Impact of Clock Drift on CAN Frame Response Time Distributions

Aurélien Monot, Nicolas Navet and Bernard Bavoux

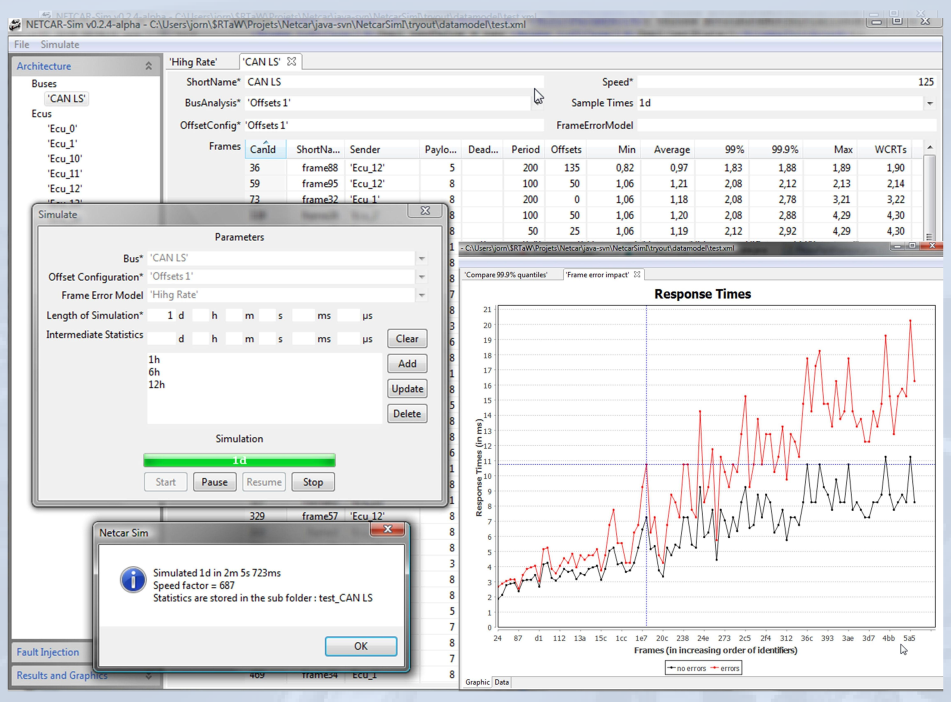
About clock drifts

Clock drifts result from the fact that the clocks of the ECUs do not exactly operate at the same frequency. Due to production tolerances, the oscillators are not exactly identical. Their frequency may also change over time because of environmental factors such as the temperature. In practice, the clock drifts are unavoidable and cause the **phasings between the communicating ECUs to vary continuously over time**. As a consequence, the response times of periodic frames vary continuously too.

Simulation Tool

The software used in this study, **RTaW-Sim*** is a **fine grained discrete-event CAN bus simulator** providing the frame response time distributions.

The granularity of the simulation is 1µs allowing thus to simulate accurately a CAN bus at the bit level even at the highest possible speed of 1 Mbit/s.



Use Cases

A. Deriving frame response time distributions

Using **long observation windows**, we observe the overall response time statistics over long scenario.

The statistics obtained by simulation will show what kind of performance can be expected from the studied configuration.

B. Reproducing worst case scenario

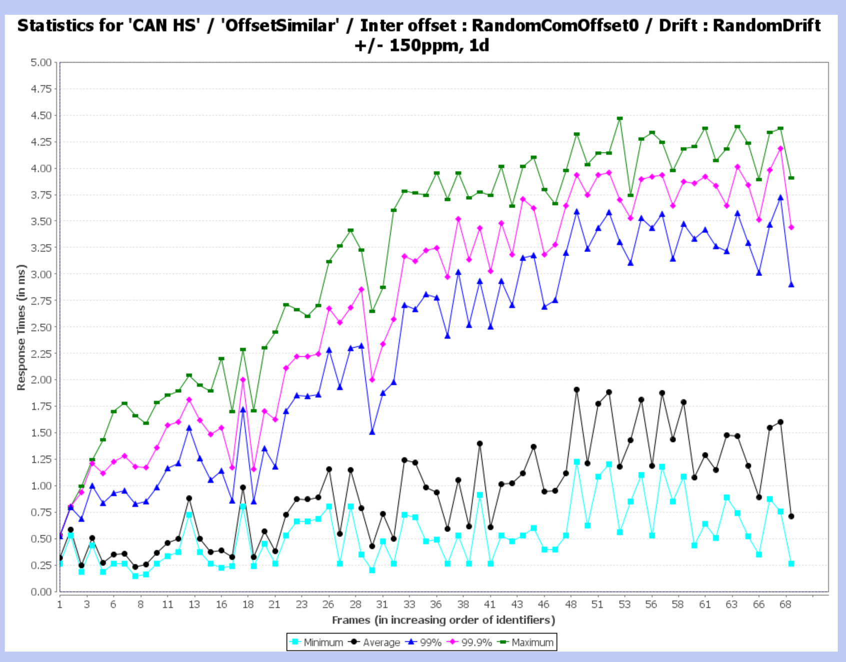
Using **short observation windows**, we observe some specific scenario with phasings conditions that provoke the worst case response time for some frame.

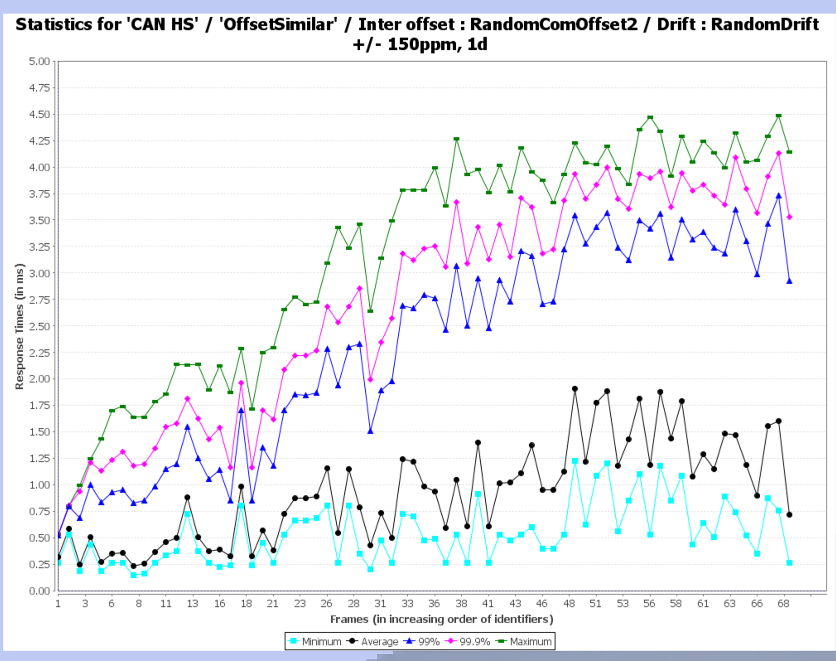
The statistics obtained by simulation will show how long this situation lasts and where the clock drifts lead from there.

Experiments

Deriving frame response time distributions

The graphs show response times statistics for two configurations corresponding to different clock drifts parameters and initial phasing configurations. Intermediate statistics corresponding to intermediate simulation times show that, after a while, the different curves **converge** to the same values.

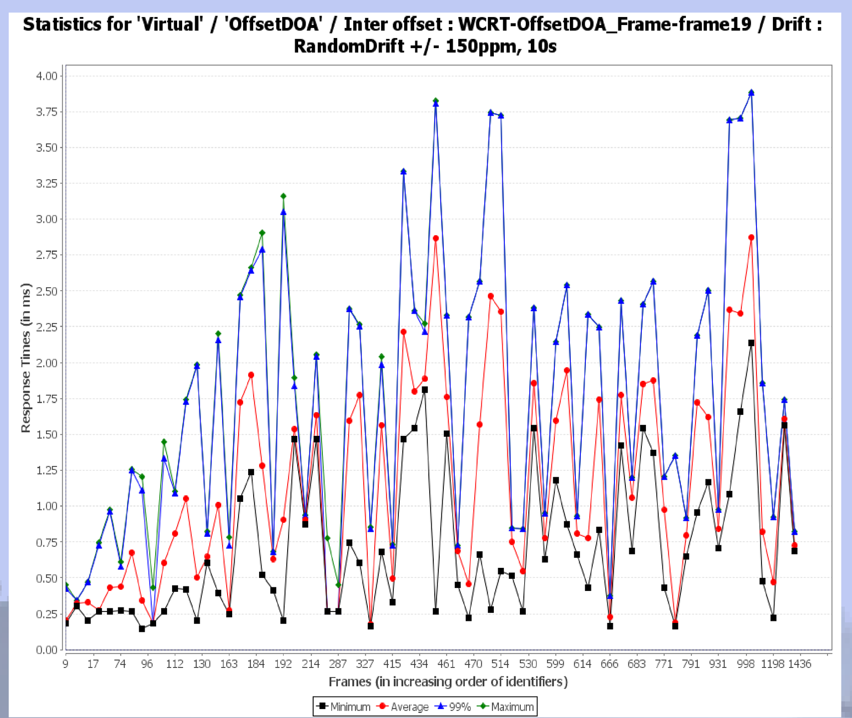


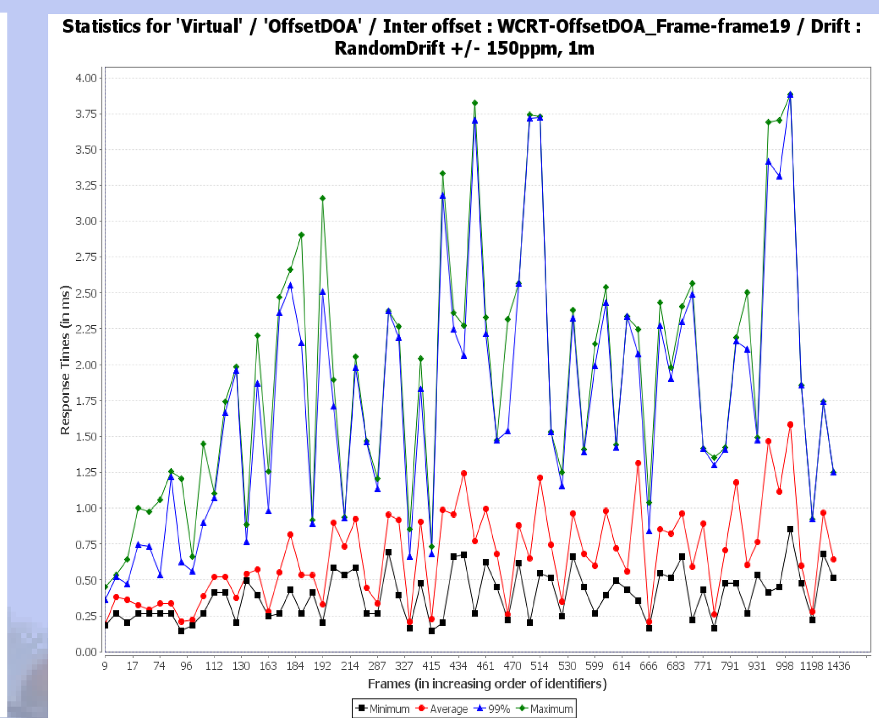


It suggests that, for a long simulation time, **the clock-drift parameters and initial simulation phasings are not relevant for the final response time distributions statistics**.

Reproducing worst case scenario

The left graph shows that after 10s of simulation, high response times were reached for numerous frames as a consequence of the initial parameters. However, the right graph shows that after 1 minute of simulation, the minimum and **average response times are significantly lower**.





Clock drifts are usually seen as being detrimental because they reduce the predictability of the system. These results suggest that it might also be beneficial as they help going out of phasing configurations leading to large response times relatively quickly. In other words, these **worst case situations are transient**, when clock drifts are taken into account.

Conclusion

We presented how it is possible to analyze the impact of clock drifts from a given initial configuration or over the overall lifetime of a vehicle through a **simulation tool**. We showed experimentally that **the response time distributions converge whatever the initial phasings between sending nodes**. This result is intriguing and deserves further research in order to understand it formally,and be able to identify the conditions that are necessary for it to hold. Furthermore,we showed that, as a result of the clock drifts, **the worst case response times are transient**. Our ongoing work is to extend the existing CAN stochastic analyses to take into account clock drifts.

* available at http://www.realtimeatwork.com/software/rtaw-sim/

16th IEEE Internation Conference on Emerging Technologies and Factory Automation - September 5-9, 2011- Toulouse, France