Timing analysis for ADAS Architectures

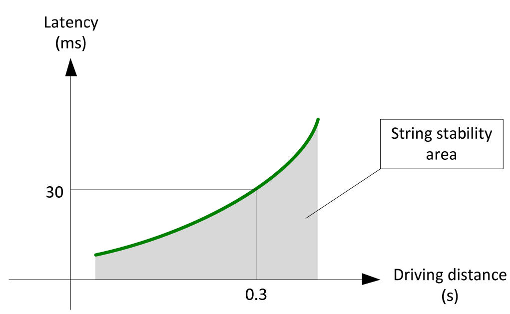
Description:

TNO is the world leader in truck platooning technology. This technology allows a group of trucks to become linked to each other, using data transmitted over radio communication, forming a virtual "vehicle train" driven by the front vehicle driver only (the other drivers become passengers).

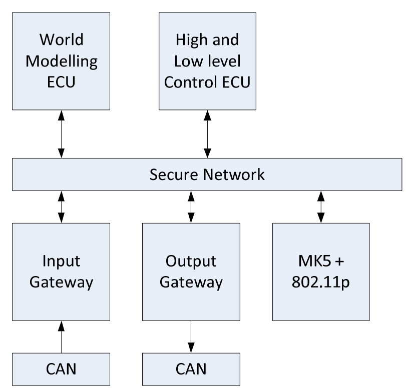
Platooning offers multiple benefits, among which fuel economy is the strongest, especially at small the inter-truck driving distances (distances of 0.8 seconds at 80km/h are not uncommon).

The technology that enables truck platooning is called Cooperative Adaptive Cruise Control (CACC). It makes use of radio communication to transmit the intended acceleration of any truck in the platoon to its immediate follower. The intended acceleration is then used to determine the follower's intended acceleration, which is in turn transmitted to the next vehicle, and so forth.

It can be shown that for CACC to "work properly" (i.e., to be string stable[1]), the total time it takes for the intended acceleration information to go from one truck to its follower (i.e., the latency) must bounded by a curve that depends on the inter-truck driving distance as shown below (left):



Latency bound as a function of inter-vehicle driving distance.



Sketch of CACC hardware platform

Thus, to guarantee correct CACC behavior it is important to accurately derive the data transmission latencies between trucks. The latency calculations should take into account not only the radio communication delays, but also the delays introduced by the data flowing from one component of the truck hardware platform to another (and sketch of such platforms is shown in the figure above, right): E.g., network delays, ECU delays, etc.

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[1] See E. Semsar-Kazerooni and J. Ploeg, "*Performance Analysis of a Cooperative Adaptive Cruise Controller Subject to Dynamic Time Headway,*" in Proc. 16th International IEEE Annual Conference on Intelligent Transportation Systems, pp. 1190-1195, 2013

Although the delays introduced these components can be measured independently, it is important to develop a systematic methodology to ascertain the worst-case-scenario end-to-end latencies, together with its statistics, in a way that is modular and captures the shared resources interactions.

Assignment description:

The main goals for this assignment are:

- Contribute in developing a systematic methodology for latency estimation in ADAS platforms
- Validate the methodology using a tool (e.g. POOSL related tools) that support modularity, composability and reusability of component specifications
- Demonstrate the tool outcome by comparison with real-world measurements

Main Elements

- Methodology should be grounded in schedulability theory for distributed real-time systems
- Ideally, the tool should be able to extract its required information directly from hardware and software diagrams modeled in, for instance, Enterprise Architect or similar tools.
- Real-world measurements could be performed at TNO-Helmond facilities

Added value

For the project:

- Tool and methods for the systematic timing analysis of ADAS architectures

For the student:

- Know – how real-life ADAS architectures
- Working in a dynamic environment on automated driving functions
- Opportunity to test the link between theory and practice on timing analysis

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