

Tutorial #1

The WAVE Solution – Coming Soon to a Car Near You: Wireless Access

-When Wi-Fi Technology applied to Vehicular Networks

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Tutor: Guillermo Acosta-Marum received his Ph.D. from the School of Electrical and Computer Engineering at the Georgia Institute of Technology, in Atlanta, Georgia in 2007. He has been an adjunct instructor in Electrical Engineering in the Instituto Tecnológico Estudios Superiores de Monterrey Campus Estado de Mexico (ITESM-CEM), the Universidad Iberoamericana and Georgia Tech. His research interest includes wireless LAN, wireless MAN, OFDM, MIMO and channel modeling.

Highlight: This tutorial will provide audience with a whole and solid understanding of emerging wireless local area networks (wireless LANs) and their application to vehicular networks: wireless access for vehicular environments (WAVE). Topics of the tutorial will cover physical layer technology including orthogonal frequency-division multiplexing (OFDM) modulation and channel model, network infrastructure, media access control (MAC) and networks protocols and applications. In this tutorial, we aim to present a high level but yet in-depth description of the principle, fundamentals, performances and design of Wi-Fi and WAVE systems.

Abstract: Wireless LAN applications have blossomed tremendously over the last few years. What started out as a cable replacement for stationary wired Ethernet, wireless LANs have evolved into broadband mobile applications ranging from low-mobility pedestrians to high-mobility vehicles. On the other hand, their data rates have continued to increase from 54Mbit/s to 600Mbits/s for up-to-date multiple-input multiple-output (MIMO) wireless LAN based on recent the IEEE 802.11n standard. A wireless LAN not only transfers purely data traffic, but also supports packetized voice and video transmissions. People today are spending huge amount of money, even from office to office, calling by cell phones. With a wireless LAN infrastructure, the voice over IP service costs people a fraction of what it costs them when using cell phones. Thus, voice telephony products based on Wi-Fi networks have recently emerged. Besides, an increasing number of municipal governments and metropolitans worldwide are financing the deployment of mesh networks with the overall aim of providing ubiquitous Internet access and enhanced public services. Cheaper voice over IP phone will gradually dominate.

Furthermore, wireless communication services tend towards vehicular environments that require a stationary base station to provide links between mobile stations. Wideband mobile-to-mobile (MTM) communications facilitate the deployment of WAVE, or called dedicated short-range communications (DSRC) in previous literature, which is a short to medium range service that supports both public safety and private operations over vehicle-to-infrastructure (V2I) and vehicle-to-vehicle communications.

Wideband measurements of the MTM, especially of the harshest channels, are necessary for proper design and certification testing of mobile-to-mobile communications systems. A complete measurement implies that the Doppler and delay characteristics are measured jointly. Increased data rate requirements and technological advancements have allowed a substantial improvement in spectrum utilization through MIMO systems. MIMO systems require Doppler and delay characteristics for each of the possible transmitter (TX) – receiver (RX) combination, which increases the required channel measurement resources.

In this tutorial, we will present a practical description of the design and implementation of wideband MTM channel sounders. We first describe a single-input single-output (SISO) design and implementation and show how to grow this system into a MIMO channel sounding system. We also present the specifications of each of the system elements so that an attendee may have several options for his or her design. Finally, we will present results obtained with our SISO and MIMO systems.