



Graduate Seminar (EEL 6936)
Department of Electrical Engineering
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Antenna Systems for 21st Century Satellite Communication Payloads

Abstract

The 21st century has so far seen several new satellite services such as local-channel broadcast for direct broadcast satellite service (DBS), high capacity K/Ka-band personal communication satellite (PCS) service, hosted payloads, mobile satellite services using very large deployable reflectors, high power hybrid satellites etc. All of these satellite services are driven by the operators need to reduce the cost of satellite and pack more capability into the satellite. Antenna sub-system design, mechanical packaging on the spacecraft, and RF performance become very critical for these satellites. This talk will cover recent developments in the areas of antenna systems for FSS, BSS, PCS, & MSS satellite communications. System requirements that drive the antenna designs will be presented initially with brief introduction to satellite communications. Typical block-diagrams of the satellite payload including antenna and repeater will be presented.

Advanced antenna system designs for contoured beams, multiple beams, and reconfigurable beams will be presented. Contoured beam antennas using dual-gridded reflectors, shaped single reflectors, and shaped Gregorian reflectors will also discussed. The figure of merit of these antennas using gain-area-product (GAP) will be addressed. Multiple beam antenna (MBA) concepts and their advantages compared to conventional contoured beams will be introduced. Various designs of the MBA for DBS, PCS, and MSS services will be discussed along with practical examples. Recent advances in feed technology and reflector technology will be addressed and few examples. Advances in multi-band antennas covering multiple bands will be presented. Reconfigurable antennas, phased array systems, and lens antennas will be discussed. Topics such as antenna designs for high capacity satellites, large deployable mesh reflector designs, low PIM designs, and power handling issues will be included. Introduction to remote sensing antennas with examples will be included in the talk. Advanced high power test methods for the satellite payloads will be addressed. Brief introductions to TT&C antennas, passive inter modulation products (PIM) and multipaction for satellite payloads will be given. Antenna test ranges and software tools required for test and design of 21st century satellite antennas will be presented. Future trends in the satellite antennas will be discussed. At the end of this talk, engineers will be exposed to typical requirements, designs, hardware, software, and test methods for various satellite antennas.



Biography

Sudhakar K. Rao received B. Tech degree in electronics & communications from Regional Engineering College, Warangal in 1974, M. Tech in Radar Systems Engineering from Indian Institute of Technology, Kharagpur in 1976, and Ph.D. in Electrical Engineering from Indian Institute of Technology, Madras in 1980. During the period 1976-1977 he worked as a Technical officer at Electronics Corporation of India Limited, Hyderabad, on large reflector antennas for LOS and TRPO microwave links, and during the period 1980-1981 he worked in the Electronics and Radar Development Establishment, Bangalore, as a Senior Scientist and developed phased array antennas for airborne applications. He worked as a post-doctoral fellow at University of

Trondheim, Norway during 1981-1982 and then as a Research Associate at University of Manitoba during 1982-1983. From 1983-1996, he worked at Spar Aerospace Limited (now MDA), Montreal, Canada, as Staff Scientist and developed advanced antennas for several satellite communications. From 1996-2003 he also worked as Chief

Scientist/Technical Fellow at Hughes/Boeing Satellite Systems and developed multiple beam antennas and reconfigurable beam payloads for commercial and military applications. During the period 2003-2010, he worked as a Corporate Senior Fellow at Lockheed Martin Space Systems and developed antenna payloads for fixed satellite, broadcast satellite, and personal communication satellite services. He invented novel high power TVAC test methods for satellite payloads using “pick-up horn absorber loads” that have about 8 times cost and schedule savings which has become a standard method at Lockheed Martin and used successfully on last 10 satellite payloads. He is currently a Technical Fellow at Northrop Grumman Aerospace Systems, Redondo Beach, CA, working on advanced antenna systems for space and aircraft applications.

Dr. Rao developed antenna payloads for more than 65 satellites including first mobile satellite M-Sat and pioneered development of first Direct Broadcast Satellite with local channels (DirecTV-4S). His work on development of radiation templates for complex radiation patterns of satellite antennas for interference analysis was adopted and recommended by the International Telecommunication Union (ITU)/CCIR in 1992 as the world-wide standard for satellite manufacturers and operators. He authored over 160 technical papers and has 41 U.S patents. He authored and co-edited three text book volumes on “Handbook of Reflector Antennas and Feed Systems” that are published in June 2013 by the Artech House.

Dr. Rao became an IEEE Fellow in 2006 and a Fellow of IETE in 2009. He has received several awards and recognitions that include 2002 Boeing’s Special Invention Award for series of patents on satellite antenna payloads, 2003 Boeings’ technical achievement award, Lockheed Martin’s Inventor of Technology award in 2005 & 2007, IEEE Benjamin Franklin Key Award in 2006, Delaware Valley Engineer of the Year in 2008, and Asian American Engineer of the year award in 2008. He also received IEEE Judith Resnik Technical Field Award in 2009 for pioneering work in aerospace engineering. Dr. Rao is appointed as the Distinguished Lecturer by the IEEE APS for a three year period (2014-2016). He is the Chair for the IEEE APS “Industry Initiatives Committee” with 12 international members, associate editor for the IEEE Antennas & Propagation Magazine’s “Antenna Applications Corner”, Special Session Organizer/Chair for the last 5 IEEE APS/URSI Symposia, Technical Program Committee member for IEEE APS/URSI Symposia from last 10 years, and reviewer for the IEEE AP Transactions, WPL, IEE etc. Dr. Rao mentored more than 50 engineers in his career who are now in key technical and management positions throughout the aerospace industry.