ETSI TR 102 861 V1.1.1 (2012-01)

**Intelligent Transport Systems (ITS);
STDMA recommended parameters and
settings for cooperative ITS;
Access Layer Part**

Reference

DTR/ITS-0040020

Keywords

CSMA, ITS, MAC, MS-Aloha, STDMA

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

Individual copies of the present document can be downloaded from:
http://www.etsi.org

The present document may be made available in more than one electronic version or in print. In any case of existing or perceived difference in contents between such versions, the reference version is the Portable Document Format (PDF). In case of dispute, the reference shall be the printing on ETSI printers of the PDF version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
http://portal.etsi.org/tb/status/status.asp

If you find errors in the present document, please send your comment to one of the following services:
http://portal.etsi.org/chaircor/ETSI_support.asp

Copyright Notification

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (http://ipr.etsi.org).

Pursuant to the ETSI IPR Policy, no investigation, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Intelligent Transport System (ITS).

Introduction

It is essential to decrease the number of fatalities on our roads, not only because it causes much grief for individuals each year, but also because it costs enormous amounts of money for society. There are different ways of increasing the road traffic safety, which all contribute to a better and more efficient road traffic environment. One way is to build new highways with separated lanes as these are less prone to traffic accidents. However, this is only possible to some extent due to space limitations. Another way is to introduce wireless communications between vehicles which enable new applications for increasing road traffic safety such as wrong way warning, red light violation, intersection collision warning and emergency brake warnings. This is termed cooperative intelligent transport systems (ITS).

The impact of road traffic safety applications as well as road traffic efficiency applications is likely dependent of a considerably amount of vehicles being equipped with communication devices. The exact penetration of course depends on the application in question, but generally the more vehicles that are equipped the better. However, it is also at this stage the current technology chosen for cooperative ITS may encounter problems. When the number of ITS equipped vehicles increases, the standardized technology based on CSMA will face problems with scalability. The scalability of CSMA directly influences the reliability of the transmission, the channel access delay and thereby the fairness. When the number of nodes increases, the number of simultaneous transmissions will increase, resulting in lower reliability and decoding problems due to interference. One way to counteract the scalability issue of CSMA is to introduce decentralised congestion control methods (DCC) such that the amount of data traffic transmitted is restricted and transmit power levels adjusted. However, by decreasing the amount of data traffic transmitted the road traffic safety applications may suffer with performance degradation as a result.

Another way to counteract the scalability issue is to investigate the performance of other medium access control (MAC) protocols in terms of scalability, reliability, delay and fairness. Self-organizing time division multiple access (STDMA) and mobile slotted Aloha (MS-Aloha) are two time slotted MAC approaches designed for *ad hoc* networking (they are self-organizing and decentralized) and both can cope with a high and varying number of nodes without collapsing. When the number of nodes increases within radio range and all free resources are exhausted, both algorithms still admit transmissions through careful scheduling to maintain a high reliability for the nodes closest to the transmitter. This implies that the channel access delay has a maximum upper limit and the resulting network is fair and predictable.

In the present document, the performance of CSMA, STDMA and MS-Aloha are investigated through simulations with a varying number of vehicles, all equipped with cooperative ITS units. In particular, the performance measures *channel access delay* and *packet reception probability* are evaluated as these measures captures the reliability, the delay and the fairness of resulting system as well as how these depend on scalability.

1 Scope

The present document summarises the result from performance evaluations of CSMA and two time slotted MAC approaches through simulations. Two different time slotted MAC approaches, self-organizing time division multiple access (STDMA) and mobile slotted Aloha (MS-Aloha), have been considered in two different scenarios; highway and urban. CSMA, the MAC algorithm proposed for the current generation of vehicular *ad hoc* networks (VANETs) has been used as a benchmark. Packet reception probability at different distances from the transmitter together with the channel access delay has been used as performance measures. The purpose is first and foremost to evaluate the scalability of the resulting system, as initial results have shown that CSMA may degrade in performance when the number of vehicles equipped with cooperative ITS units increase.

NOTE 1: Håkan Lans holds a patent on STDMA [i.25], which expires in July 2012. The patent has been re-examined in the US cancelling all claims on March 30, 2011.

NOTE 2: A European patent procedure has been started by ISMB on MS-Aloha techniques (European patent request filed with number 10163964.9, May 26, 2010). They have received in September 2011 Communication Under Rule 71(3) EPC of the intention to grant a patent.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at http://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TR 102 862: "Intelligent Transport Systems (ITS); Performance Evaluation of Self-Organizing TDMA as Medium Access Control Method Applied to ITS; Access Layer Part".

[i.2] IEEE 802.11p: 2010: "IEEE Standard of Information Technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements; Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; Amendment 6: Wireless Access in Vehicular Environments".

[i.3] M. Nakagami: "The m-distribution, a general formula of intensity distribution of the rapid fading", Oxford, England, Pergamon, 1960.

[i.4] V. Taliwal, D. Jiang, H. Mangold, C. Chen and R. Sengupta: "Empirical determination of channel characteristics for DSRC vehicle-to-vehicle communication," in Proc. ACM Workshop on Vehicular Ad Hoc Networks (VANET), Philadelphia, PA, USA, October 2004, pp. 88-88.

[i.5] L. Cheng, B. E. Henty, D. D. Stancil, F. Bai and P. Mudalige: "Mobile vehicle-to-vehicle narrow-band channel measurement and characterization of the 5.9 GHz dedicated short range communication (DSRC) frequency band," IEEE Journal on Selected Areas in Communications, vol. 25, no. 8, pp. 1501-1516, October 2007.