How to Build Vehicular Networks in the Real World

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Abstract

There are now 1 billion vehicles in the world waiting to be connected to the Internet. At the same time, vehicular communication technologies have matured to a point in which massive deployment is both possible and feasible. One option for deployment is to wait for car manufacturers to embed DSRC/WAVE interfaces inside their latest models. However, since only 9% of the world's fleet is new every year, this would result in a time span of up to 20 years until 90% of the vehicles are finally connected. Another option is to rely entirely on cellular communications, such as GPRS, EDGE, 3G and LTE. This cellular only approach is impractical due to the capital expenses required for telecom operators to meet the demands of the impending tsunami of mobile data (expected to grow 1800% until 2016). Clearly, there is need for a low-cost wireless networking solution that can be placed in any vehicle and offers reliable connectivity, improved quality of experience and higher safety for drivers and passengers. This solution, we will argue, is vehicular mesh networking.

Drawing from five years of research and our experience with a large testbed with hundreds of taxis and buses, currently under deployment in Porto, Portugal, we will address how city-scale deployment can be achieved and what kind of connectivity, bandwidth, quality of service and application support can be provided as the density of Internet gateways and the density of connected vehicles grows towards widespread deployment. Some attention will also be given to relevant issues in system design such as channel modeling, mobility patterns, networking protocols and large-scale simulation with manageable complexity. Finally, we will show how a vehicular mesh network can be used as a highly dense urban scanner, producing real-time data on-the-move, which can be leveraged from the cloud to help manage future cities, protect our environment and improve our quality of life.

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Joint work with Susana Sargento, Peter Steenkiste, Michel Ferreira, Ana Aguiar, Muriel Médard and more than twenty colleagues, graduate students and engineers at Universidade do Porto, Universidade de Aveiro, Instituto de Telecomunicações, Carnegie Mellon University, and Veniam'Works, Inc.

ACM Classification:
A.1 General Literature: INTRODUCTORY AND SURVEY; C.2.2 Computer Systems Organization, COMPUTER-COMMUNICATION NETWORKS, Network Protocols: Protocol architecture (OSI model); Routing protocols

Author Keywords: Intelligent transportation systems; Network protocols; Vehicular networks

Bio

João Barros is an Associate Professor of Electrical and Computer Engineering at the University of Porto, Founder and CEO of Veniam'Works and Founding Director of the Institute for Telecommunications (IT) in Porto, Portugal. He was a Fulbright scholar at Cornell University and has held visiting appointments at MIT and Carnegie Mellon. He also teaches at the Porto Business School and co-founded two recent startups, Streambolico and Veniam'Works, commercializing wireless video and vehicular communication technologies, respectively. Between 2009 and 2012, Dr. Barros served as National Director of the Carnegie Mellon Portugal Program, a five-year

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In recent years, João Barros has been Principal Investigator (PI) and Co-PI of numerous national, European and industry funded projects, co-authoring one book and more than 150 research papers in the fields of networking, information theory and security, with a special focus on smart city technologies, network coding, physical-layer security, sensor networks, and intelligent transportation systems. Dr. Barros has received several awards, including the 2010 IEEE Communications Society Young Researcher Award for the Europe, Middle East and Africa region, the 2011 IEEE ComSoC and Information Theory Society Joint Paper Award, the 2012 BES National Innovation Award, the 2013 Building Global Innovators Grand Prize (ISCTE-IUL and MIT) and a state-wide best teaching award by the Bavarian State Ministry of Sciences, Research and the Arts.

Dr. Barros is frequently invited as an expert speaker by international organizations such as the European Commission, OECD, ITU, EuroDIG and IEEE. He also worked as an independent consultant for various organizations and projects. Dr. Barros is fluent in Portuguese, German, English, French and Spanish. He received his undergraduate education in Electrical and Computer Engineering from the Universidade do Porto (UP), Portugal and Universitaet Karlsruhe, Germany, a performing arts degree in flute from the Music Conservatory of Porto, and the Ph.D. degree in Electrical Engineering and Information Technology from the Technische Universitaet Muenchen (TUM), Germany.