VAS – VEHICLE ALERT SYSTEM

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The Vehicle Alert System (VAS) project focuses on cooperative alert services based on timely and reliable (real-time) communication under the challenging circumstances pertaining to a highly mobile vehicular network. Both vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, and systems based on such communication, are in focus in the project. We take a cross-layer approach including three different levels of abstraction: link, network and application perspective.

1. Background and Motivation

The Vehicle Alert System (VAS) project is a platform for research in the areas of cooperating embedded systems, vehicular ad-hoc networks (VANETs), wireless sensor networks and wireless digital communication. VAS aims at using vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) cooperative communications to provide different types of warning messages in a timely and reliable fashion.

2. Problem

The VAS project poses challenging and interesting problems on several levels. At the application layer the system must be able to handle heterogeneous nodes in secure and scalable ways. Specific sub-goals include:

- Develop a system architecture that takes into account the roles of infrastructure versus vehicles as carriers, interpreters and goal driven controllers of information.
- Find methods for modeling, prioritizing and handling situational information and decision making in a scalable way, even in overload situations.
- Enable cooperation between autonomous nodes with multiple, possibly conflicting, control goals.

At the network level, we are faced with problems due to high vehicle mobility. Scheduling of messages must be done according to their importance levels and timing requirements. Specific sub-goals include:

- Develop protocols and methods that are able to handle highly dynamic environments and that enable fast connection setup and instant delivery of critical data.
- Investigate how to take a joint approach to connection setup methods, medium access control and schemes to handle base station access (V2I) and/or routing in ad-hoc networks (V2V).

At the link level reliable connections must be formed using efficient coding and modulation methods for timely delivery of information. Specific sub-goals include:

- Design transmitters and receivers using error control coding and cooperative diversity to provide reliable information transfer within limited time frames.
- Use the application specific quality of service parameters to prioritize traffic even at the lowest protocol layers to achieve maximum utilization of the limited resources in a wireless network.

3. Application scenarios

Emergency vehicles, e.g., ambulances, traditionally use sirens and light to inform other road-users that they are approaching. Using V2V communication, the zone of awareness can be extended considerably. In the emergency vehicle routing scenario, Figure 1, vehicles warn each other about approaching emergency vehicles and inform their drivers so that a path can be cleared in a timely and coordinated way. The emergency vehicle should be able to communicate with VAS infrastructure to query for suitable routes to its destination, as well as to request traffic signal pre-emption.

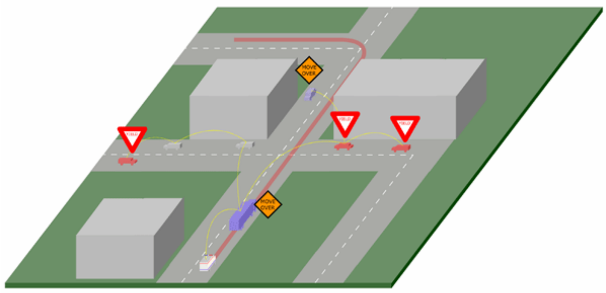

Figure 1. Vehicles and infrastructure cooperate on the macro level to create a "green wave" for the ambulance.

The merge assistance scenario, Figure 2, illustrates how cooperating vehicles can increase safety and efficiency at highway on-ramps. Vehicles that negotiate with each other could advise their drivers on speed and acceleration, settling hazardous situations before they arise. A highway entrance might be a given spot for roadside infrastructure. A roadside unit can help relay data between vehicles involved in the merge situation as well as spread other types of information (e.g. road condition data) to passing vehicles.

The pedestrian crossing warning scenario, Figure 3, employs mainly V2I communication to warn the driver that pedestrians are located on, or near the crossing. Crosswalk signaling infrastructure can also benefit from interaction with vehicles.

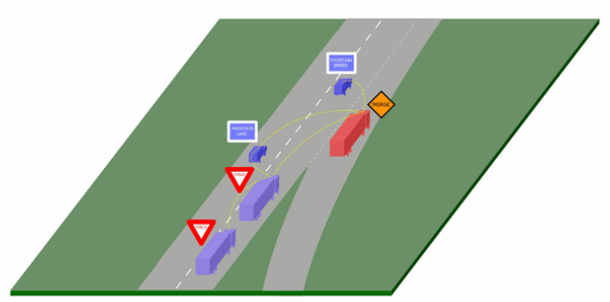

Figure 2. A truck merging onto the highway coordinates with other traffic for a safer and smoother maneuver.

If a vehicle is unable to stop in time, for example due to road conditions or driver inattention, the crosswalk signaling system could delay giving the "walk" signal or alert pedestrians. At unguarded crossings detectors could alert drivers that there are pedestrians waiting to cross.

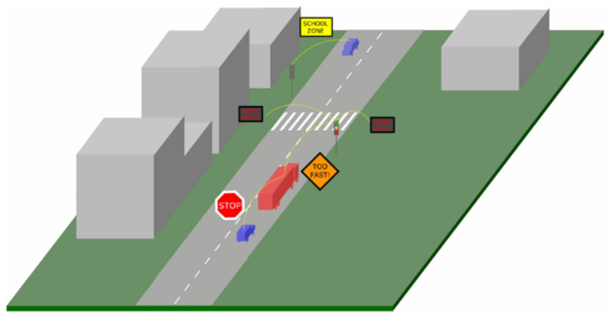

Figure 3. Vehicles and infrastructure cooperate to create a safer situation at a pedestrian crossing.

4. Results

We have made several state-of-the-art surveys together with pre-studies in the form of master thesis works. Surveyed topics include: communication standards for wireless vehicle communication, medium access control (MAC) protocols, routing and forwarding techniques, and fast handover techniques.

Initial simulation results of the MAC protocol in the standard IEEE 802.11p indicates that additional efforts are needed to provide timely and reliable vehicular communications. In addition, cooperative communication is needed to provide scalable solutions. Furthermore, we have made simulation studies of routing protocols for V2V communication and developed a preliminary design for the scheduling of alert traffic with real-time constraints in a merge assistance scenario. Additionally, studies of the effects of cooperatively comparing observations of the environment as well as of the behavior of the system itself indicate that it is a possible approach for increasing the safety of the driver assistance services.

Coordination with the technology platform developed in the European IP project CVIS[i] is initiated. VAS will use and evaluate the CVIS platform and provide input on scalability and deployment to the CVIS consortium. Contacts have been initiated with the COST Action 2100[ii] to evaluate suitable channel models for vehicular communications.

PARTNERS AND STATUS

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Project leader: Björn Åstrand

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[i]www.cvisproject.org [ii]www.cost2100.org