VAS: RECEIVE – REAL-TIME ACCESS IN VEHICULAR AD HOC NETWORKS

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Intelligent transport systems (ITS) aiming to increase traffic safety through cooperating ITS stations, need low-delay, scalable, reliable, real-time wireless communications. So far, wireless systems have been designed to provide *either* reliable *or* real-time communications, but *not both* concurrently and especially not at vehicular speeds. In this project, we analyze the specific communication requirements introduced by traffic safety applications, and evaluate the conditions that vehicle ad hoc networks operate under. Special focus is given to the medium access control (MAC) algorithm and thus the appropriateness of using CSMA/CA and/or STDMA for traffic safety applications in vehicular ad hoc networks is evaluated.

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1. Background and Motivation

Cooperative systems using wireless vehicular communications to complement intelligent transport systems currently receive a great deal of attention worldwide. One of the motivations is to reduce traffic accidents and human injuries by introducing traffic safety applications based on vehicular communications. Another is to reduce congestion, travel-time and pollution through traffic efficiency applications. In addition, other types of services may be implemented and offered in order to facilitate system introduction and provide sustainable business and operation models. Thus, mainly three types of applications are considered: traffic safety, traffic efficiency and value-added services. The main focus of the RECEIVE project is traffic safety applications since the communication requirements of these applications are highly complex and notably differs from those of most existing applications relying on wireless communications.

2. Problem formulation

Intelligent transport systems (ITS) aiming to increase traffic safety through cooperating ITS stations, need low-delay, scalable, reliable, real-time wireless communications. Real-time since the signaling must be capable of meeting strict deadlines, reliable since the communicated information is control traffic from sensors and actuators, scalable since many vehicular communication links will have to share the common radio spectrum in a limited geographical area and low-delay since lower response times increase the driver awareness horizon.

In order to meet real-time deadlines, a system does not necessarily need to be fast – but it does need to be predictable such that the maximum delay can be upper bounded. Basically all traffic safety applications have real-time requirements. Either it is critical that a message reaches its intended recipient before a particular time instant (e.g., a crash as in event-driven hazard warning systems) or the deadline simply tells us that the messages is now expired and no longer of interest (possibly because a newer version is available, as in time-triggered cooperative awareness systems).

Figure 1. Scalability is of essence when vehicles are communicating to increase traffic safety.

So far wireless systems have been designed to provide reliable communications suitable for emailing and different types of data traffic, *or* real-time communications, typically used for voice and video applications, but *not both* concurrently and especially not at vehicular speeds.

3. Approach

A vehicular ad hoc network has two main benefits for traffic safety applications: it eliminates the problem of guaranteeing coverage (by base stations or access points) and it reduces the average communication delay. However, using an ad hoc network implies that problems with scalability become more imminent since the network cannot be centrally orchestrated. Further, guaranteeing real-time communications in a vehicular ad hoc network requires not only that the medium access control (MAC) method is predictable but also decentralised. The only standard currently supporting communications in vehicular ad hoc networks is the upcoming IEEE 802.11p. However, the MAC method used in 802.11p, carrier sense multiple access with collision avoidance (CSMA/CA), is decentralized, but unpredictable since it does not guarantee channel access before a finite deadline. The use of self-organizing time division multiple access (STDMA) is a potential remedy for this problem. This system is already in commercial use for collision avoidance between ships (called AIS – Automatic Identification System), but

the protocol parameters of STDMA needs to be adapted to better suit vehicular communications.

In the RECEIVE project, we will analyze the specific communication requirements introduced by traffic safety applications, and evaluate the conditions that a vehicle ad hoc network is to operate under. Further, the appropriateness of using CSMA/CA and/or STDMA for traffic safety applications in vehicular ad hoc networks is to be evaluated.

4. Results

We have made an initial evaluation of the appropriateness of using CSMA/CA and STDMA by means of computer simulations of a time-triggered cooperative awareness scenario. The real-time aspects are evaluated by considering performance measures on the transmitter side such as the variation of packet drops between different nodes in the system, consecutive packet drops from a single node and distance between two concurrently transmitting nodes. CSMA does not only result in packet drops that are extremely unevenly distributed in the system (up to 50% difference between the worst and the best case node), it also experiences consecutive packet drops that render certain nodes invisible for several seconds. Since no packets are ever dropped with STDMA, the network load and thereby the interference can be expected to be heavier than if CSMA was used. We therefore considered the distance between two concurrently transmitting nodes, Figure 1, but even if more packets actually gets transmitted with STDMA the distance between two concurrently transmitting nodes is still larger than it is with CSMA. Note that a data collision in a wireless system is a function not only of time but also of space.

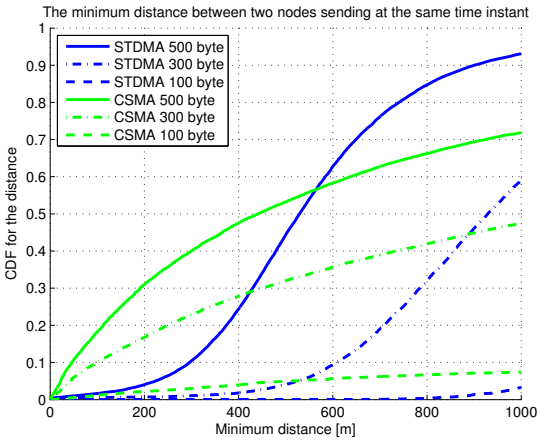

Figure 1. Distance between two concurrently transmitting nodes with CSMA and with STDMA.

Close collaboration has been established with COST Action 2100, www.cost2100.org, and Chalmers vehicle and traffic safety center SAFER, www.chalmers.se/safer/. Katrin Bilstrup, CERES Ph.D. student, has been invited to present her research results at ETSI TC ITS and C2C-CC for consideration in ongoing standardization activities.

PARTNERS AND STATUS

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RELATED PUBLICATIONS

K. Bilstrup, E. Uhlemann, E. G. Ström and U. Bilstrup, "On the ability of IEEE 802.11p and STDMA to provide predictable channel access," to appear in *Proc.16th World Congress on ITS*, Stockholm, Sweden, Sept. 2009.

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