

## Reviewers' Comments and Authors Response

**Paper number: ADHOC-D-13-37R1**

**Paper title: Reverse Back-off Mechanism for Safety Vehicular Ad Hoc Networks**

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The authors would like to thank the area editor and the reviewers for the time spent helping us improve this paper. We addressed the two remaining comments, as described below:

**Managing Editor:** By the way, authors are recommended to evaluate the inclusion of citations of the following recent papers, which appears to be relevant references to complete the state of the art analysis for this paper contribution:

M. Di Felice, L. Bedogni, L. Bononi, "Group Communication on Highways: An Evaluation Study of Geocast Protocols and Applications", Elsevier's Ad Hoc Networks Journal, vol.11, No.3, pp. 818-832, May 2013,

A.J. Ghandour, M. Di Felice, H. Artail, L. Bononi, "Dissemination of Safety Messages in IEEE 802.11p/WAVE Vehicular Network: Analytical Study and Protocol Enhancements", Elsevier's Pervasive and Mobile Computing (PMC) Journal, <http://dx.doi.org/10.1016/j.pmcj.2013.03.003>

These references have been added in the related work section, in the paragraph discussing multi-hop broadcast.

### **Reviewer #4:**

I still have the following question:

-Earlier, I mentioned that dropping expired messages is not a requirement of WAVE: "Actually, The approach described by the author is one possible option for queue handling. However, this is a chipset implementation issue not specified in the WAVE standard. Alternative options are possible and might be adopted where the old beacon is not flushed"

The authors mentioned in their reply that ETSI ITS "clearly required dropping expired messages" but they did not discuss WAVE requirements.

First, please make it clear in Section 2.1 that this is an ETSI requirement. Second, what about WAVE compatibility when a dedicated radio is used to monitor CCH? Can we assume that the suggested work is only compatible with the European standard? Please elaborate on this.

The reviewer addresses an interesting question, that of the differences between the ETSI ITS and IEEE WAVE architectures. While the two standards are generally presented as very similar, we believe that important differences exist. One of these differences regards the management of safety messages.

The reviewer is right by noticing that the IEEE WAVE architecture does not specifically require dropping expired messages. This is because the safety messages are not defined at all in the WAVE architecture, using instead the definitions provided by the SAE J2735 DSRC Message Set Standard. This SAE standard proposes several types of safety messages, which depend on the deployed safety applications. On the other hand, quality of service requirements for these applications are defined by US DoT, meaning that three different entities are involved in the US standardization process, sometimes proposing three different visions. Because IEEE WAVE does not standardize the message format and requirements, the problem of detecting expired information at the MAC layer has not been addressed. At the same time, SAE or US DoT do not consider channel access time in their definitions, so this issue is yet to be addressed, as it would require re-thinking the entire architecture.

Moreover, even the transmission of Basic Safety Messages (BSM, the closest equivalent to safety beacons in the SAE standard) on the CCH is considered today as an obsolete approach, due to an early misconception of the US DoT requirements. Actually, in its decision from October 1999, the FCC

defined Ch178 as a Control Channel, while the six others were named Service Channels. From these SCH, the FCC assigned Ch172 “exclusively for vehicle-to-vehicle safety communications for accident avoidance and mitigation, and safety of life and property applications”, and Ch184 “exclusively for high-power, longer-distance communications to be used for public safety applications involving safety of life and property, including road intersection collision mitigation”. Basically, the role of the CCH was limited to WSA transmission and safety messages were to be transmitted on two of the SCHs. This has been ignored by the IEEE WAVE standards, but it is still a strong requirement for the other involved parties. Actually, in 2011, the US DoT conducted a series of six Safety Pilot Driver Acceptance Clinics at locations around the country, in which all BSM communication took place on Ch. 172. Similarly, the US DoT began a year-long Model Deployment in August 2012, equipping nearly 3000 vehicles with DSRC OBUs that send BSMs on Ch. 172. This Model Deployment, although in clear disagreement with the IEEE WAVE standard, is expected to form the basis for US DoT decisions about actual deployment in years to come.

The authors' opinion is that the IEEE decision of relying on SAE messages with per-application format will prove to be a wrong decision for multiple technical and economical reasons. But, without letting this subjective opinion interfere, we believe that dropping expired messages at the MAC layer is the only reasonable approach, and this solution will prevail with or without an explicit support in IEEE WAVE. Therefore, we believe that our solution is generic and will apply to the transmission of safety messages in any system using periodic dissemination of embedded sensor data.

However, as you can see from this answer, the discussion on the different architectures is really complex and can lead to long debates in the community. We do not believe it is the purpose of this paper to address this debate, therefore we decided to add only the following clarification in the paper:

Section 2.1: "While dropping an expired safety message from the MAC layer queue is a requirement of the ETSI ITS architecture, the IEEE WAVE framework provides no explicit requirement on this issue. However, we believe that the dissemination of outdated information is not only a waste of network resources, but also a danger from a safety point of view. Therefore, we assume in this work that safety messages have a limited lifetime and they are dropped when the expiration time is reached."