Utilization of rich context information for wireless communications in vehicle platooning

Wireless communications have been applied in various areas of our daily life, from TV or garage pilots to CB radio for drivers to terrestrial TV broadcasting systems to cellular and WiFi networks to satellite links. However, the continuous and highly dynamic development of information society results in a strong need for new, improved solutions in this area. One of the key watchwords related to the introduction of so-called 5G wireless networks is the ubiquity of communications. This idea considers, among other issues, the delivery of high-reliability services, such as vehicle-to-vehicle (V2V) communications for autonomous and self-driving/driverless steering of platoons on high-speed roads. In such a case, the group of short-distanced vehicles (when the distance is reduced down even to a few meters) mutually exchange numerous control and steering information enabling the autonomous movement of the whole platoon with no human intervention. Various procedures, such as lane change (with simultaneous use of blinkers), adjusted braking or by-passing obstacles or other cars, etc., will be possible when and only when high reliability of message transfer is guaranteed.

One may ask, however, what are the true reasons for the introduction of autonomous and driverless movement of platoons? To tell the truth, numerous reasons may be identified, but let us focus on the financial one. It appears, based on various real-life experiments conducted in the past that such solutions may entail better road capacity utilization and reduction of fuel consumption (by up to 15%). It is due to the fact that the aerodynamic resistance of the vehicle is reduced as the distance between successive cars is minimized. The stable movement of the so-called "road-train" on the highways will contribute to the reduction of the overall fuel consumption in the transportation company, which apart from the financial gain also has strong environmental value. Let us stress that when the distances between the vehicles are reduced, the significance of fast and reliable reaction of the entire control system is very high and necessary for accurate and correct exchange of messages about ambient environment. A big step towards attaining this aim is proposed in the literature in the form of the mechanism for *Cooperative Adaptive Cruise Control, CACC*. The main disadvantage of CACC is its strong dependency on wireless communication that can be realized with the use of, e.g., IEEE 802.11p standard which is applied in Intelligent Transportation System, ITS. The classic, well-known problem of channel congestion in highly occupied WLAN networks is of particular importance in the CACC context. It seems that the dynamic and adaptive selection of a vacant spectrum band, which is not occupied at a certain time and location, could play a major role here. As single-node spectrum sensing is not reliable enough, the utilization of processed information collected originally from numerous sources of different types (e.g., vehicles, infrastructure elements etc.) would be profitable. The application of rich context information about surroundings, stored in some sort of databases, is also of highest importance. As an example, one may envisage the utilization of e.g. historical spectrum occupancy statistics for improvement of the system performance. For example, changes in spectrum occupancy as a function of time (hours, days or even weeks) as well as information about current traffic characteristics (e.g. hard weather conditions, car accidents or way-constructions will impact the car density on the road, the average speed and at the end – band selection procedure) may help in decision making process for proper band selection.

The above discussion, and in particular the drawn conclusions, constitute the rationale for our new research hypothesis **– rich context information about the surrounding fast-varying environment results in reliability improvement of wireless communication between the vehicles inside the platoon, utilizing dynamically-selected transmission channels**. In order to verify this hypothesis, all research has been split into three connected areas. The first one deals with the identification of new ways for gathering and processing information about the vicinity, collected from numerous sources of different type with the purpose of channel occupancy assessment. The second area focuses on the optimization of transmission and reception methods by a group of collaborative devices (vehicles in the platoon) and on the derivation of the propagation model for wireless communication between cars in selected frequency bands. Finally, the last area touches the aspects of maximization of channel utilization effectiveness due to advanced channel access schemes. It also considers the investigation of new ways for smooth vertical handover, i.e., smooth change of transmission channel. The rules and principles defined in these three research areas will be the basis of the final extensive computer experiment, where the movement of platoons on a highway will be simulated and where the wireless communication between vehicles is carried out via dynamically-selected channels based on rich context information.