Chapter 5
The Challenge of a Future Slotted Standard for Vehicular Ad–Hoc Networks

Riccardo Maria Scopigno
Istituto Superiore Mario Boella, Italy

Hector Agustin Cozzetti
Istituto Superiore Mario Boella, Italy

ABSTRACT
This chapter is about alternative MAC solutions for VANETs, based on a synchronous, slotted philosophy. After highlighting the limitation of the incumbent CSMA/CA solution, the chapter explains the rationale for a slotted standard and briefly introduces the three solutions found in literature (namely MS-Aloha, D-TDMA and STDMA). In particular, one of them, MS-Aloha, seems particularly rich in functionalities and solves several open issues, in particular in terms of scalability. Its characteristics are presented and discussed, also by means of simulations and quantitative metrics. The comparative analysis between CSMA/CA and MS-Aloha performances permits to gain a deeper insight and draw conclusions on possible perspectives.

SLOTTED PROTOCOLS FOR VANETS: MOTIVATIONS AND CHALLENGES

So far, the only standardized solution for VANETs relies on collision avoidance as defined in WiFi. As a matter of fact, the American WAVE standard (and European standards as well) is built on the top of IEEE 802.11p, which largely inherits IEEE 802.11a features.

The reasons why IEEE 802.11 met such a unanimous suffrage are manifold and can be deduced by analyzing the intrinsic requirements of VANETs: some of them – unfortunately not all – are simply fulfilled by CSMA/CA. This perspective also highlights, on the other hand, the
main limitations of current solutions and explains a certain motivation spread in literature towards possible alternative solutions.

Some emerging synchronous protocols are aimed at this goal and have been recently demonstrated to be theoretically able to satisfy all the requirements subtended by VANETs; as a result, their investigation was further encouraged, specifically addressing some practical open issues.

In order to proceed neatly, first the specific characteristics of vehicular ad hoc networks are shortly recalled in order to highlight the underlying requirements.

In VANETs the number of participating nodes is not always known and, more importantly, cannot be restricted. In addition the number of nodes which can be sensed may strongly vary due to: (i) fading, (ii) obstruction by buildings (in urban areas) and other vehicles and (iii) mutual mobility among cars - which can reach as high as 300 Km/h in highways.

Furthermore, the ad hoc network topology is decentralized, without stationary access points or base stations that regulate access to the shared channel: the so-called infrastructure may be present under certain scenarios but is not mandatory and, consequently, a coordination function cannot be demanded. All in all, the concept of radio-cell and channel reuse, as applied in cellular networks, does not hold for VANETs.

Scalability issues, therefore, become more prominent due to the lack of a central mechanism that has global knowledge of all nodes within the network. The capability to support a certain network load is determined by a number of factors. A desired solution should scale properly both with an increasing number of users and with heavier per-node traffic loads – the two constraints often struggle the one against the other and cannot be simultaneously satisfied.

Notably, in a broadcast environment, traditional methods for delivery control - such as acknowledgements (ACK) - cannot be easily adopted; consequently, reliability in broadcast mode can only be increased by multiple transmissions, which, conversely, impact the network load.

Summing up these considerations, an architecture for broadcasted cooperative awareness messages (CAM) in VANETs, requires a MAC which can satisfy the following requirements (from here onwards referred to as VANET MAC Requirements). A MAC should be:

1. decentralized, in order to work without any fixed infrastructure;
2. immune from the problem of hidden terminal;
3. reactive, so as to cope with rapid changes in the network topology;
4. properly scalable both with traffic and with the number of stations, consequently
5. involving a low protocol overhead, for the sake of efficiency.

As a sub case of scalability, the MAC should also boost the effective delivery of urgent messages by mechanisms such as:

6. priority (and/or pre-emption) and
7. prevention of blocking states.

The MAC method should also be

8. deterministic, in order to guarantee a fixed delivery-time for safety messages;
9. reliable by providing a high packet-delivery rate (almost ideal);
10. fair, giving all nodes at least one opportunity to access the channel within each time period.

Finally a MAC solution would be preferred if:

11. it could be compatible to some already existing solutions – in order to shorten the time-to-market and rely on existing experience;
12. it provided some additional “awareness tools”, such as some kind of acknowledgement for broadcast packets – this could
Related Content

An Exploration of the Critical Need for Formal Training in Leadership for Cybersecurity and Technology Management Professionals

A Security Framework for Enhancing User Experience
[www.igi-global.com/article/a-security-framework-for-enhancing-user-experience/179895?camid=4v1a](www.igi-global.com/article/a-security-framework-for-enhancing-user-experience/179895?camid=4v1a)

Channel Impairments for V2V Communications in ITS Scenarios
[www.igi-global.com/chapter/channel-impairments-v2v-communications-its/62810?camid=4v1a](www.igi-global.com/chapter/channel-impairments-v2v-communications-its/62810?camid=4v1a)

Vehicular System Management Architecture and Application Platform
[www.igi-global.com/chapter/vehicular-system-management-architecture-application/39532?camid=4v1a](www.igi-global.com/chapter/vehicular-system-management-architecture-application/39532?camid=4v1a)