Prototyping of time-sensitive connected video services

Table of contents

1. Executive summary

This document provides an overview of RETINA – Prototyping of time-sensitive connected video services, aimed for the automotive market – provided by the partners Alkit Communications, Time Critical Networks (TCN) and Evidence Srl.

Rapid prototyping of

Real-time video services
Time sensitive control messages
In-vehicle & V2V/V2X communication.

Design, monitor and evaluate on a common reference hardware to efficiently examine trade-offs in a large design space.

Major benefits

Fast and agile
- Speed up development and implementation

Maximize utilization of resources
- Study how the network behaves under different load conditions, to find suitable trade-offs between network performance and hardware and software costs

Quickly gain insights
- Understand how communication behaves under different configurations and usage scenarios.

This solution can be used during all stages in your development, from idea to continuous integration in an operational environment.

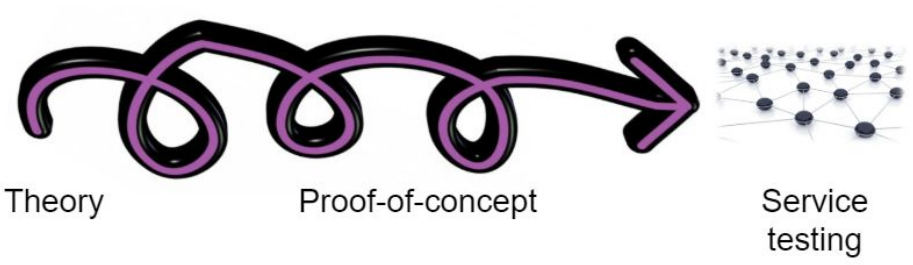


Figure 1. Conceptual design of time-sensitive connected video services.

2. Background

The fast development in the telecom and automotive industries creates opportunities for new, advanced applications. Modern cars can comprise more than 100 ECUs exchanging predictable, real-time communication.

Autonomous and connected cars will communicate with the infrastructure and other vehicles. There is an evident lack of a complete tool set for development of the next generations of complex, heterogeneous automotive networks and safety-critical applications.

In 2016-2018, during the Eurostars project "Real-time support for heterogeneous networks in automotive applications" , or "RETINA", the partners addressed the requirements in a continuous connected automotive environment. The project developed an integrated software tool set to predict, simulate, test and support real-time communication in heterogeneous vehicular networks.

The tool set will allow users to design, develop, monitor and evaluate time-critical applications, such as advanced safety systems and autonomous vehicles for both in-vehicle communication, as well as vehicle-to-vehicle and vehicle-to infrastructure for C-ITS.

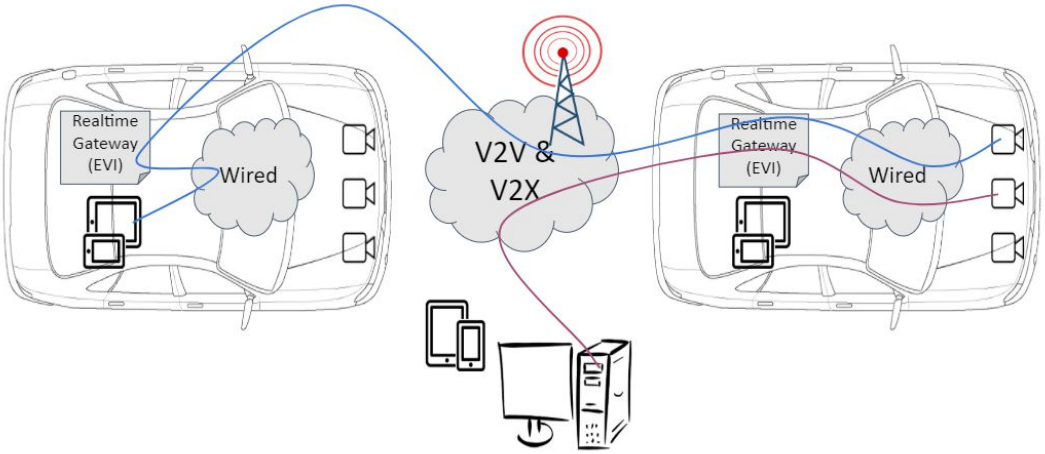
Tool set content

Rapid Prototyping of

- Real-time video services
- Time sensitive control messages
- In-vehicle & V2V/V2X communication.

Design, record & process data sets using pre-defined building blocks

On-line or off-line post processing
Open SDK for configuration
Simulation for design and validation.



3. Solution overview – Prototyping of time-sensitive connected video services

Make conceptual designs of your connected services to develop, monitor and evaluate time-critical applications in an agile way. The solution allows you to test theories and hands-on proof-of-concept testing on either a small or large scale.

This hardware and software-based platform is easy to customize to your work processes, where you may enter directly into any of the phases proposed below around the Reference platform: Design & Simulate or Monitor & Evaluate.

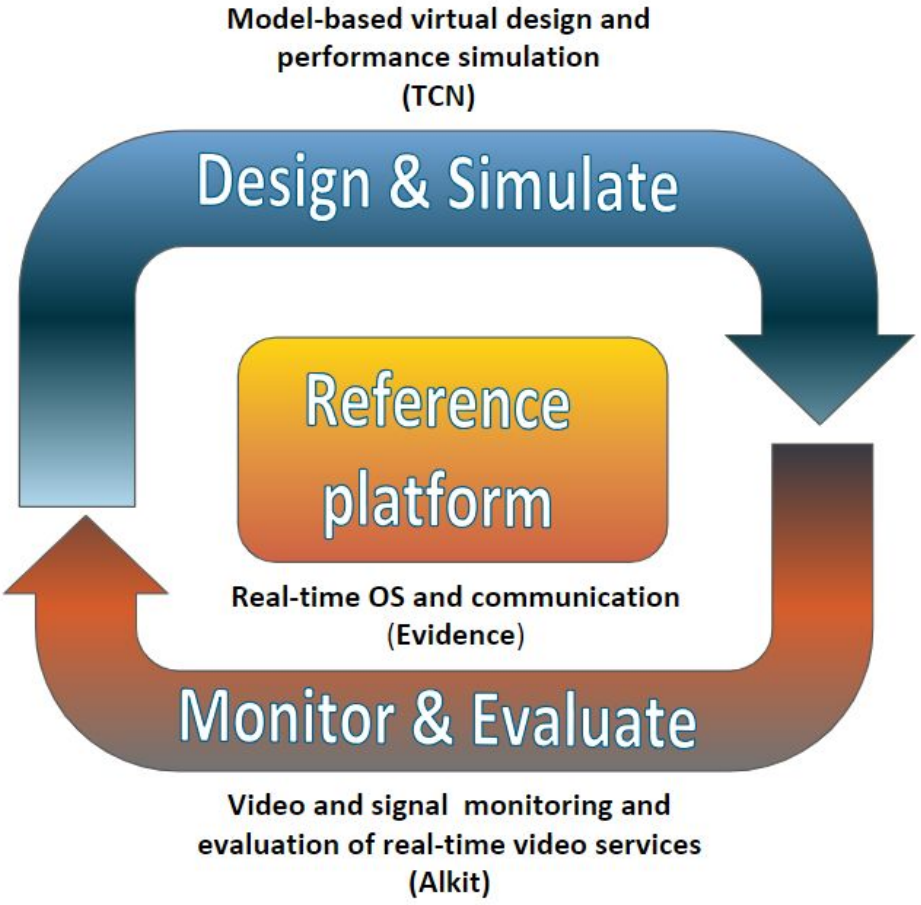


Figure 3. Design, monitor and evaluate on a common reference platform to efficiently examine trade-offs in a large design space.

Benefits of the **Prototyping of time-sensitive connected video services** solution:

Fast and agile

The solution especially speeds up development and implementation in a fast and agile way, saving money and development time

During the design and performance simulation, the behavior of the virtual network devices and the traffic they forward mirrors what would be occurring in the physical network counterpart, making communication behaviour more transparent

Video and signal monitoring on real physical devices help you to complement measurement data from e.g. CAN and FlexRay buses with video for specific vision-related needs and to capture the visual context of tests

The on-board real-time multi-OS and hypervisor allows you to completely test your application in live operation.

Maximize utilization of resources

Efficiently examine trade-offs in a large design space

Study how the network behaves under different load conditions, and find suitable trade-offs between network performance and hardware and software costs

This solution will minimize learning curves and debugging times.

Quickly gain insights

Understand how communication behaves under different configurations and usage scenarios

Evaluate different network topologies and network parameter configurations

Identify possible hot-spots where contention occur, due to high link utilization

Estimate the probability of worst-case delay and jitter for a data frame, or even the occurrence of packet drop due to limited memory buffers sizes.

Figure 4. The partners TCN, Evidence and Alkit complement each other in this solution.

4. The solution in-depth

The main industrial use case is to provide automotive OEMs with a solution to try out a new in-vehicle function or service that needs real time communication capabilities in a cloud infrastructure (V2X) or with another vehicle (V2V). For example, a service rendering condition monitoring of critical parts in a process.

This can be done using a ”**rapid prototyping**” solution consisting of an in-vehicle unit with a hypervisor architecture, wherein AUTOSAR Classic components can be executed in an ERIKA3 RTOS and a connectivity and a telematics platform running on Linux provides communication and video communication support.

Reference hardware

The reference hardware, shown in Figure 5, consists of a SINTRONES VBOX-3610 based on the Intel i7 processor.

Figure 5: SINTRONES VBOX-3610.

The CAN interface is provided by the additional PCIe expansion board Advantech PCM-26D2CA, shown in Figure 6.

Figure 6: Advantech PCM-26D2CA CAN interface.

Software architecture

Figure 7 shows the overall software architecture.

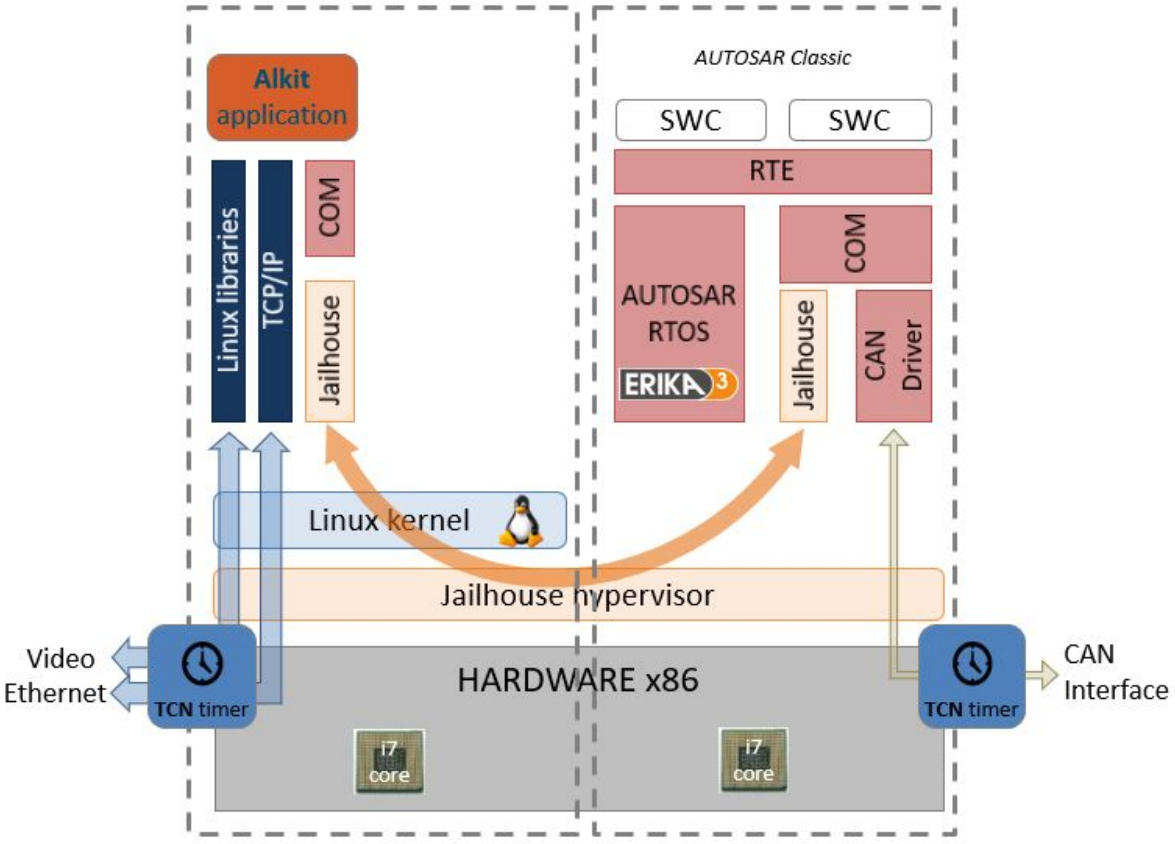


Figure 7: Overall architecture of the in-vehicle execution platform.

Note that the ERIKA part will have direct access to a CAN interface without the need to go through Linux. The support has been developed for the PCIe CAN interface described in the previous sections. The communication between the Linux and RTOS parts of the system, instead, is by means of a library providing the same API as the AUTOSAR COM standard. This library has been developed by Evidence as well.

Additionally, the package contains an Eclipse graphical plugin for editing the properties of the messages and communication channels within the system.

ERIKA Enterprise RTOS

ERIKA Enterprise (http://www.erika-enterprise.com) is an RTOS developed by Evidence Srl and specifically designed for the automotive market. The RTOS is certified OSEK/VDX and based on the AUTOSAR Classic standard. It is released under a dual license scheme, consisting of a free GPL and a commercial linking exception for linking proprietary code. The RTOS supports a wide range of microcontrollers, and is already used by renowned

OEMs operating in the automotive market (e.g. Magneti Marelli, Vodafone automotive, Piaggio).

Measurement and simulation platform

In the Linux part of the system, measurement data can be collected by measurement modules and software probes (i.e. TCN timer). The measurement data can be used as input to simulations of e.g. end-to-end latency communication.

As a result of simulations, the Ethernet port or link utilization can be analyzed as well as the possible loss of individual data packets in the network. Packet drops occur due to high instantaneous link load and limited frame buffer memory in the switch output ports. In general, the higher the load and the more bursty the traffic is, the higher the probability that packet drop occurs given a certain size of the output port memory.

Furthermore, similar timer probes as above can also be applied to the links in the virtual Ethernet network. During a simulation, each timer registers the points in time when a specific data frame passes by. By doing this in both a network ingress and egress point, packet forwarding latencies can be collected.

Based on the length of the simulation and the frequency of the data frame, the forwarding latency distribution of an individual data frame can be predicted, see fig 8.

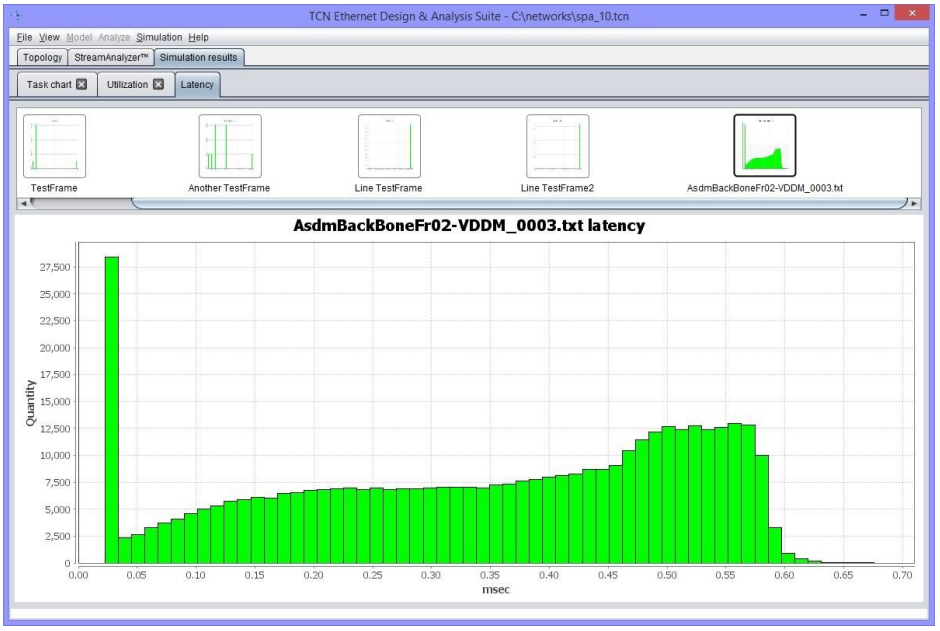


Figure 8. TCN TimeAnalysis = histogram showing a forwarding latency distribution for a selected frame.

Presentation components

Live data from a vehicle in use, including Video, VCAN-bus signals and other data from the prototype application can be presented on a PC or any similar devices during online usage, see Figure 9 and Figure 10 for an example using Alkit's WICE system with ongoing video components from the RETINA project results.

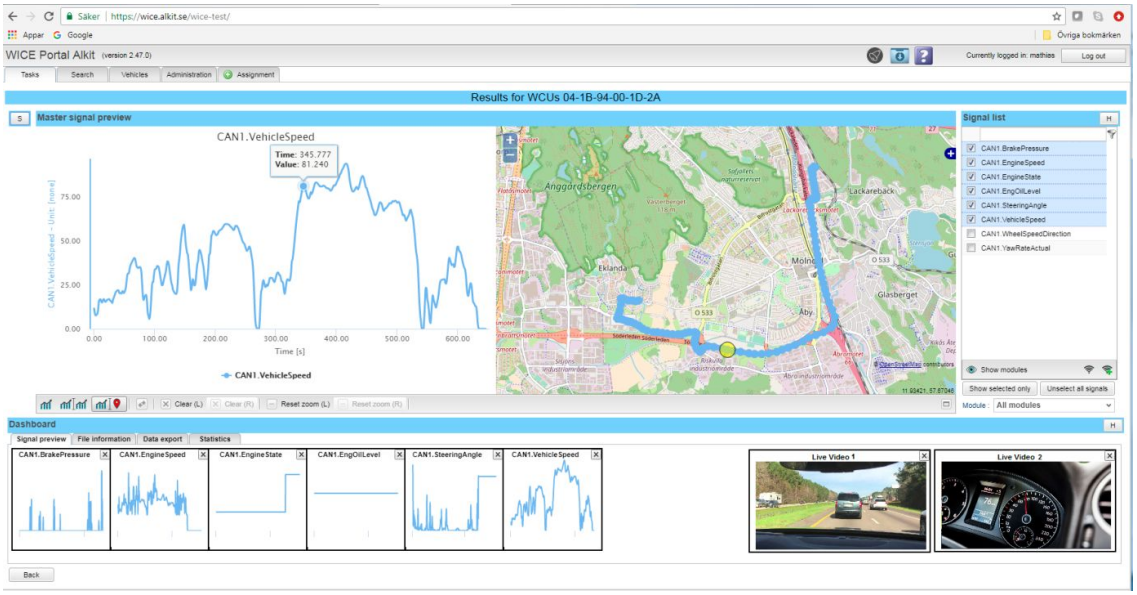


Figure 9: Alkit's WICE GUI for demonstrating live CAN + video from vehicle.

5. Offering

The partners will jointly offer a software tool set that provides time-critical, predictable and reliable communication for automotive applications in heterogeneous systems and networks. The tool set enables users to design, develop, monitor and evaluate time-critical applications, for example, advanced safety-systems and other applications for autonomous vehicles. All products and services will take advantage of the next generation mobile networks for C-ITS.

Realization

Alkit develops the applications on the Linux side, which handles communication with offboard infrastructure and supports video capture, processing and communications.

Evidence provides the ERIKA RTOS execution environment where a demonstrator SWC is installed and communicate with the Alkit application using COM.

TCN develops simulation software and timing probes to measure latencies.

The ***Prototyping of time-sensitive connected video services*** offering includes:

Software:

Software subscription of ***TCN TimeAnalysis™*** run within your site or as a service by TCN (or partner)

WICE software by Alkit supporting telematics, in-vehicle rapid prototyping and video communication

Software by Evidence: GPL version of the **ERIKA RTOS** and non-commercial versions of the communication library and the Eclipse-based configurators.

Hardware:

Hardware is acquired by the customers themselves, but can be also integrated as a service provided by Evidence, Alkit or TCN.

Services:

Optionally TCN, or partner, creates simulation models to perform the analysis on-site and/or off-site. TCN can develop software to the customer's specific needs, for instance reading customer specific files for import (e.g. ARXML) or to import data collected from a physical network measurement tool of your preference

- Alkit provides hosting services for WICE back-end telematics infrastructure, including Rapid Prototyping continuous deployment services
- Evidence provides both customization services and commercial licenses for the software provided (i.e. ERIKA RTOS, communication libraries, Eclipse-based development tool).

About Time Critical Networks, Alkit Communications and Evidence

Time Critical Networks (www.timecriticalnetworks.com) main focus is on developing simulation software tools to evaluate next generation Ethernet based architectures and networks. Using TCN TimeAnalysis™ software - model based performance simulation of the network, the user can build robust data networks with latency and packet-delivery in mind.

Alkit Communications AB (www.alkit.se) is a research and development SME with two main focus areas: automotive and e-health. In the automotive market Alkit works closely with leading OEMs and tier 1 suppliers in developing solutions for gathering, analysing and presenting data from test vehicle fleets for product development and time-critical monitoring of vehicle performance and usage. Example customers in the automotive market are Volvo Car Corporation, CEVT, Zenuity and Autoliv.

Evidence Srl (www.evidence.eu.com) is an Italian SME specialized in firmware and operating systems for embedded devices Evidence recently became a developer member of the AUTOSAR consortium. Among its products, ERIKA Enterprise (www.erika-enterprise.com) is an RTOS based on the AUTOSAR standard. The company has also contributed to the Linux kernel development since 2008, and has designed Multi-OS solutions with hypervisor for the embedded market.

Contact

To learn more, please contact

Time Critical Networks AB	hello@timecriticalnetworks.com
Alkit Communications AB	mathias@alkit.se
Evidence Srl	erika-enterprise@evidence.eu.com

References

Link to RETINA project results publications

(http://retinaproject.eu/publications-deliverables)