Heterogeneous Vehicular Communication Systems in Smart Cities

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As the concept of smart city gradually moves from lab towards the reality, vehicular communication systems (VCS) become an important component of such large-scale smart city setup. In particular, vehicular communication systems enable both the inter-vehicle communication (V2V) and communication between vehicle and infrastructure (V2I), which are envisioned to support various applications for road safety (e.g., collision detection, lane change warning, and cooperative merging), smart and green transportation (e.g., traffic signal control, intelligent traffic scheduling, and fleet management), location dependent services (e.g., point of interest and route optimization), and in-vehicle Internet access.

For sure, cellular-based access technologies (on licensed spectrum), such as 3G and Long Term Evolution (LTE), play an increasingly important role nowadays in delivering data traffic for VCS and providing reliable and ubiquitous Internet access services. Cellular-based VCS is already becoming a mass market, due to vehicle OEM's mass deployment efforts in the past 2 years. However, today's cellular network is straining to meet the current mobile data demand, resulting in an increasingly severe overload problem. On the other hand, the cellular usage cost for data delivery is relatively high. Clearly, alternative solutions are envisioned to compliment the current mainstream approach of cellular system. In particular,

1. With millions of hotspots deployed all over the world, WiFi (on unlicensed spectrum) or DSRC can be a complementary solution to the vehicular Internet access with low cost. The feasibility of WiFi for outdoor Internet access at vehicular mobility has been demonstrated, termed drive-thru Internet. Recent advances in Passpoint/Hotspot 2.0 make WiFi more competitive to provide secure connectivity and seamless roaming. The dedicated short-range communication (DSRC) technology can be considered as a similar technology to WiFi.

2. Due to recent advances in cognitive radio, dynamic spectrum access (DSA) is becoming a possible complementary technology for vehicular communications. DSA allows vehicles to communicate opportunistically on spatially and/or temporally vacant licensed spectrum for other communication systems. The feasibility of using TV white space for VCS has been demonstrated.

The problem of using WiFi/DSRC on unlicensed spectrum and DSA on TV white space is that the communications have to be done in an opportunistic manner due to limited spectrum availability. The objective of this line of academic research by NSF is to develop an alternative data traffic delivery solution (an integration of WiFi/DSRC drive-thru Internet and DSA over TV white space) to complement and enhance existing mainstream cellular-based VCS, towards a heterogeneous spectrum for delivering Internet services to vehicles. Such an alternative solution could offer increased wireless bandwidth to vehicle users without introducing significant cellular usage cost.

[Bio]
Dr. Fan Bai (General Motors Global R&D) is a Staff Researcher in the Electrical & Control Systems Lab., Research & Development and Planning, General Motors Corporation, since Sep., 2005. Before joining General Motors research lab, he received the B.S. degree in automation engineering from Tsinghua University, Beijing, China, in 1999, and the M.S.E.E. and Ph.D. degrees in electrical engineering, from University of Southern California, Los Angeles, in 2005.

His current research is focused on the discovery of fundamental principles and the analysis and design of protocols/systems for next-generation vehicular networks, for safety, telematics and infotainment applications. He published 70 research papers in top-quality conferences and journals, particularly, Mobicom, Mobihoc, Sensys, INFOCOM, SECON, IEEE JSAC, IEEE TMC, IEEE/ACM TON, IEEE TVT, and IEEE TWC. In addition, he published 1 book and 6 book chapters. His publications received about 6,000 citations (according to Google Scholar). He also has more than 80 patents

granted or pending.

He received Charles L. McCuen Special Achievement Award from General Motors Corporation in recognition of his accomplishment in area of vehicle-to-vehicle communications for drive assistance & safety. He was featured as “ITS People” in 2014 by IEEE ITS Magazine for his technical contributions to vehicular networks and intelligent transportation systems. He serves as Technical Program Co-Chairs for IEEE WiVec 2007, IEEE MoVeNet 2008, ACM VANET 2011 and ACM VANET 2012, among other leading roles in academic and industry technical conferences. He is an Associate Editor of IEEE Transaction on Vehicular Technology and IEEE Transaction on Mobile Computing, and he also serves as guest editors for IEEE Wireless Communication Magazine, IEEE Vehicular Technology Magazine and Elsevier AdHoc Networks Journal. He is also serving as a Ph.D. supervisory committee member at Carnegie Mellon University, University of Illinois – Urban Champaign and University of Southern California. He is a senior member and Distinguished Lecturer of IEEE.