-16.50 Hrs

Abstract: A rising level of greenhouse gas emissions, its effect on life and property, food production and human productivity on the planet are raising alarm bells in the civil society, among policymakers and industry leaders. At the same time, there is a tension between industrializednations and emerging economies about the approach to global decarbonization efforts in theelectric power, transportation, ICT, buildings, agriculture and the manufacturing sectors. This presentation addresses the causes and effects of carbonization and mitigation opportunities. Amajor focus is placed on the carbon produced through electricity production, as it is responsible for roughly 30% of carbon emissions globally. The challenge of decarbonization in this sector can be addressed using a portfolio of solutions with low-carbon generation (includingrenewables & nuclear), carbon capture and sequestration, storage, cross-border electricitytransfer and advanced technology focusing on energy efficiency.

Professor Saifur Rahman is the founding director of the Advanced Research Institute at Virginia Tech, USA where he is the Joseph R. Loring professor of electrical and computer engineering. He also directs the Center for Energy and the Global Environment. He is a Life Fellow of the IEEE and an IEEE Millennium Medal winner. He is the 2022 IEEE President-elect and was the president of the IEEE Power and Energy Society (PES) for 2018 and 2019. He was the founding editor-in-chief of the IEEE Electrification Magazine and the IEEE Transactions on Sustainable Energy. He has published over 150 journal papers and has made over five hundred conference and invited presentations. He is the founder of BEM Controls, LLC, a Virginia (USA)-based software company providing building energy management solutions. He has conducted several energy efficiency, blockchain and sensor integration projects for Duke Energy, Tokyo Electric Power Company, the US National Science Foundation, the US Department of Defense, the US Department of Energy and the State of Virginia. He has a PhD in electrical engineering from Virginia Tech.

"Technology Evolution in RF Communication"

Dr. Aniruddha Mukhopadhyaya,
Field Chief Technologist Ansys, Inc., USA
Dec 13, 2022, GBR-1, 18.50-19.10 Hrs,

Abstract : Modern Aerospace and Défense assets require multiple reliable communication links to Ground Stations, Satellites and other moving assets to ensure the success of the mission. It also requires a radar/sensing system which can track and update the multiple targets around it. Similar requirements and constraints are applicable to space communication / awareness. In parallel since 1988, the telecom industry is going through exponential growth in wireless technology (2G to 5G/6G, WLAN) to provide connectivity to massive networks. These requirements have led to the development of new technologies such as cognitive, AESA, Software defined radios, etc. It has entailed the development of new technologies from the component level to the system of systems level. This TEDx talk is going to cover the challenges and opportunities in digital integration and verification of communication systems and how digital transformation is influencing measure of effectiveness up to mission level.

Bio : Anirudh is the Field Chief Technologist Ansys, Inc., Canonsburg, PA. In his current role, Anirudh engages with Ansys Enterprise Customer Executives on technology related to Digital Transformation Initiatives. The digital engineering technologies include Model Based Systems Engineering, open collaboration ecosystem, and Machine Learning based data driven decision tools. With a PhD in Mechanical Engineering and decades of professional experience, Anirudh is domain expert for multiple industry segments focusing on improving productivity, and efficiency in engineering design analysis across globally distributed teams. His current role emphasizes on developing and implementing technology adoption strategy to accelerate product design and process integration enabling continuous design change practices in aerospace, automotive and high-tech industries.

Engineering Indian space program

Dr. M Annadurai, Former Director, URSC/ISRO and Vice President, Tamil Nadu State Council for Science and Technology

Dec 13, 2022, GBR-1, 17.10-17.30 Hrs,

Abstract : Testing moments of Indian space program from concept to commercialization will be brought out in this talk.

Bio: Dr Mylswamy Annadurai, famed as the "Moon Man of India", Vice President, Tamil Nadu State Council for Science and Technology is the space scientist of International repute, has held various responsibilities like Director ISRO satellite Centre, Prog Director Mangalyaan, Project Director Chandrayaan -1&2 and Chairman, Board of Governors, National Design and Research Forum. Holding a Masters and PhD in Engineering, Dr Annadurai led more than 3000 scientists and engineers as Director, ISRO Satellite Centre. He has contributed for more than 60 satellites made in India during his 36 years of illustrious career at ISRO. Notable among them being Chandryanna-1 and Mangalyaan-1 India's first Moon and Mars missions in the capacity of Project Director and Programme Director for the respective missions. Dr Annadurai has led many international forums on Space science and technology, to name a few, Chairman, working group of the whole in United Nations Comittee for Peaceful use of Outer Space, co-chair Asia-Pacific Space Forum, Co-chair Indo German Joint working team for Space Coperation, Indo-French Joint working team for Space Coperation. He has written 5 books, authored many research papers in the area of satellite technology and holds 10 patents.Dr. Annadurai has been bestowed with Padma Shree award in 2016 for Science and Technology from Govt.of India, RajyotsavaPrashasti award for Science in 2008 from Govt. of Karnataka, IEI-IEEE(USA) Engineering Excellence award 2016, Space Systems award, 2009 from American Institute of Aeronautics & Astronautics, USA along with many national and international awards, fellowships and recognitions. Dr Annadurai's achievements in satellite technology have been highlighted in text books ofTamilnadu state Board of Education. Dr Annadurai, after his superannuation spends his time guiding the students in the innovative projects of social relevance

Millimeter Wave Integration and Packaging Strategies using Antenna-in-Package

Rashaunda Henderson, Professor,
University of Texas at Dallas, Richardson TX
Dec 13, 2022, GBR-1, 13.30-14.00 Hrs

Abstract: Affordable and high performance front end modules (FEMs) have been identified as key research challenges for millimeter wave communications. While the design of active components and sub-systems has been explored by many research groups, there is still a need to provide integration and packaging strategies that can meet system requirements and not inhibit the performance obtained at the wafer level. This poses challenges on the front-end modules (FEM) to deliver innovative packaging solutions which can fulfill the FEM integration requirements to maximize performance. Antenna in package (AiP) is a key technique that will enable the realization of 6G FEMs. The talk will discuss AiP solutions from a multi-disciplinary research team from University of Texas at Dallas. The talk will highlight the design, modeling, and characterization of planar antennas integrated into enhanced quad flat no-lead (eQFN) packages in WR8 (90GHz-140GHz) and WR5 (140GHz-220GHz) frequency bands. Further, the design, modeling, and simulation results of chip-to-package transitions, transmission line structures, and antenna feed elements are discussed. The simulated bandwidth and gain of the integrated antennas is compared with their standalone versions. To facilitate accurate design of the antennas and packaging transitions, high frequency material characterization is needed. This work will include results on the dielectric properties of the packaging substrates and over mold materials utilized in the frequency ranges mentioned. A workflow to characterize fatigue failure under board level vibration will be introduced. Simulation results indicating the potential locations of the solder failure under vibration will also be presented. Validation of simulation results is conducted using fringe projection to directly measure the vibration mode when a printed circuit board (PCB) is under vibration.

Bio: Rashaunda M. Henderson received the BSEE degree from Tuskegee University in 1992 and the MS and PhD degrees, also in electrical engineering, from The University of Michigan, Ann Arbor, in 1994 and 1999, respectively. She joined Motorola Semiconductor Product Sector in Tempe, AZ and worked as a research and development device engineer focusing on passive circuits integration in the microwave and mixed-signal technology labs for wireless

embedded systems. She joined The University of Texas at Dallas in 2007 as an Assistant Professor in the Erik Jonsson School of Engineering and Computer Science. She is now a Professor in the Electrical and Computer Engineering Department and Interim co-Department Head. Dr. Henderson is co-founder of the High Frequency Circuits and Systems Laboratory, which facilitates millimeter-wave design and development of components, circuits and integrated packages and antennas for wireless communication systems. She has co-authored more than 100 journal and conference papers focusing on packaging and integration for high frequency applications. Dr. Henderson is a Senior Member of the IEEE and the 2022 President of the IEEE Microwave Theory and Technology Society (MTT-S) Administrative Committee. She is passionate about educating the next generation student and encouraging them to seek careers in science, technology, engineering and mathematics.

A New Generation of Metasurface Antennas

Prof. Stefano Maci, University of Siena, 2023 President IEEE AP-SDec 13, 2022, GBR-1, 14.00-14.30 Hrs

Abstract:"Metasurface" (MTS) denotes a surface constituted at microwave frequency by PCB or 3D printedelements small in terms of wavelengths that collectively exhibits equivalent homogeneous boundaryconditions to any interacting electromagnetic fields. MTSs have had and are having a strong impactin Antenna applications. In the years 2000-2010 MTS for antennas were essentially uniform in spaceand realized by periodic printed elements. This was the first generation of MTS. In the secondgeneration (2010-2020), MTS for antennas was constructed in such a way to change boundaryconditions in space and control the scattered field. Today we are facing a transition to the thirdgeneration of MTS antennas, where MTSs change boundary conditions in space and time, openingnew perspectives in 5G communications and beyond. In this presentation, the evolution of MTSantennas is described, with new ideas and examples. Emphasis will be given on the use of reflectiveintelligent surfaces (RIS) for beyond 5G communications.

Bio: Stefano MACI is a Professor at the University of Siena since 97. The research interest of Prof Maciincludes high-frequency and beam representation methods, computational electromagnetics, largephased arrays, planar antennas, reflector antennas and feeds, metamaterials and metasurfaces.Since 2000, he was member the Technical Advisory Board of 13 international conferences andmember of the Review Board of 6 International Journals. In 2004 he was the founder of theEuropean School of Antennas (ESoA), a post graduate school that presently comprises 34 courseson Antennas, Propagation, Electromagnetic Theory, and Computational Electromagnetics and 150teachers coming from 15 countries. Since 2004 is the Director of ESoA. Since 2010 he has beenPrincipal Investigator of 6 cooperative projects financed by European Space Agency.Professor Maci has been a former member of the AdCom of IEEE Antennas and Propagation Society(AP-S), associate editor of AP-Transaction, Chair of the Award Committee of IEEE AP-S, andmember of the Board of Directors of the European Association on Antennas and Propagation(EurAAP). From 2008 to 2015 he has been Director of the PhD program in Information Engineeringand Mathematics of University of Siena, and from 2013 to 2015 he was member of the first NationalItalian Committee for Qualification to Professor. He foundedand has been former Director of the

consortium FORESEEN, involving 48 European Institutions. Hewas the principal investigator of the Future Emerging Technology project “Nanoarchitectronics” ofthe 8 th EU Framework program, and he is presently principal investigator of the EU program“Metamask”. He was co-founder of 2 Spin-off Companies. He has been a Distinguished Lecturer ofthe IEEE Antennas and Propagation Society (AP-S), and EuRAAP distinguished lecturer in theambassador program. He was recipient of the EurAAP Award in 2014, of the IEEE SchelkunoffTransaction Prize in 2016, of the Chen-To Tai Distinguished Educator award in 2016, and of theURSI Dellinger Gold Medal in 2020. He is President Elect of the IEEE Antennas andPropagation Society 2022.His research activity is documented in 180 papers published in international journals, (among which100 on IEEE journals), 10 book chapters, and about 450 papers in proceedings of internationalconferences. The papers he coauthored have been cited about 9000 times (h index 50, source:Google Scholar).

RF Challenges in Integration of Airborne Early Warning & Control System (AEW&C)

Dr. Rajlakshmi Menon, Director, CABS/DRDO

Dec 13, 2022, GBR-1, 14.30-15.00 Hrs

Airborne Early Warning and Control System (AEW&C) system is a system of systems with Integrated systems that work in synchronization with each other to provide a true force multiplier early warning capability. However, there are major challenges. These challenges become multi-fold in the case of integration of multiple RF systems onboard an aircraft with limited space, volume and power. The operational frequencies of the systems onboard an AEW&C system typically spreads from few MHz to tens of GHz. Effective realization and utilization of AEW&C in an operational environment requires integration of large number of antennas and external sensors. The mounting of antennae in a restricted space should not only provide good Field-of-View (FoV) but with minimal interferences between the systems. Measures are taken through spatial, temporal and spectral diversity to mitigate the challenges. The effect of aircraft structure on the antenna pattern and its impact on the performance of the system is another challenge to be addressed during the design and development of large scale complex airborne surveillance systems such as an Airborne Early Warning and Control system. Use of Computational Electromagnetic (CEM) analysis techniques to optimize the location for positioning the antennas on the aircraft fuselage provides a viable and practical solution to the problem. The design of LRUs to meet the EMI/EMC, Environmental Qualification standards are additional challenges faced by any airborne system designer. Further, the design of long-range medium-PRF airborne

pulse-doppler radar with low sidelobes is itself very challenging along with the operation of SIGINT systems. In this address, the aspect of challenges in the Design, Development and Integration of an Indigenous Airborne Early Warning and Control System is described along with the practical solutions evolved to realize, flight test and induct the system into the Services.

Dr K Rajalakshmi Menon, Outstanding Scientist/ Scientist 'H' has been appointed as Director CABS on 31 Dec 2021.Dr K Rajalakshmi Menon joined CABS/DRDO in 1988 after her MSc in Computer Science from University of Poona. She further obtained her Masters in Engineering and PhDIISc.She has made significant contributions in design and development of Airborne Surveillance Systems. Her area of expertise includes System Engineering of Complex Systems, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), Image Intelligence, Guidance and Control, Battle Management, System Design and System Analysis of Airborne Radars and EW sensors.As Team Leader for the Clutter Characterisation Project, she was instrumental in integration and flight testing of a radar on an aircraft for the first time in the country. She has played a pivotal role in the design, development, integration, testing and delivery of indigenous Airborne Early Warning & Control System (AEW&C). In the AEW&C Program, she took up many leadership roles; as Deputy Project Director and Project Director for System Engineering (SE), System Test and Integration Rig (STIR) andGround Exploitation System (GES)and design & development of Command and Control (C2) functions, viz., Threat Evaluation, Weapon Assignment, Intercept Control and Guidance for Battle Management to enable Network Centric Operations of AEW&C. The C2 functionalities meeting the IAF tactics has been developed for the first time in the country. As, coordinator for indigenous datalinks development, she has successfully demonstrated the communication capability between AEW&C and Ground Exploitation System meeting the operational role. She rose to the post of Associate Programme Director (AEW&C) in 2015 and led the System Engineering, Mission System Integration and Flight Testing, which culminated into induction of AEW&C system into IAF, in Initial Operational Capability (IOC) configuration in Feb 2017. She led all the flight test campaigns of AEW&C from 2013 to 2017. As System Engineer of AEW&C, she applied the principles successfully from concept to delivery, resulting in India becoming the fifth country in the world to have an indigenous AEW&C system.After the successful induction of AEW&C in IOC configuration, she led the design and development of Imaging Radars for UAVs, Fighters, Satellites and manned platforms during her brief tenure

at LRDE, Bangalore from Jul 2017 to Jan 2019, wherein introduced novel technologies for developing very high resolution Synthetic Aperture Radar(SAR). She was also the Associate Director at LRDE.Subsequently, as Associate Director, CABS, she led various projects and programs on Air to Ground Surveillance, specifically towards developing the technologies for Intelligence, Surveillance and Reconnaissance (ISR). She has been the Project Director for ISR Project and Program Director-Designate for Intelligence, Surveillance, Targeting and Reconnaissance (ISTAR) Program for IAF and for a similar program for NTRO. She is member of Institute of Council of System Engineers (INCOSE), Senior Member IEEE and Chairperson, IEEE AESS, Bangalore Chapter, Fellow of IETE and Life Member of Aeronautical Society of India(AeSI).She isa recipient of Laboratory Scientist of the year Award in 2006, Technology Group Award in 2008 for Mission System Controller Development, DRDO Award for Path Breaking Research for developing critical technologies for AEW&C in 2012, DRDO Scientist of the year Award in 2015 and DRDO Technology Group Award for the design and development of Intercept Control and Battle Management System for AEW&C in 2018. She is also a recipient of Outstanding Women Scientist/Technologist/ Engineer Award for2018 from Aeronautical Society of India and Distinguished Alumni Award for 2019 from the prestigious Indian Institute of Science. She is one of the 51 Women Achievers in STEM, all over India and is profiled in e-book launched by Confederation of Indian Industries (CII) in 2021.

Probing the Universe using radio waves: where engineering meets astronomy

Yashwant Gupta, Centre Director,
NationalCentre for Radio Astrophysics, Pune
Dec 13, 2022, GBR-1, 15.00-15.30 Hrs

Abstract : The demonstration of how to transmit and receive radio waves, first done by Sir J.C. Bose in1894, led to the opening up of a new window to the Universe. Radio astronomy involves tight interaction with many fields of engineering, especially those relevant to MAPCON! India has a strong tradition in this branch of astronomy, starting with Prof Govind Swarup who kicked off activities in this area at TIFR in 1963. In this talk, we will trace the fascinating story of radio astronomy and the engineering behind it, with special emphasis on its growth and current status in India, ending with the frontline Indian facility -- the Giant Metrewave Radio Telescope (GMRT). The GMRT, a world class low frequency radio observatory operational since 2002, consists of 30 fully steerable antennas of 45 metre diameter each and can be used as an aperture-synthesis array

for imaging, as well as a phased array to study compact radio sources such as pulsars. It uses several interesting and innovative ideas and technologies. We have recently completed a major upgrade of the GMRT that has improved its sensitivity by a factor of three and has also made it a much more versatile instrument. This upgrade, which employs some cutting edge new technologies, will keep the GMRT at the forefront as one of the most sensitive facility in the 100 to 1500 MHz range for the next decade or so. This talk will spotlight some of these multi-disciplinary technological aspects of the GMRT, and also take a look into how it has improved our understanding of the Universe, and what the future holds.

Bio: Professor Yashwant Gupta presently at the position of Distinguished Professorin the Tata Institute of Fundamental Research (TIFR), heads TIFR's National Centre for RadioAstrophysics, located in Pune, as the Centre Director. He obtained his M.S. and Ph.D. in Radio Astronomy from the University of California, San Diego in 1990, after completing his Bachelor's degree in Electrical Engineering from IIT Kanpur in 1985. Professor Gupta is known for his research on pulsars (which are very rapidly rotating, highly magnetised neutron stars) and the interstellar medium, as well as development of instrumentation and signal processing techniques for radio astronomy. In particular, he has contributed significantly to the building and running of the Giant Metrewave Radio Telescope (GMRT) observatory -- a world class facility located near Pune and operated by NCRA -- right from its conceptualisation to its recent upgrade. He also spearheads India's participation in the Square Kilometre Array (SKA) project -- an international collaborative project to design and build the next generation global radio astronomy facility.He has published more than 175 research articles in international journals, and has also delivered several plenary speeches and keynote addresses in several international and national level meetings. He is a member of several professional bodies: the International Astronomical Union (IAU), the International Union of Radio Science (URSI) and also a Senior Member of the Institute of Electrical and Electronics Engineers (IEEE). He has also been elected to the main national academies of science and engineering in India: INSA and INAE. For his contributions, Prof. Gupta has also been honoured with a number of awards: in 2007, he was awarded the Shanti Swarup Bhatnagar Prize for Science and Technology by the Council of Scientific and Industrial Research, Governmentof India -- one of the highest Indian science awards, for his contributions to physical sciences. Recently, in 2019, he and his team have been awarded the ZubinKembhavi Award by the Astronomical Society of India, for the work of the upgrade of GMRT. In 2022, he has been selected for the Murli M. Chugani Memorial Award of the Indian Physics Association, for his achievements in applied physics.

Modeling Electromagnetic Phenomena in Large Quantum Systems

Amir Boag, School of Electrical Engineering,
Tel Aviv University, Tel Aviv 69978, Israel
Dec 13, 2022, GBR-1, 15.30-16.00 Hrs

Abstract: Density Functional Theory (DFT) is a common method for quantum calculations that offers agood balance between accuracy and computational cost. An important challenge in both
ground state and excited state DFT is the calculation of electrostatic and electro dynamicinduced potentials, as well as the Fock exchange interaction. For the ground state, we present an accurate scalar Green's function kernels to efficiently evaluate the Hartree and Fockpotentials using a Fast Fourier Transform (FFT) method to solve the Poisson equation. Wedemonstrate theefficiency of this method, using hybrid and screened hybrid DFT, to studythe properties ofsilicon quantum dots comprising over a thousand atoms (3 nm diameter). Inthe excited state, electrodynamic fields are formally incorporated within time dependent Density FunctionalTheory (TDDFT) by considering both induced scalar and vector potentials. The Hamiltonian is described in both the Coulomb and Lorenz gauges, and the advantages of the latter are outlined. Integral expressions are defined for the retarded potentials of each gauge and a methodological approach to evaluating these nontrivial expressions with a low computational cost is adopted. The faster potential calculation senables the study of larger systems, such as nanoscale antennas.

Bio: Amir Boag received the B.Sc. degree in electrical engineering and the B.A. degree in physics in 1983, both Summa Cum Laude, the M.Sc. degree in electrical engineering in 1985, and the Ph.D. degree in electrical engineering in 1991, all from Technion - Israel Institute of Technology, Haifa, Israel.From 1991 to 1992 he was on the Faculty of the Department of Electrical Engineering at the Technion. From 1992 to 1994 he has been a Visiting Assistant Professor with the Electromagnetic Communication Laboratory of the Department of Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign. In 1994, he joined Israel Aircraft Industries as a research engineer and became a manager of the Electromagnetics Department in 1997. Since 1999, he is with thePhysical Electronics Department of the School of Electrical Engineering at Tel Aviv University, where he is currently a Professor.Dr. Boag's interests are in computational electromagnetics and acoustics, numerically efficient algorithms

for quantum-electromagnetic simulations, radarimaging, and design of antennas and optical devices. He has published over 130 journal articles and presented more than 290 conference papers on electromagnetics and acoustics.Prof. Boag is an Associate Editor for IEEE Transactions on Antennas and Propagation. He is a Fellow of the Electromagnetics Academy. In 2008, Amir Boag was named a Fellow of the IEEE for his contributions to integral equation based analysis, design, and imaging techniques.

Emerging Trends in Reconfigurable Antennas for SATCOM Applications

Dr. Milind Mahajan, GD, ASG, SAC/ISRO Ahmedabad

Dec 13, 2022, GBR-1, 16.30-17.00 Hrs

Abstract : Reconfigurable antennas have become the need of the hour to provide the flexibility in satellite communication. In this talk, what are different types of Reconfigurable antennas , need of reconfigurability and fundamental concepts of achieving beam reconfigurability are discussed. Advances and emerging trends in technologies like holography based reconfigurable metasurface antennas, digital beam forming reconfigurable antenna, active integrated miniaturized phased array, ferro-electric property based reconfigurable antenna, Lens based antennas, mechanically reconfigurable antennas etc. along with their applications are discussed.

Bio : Milind Mahajan obtained his B.E . (electronics) degree in 1991 from Marathwada University,Aurangabad and M.Tech. degree in Microwave Engineering from I.I.T., BHU, Varanasi in 1993.

He received Ph.D. degree from D.D. University, Nadiad in 2015. He started his carrier inSpacecraft Payload Group of Space Applications Centre, Ahmedabad from 1993. He is currentlyworking as Group Director, Antenna Systems Group. He has worked as guest Scientist atGerman Aerospace Centre (DLR) in 2001. He was the designer of shaped reflectors and DualGridded Reflector Antennas, high power helix antenna, multiple beam antennas for the variousINSAT and GSAT programs. His current areas of interests are metasurface based reconfigurableantennas, contoured beam reflector antennas and digital beam forming based antennas. Heheld many responsibilities as Deputy Project Director, Comm. Payload Antenna Systems ofINSAT-4A/4B/4C,GSAT-5/5P GSAT-7/7A and Advanced Communications Satellite , GSAT-11/19 projects. He has led the

team to develop the antenna systems for navigation satellites, radarimaging satellites and Chandrayaan-2 missions. He is recipient of Space Gold Medal of Astronautical Society of India in 2005, ISRO's team excellence awards in 2007, 2008, 2015 and 2017. He has more than 50 publications in national/ international journals and conferences and 5 national /international patents to his credit.

UWB Future 5G Transceivers & Wearable Electronics

Prof. John L. Volakis, Dean, Florida International University
Miami, FL 33174
Dec 13, 2022, GBR-1, 17.30-18.00 Hrs

Future communication links (future 5G) will require higher data rates, multiple beams, and higher transmit/receive gains, in addition to smaller weight, cost, and power. With the growing interest for reduced size platforms and the requirement for ultra-wideband (UWB) performance to address multi-functionality, there is a strong need for UWB RF front-ends with ultra flexible interfaces. The latter will include millimeter wave and THz capabilities to enable increased spectral efficiency, multi-functionality and security. Simultaneous transmit and receive (STAR) transceivers are also becoming a focus for the coming decade. Further, in recent years, a variety of flexible fabric-based electronics have been proposed. To this end, our team proposed a new class of conductive textiles that have demonstrated unique capabilities in terms of flexibility, durability and manufacturing-ease using standard automated embroidery machinery. These electronic threads (E-threads) have the capability to generate fully embroidered microwave circuitry that has the same electrical properties as traditional microwave circuits printed on PCBs. As such, a new class of wearable devices that are fully integrated and inconspicuously placed within clothing is possible.This presentation will focus on innovative methods for handling UWB communications with RF front end and back-end capabilities having historically low power and game-changing frequency-independent operation. They will includelow power MIMO and beamforming across large bandwidths, from MHz to millimeter wave bands. Challenges in realizing future textile-based electronic devices, including wearable wideband transceivers will be presented. Among them, reliable wearable interconnects, chipsets that are less bulky and integrated with the textile circuitry, and manufacturing challenges will be discussed.

John L. Volakis is the Dean of the College of Engineering and Computing at Florida International University (FIU), and a Professor in the Electrical and Computer Engineering Dept. He is an IEEE, AAAS, NAI, URSI and ACES Fellow. Prior to coming to FIU, he was the Roy and Lois Chope Chair in Engineering at Ohio State and a Professor in the Electrical and Computer Engineering Dept. (2003-2017). He also served as the Director of the Ohio State Univ. ElectroScience Laboratory for 14 years. His career spans 2 years at Boeing, 19 years on the

faculty at the University of Michigan-Ann Arbor, and 15 years at Ohio State. At Michigan he also served as the Director of the Radiation Laboratory (1998-2000). Prof. Volakis has 39 years of engineering research experience, and has published over 450 journal papers, 950 conference papers, over 30 chapters and 31 patents. In 2004, he was listed by ISI Web of Science as one of the top 250 most referenced authors, and his google h-index=74 with over 29000 citations, among the largest in Engineering. He mentored over 100 Ph.Ds/Post-Docs and has written with them 43 papers which received best paper awards. He is one of the most active researchers in electromagnetics, RF materials and metamaterials, antennas and phased array, RF transceivers, textile electronics, millimeter waves and terahertz, EMI/EMC as well as EM diffraction and computational methods. He is also the authors of 9 books, including the Antenna Handbook, referred to as the "antenna bible." His research team is recognized for introducing and/or developing 1) hybrid finite method for microwave engineering, now defacto methods in commercial RF design packages, 2) novel composite materials for antennas & sensor miniaturization, 3) a new class of wideband conformal antennas and arrays with over 30:1 of contiguous bandwidth, referred to as tightly coupled dipole antennas, already garnering over 6 million citations, 4) textile surfaces for wearable electronics and sensors, 5) battery-less and wireless medical implants for non-invasive brain signal collection, 6) diffraction coefficients for material coated edges, and for 7) model-scaled radar scattering verification methods.

Microwave – THz-wave Technology & Applications – An Indian Perspective

Lalit Kumar INAE Expert Group MW-TW, CSIR-CEERI, Pilani, India

Dec 13, 2022, GBR-1, 18.00-18.30 Hrs

Abstract: The Microwave/millimetre-wave technology had taken strong root in the country in 1895, when JC Bose pioneered the mm-wave wireless technology in India. Ever since, there has been a widespread activity in this field and a robust eco-system comprising of several academic institutes, R&D laboratories, test & measurement facilities, public and private industries has been established in India. This has enabled the country to achieve considerable success in theoretical research, indigenous design, development of various microwave/mm-wave systems, sub-systems and components. Some of the sub-areas wherein substantial achievements have been made include: antennas, coaxial and waveguide passive components, GaAs active devices, MIC and MMIC modules, RF-MEMS, high power vacuum electronic devices, solid-state devices, TR-modules, microwave power modules, systems for civilian and defence communications, satellite communications, deep-space communications; high resolution space-borne imaging sensors, radiometers, scatterometers, altimeters, weather radars, defence radars, missile guidance and electronic warfare systems; microwave driven particle accelerators, intense x-ray sources for hyperthermia, radiography and cargo scanners; microwave heating for drying and disinfection of food, material processing, and area-sanitization; mm-wave plasma diagnostic and microwave/ mm-wave plasma heating for fusion reactors (ITER & IPR-Tokamak) etc.

Besides this, several initiatives have also been taken in the THz-wave domain, such as, THz astronomical telescope, imaging system and short range high data rate communication system etc. However, despite our successes in indigenous development of several complex component, device and system technologies, the translation of technology to market has been rather limited. Moreover, the manufacturing base for special materials, components and devices is almost non-existent with us, leading the local industry to be largely dependent on imports. It is also difficult to find enough industry-ready engineers in-spite of a huge number of electronics engineers graduating every year. Thus, there is a need to take a holistic view of the microwave-terahertz-wave technology domain, which is so crucial for national development. It is in this context that, the Indian National Academy of Engineering has set up an expert group on, "Advanced Microwave-THz-wave technology & Applications- Way ahead for India" _to evolve a position paper to serve as a reference document for various stake holders and policy makers. The group is involved in making a thorough assessment of the technology status and market scenario in short- and long- term, identify the facilitating factors for growth of indigenous technology and industry in this strategic area and propose intervention measures. In this talk, a brief perspective on the MW-THz-wave Technology and Applications in the Indian context will be presented on behalf of the expert group, with a view to connect with the stake holders and the experts to gather further inputs on the subject.

Bio: Lalit Kumar obtained Ph.D. from BITS, Pilani. He is Chairman, INAE Expert group on 'Microwave-Terahertz-wave Technology & Applications, CSIR-CEERI, Pilani; Adjunct Professor, BITS-Pilani, Hyderabad; and Editor, IEEE-TED. He was Director, MTRDC-DRDO, Bangalore; Chairman, CEPTAM-DRDO, Delhi; Scientist, CSIR-CEERI, Pilani; Research Fellow: University of Tuebingen, Philips, Hamburg and Lancaster University; and AICTE_INAE Visiting Professor at IITs and engineering institutes. He attended leadership courses at IIMs, NIAS and Harvard University. His contributions include: theory and CAD for electron-optical systems and microwave structures; indigenous development of VEDs: TWTs, MBK, coaxial-magnetron, MPM and transmitters; and research on: gyrotron, HPM devices, and vacuum-microelectronic devices.Fellow: INAE and IETE; Fellow & Founder President (2005-07) VEDA-Society; Senior Member, IEEE/EDS; Member: IPA, IVS, MSI, IEEE-EDS TC-VED (2006-15), EXECOM-IEEE Delhi (2017-19), General Chair, IEEE-IVEC-2011, Bangalore. Co-guest Editor, Special issue-IEEE-TED. Received: DRDO Agni Award–2003 & 2013, IETE RL Wadhwa Award, IETE-IRSI-(83) Award, IETE-JC Bose Award, and CEERI Best Project Award.

Development of mmW/THz Sources

Dr. Madhumita Chakravarti, Director, CMSDS, DRDO

Dec 15, 2022, GBR-1, 8.30-9.00 Hrs

Abstract: Advancement in industry automation, bio-imaging, bio-sensing, military applications have generated research interest in mmW and THz technology. Development of mmW/THz solid-state source with appreciable power is attracting attention of researchers due to their important applications in short range terrestrial and airborne communication including space-based communication. Some of the THz sources reported in the literature are electron beam, optically pumped far-infrared gas lasers, semiconductor QCLs, resonant tunneling diode, IMPATT diode and Gunn diode. Cascaded frequency multipliers are also in use for high frequency generation. These solid-state sources can be tuned to appropriate THz frequency. IMPATT devices based on Si are reported to provide high power at different frequencies in mm-wave window. But the power generated by these sources at THz is not sufficient for intended applications. The researchers are therefore exploring solid-state sources at THz frequency band which should be compact, cost-effective, efficient and powerful. In this respect, the potentiality of IMPATT devices based on WBG semiconducting materials such as SiC, GaN and type-IIb diamond as high-power sources has been reported at THz frequencies.

Bio : Madhumita Chakravarti completed her B Tech and M Tech degree from Instt. Radio Physics and Electronics, Calcutta University. She worked in the field of programmable and re-configurable Airborne RF Sensors for various Air defence and Area Defence Missile programs of DRDO. She has developed multi-function RF Chips for indigenous development of sensors. The system designed by her has been inducted to Indian Air Force and Indian Army. Presently, she is serving as the Director of Centre for Millimeterwave Semiconductor Devices and Systems (CMSDS), a DRDO lab in Kolkata. She is recipient of Path Breaking Technology Award of DRDO in 2010 and in 2017. She received felicitation from State of Andhra Pradesh and Telangana for developing MSMEs in 2015. She has received INAE Woman Engineer of the Year Award 2021. Apart from this, she has served as secretary for IEEE Hyderabad Section in 2015-16. She is founder Chair of IEEE MTT/AP/EMC Chapter, ad-com member of MTT-s in 2009, founder member of WIE affinity group and founder Chair of AESS Chapter in IEEE Hyderabad Section.

Compact Circularly polarized antenna designs for RF energy harvesting system

Dr. Nasimuddin, Institute for Infocomm Research, A-STAR, Singapore

Dec 15, 2022, GBR-1, 9.00-9.30 Hrs

Abstract: Global demand for energy has grown rapidly in recent years. To meet the long-term demand of global energy, different techniques of wireless energy harvesting were introduced. Harvesting RF energy is an alternative solution, especially with the advances and popularity of wireless communication devices. These communication devices are constantly transmitting RF energy, so RF energy harvesting paves a way to utilize the abundant scattered electromagnetic (EM) waves in our surroundings environment. The available EM waves (RF energy) can be in any polarizations, such as elliptical, linear, or circular. By using an appropriate receiving antenna, EM waves can be converted into electrical energy for low-powered devices, and thus, there is much focus put toward RF energy-harvesting (RFEH) systems, especially in the antenna designs. A CP antenna enables the system to harvest RF energy regardless of the device orientation as well as making the insensitive to polarization loss. The RF waves/energy that is found in the surrounding area can exist in any orientation and phase alignment, so CP antennas are more desirable for energy harvesting systems. A dual-feed structure provides a wider 3-dB AR bandwidth compared to the single-feed CP antenna, but it involves a bulky feeding system with a ground plane. For a single-feed CP antenna with compact size, the slight perturbing of the radiator structure for the single-feed configuration is required to excite two modes with a phase shift of 90°. There are different perturbation methods for a square patch radiator, such as truncated corners, slits, slots, and stubs, to generate CP radiation. This invited talk presents an overview on the antenna design considerations for RFEH systems and describes updates recent progress in the antenna technologies for RFEH. Compact and low-profile CP antenna designs will be also presented in detail for RFEH applications.

Dr Nasimuddin (M'2003-SM'2009) received his B.Sc. degree in 1994 from Jamia MilliaIslamia, India, and his M.Tech. (Microwave Electronics) and Ph.D. degrees in 1998 and 2004, respectively, from the University of Delhi, India. Dr Nasimuddin has worked as a Senior Research Fellow (1999-2003) in DST sponsored project and CSIR grant, Senior Research Fellow in Engineering Science at Department of Electronic Science, University of Delhi,

India. He has worked as an Australian Postdoctoral Research Fellow (2004-2006) in awarded Discovery project grant from Australian Research Council at the Macquarie University, Australia. Currently, he is working as a scientist III at the Institute for Infocomm Research, A-STAR, Singapore. He has published 220 journal and conference technical papers on microstrip-based microwave antennas and components. Three US/SG patents have been granted and two filed on leaky wave/RF energy harvesting/circularly polarized/grid antenna technologies. He has edited two books and contributed a chapter to a book "Microstrip antennas" published in 2011. His research interests include multi-layered microstrip-based structures, antenna system research and development. DrNasimuddin is a Senior Member of the IEEE and the IEEE Antennas and Propagation Society. He was awarded a Senior Research Fellowship from the CSIR, India in Engineering Science (2001-2003); a Discovery Projects Fellowship from the Australian Research Council (2004-2006); Singapore Manufacturing Federation Award (with project team) in 2014, the Young Scientist Award from the International Union of Radio Science (URSI) in 2005, and Exceptional Performance Reviewer Award Certificate from the IEEE Antennas and Propagation Society in 2019.He is an Associate Editor of the International Journal of Antennas and Propagation and various antennas/microwave/RF related journal's editorial broad member. He has been members of organizing committees of several Antenna and Propagation included IEEE APS 2021 related conferences, serving as Publication Chair/Publicity Chair/Conference Secretary. He is the Chair of IEEE Singapore MTT/AP Joint Chapter.

Building Uncooled Infrared Camera based on One Atom Thick Graphene

Prof. Debashish Chanda, University of Central Florida, USA

Dec 15, 2022, GBR-1, 9.30-10.00 Hrs

Abstract: The talk will outline a novel strategy for uncooled, tunable, multispectral infrared detection. Due to the low photon energy, detection of infrared photons is challenging at room temperature. One atom thick graphene offers an alternative mechanism bypassing material bandgap restriction. Further, the ability of carrier concentration modulation on graphene via external voltage offers dynamic spectral selectivity for "color" night vision/sensing. The performance of preliminary demonstration compares favorably even with present cryogenically cooled detection schemes paving the path for commercial development of many applications from space exploration to healthcare.

Prof. Debashis Chanda is a Professor, jointly appointed with NanoScience Technology Center, Dept. of Physics and College of Optics and Photonics (CREOL), University of Central Florida (UCF). Dr. Chanda received his PhD from University of Toronto. His PhD work was recognized in the form of several awards, including prestigious National Sciences and Engineering Research Council (NSERC) fellowship. Dr. Chanda completed his post-doctoral research with Prof. John A. Rogers at Beckman Institute, University of Illinois at Urbana-Champaign. Quite a few of this research works were extensively covered by National Science Foundation news, BBC, Daily Mail, NBC, Fox, Science Radio and other national/international media outlets. His research has appeared on American Scientist magazine as focused article where it was outlined how companies like Intel, Toshiba etc are trying to adopt some of the printing techniques which were developed in his group. Dr. Chanda is a recipient of the 2012 DOE Energy Frontier Research Center (EFRC) Solar Energy Future Direction Innovation Proposal Award, 2013 NSF Summer Institute Fellowship and International Displaying Future Award-2016 by Merck Germany, UCF Reach of the Stars Award (2018)etc. Dr. Chanda's research has been supported by NSF, DoD, DARPA, Florida Space Institute/NASA, Northrop Grumman, Lockheed Martin etc. Apart from that Dr. Chanda is the founder of start-up, E-Skin Displays Inc., out of his research in California.

Chipless RFID Technology

Giuliano Manara Dipartimento di Ingegneriadell'Informazione University of Pisa, Pisa, ITALY

Dec 15, 2022, GBR-1, 10.00-10.20 Hrs

Abstract: Radio Frequency Identification (RFID) is a low-cost wireless technology, enabling to engage, identify, locate, transact, and authenticate products. RFID market has identified as a growing market of enormous potential over the past few years. It is worth observing that most of RFID applications in logistics and other areas can successfully develop in the market only if the cost of RFID tags drops to a very low price. Standard RFID tags do contain chipsets, which need to get the power required for their activation from the reader, through a wireless power transfer procedure. In this context, chipless RFIDs represent an alternative approach for identifying objects, authenticating and sensing. The basic idea is to simplify the tag by removing any active circuit from it. Indeed, even if the cost of chipped RFID tags is already low (about 10 eurocents when distributed in large quantities), the removal of the microchip could make radio frequency labels available at a sub-cent cost. In this respect, it is important to consider that chipless tags fabrication is fully compatible with printed electronics low-cost

manufacturing methods such as, for instance, screen printing, gravure, offset lithography, and inkjet printing. Another important advantage of chipless tags is to open the way of application of radio frequency labeling in extreme environments, where electronics may not be used. Some application examples of chipless RFID technology will be shown at the conference to the end of demonstrating its potentiality.

Giuliano Manara received the Laurea (Doctor) degree in electronic engineering (summa cum laude) from the University of Florence, Italy, in 1979. He was first with the School of Engineering of the University of Florence, Italy. Then, in 1987 he moved to the University of Pisa, Italy, where he is presently a Professor of Electromagnetics and Microwave Techniques at the Department of Information Engineering of the School of Engineering. Since 1980, he has been collaborating with the Department of Electrical Engineering of the Ohio State University, Columbus, Ohio, where, in the summer and fall of 1987, he was involved in research at the ElectroScience Laboratory.His research interests have centered mainly on the asymptotic solution of radiation and scattering problems to improve and extend the uniform geometrical theory of diffraction (UTD). In this framework, he has analyzed electromagnetic wave scattering from material bodies, with emphasis on the scattering from both isotropic and anisotropic impedance wedges. He has also been engaged in research on numerical, analytical and hybrid techniques (in both frequency and time domain), scattering from rough surfaces, frequency selective surfaces (FSS), and electromagnetic compatibility. His research has also been focused onmicrowave antennas with application to broadband wireless networks and on the development and testing of new microwave materials (metamaterials) for electronic systems. More recently, he has conducted research onelectromagnetic issues enabling the development of the Internet of Things (IoT), with specific attention to antennas for near-field applications and the analysis (theoretical and experimental) of Radio Frequency Identification (RFID) systems.

Prof. Manara has authored more than 160 papers on qualified technical journals with referees, and more than 250 papers presented at international conferences. He was elected an IEEE Fellow in 2004 for “contributions to the uniform geometrical theory of diffraction and its applications.” From August 2011 to August 2014, he served as the International Chair of URSI (International Union of Radio Science) Commission B – Fields and Waves. In this context, he was the General Chair of the URSI Commission B International Electromagnetic Theory Symposium (EMTS), held in Hiroshima, Japan, during May 2013. In 2017, he was elected an URSI Fellow. Since August 2021, he has been serving as an URSI Vice-President.

Special Session on 6G

Abstract: As 5G systems are getting deployed in major parts of the world, academia and industry have initiated research activities towards conceptualizing a 6G communication system. In an overall sense, 6G vision is to make the world hyper-connected: a world that presents rich-media content. On one hand, exponential growth of cutting-edge technologies such as Next-gen Networks, AI, IoT, Robotics are driving a directional shift in the industry. On the other hand, Tera-Hertz Communication would entail enabling technologies: from newer materials in wireless devices to larger antenna arrays in base stations. Intelligent Reflecting Surfaces (IRSs) that tune the wireless propagation environment with an array of IRS units are expected to play a critical area in 6G system design. Energy-efficiency will further demand associated system improvement in IC and RF technologies from ADC-DAC to low-loss antennas. In this panel, we will deliberate upon the opportunities and challenges around 6G enabling technologies as well as future standard development.

Session Chair: Dr. Aloknath De, FNAE, Exec Consulting Director and ex-CTO---Samsung India

Co-Chair: Prof. K J Vinoy, ECE Dept, IISc, Bangalore.

Invited Speakers:

Dr. Tushar Sharma, Renesas USA, "Shaping the 5G and Beyond Ecosystem in India"

Dr. Kiran Mukkavilli, Qualcomm USA, "Technology Enablers and Roadmap to 6G"

Panel Discussion:

Moderator: Dr. Aloknath De, Samsung

Panelists: Dr. Tushar Sharma, Renesas

Dr. Kiran Mukkavilli, Qualcomm

Mr. Santhosh Kumar, TI *

Mr. Akshay Aggarwal, MediaTek

Special Session on Session: GaN MMIC: Impact on Strategic Systems

Future trends for next generation strategic systems require multifunctionality and modularity like combining radar, communications, and electronic warfare in one system. This higher level of functional integration improves system performance through heightened awareness, improved responsiveness, and mission execution. The use of gallium nitride (GaN) MMIC as key component enables higher performance of systems meeting the requirements in small size with high power and hence GaN MMIC areemerging as an alternative or replacement for laterally diffused MOSFET (LDMOS) components. In most of next generation systems GaN MMIC technology is being considered becauseof high power density, high efficiency, wide bandwidth, and exceptionally long life. GaN on SiC has superior properties like higher breakdown voltage; higher saturated electron drift velocity and higher thermal conductivity. Hence GaN HEMTs also offer greater power density and wider bandwidths compared to Si; GaAs; and GaN on Si transistors. As shorter gate length GaAs and GaN transistors become available, coupled with improved circuit design techniques, new devices are becoming available that can perform comfortably to millimeter wave frequencies, opening new applications that were hard to contemplate a decade ago. This session will briefly describe the state of the semiconductor technology that is enabling these developments to achieve optimum performance of devices, circuits and subsystems based on this technology.

Session Chair: Dr S Christopher, Former Chairman of the Defence Research and Development Organisation (DRDO). Presently professor in Electrical Science Department at India Institute Technology, Madras.

1. GaN MMIC Technology and its impact on Design of Strategic Systems

   -Keynote Address By Dr Suma Varughese, DG Med& Cos OS, Sc-H,DRDO.
2. Status of Indigenous GaN MMIC Technology by Dr D S Rawal, Sc-G,SSPL,DRDO.
3. GaN MMIC Applications and Way Forward by Mr Anant Naik, CEO GAETEC ,Sc-G .

4. Development of Indigenous Process Design Kit for GaN MMIC by Mr Samuder Gupta, Sc-G,SSPL.
5. Development of Indigenous GaN MMIC by Dr Meena Mishra, Sc-G,SSPL

GaAs and GaN MMIC s for strategic Applications

Dr Suma Varughese, Outstanding Scientist, Director General MED, CoS&CS (MCC)

Gallium Arsenide (GaAs) and Gallium Nitride (GaN)-based technologies are revolutionizing the modern defence RF and space application. The capabilities to deliver high power, high frequency, high linearity, high efficiency and high temperature performance renders it the most sought after device for applications in advanced radars, data links, satcoms, etc. GaAs and GaN Monolithic Microwave Integrated Circuits (MMICs) are key enablers for the ever shrinking defence and space systems.GaN-based HEMT technology offers a significant advantage over the existing gallium arsenide (GaAs) Monolithic Microwave Integrated Circuits (MMICs) due to the capability of GaN devices to operate at higher voltages owing to very high breakdown fields associated with them. Additionally, the GaN devices offer much higher impedance resulting in the requirement of less complex matching networks in RF power amplifier integrated circuits. The low current operation aided with a higher efficiency results in power saving and reduced costs for cooling the system. Therefore, the GaN-based power amplifiers constitute the heart of present day transceiver (T/R) modules in AESA (Active Electronically Scanned Array) radars and communication systems.

Status of Indigenous GaN HEMT based MMIC Technology

D. S. Rawal, Solid State Physics Laboratory,Delhi, India

Advancement in III-N device technology have mainly taken place due to material innovations that paved the way for the development of new generation of microwave devices based on confinement of carrier in quantum well with superior transport properties. Consequently AlGaN/GaN HEMT (High Electron Mobility Transistor) based MMICs (Monolithic Microwave Integrated Circuit) with improved performance are being developed worldwide for high frequency, high power, and broadband civil/military systems. Indigenous HEMT MMIC technology is developed on 100µm thick, 75mm diameter SiC semi-insulating substrate, to deliver RF power output ~ 5W/mm @28V for up to X-band applications. The main technology breakthrough has taken place in HEMT device design, epi-layer structure, improved S/D contacts, reduced gate length (< 0.2µm) with gate engineering, innovative multi-finger field plate design and low parasitic interconnection techniques using air-bridge metal cross overs/through substrate

via-hole source grounds. Following device development, extensive device characterization is done, Process Design Kit (PDK) specific to indigenous foundry capability is developed and C/X band Power amplifier, Low noise amplifier and Switch MMICs are designed and fabricated. The talk will mainly cover all the important aspects of GaN HEMT device technology right from HEMT material structure optimization, device design to unit process development on front side/backside of wafer to fabricate active/passive component, characterization and their integration including PDK development suitable for X-band MMIC applications.

Development of Indigenous Process Design Kit for GaN MMIC

Mr Samuder Gupta,Sc-G,SSPL

SSPL has successfully developed process design kit for the indigenous GaN MMIC technology process. This process design kit is required for MMIC design involving power amplifiers, low noise amplifiers SPDT switches and multifunctional MMICs in various frequency ranges. The kit contains passive and active components required for the design.

Development of Indigenous GaN MMIC

Dr Meena Mishra, Sc-G,SSPL,DRDO

SSPL/GAETEC have successfully demonstrated GaN technology at C band, X band and is presently working towards the development of Ku band applications.130W discrete GaN power bar , GaN based C band X band 10W,20W and 30W power amplifiers, C-Ku band and Ku band Power amplifiers and multifunctional MMIC, low noise amplifiers SPDT MMICs have been successfully demonstrated The RF characterisation has been carried out in all the X band circuits in pulse mode and for C-Ku band and Ku band circuits in pulse mode as well as CW mode. Out of these circuits C-Ku band power amplifier on 0.25 µm node , C-Ku band TR chip and Ku band TR chip based on 0.15 µm node are the circuits designed with innovative techniques and are not off the shelf available components.

Special Session on Array Antennas

(Session Chair: Prof. Prabhakar Pathak, OSU, USA)

1. Near-Field Focused Antenna Arrays for Short Range Communications and Wireless Power Transfer, Prof. Giuliano Manara, Dipartimento di Ingegneriadell' Informazione, University of Pisa, Pisa, ITALY

Abstract - Conventional wireless applications are often characterized by a large distance in termsof wavelengths between the transmitting antennas and the receiving antennas or scatterers, allowing the application of far-field approximations, as well as standard antenna characteristicparameters. Nonetheless, an increasing number of wireless systems have been recently proposed, where the far-field condition is not met and specific coupling models and ad-hoc antenna designcriteria must be necessarily adopted to the end of optimizing system performance. As far as near-field applications are concerned, it is worth mentioning wireless power transfer, near-fieldcommunications (NFC), radio frequency identification, antenna measurements, non-destructivesensing, chip-to-chip wireless links, biomedical applications, body-centric communications, microwave imaging, among many others. This talk is aimed to present an overview of the basic working principles of near-field focused antenna arrays and the main design criteria proposed fornear-field shaping around the focal point. A brief overview of the applications requiring such classof antennas is also provided. Among others, specific attention will be given to RFID (RadioFrequency IDentification) technology.

2. Dynamic Beam Forming and Modulation using a Reconfigurable Metasurface, KJ Vinoy, Aritra Roy, Gouranga Dhaundia, Electrical Communication Engineering, Indian Institute of Science, Bengaluru

Abstract: Reconfigurable meta surface scan be used with antennas for dynamic beam forming and beam steering. These meta surfaces are designed by incorporating switching components within subwave length unit cells. Recently, our group has designed a meta surface and developed its controller for directly modulating the data in the channel. This design employs a compact meta surface unit cell with maximum difference between its switching states. Meandered line segments whose resonant frequency is changed by switching a PIN diode embedded in the unit cellON or OFF, have been employed for this design. The array is placed directly in front of a microstrip antenna in its near field. Several parametric studies have been conducted to design of this transmitarray metasurface and aunique communication scheme has been demonstrated using this, where the data is used to modulate the channel directly, unlike conventional approaches of modulating the carrier. An extension of this configuration with a wideband antenna may be employed for computational microwave imaging. Our recent research indicates that the overall variation in the complex field for illuminating the imaged object can be improved with some modifications to the primary radiator used with

this transmitarray metasurface. A preliminary co-design approach for the antenna-metasurfaceconfiguration for maximizing the overall performance will also be presented.

3. Simultaneous Near- and Far-field Beam Radiations of Phased Array of Antennas Excited by a Generalized Rotman Lens Beamformer for Vehicular ADAS Application, Hsi-Tseng Chou, Shih-Kai Ho and Siddhartha Panigrahi

Smart cars with vehicular advanced driver assistance systems (ADASs) have become animportant industrial trend. The functionality of ADASs is to detect the surrounding targets atnear- and far distances to increase driving safety. Conventional ADASs install several different sets of phased arrays of antennas that are excited to produce high-directional gain with narrowbeamwidths, and low gain with broad beam widths for long and short-range coverages, respectively. These long- and short-range detections appear simultaneously in the front-viewcoverage pointing directly to the vehicles' broadside lane and two adjacent side lanes. In this case, the broadside far-field focused (FFF) beam is angularly narrow, while the defocused beams for the two side-lane coverages are very broad. Thus, from a system point of view, the ADAS simultaneously operate in three modes for front-view coverage by alternatively exciting different antenna arrays for long- and short-range detection purposes. Large antenna arrays may produce good radiation characteristics of beam radiation, and inter-beam overlapping with dramatic coverage cutoff to avoid detection ambiguity in the inter-beam overlapping region, which may cause oversize when three large antenna arrays are used. To reduce the system complexity, sharing a common lar ge antenna array appears to be the most effective for compactness, which may produce multiple beams as the desired operational modes by using a proper beamformingcircuit (BFC), such as the Butler matrix, Blass matrix, Rotman lens, and Luneburg lens.

Conventionally available multi-beam BFC excites the common antenna array to radiate eithersole FFF beams, or near-field focused (NFF) beams by using the Luneburg lens or Rotman lens. These multi-beam BFCs are not applicable to the ADAS systems that need to simultaneouslyproduce both far-field focused and defocused beams with relative beam controllability fordifferent range detections. A new Rotman lens BFC design is thus proposed in this paper, whichmay excite the antenna array to radiate far-field focused, NFF (far-field defocused beam), andshaped beams by selecting different beam ports of the BFC (referred to as the different modes ofoperation). This new Rotman lens BFC was made possible by generalizing the three designequations, arising from the equal-time-delay ray propagations inside the BFC with respect to thethree different beam ports, to phase-matching to the desired array excitations of different beams. This introduction of excitation phase matching allows the excitations of the antenna array to berelative arbitrarily specified for either FFF, NFF, or shaped beams, as required in the ADASs for different range coverages. In other words, this new Rotman lens BFC may produce arrayexcitations to radiate different beam characteristics of hybrid

combining FFF, NFF, and shapedbeams by using the common set of antenna arrays. This multi-beam design concept with FFF and NFF/shaped beam capability is applied to design a practical antenna system for ADAS applications, especially for transmitting (TX) antennas.

This antenna system consists of three TX antenna ports and four receiving (RX) antenna ports for MIMO applications. The three TX antenna ports behave like the three radiation modes of ADASs to provide a high-gain, narrow FFF beam for broadside target detection inside the front lane and two NFF/shaped beams of broad beam widths for short-range detections on both side lanes. On the other hand, the four RX antenna ports allow the DSP of received signals to estimate the angle of arrival (AoA). This antenna array has been realized by using various series-fed column arrays of patch antennas to form the multi-beams. Both full-wave simulation and measurement over the antenna array prototype were compared with good agreements. The new Rotman lens BFC can also be applied to various communication applications requiring flexible

4. Antenna-Platform Interaction Study in Phased Array Antennas, Dr.AshutoshKedar, LRDE/DRDO

Phased array antenna systems (PAAS) for radars need to consider the effect of the surrounding environment and the platform for mounting to correctly assess its performance in the field scenario. This paper discusses these aspects of the design and development of PAAS. A substrate integrated waveguide technology (SIW) based U-slot microstrip patch antenna (SIW_MPA) is designed with wide beam width and wide band performance and used for realizing the antenna array for PAAS. The design cycle of PAAS includes the single element design (isolated), element performance in array environment, followed by the effect of platform and surrounding structures on array performance. A hybridization of finite element method (FEM) and shooting bouncing ray (SBR) modules in electromagnetic (EM) solver, Ansys HFSS are utilized to carry out the various simulations. The results are quite informative and useful for mast mounted phased array antenna systems.

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Union Minister of State for Ministry of Electronics & Information Technology and Skill Development and Entrepreneurship

S. Somanath

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G. Satheesh Reddy

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Prof. Emeritus at OSU

Prof. John Volakis
Florida International University

Prof. Giuliano Manara
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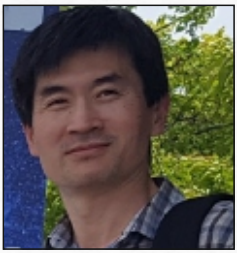
Prof. Debashis Chanda
Uni. Of Central Florida

Dr. Rajlakshmi Menon
Director, CABS, DRDO



Prof. Sungtek Kahng
Incheon National University

Prof. Amir Boag
Tel Aviv University

Prof. Jiro Hirokawa
Tokyo Institute of Technology

Dr. Madhumita Chakravarti
Director, CMSDS

Milind Mahajan
GD, ASG, SAC/ISRO Ahmedabad

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Dr. Chinmoy Saha
IIST, Trivandrum

Sherry Hess

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