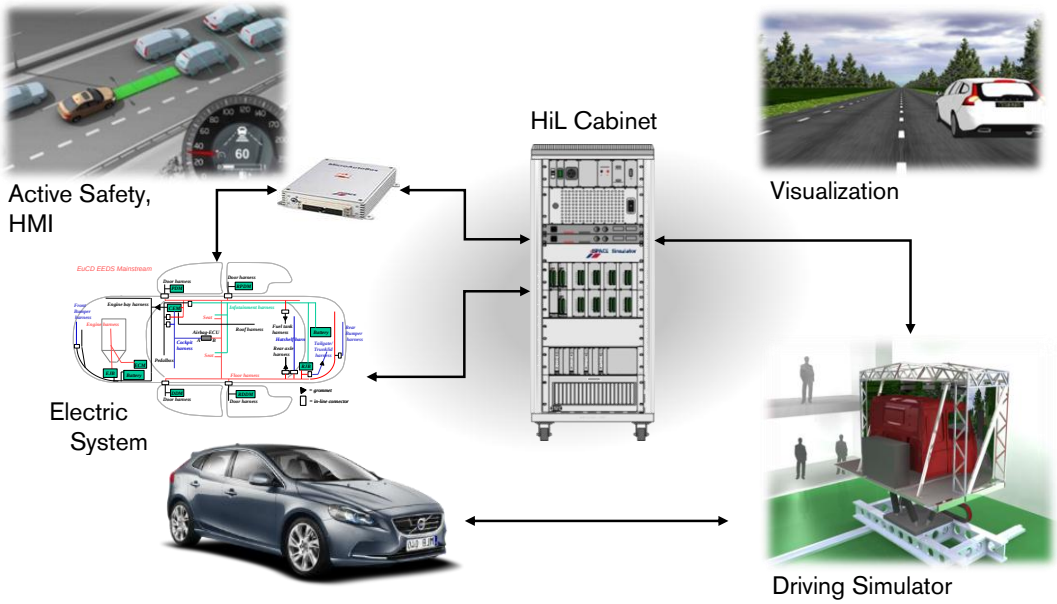
Second Road phase 1

A shared simulation platform for Active Safety and HMI



Project within: Fordonsutveckling

Author: Emil Knabe

Date: 2014-01-20

Content

FFI in short

FFI is a partnership between the Swedish government and automotive industry for joint funding of research, innovation and development concentrating on Climate & Environment and Safety. FFI has R&D activities worth approx. €100 million per year, of which half is governmental funding. The background to the investment is that development within road transportation and Swedish automotive industry has big impact for growth. FFI will contribute to the following main goals: Reducing the environmental impact of transport, reducing the number killed and injured in traffic and Strengthening international competitiveness. Currently there are five collaboration programs: **Vehicle Development, Transport Efficiency, Vehicle and Traffic Safety, Energy & Environment and Sustainable Production Technology.**

For more information: www.vinnova.se/ffi

1. Executive summary

The traditional “first road”, used over the last hundred years, repeatedly integrates subsystems in physical test vehicles for evaluation on closed or open roads. With relatively low growth rate of electronic systems and long development cycles of 4-5 years this strategy has been adequate. However exponentially growing complexity of the electrical systems in today’s cars in combination with market demands on shorter development and faster more frequent launches, the First Road is way too narrow.

One key to stay competitive is to explore and utilize simulation based methods and technologies for accelerated development and rapid, even continuous, integration and verification of the system and functions. This is the Second Road.

By exploring;

1. Complete car simulation for active safety and vehicle HMI.
2. Simulation bridge between VCC simulators and the VTI SIM4.
3. Work process to increase model sharing and shorten time to market.

The project has contributed to a national simulation platform and to Volvo Cars ability to remain leader of safety and stay competitive in a reality of extreme system complexity of tomorrow’s cars.

At Volvo Cars the first SPA based car, verification prototype (VP) of upcoming XC90 gen 2, has successfully been integrated, started and roll tested according to plan. This is outstanding results that directly map to the Mozart and Second Road phase 1 projects. Correlation between HIL and car has been terrific, whereby lots of critical issues has been eliminated before going to physical car. Of course many challenges remain, so further continuous support and PMT development ahead is vital.

A desired effect of the Second Road vision is to support and stimulate innovation in particular, but also research, in the areas of vehicle and transportation system. To this vision Second Road phase 1 has clearly contributed.

2. Background

There are two emerging concerns with the way cars are developed today. Firstly, the need to evaluate and simulate functionality prior to physical vehicle tests has led to the introduction of numerous non-connected single-purpose simulators. Models and scenarios are often duplicated and recreated, complicating overview and coordination. The second concern is that the rapidly trend of complex functionality creates need for a complete virtual vehicle for simulation based tests. It is not enough to test on sub system level.

We expect these issues to become an even greater concern in the near future as the active safety functionality and HMI footprint rapidly increases. These are two important and prioritized areas for Volvo Cars and have been selected as focus areas for this project.

Volvo Cars electrical department started the road towards virtual driven integration and testing with the VINNOVA project Mozart 2005-2008. Results from this project is now a critical part of the development of Volvo's new platform SPA, where the Mozart developed HIL-integration speeds up the integration process and helps finding issues much earlier which is a huge time and money saver.

With this in place the next step was to identify and define synergies between simulation environments horizontally and vertically both internally at Volvo Cars and externally with for instance SIM4 at VTI.

3. Objective

The purpose of Second Road phase 1 was to reduce costs and improve the safety and quality of cars produced at Volvo Car Corporation. The results of Second Road will benefit several simulation initiatives within Sweden by collaboration and making simulators more compatible. Second Road contributions within simulation based methods and technologies are one important key for Volvo Cars to stay in the lead of safety and to stay competitive in a reality of extreme system complexity of tomorrow's cars.

High level objectives:

- Be able to co-simulate advanced Active Safety & HMI functionality
- Achieve transparency between models, simulators and real cars
- Model Once USe Everywhere – MOUSE (active safety and HMI)
- Reduce cost and improve vehicle safety & quality by:
    - Exploring combinations of variants
    - Enabling test of hazard scenarios
    - Optimizing features and properties
    - Reducing driving hours
    - Decreasing time-to-market

4. Project realization

Second Road phase 1 was a collaboration between internal departments within Volvo Cars as well as collaboration with strategic partner organizations. It was prepared by Volvo Cars Electrical and Electronics Systems Engineering department (EESE) and the

partner companies: HiQ, Mecel and Semcon. Initially Knowit was also part of the project but decided early to leave, handing over commitment to Mecel.

Internal partners at Volvo Cars: departments at EESE, (e.g. Electrical Architecture, HMI, Active Safety), Chassis department, Complete Vehicle and Safety Centre.

Focusing on different project goals the project was divided into four sub-projects:

SP1: Harmonization of simulator environment
SP2: Modularization of simulator environment
SP3: Enhancement of HMI simulation process
SP4: Concept for distributed simulation

The project organization is showed in the figure below:

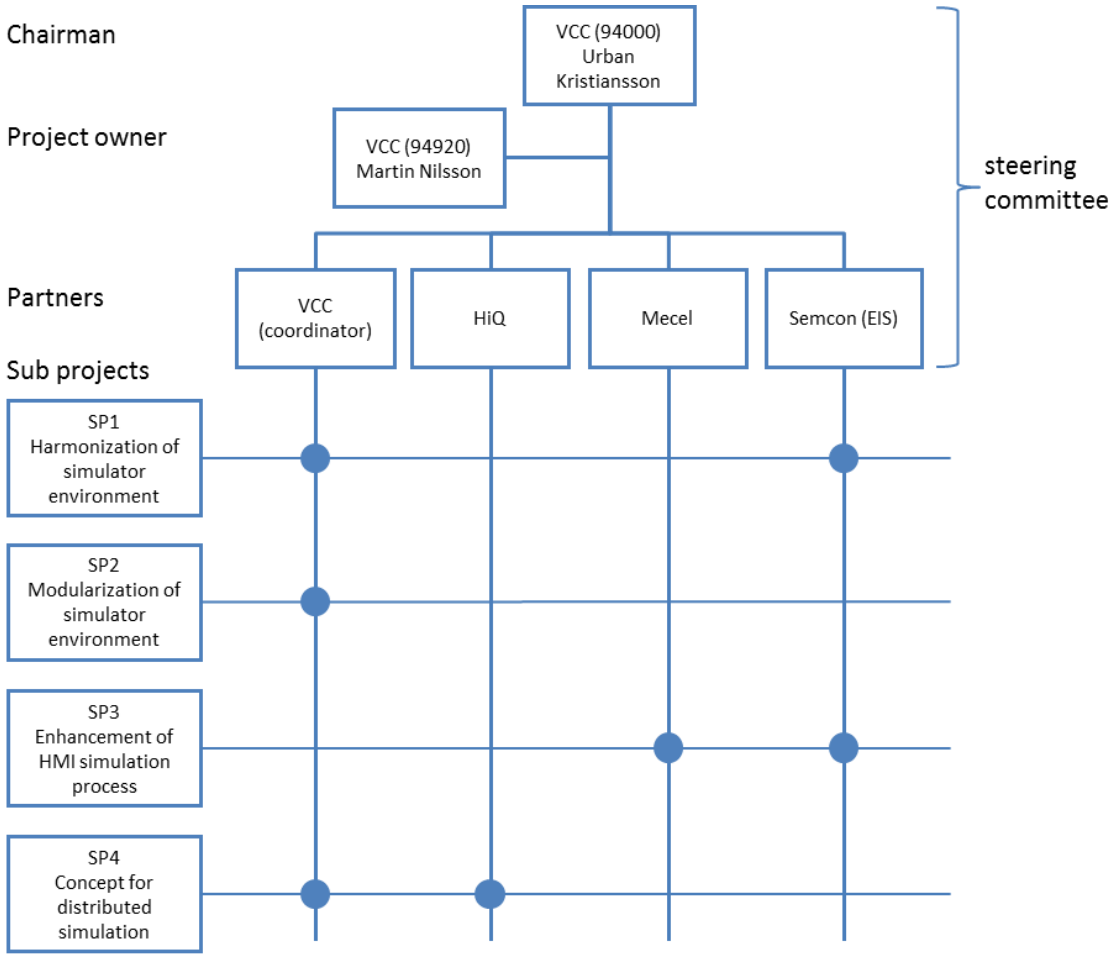


Figure 1. Project organization

Second Road phase 1 has been coordinated by a VCC appointed project manager. Work within sub projects has been managed by involved partners. The project manager has on a regular basis reported progress and status to a steering committee consisting of members from each partner, in addition to regular VINNOVA reports.

5. Results and deliverables

5.1 Project results

Shared simulation platform
Seven selected simulation environments, inside and outside of VCC, have been investigated, compared and described. Based on these investigations a reference simulation architecture has been defined.

Tools and methods for integrating Volvo Cars functions with VTI SIM4 have been developed as part of the pilot study Traffic Jam Assist (TJA).

Next generation model library for the virtual vehicle was initiated and is now continued as the Volvo Cars internal project Virtual Vehicle Architecture (VVA). A model repository is now being deployed as part of the VVA project.

HMI simulation methods and tools
Mecel has developed a plugin for their Populus Suite automatically connecting HMI to AUTOSAR components. Further, Populus has been ported to Android, offering a commercially available open platform for rapid HMI development and simulation.

Semcon has developed and presented an open source/platform based tool chain and method for evaluation of simulated advanced vehicle functions including HMI on a very early stage, before dependent ECUs and signals are available.

Distributed simulation
Investigation of various VCC simulation environments, concepts and available products for distributed simulations resulted in a plan for a co-simulation of three selected VCC simulation tools interconnected by HLA simulation network technology.

The co-simulation was cancelled in favor of an evaluation of a 3D visualization software framework part of the ViP simulation software platform. As proof of concept, a pilot application was developed and integrated with VCC complete vehicle HIL simulator, visualizing participating vehicles in a 3D environment.

Results context mapping
Results mapped into the Volvo Cars context of domains and verification levels:

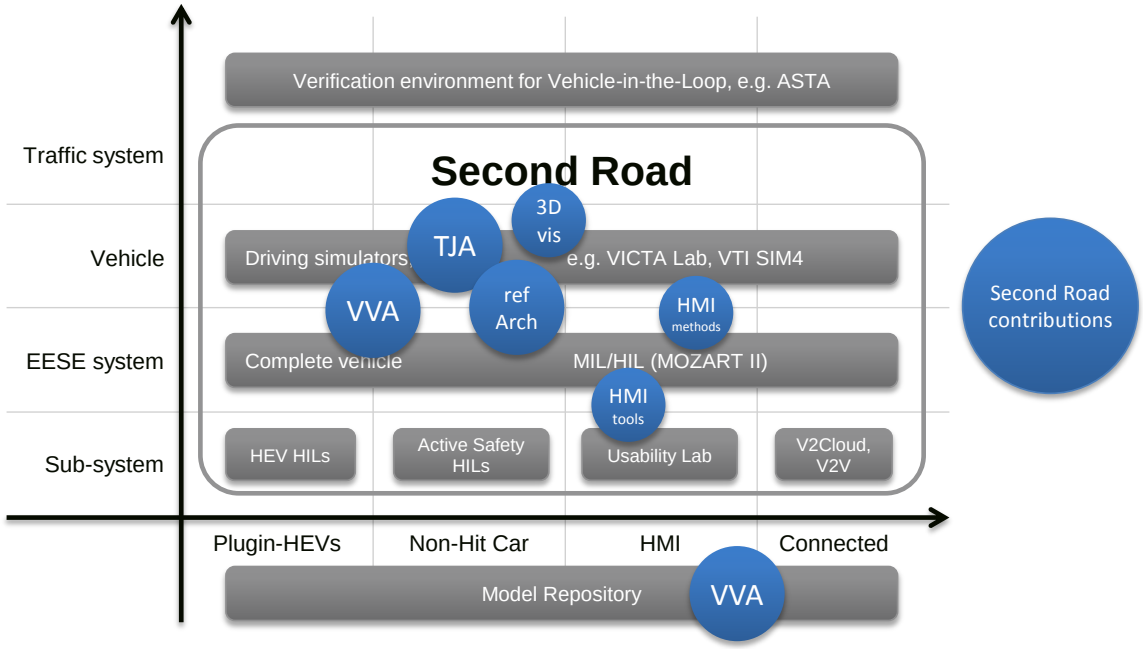


Figure 2. Results context mapping

5.2 Delivery to FFI-goals

Second Road phase 1 has contributed to the following FFI-goals:

Generic goals of VINNOVA programs:

- Ensure jobs and competiveness within the vehicle industry
- To stimulate long-term and potentially radical projects
- Stimulate collaboration between project partners

Contributions in terms of research, innovation and development in the following areas:

- Vehicle electrics and electronics
- Embedded systems and software
- Methods and tools for vehicle development

Explicit goals of the vehicle development program:

- Improved traffic safety
- Improved competitiveness
- Increased technical maturity enabling faster industrialization of results and increased customer value.

Motivations:

- By developing state of the art simulation based methods and tools competence and competitiveness is ensured and we are prepared for the challenges ahead of complex

vehicle systems, shorter development cycles and fewer physical test vehicles. This project has definitely contributed to this position.

- Volvo Cars establishment of HIL based integration and verification is a very important investment to support future car projects within Volvo Cars. Second Road has contributed with PMT and collaboration within this area. Hence long term projects are stimulated.
- Through regular project meetings and especially the two appreciated seminars important networks have been established between partners and also between groups within Volvo Cars.
- The electronic system of a modern car is definitely an example of a complex distributed embedded system with massive amounts of software from various suppliers. Typically a car project also has a tight time plan. This project has contributed with important development, and some degree of innovation, within PMT for development, integration and verification of embedded system and software.
- Improved simulation based methods definitively contribute to safer cars since Active Safety functions can be validated and verified in virtual environments. One result is enabling early integration of systems for early functional tests. Another result is the possibility to exercise the behavior of the system in extreme and dangerous situations not suitable or possible to test in real traffic.
- Simulation is a key to solve the equation of reduced physical test vehicles plus increased complexity of system and functions and also reduced development time. The Virtual Vehicle Architecture (VVA) project and positioning sensor simulation are examples of actual results increasing Volvo Cars capacity to handle the deployment of all the features and functions that tomorrow's customers will demand and desire.

6. Dissemination and publications

To spread results and experiences, initiate discussions and perhaps stimulate future collaborations two open seminars were arranged.

2012-11-01 program:

- Simulation Reference Architecture, Björn Fridholm and Kenneth Lind, Viktoria
- HMI architecture for rapid prototyping and production, Fredrik Björndahl, Mecel
- Thinking out of the (lab)box, Johan Sandgren, Semcon
- Co-simulation 1+1=3, Anders Bengtsson, HiQ
- Panel discussion and questions

2013-05-21 program:

- 1200 seconds on the second road, Martin Nilsson, VCC
- Implementation of Active Safety functions in VTI Sim4, Ola Jakobson, VCC
- Complete vehicle HIL in SPA, Annica Normén, VCC

- Development simulators and simulation within the aerospace industry, Kristoffer Johansson, HiQ
- VVA - Next generation simulation model architecture, Ulf Gimbergsson, VCC
- Enhancement of HMI simulation process, Christopher Olofsson & Fredrik Björndahl, Mecel
- Automatic code generation of AUTOSAR compliant HMI applications, Samira Afshoon & Fredrik Björndahl, Mecel

In addition, several presentations and demonstrations were arranged within the project, for example:

- 2012-06-28 at VCC HIL lab: ITS function and HMI tool demonstration (Semcon).
- 2013-10-14 at VCC HIL lab: VISIR 3D visualization (HiQ).

A technical report [1] describing the project in more detail including special purpose reports and presentations is available at request.

7. Conclusions and future research

Second Road phase 1 has contributed with competence, methods and tools within simulation based integration and verification. Supporting development of complex and innovative functionality it contributes indirect to long term automotive competitiveness.

Investigations and benchmarking of existing simulation environments led to common reference architectures for simulators and simulation models.

The pilot study in VTI SIM4 resulted in knowledge and partial framework as a bridge between VCC and VTI simulator environments, with focus on Active Safety.

HMI tools and methods were developed and tested on a concept level.

With these results achieved, some of the next challenges are:

- A complete representation of the virtual vehicle for integration and verification of complex, even multi domain, functions.
- Continuous roll out of small changes gradually improving functions adapting to user demands and behavior.
- Common scenario description format between teams, domains and rigs enabling test sharing and comparison. Automation as a positive side effect.
- New processes, methods and tools for planning, control and execution of software integration. Driven by system complexity and aggressive launch time plans.
- An open lab making all common achievements and platforms available to regional companies and institutes stimulating contributions to the development of future cars.

Joined by 11 partners, VCC has submitted an application for Second Road phase 2 addressing these challenges. Possible project start early 2014.

8. Participating parties and contact person

VOLVO	Martin Nilsson martin.p.nilsson@volvocars.com
HiQ	Anders Bengtsson anders.b.bengtsson@hiq.se
Mecel	Anders Eliasson anders.eliasson@mecel.se
semcon	Johan Kristensson johan.kristensson@semcon.com
VINNOVA	Eric Wallgren eric.wallgren@vinnova.se

9. References

[1] VCC, ”Second Road fas 1 - Teknisk rapport.pdf,” 2013.