

1. Course header

a. Course title

MIMO antenna measurements made simple for 4G systems

b. Course type

½ day

c. Contact person

David A. Sanchez-Hernandez
Technical University of Cartagena, Antiguo Cuartel
Antigones, E-30202 Cartagena, Spain
Tel.: +34968325317
Email: david.sanchez@upct.es

2. Course description

a. Who should attend this course and why

With LTE already deployed in some cities by the end of 2010 and the compulsory use of MIMO into 3.9G standards (IEEE802.11n, HSPA+, WiMAX and LTE), MIMO technology has finally exploded. Mobile Internet Peripherals and Devices are said to take a market share of 30% of all handsets and non-handsets wireless devices by 2013. In this complex scenario, antenna engineering has gained a tremendous importance. While the use of multiple antennas in the base station or access point (AP) is usually feasible, user terminals have size and weight restrictions that make the use of conventional antenna elements such as dipoles or patch antennas problematic. Thus, novel array topologies and antenna elements for multi-antenna systems are of great interest. Not only new geometries and designs are required, but also the antenna engineer is faced with a novel way to evaluate performance. While the parameters to characterize antennas in general are well defined and worldwide accepted, the way to evaluate the performance of an antenna array for MIMO is still an open issue, since multiple new concepts have to be considered, such as pattern diversity, correlation among elements, fading environment or polarization diversity, among others. Several new parameters and different figures of merit have been proposed to characterize antennas for MIMO systems, including efficiency, diversity gain, MIMO capacity and Throughput, among others. Consequently, the antenna engineer is condemned to learn all these new parameters if he/she can face 4G designs successfully. In this short course, these new antenna parameters will be described in detail. The basics of MIMO testing will be explained from the antenna engineering point of view. The concepts will be reviewed by case studies used in some MIMO testing tools. Both passive and active antenna testing parameters of standardized bodies and round robin results between labs worldwide will be presented and analyzed. The different methodologies for testing which have been approved by standardized bodies (3GPP/CTIA) will be reviewed and compared.

The course is an ideal getting started document for antenna engineers that are first faced with the novel MIMO testing tools for antennas, which will become a must for any 4G antenna technology onwards.

Likewise, it represents an update of the latest figures of merit and measurement techniques for those antenna engineers already keen on MIMO.

b. Course topics, and names of instructors

MIMO techniques: Basics and fundamentals - Prof. David A. Sanchez-Hernandez

- What is MIMO?
- MIMO parameters and Figures of Merit
- The physical structure of the channel
- The radiation and configuration characteristics of the MIMO antenna array
- The MIMO algorithm at transmit and receive modules

MIMO antennas for small handsets - Prof. Gert F. Pedersen and Dr. Mauro Pelosi

- Design, development and testing
- Field trials
- OTA and standardization

MIMO testing - Dr. Juan F. Valenzuela-Valdes

- MIMO antenna performance parameters
- MIMO fading parameters
- MIMO physical parameters
- MIMO active power parameters

MIMO case studies - Dr. Juan F. Valenzuela-Valdes and Prof. David A. Sanchez-Hernandez

c. Means of instruction

No software will be used

3. Course instructors

a. Name, full institutional/professional affiliation, postal and email address, phone number

Prof. David A. Sanchez-Hernandez
Technical University of Cartagena, Antiguo Cuartel
Antigones, E-30202 Cartagena, Spain
Tel. + 34 968 325317
Email: david.sanchez@upct.es

Prof. Gert F. Pedersen
Aalborg University, Department of Electronic Systems, Niels
Jernes Vej 12, DK-9220 Aalborg, Denmark

Tel. + 45 9940 8617

Email: gfp@es.aau.dk

Dr. Mauro Pelosi

Aalborg University, Department of Electronic Systems, Niels Jernes

Vej 12, DK-9220 Aalborg, Denmark

Tel. + 45 9940 8656

Email: mp@kom.aau.dk

Dr. Juan F. Valenzuela-Valdes

EMITE Ing, Edificio CEEIM, Campus Espinardo

E-30100 Murcia, Spain

Tel. + 34 968 100181

Email: juan.valenzuela@emite-ingenieria.es

b. Short bio

Prof. David A. Sanchez-Hernández (Dipl.-Ing., Ph.D., CEng, SMIEEE, FIET) is with the Technical University of Cartagena, Spain, where he leads the microwave, radiocommunications and electromagnetism engineering research group (GIMRE, <http://www.gimre.upct.es/>). He obtained his Dipl.-Ing. in Telecommunications Engineering from Universidad Politécnica de Valencia, Spain, in 1992 and his Ph.D from King's College, University of London, in early 1996. From 1992 to 1994 he was employed as a Research Associate for The British Council-CAM at King's College London where he worked on active and dual-band microstrip patch antennas. In 1994 he was appointed EU Research Fellow at King's College London, working on several joint projects at 18, 38 and 60 GHz related to printed and integrated antennas on GaAs, microstrip antenna arrays, sectorization and diversity. In 1997 he returned to Universidad Politécnica de Valencia, Spain, where was co-leader of the Antennas, Microwaves and Radar Research Group and the Microwave Heating Group. In early 1999 he received the Readership from Universidad Politécnica de Cartagena, and was appointed ViceDean of the School for Telecommunications Engineering and leader of the Microwave, Radiocommunications and Electromagnetism Engineering Research Group. In late 1999 he was appointed ViceChancellor for Innovation & Technology Transfer at Universidad Politécnica de Cartagena and member of several Foundations and Societies for promotion of R&D in the Autonomous Region of Murcia, in Spain. In May 2001 Dr. Sánchez-Hernández was appointed official advisor in technology transfer and member of The Industrial Advisory Council of the Autonomous Government of the Region of Murcia, in Spain, and in May 2003 he was appointed Head of Department. He is also a Chartered Engineer (CEng), IET Fellow, IEEE Senior Member, Ampere Board member, CENELEC TC106X member, and is the recipient of the R&D J. Langham Thompson Premium, awarded by the Institution of Electrical Engineers (now formerly the Institution of Engineering and Technology), as well as other national and international awards. He holds over 45 scientific papers, 90 conference contributions, 6 patents and 8 books, acting regularly as a reviewer of many IET and IEEE publications and conferences. He has also been awarded several national and international prizes, including the R&D J. Langham Thompson Premium, awarded by the Institution of Electrical Engineers (now formerly The Institution of Engineering and Technology, IET), or the i-patentes award by the Spanish Autonomous Region of Murcia to innovation and technology transfer excellence. He is also a member of CTIA Reverberation Chamber SubGroup (RCSG), 3GPP RAN#4 and has participated in COST2100. His research interests encompass all aspects of the design and application of printed multi-band antennas for mobile communications, electromagnetic dosimetry issues and MIMO techniques.

Prof. Gert Frølund Pedersen was born December 2nd 1965 in Denmark. He received the B.Sc. E. E. degree, with honours, in electrical engineering from the College of Technology, Dublin, Ireland in 1991, and the M.Sc. E. E. degree and Ph. D. from Aalborg University, Denmark in 1993 and 2003. He has been employed by Aalborg University, since 1993 where he currently is working as Professor heading the Antenna and Propagation group. His research has focused on radio communication for mobile terminals including small antennas, antenna systems, propagation and biological effects. He has also worked as consultant for development of antennas for mobile terminals including the first internal antenna for mobile phones in 1994 with very low SAR, first internal triple-band antenna in 1998 with low SAR and high efficiency and various antenna diversity systems rated as the most efficient on the market and holds more than 15 patents. He started the area of measurements of small active terminals including the antenna and developed a measuring setup, which now is used worldwide. He is involved in small terminals for 4G including several antennas (MIMO systems) to enhance the data communication.

Mauro Pelosi is from Picinisco, Italy, and he was born in 1982. He received his B.Sc. Degree (Laurea) in Telecommunications Engineering in 2004 from University of Cassino, Italy. In 2006 he received his M.Sc. Degree in Electrical Engineering, from Aalborg University, Denmark. He also received his M.Sc. Degree (Laurea Magistrale, "summa cum laude") in Telecommunications Engineering in 2007 from University of Cassino. In 2009 he received his Ph.D. in Wireless Communications from Aalborg University. Currently, he is a Postdoctoral Fellow at the Department of Electronic Systems, Aalborg University. He is also Deputy Project Manager for the Smart Antenna Front End (SAFE) Project sponsored by the Danish National Advanced Technology Foundation. His research interests include computational electromagnetics, innovative multiple antenna systems and antenna proximity effects with focus on the influence of the user's body. He is also involved in the COST Action 2100 on "Pervasive Mobile & Ambient Wireless Communications".

Juan F. Valenzuela-Valdés was born in Marbella, Spain. He received the Degree in Telecommunications Engineering from the Universidad de Malaga, Spain, in 2003 and his PhD from Universidad Politécnica de Cartagena, in May 2008. In 2004 he worked at CETECOM (Malaga). In 2004, he joined the Department of Information Technologies and Communications, Universidad Politécnica de Cartagena, Spain. In 2007 he joined EMITE Ing as Head of Research. His current research areas cover MIMO communications, multimode-stirred chambers and SAR measurements.

4. Additional Information

The short course was offered at EuCAP2010 with an extraordinarily high number of attendees in comparison to other short courses. In this edition special emphasis will be placed on those figures of merit and test methodologies approved by standardization bodies worldwide for 4G technologies.