Creating resilience for vehicular applications

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Lab-scaled tests of a 'black box' for car crashes. © Hidenets

(PhysOrg.com) -- European researchers have developed promising approaches to a long-neglected aspect of car-to-car and car-to-infrastructure communications: fault-tolerance and resilience. The technology is a vital component of emerging applications in such communication scenarios.

Automotive communications are a major element in the near future of vehicle technology, with applications ranging from variable road sign visualisation, to accident warnings and driver-support systems which automatically reduce speed in a hazardous situation. Ultimately, these systems could lead to much more automatic driving.

There are dozens of small, medium and large-scale EU-funded research projects aimed at safety on the road.

Hidenets is another one, but it is looking at a unique aspect: “We pretty much look at one aspect that has been neglected so far, mainly the reliability and dependability of applications running in these settings ... [making] sure that they do work reliably and that they are also available in the scenario, when you need them,” explains the project's coordinator Hans-Peter Schwefel.

Most projects look at specific issues relating to application optimisation, or fundamental communication issues - all essential elements for enhanced road safety through automotive communications.

But resilience is another essential aspect. Automotive communication in traffic scenarios is a phenomenally complex and dynamic field, dealing with vast numbers of fast-moving vehicles, all tied together by transitory webs of communications that can fade in and out. And they deal with potentially catastrophic events, like a car crash, where communications become even more vital.

The question Hidenets sought to answer was how can applications based on communications continue to function when the communications themselves break down?

“This is a problem that you don't only solve on the communications layer. The approach in Hidenets is to say that we cannot solve it all just by communications enhancements, we need to do something on middleware with some functionality that makes sure that, even if the communications doesn't work properly, the application can react to it, reconfigure itself and adapt to the situation,” Aalborg University's Schwefel stresses.

Platooning

It is an important problem. Aside from safety and reliability issues, user

acceptance and adoption of automotive communications technologies will depend on their trustworthiness.

Take ‘platooning’, where cars drive in a line with the lead car driven by a human that passes control information like speed, braking, turning and indicating to following cars. The cars drive tightly together, to take advantage of the slipstream.

This is an extreme dependability scenario, and the cars following are driven by the in-car control system. Such a platooning application is currently envisaged mainly for trucks; it may still take quite some time until it is available for private vehicles. Nevertheless, it is a useful use-case scenario because it requires very fast and reliable communications and computations.

All cars need to receive each piece of information and they need to receive it quickly and reliably - even when other nearby platooning cars are crowding the bandwidth with information zipping between them.

The issues here are timeliness and the detection of timing violations is crucial, so Hidenets developed the concept of a Reliable and Self-Aware clock. Duration measurement is a concept that notes any slowing caused by the local network or sluggish computation and factors that into communications and the application behaviour.

Timely timing, no less

The Timely Timing Failure Detector keeps track of the performance and can take fault-tolerance measures if required, for example alternative routing or a controlled braking instruction.

There are many other use cases, like Assisted Transportation, which looks at general driver assistance and collision avoidance. Or Car

Crashes, where a distributed 'black box' can help provide context in the moments up to the crash, information that is time stamped and passed on to infrastructure and other cars as they pass.

Hidenets developed dozens of elements addressing specific resilience needs, such as continuity of communication, continuity of data, back-up and alternative actions in the absence of communication.

The project developed lab-based proof-of-concept scenarios, both in scaled-down models using remote-control cars, and computer simulations mimicking the network traffic for a busy road. The demonstrators succeeded and validated the researchers' approach.

But the greatest contribution of the project was to develop a reference architecture and design methodology and related tools, so that researchers in the future can benefit from what Hidenets learned in their work. It is an impressive package.

Challenges remain

Even though the project is finished, some research problems remain to be solved. "We developed promising approaches and demonstrators proved the concepts, but more work needs to be done, particularly in relation to standards," warns Schwefel.

Standards are essential if fault-tolerance and resilience are to gain traction in the industry, though Schwefel sees some promise in the example from the telecoms industry.

"The telecoms industry only started to really talk about resilience and reliability in the early 90s, but it was the late 90s by the time they had developed standard approaches to the problem. Before that they were proprietary," he reveals.

One of the main fault-tolerance safeguards in the telecoms sector is a concept called cluster solutions, where multiple back-up nodes ensure communication is smoothly maintained even if an individual node breaks down. That is not an option for the highly dynamic traffic environment.

Nonetheless, Hidenets has made a promising start and Schwefel believes work on standards will begin to emerge as more and more in-car communications applications become active and the issue becomes more urgent.

In the meantime, the Hidenets consortium will discuss future potential projects and will continue their work through other research efforts. “And the partners have developed strong relationships and will continue to cooperate on certain aspects of the problem,” Schwefel underlines.

Ultimately, though, Hidenets has put resilience on the car communications development roadmap.

More information: www.hidenets.aau.dk/

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