

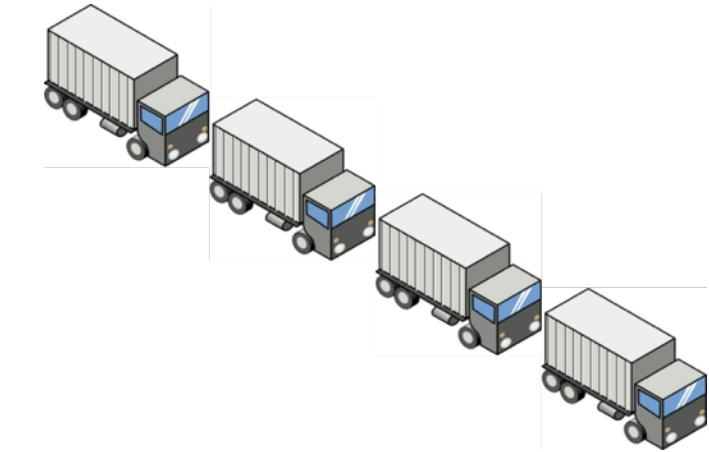
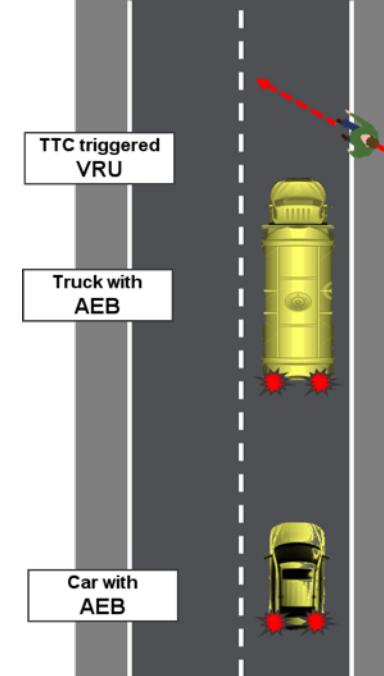
# AUTOMOTIVE CHALLENGES

Student lecture 170906

Kenneth Lind

kenneth.lind@ri.se

Research Institutes of Sweden



# Agenda

- Who am I?
- Automotive background
- Future challenges
- Experiment and testing ecosystem
- Student project

# Who am I?



**VOLVO**



**SCANIA**

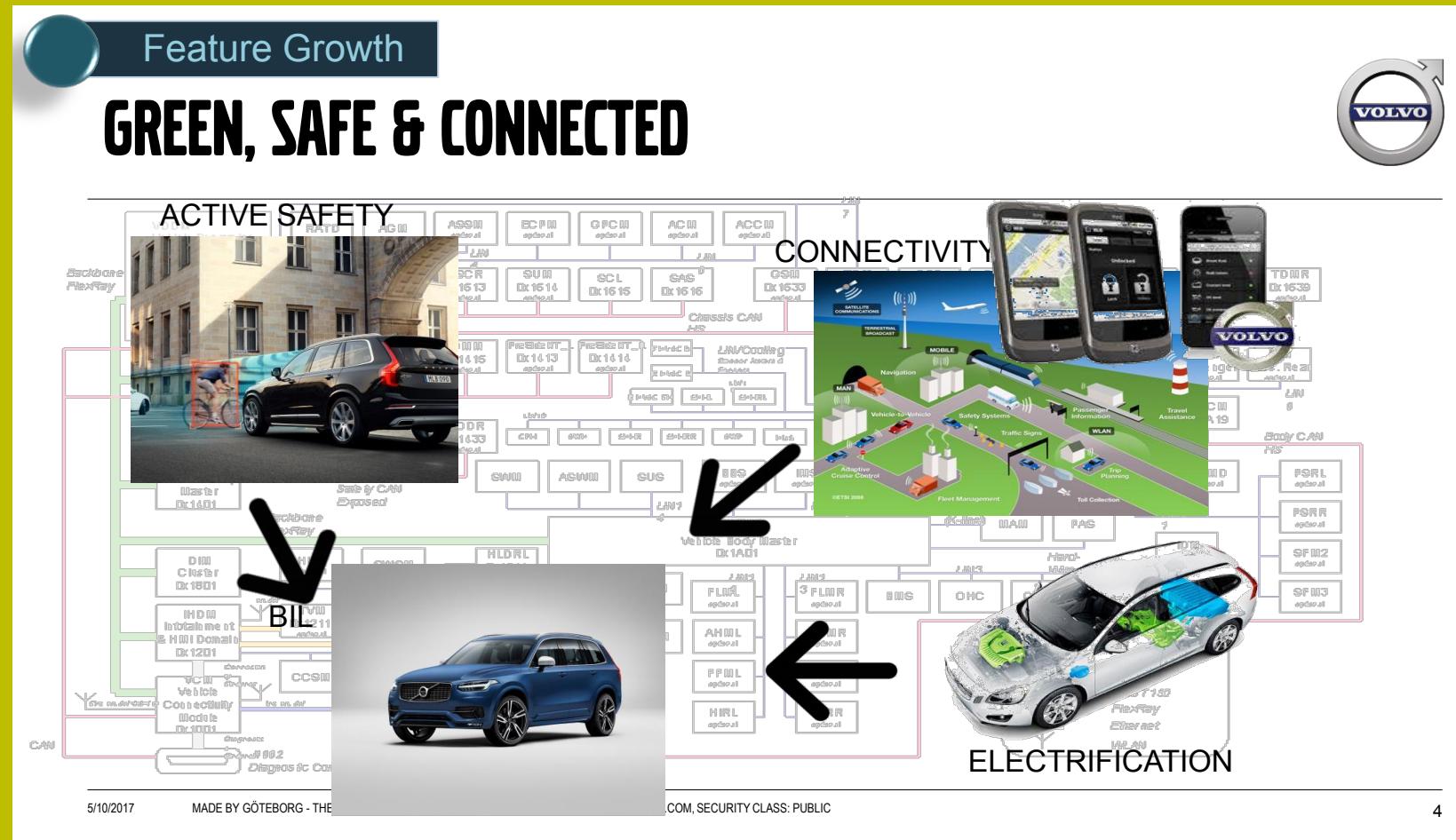
- Senior researcher at RISE Viktoria
- VICTA lab project leader
- Saab Automobile 1998-2011
- Volvo Aero Corp. 1994-1998
- Scania 1987-1994
- PhD in Software Engineering at Chalmers
- MsC in Applied Physics and Electrical Engineering at Linköping University

# Agenda

- Who am I?
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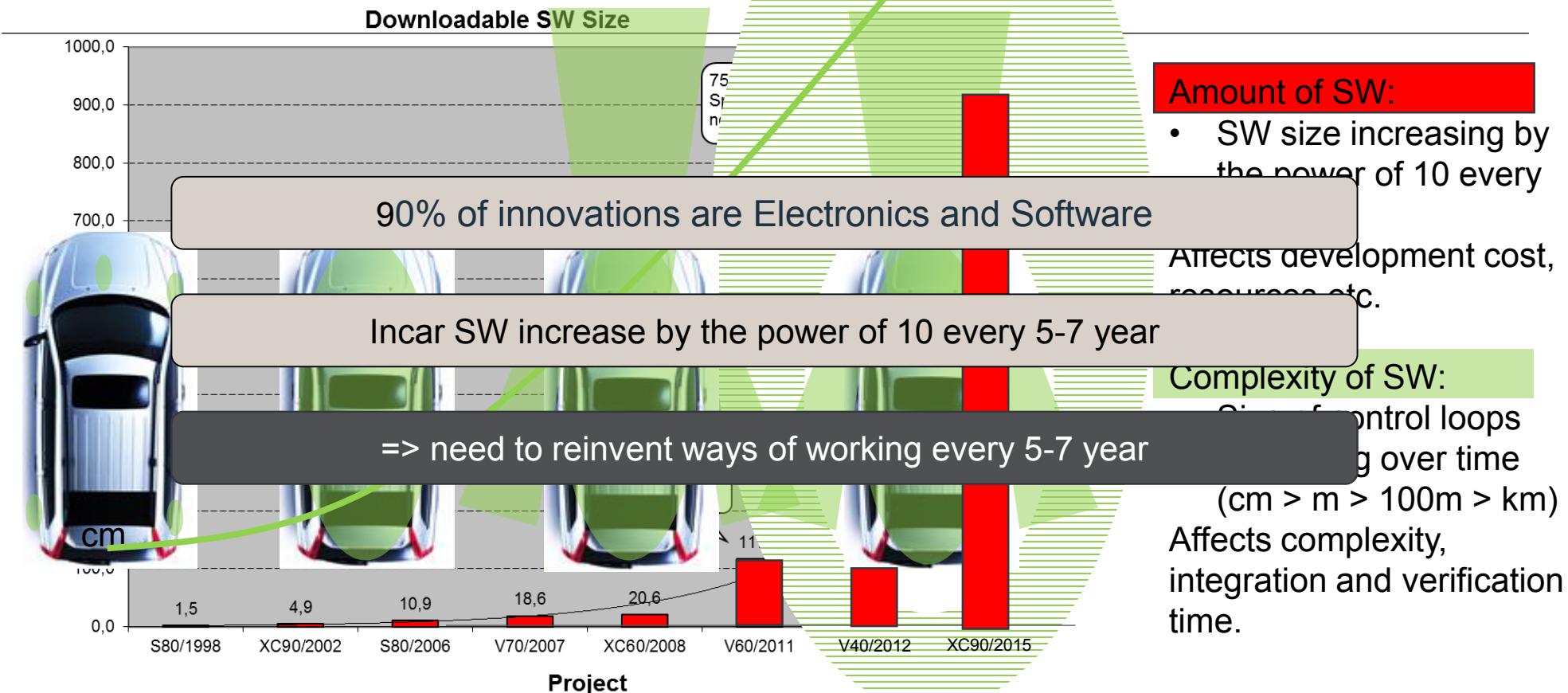
# Automotive background

(Slides from Volvo Cars)



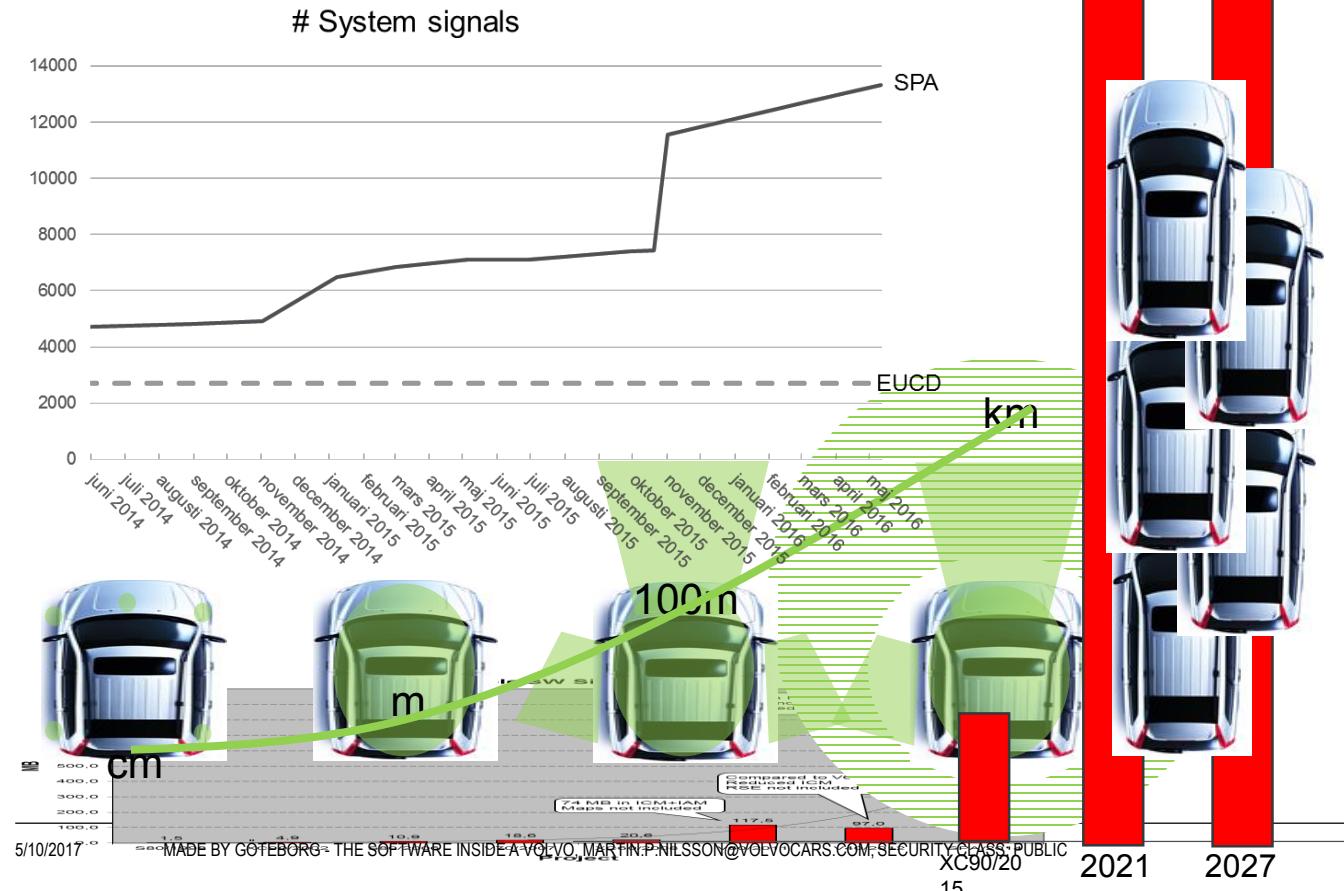
# Software growth

## SW GROWTH AND COMPLEXITY INCREASE



# Software growth

## SW GROWTH AND COMPLEXITY INCREASE



X8...



### Amount of SW:

- SW size increasing by the power of 10 every year
- $SPA2 = SPA \times 10 - SPA \times 100$

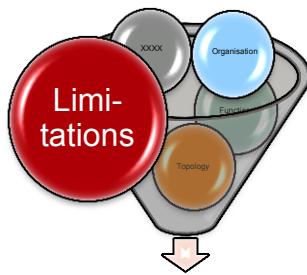
Affects development cost, resources etc.

### Complexity of SW:

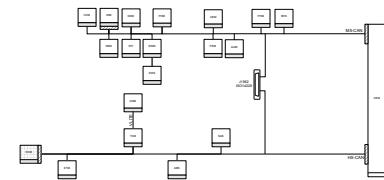
- Size of control loops increasing over time

Sharing (SoS, people, Grid, AD, brands, ...) integration and verification time.

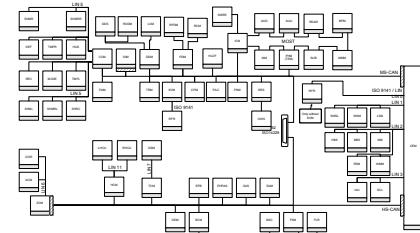
# Onboard vehicle topology before



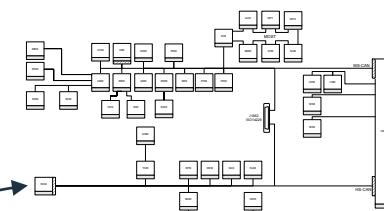
## DRIVERS - LIMITATIONS - *NETWORK TOPOLOGY*



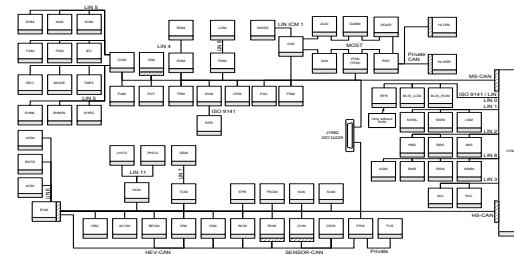
1998 – First S80  
(18 ECUs)



2006  
(68 ECUs)



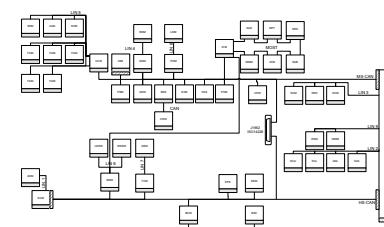
2002 - S/V 40  
(38 ECUs)



2012-Hybrid  
(78 ECUs)



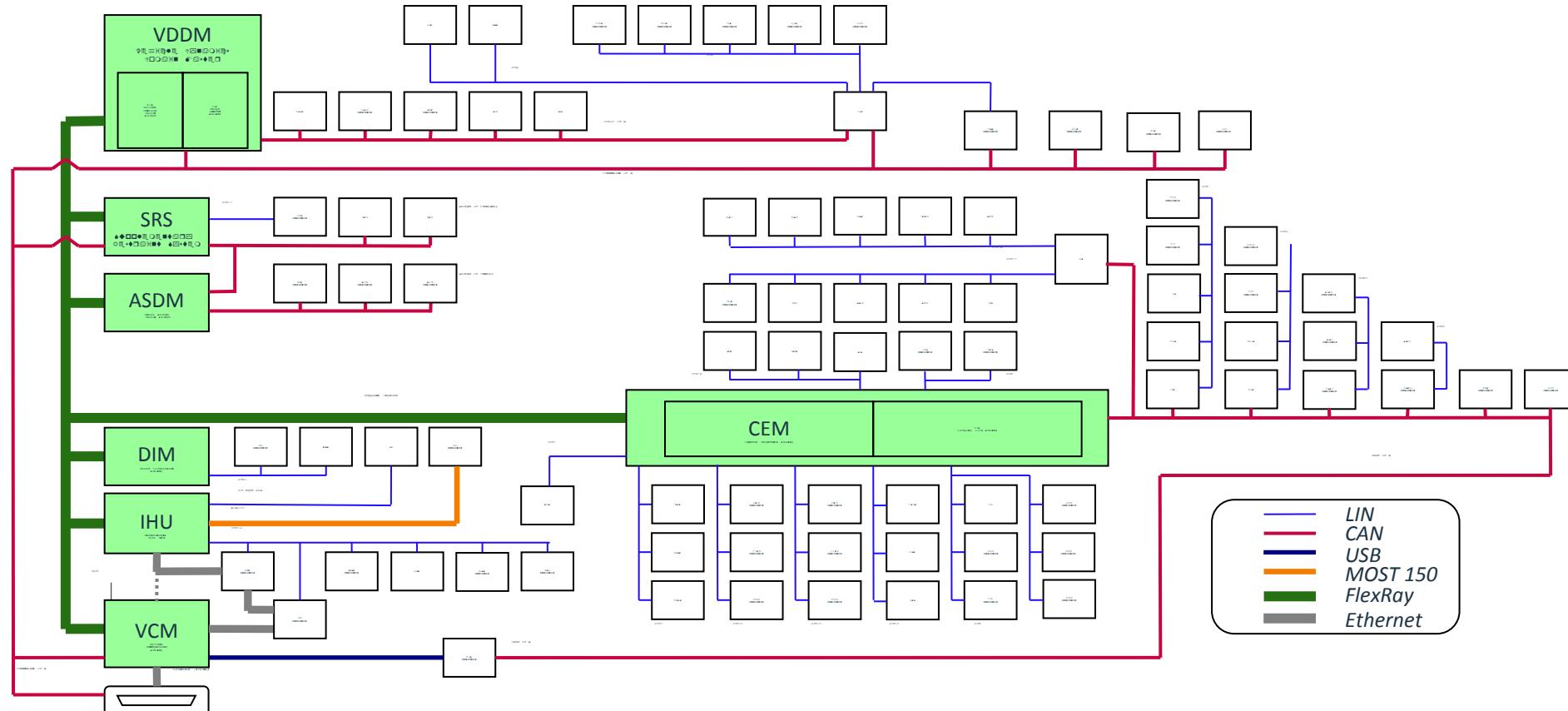
(ECU- Electronic  
Control Unit)



2003  
(49 ECUs)

# Onboard vehicle topology today

## BACKBONE BASED NETWORK TOPOLOGY, DETAILS

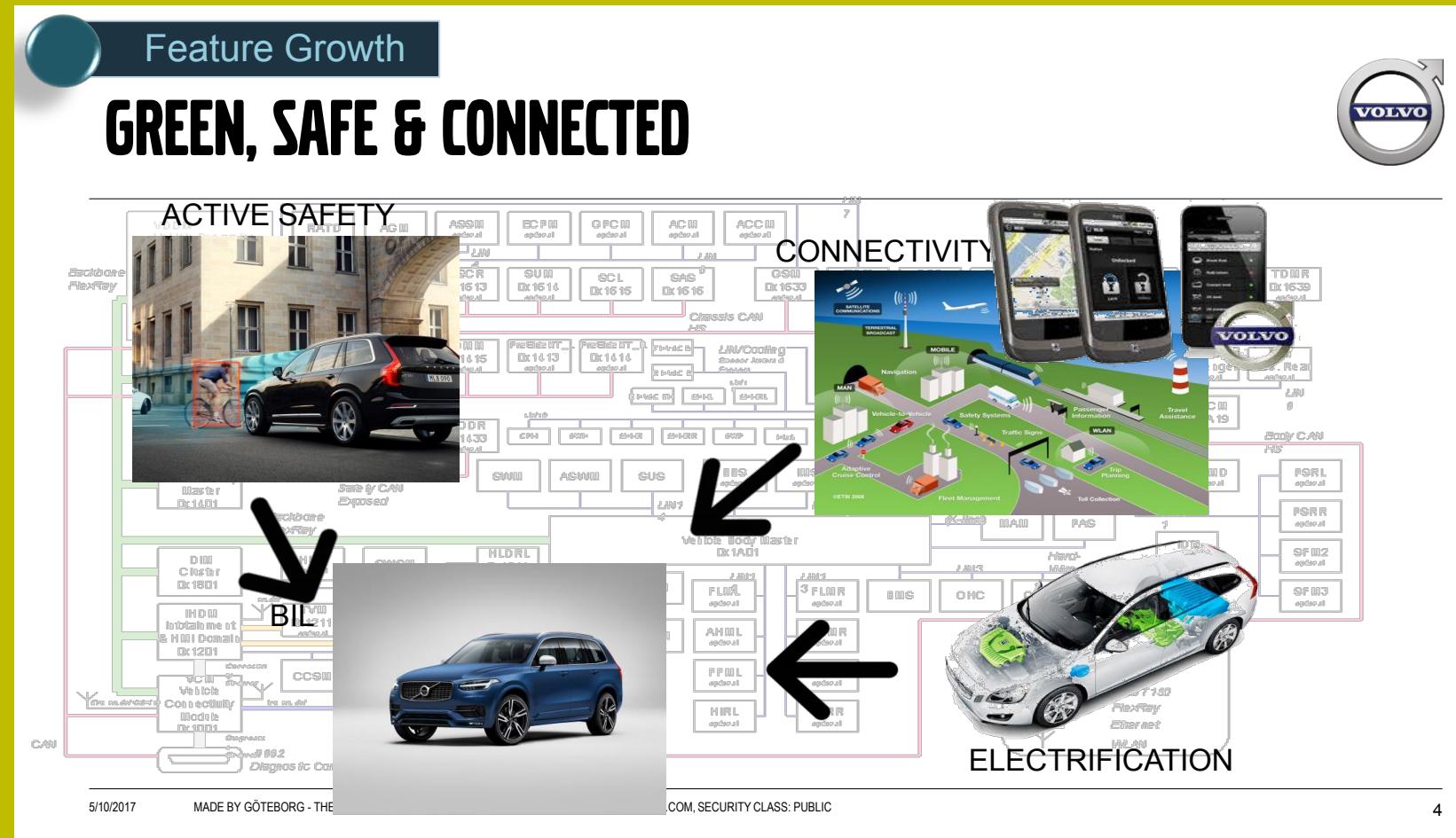


# Agenda

- Who am I?
- Automotive background
- Future challenges
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- Student project

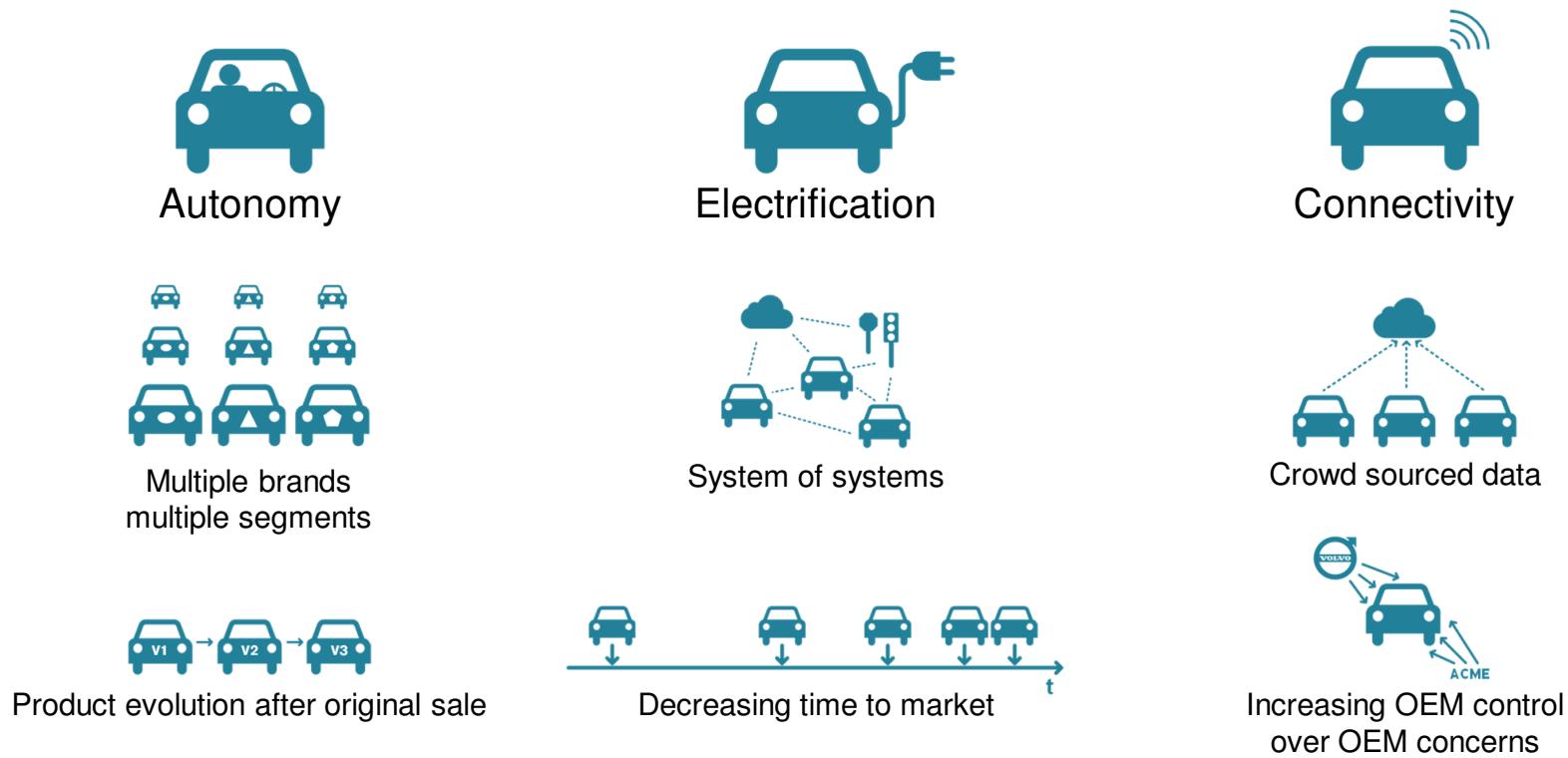
# Future challenges

(Slides from Volvo Cars)

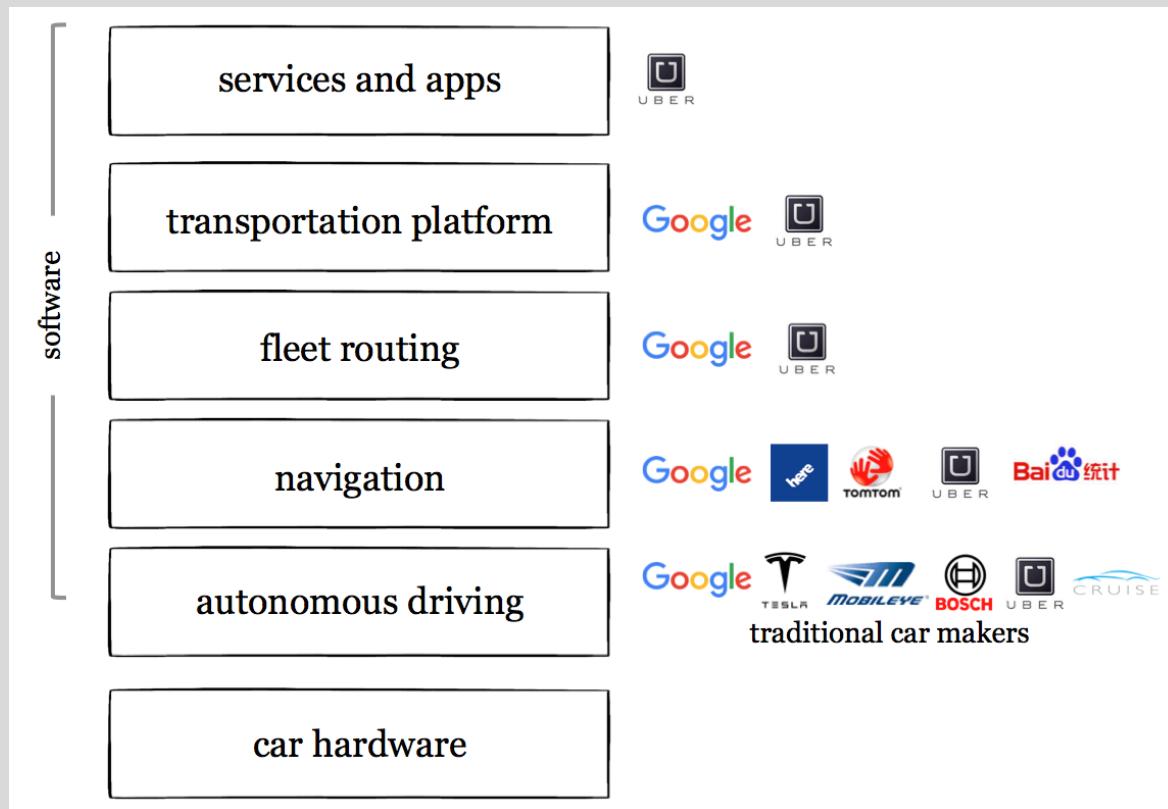


Sharing economy  
And more!

# ON THE HORIZON



# SELF DRIVING CARS BUSINESS LANDSCAPE



Only few players are still attacking the challenge from the complete perspective. All traditional companies are working at the lower levels.

An eco-system will grow where a lot of new companies, and businesses, will evolve at the different levels. Especially the top levels are hard to imagine today.

Eco-system growth pushes for a platform based structure, which means new interface layers and service oriented structure needs to be developed.

Image source: Michael Vakulenko Nov 2015.  
<https://www.visionmobile.com/blog/2015/11/self-driving-cars-are-about-platforms-not-about-cars>

## Game Changing Technologies

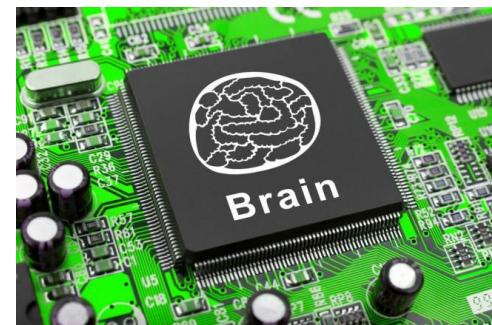
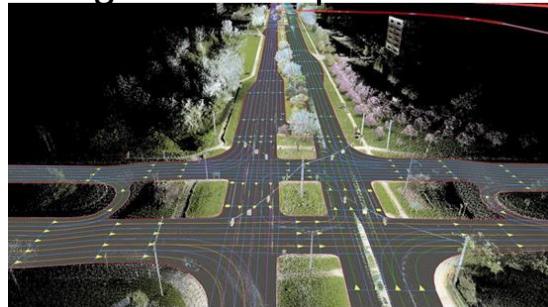
# "DISRUPTIVE" TECHNOLOGIES => NEW SOLUTIONS



5G Connectivity



Digital HD maps

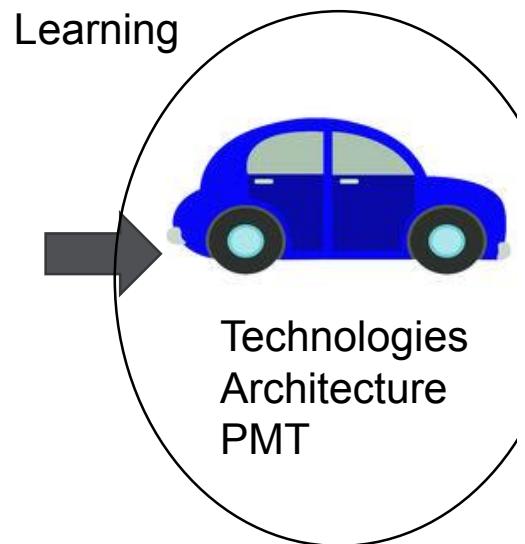


IoT  
SOS

Crowd sourced data



Deep  
Machine  
Learning



Big data



# Indian intersection

- <https://youtu.be/nVUDFizBLxw>

# Agenda

- Who am I?
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- Student project

# Experiment and testing ecosystem



ASTAZERO



# VEHICLE ICT ARENA

## COMPETENCE & INNOVATION NODE



# Arena for innovation and competence

- Join forces within vehicle ICT to reach world class
- Contribute to industrial innovation
- Driven by societal challenges for safe and sustainable transports



VEHICLE ICT ARENA  
COMPETENCE & INNOVATION NODE

# Vision and Goals

Ensure Sweden's leading position in safe and sustainable transport systems with the help of vehicle ICT

## Primary Goals

- New innovations
- Access to competence
- Contribute to a new supplier structure and attract new companies



# 45 PARTNERS 2016

## Companies

- Actia
- Alpine
- Altran
- ArcCore
- Autoliv
- Combitech
- Cybercom
- Delphi
- Denso
- Ericsson
- Fengco
- HiQ
- Interaktionsbyrån
- Kapsch
- Microship /SMSC
- Mitsubishi Electric
- Modelon

- Netgroup Engineering
- NIRA Dynamics
- Pelagicore
- Prevas
- Qamcom
- QRtech
- Semcon
- Sentient
- Smart Eye
- Swedspot
- Talkamatic
- Time Critical Networks
- Vector informatik
- Volvo Cars
- Volvo Group
- Yazaki
- ÅF

## Universities and Institutes

- Chalmers TH
- Fraunhofer-Chalmers
- Högskolan i Halmstad
- Högskolan i Skövde
- SP
- Viktoria Swedish ICT
- VTI

## Colour coding

- Core partners
- Premium Partners
- Associate Partners
- Public co-financing

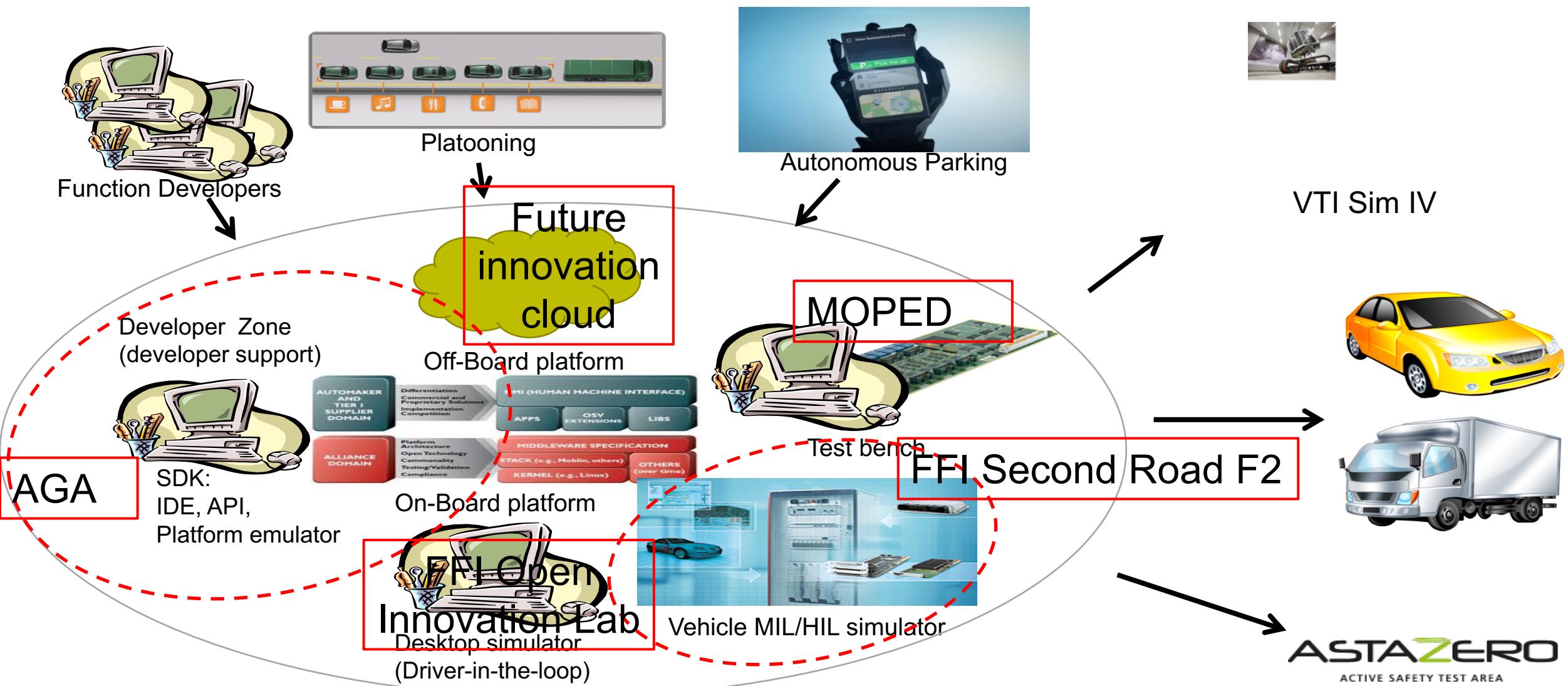
## Public co-financing

- Business Region Göteborg
- VINNOVA
- Västra Götalandsregionen

## Host

Lindholmen Science Park

# VICTA Lab



SDK = Software Development Kit

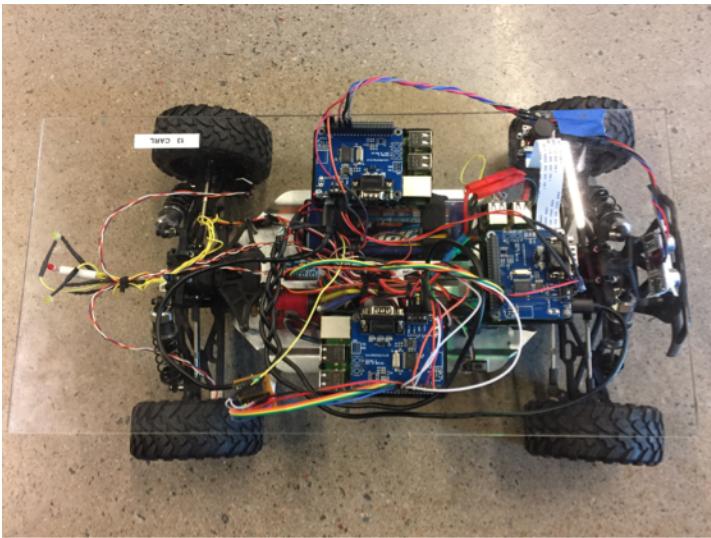
API = Application Programming Interface

MIL = Model-in-the-loop

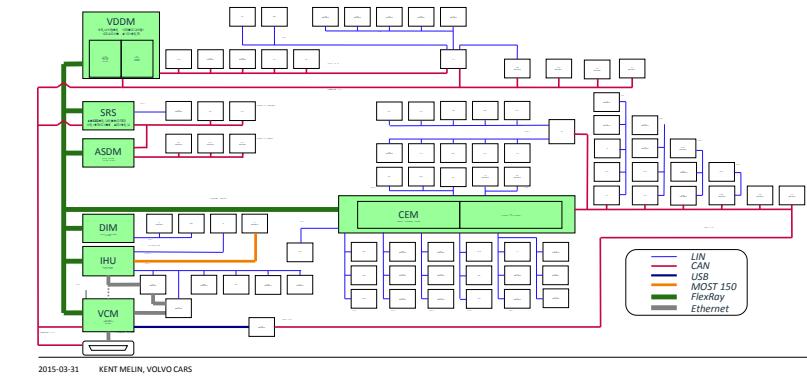
IDE = Integrated Development Environment

HIL = Hardware-in-the-loop

# MOPED



## BACKBONE BASED NETWORK TOPOLOGY, DETAILS



Mobile  
Open  
Platform for  
Experimental  
Design of Cyber-Physical Systems

# Vehicle MIL/HIL simulator



Model-In-the-Loop/  
Hardware-In-the-Loop  
simulator

# Vehicle MIL/HIL simulator

- Developed as part of FFI Second Road F2
- Developed by VCC, VTI, Semcon, HiQ, and RISE Viktoria
- Launched 2017-03-22
- Supports development and testing of active safety functions and infotainment applications
- 3 demo cases implemented for user inspiration
- Located at Lindholmen Science Park

# Vehicle MIL/HIL simulator

Simulation environment  
on VIP platform

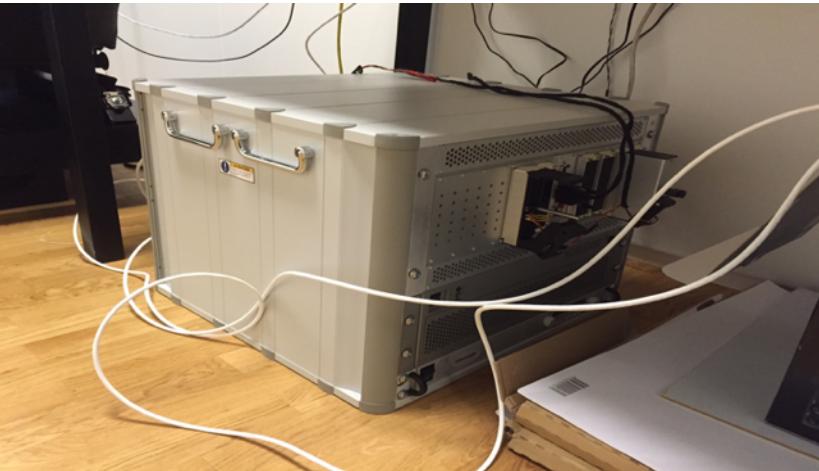
Test  
scenario

Environment  
driving, core  
and data log

VIP SW

PC HW

Vehicle simulator run



Cameras  
on VISIR  
camera  
stream  
SIR SW  
C HW

Ethernet

SDR/SID HW  
(Freescale 5)

Cloud  
Services  
(TBD)



DIM from SPA XC90

DIM SW  
DIM HW

Flexray

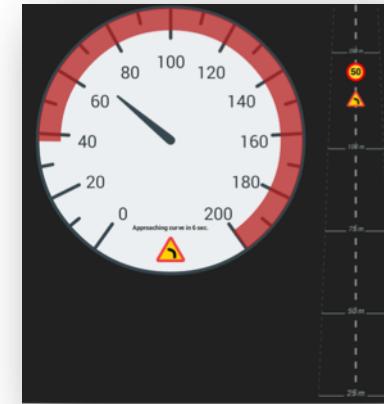
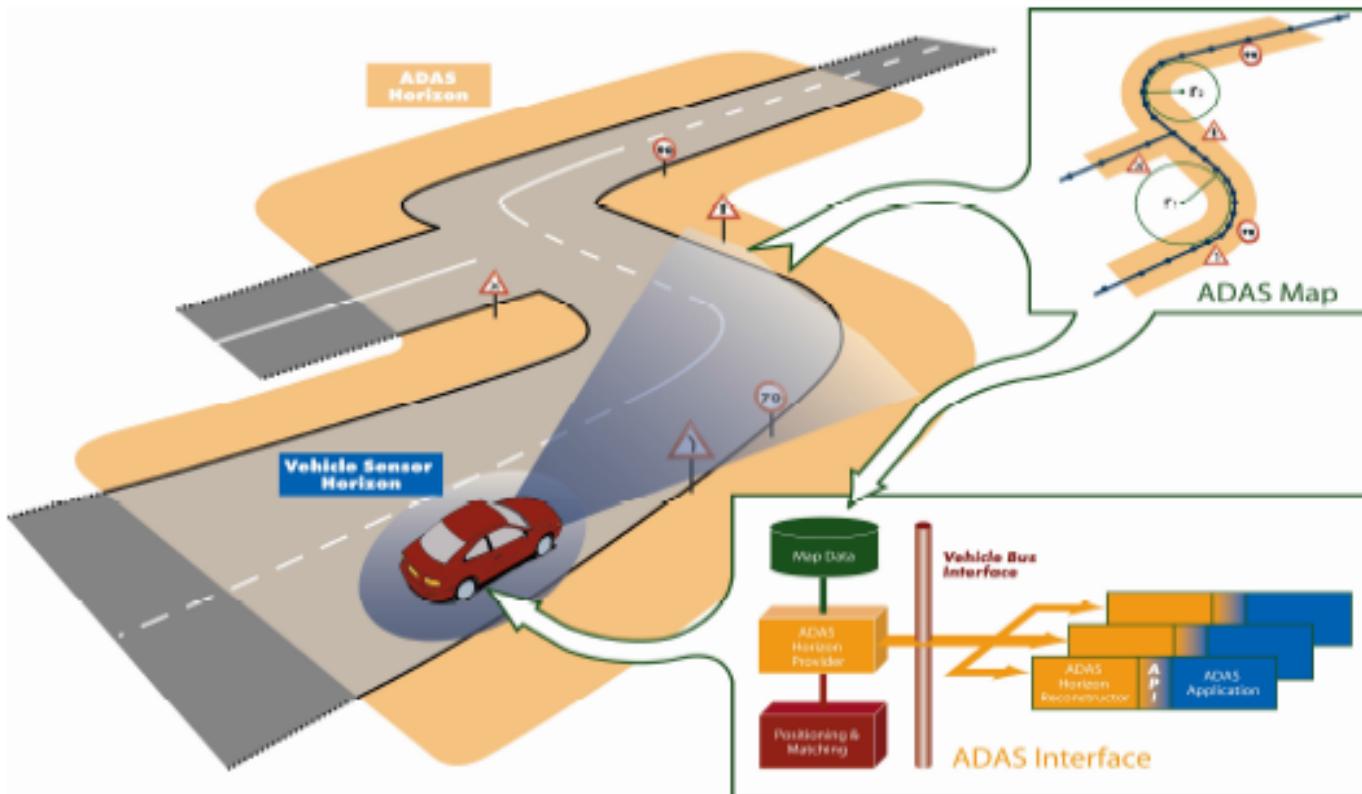
CAN



# Application example: Electronic Horizon based Curve advisor

See the road ahead...

Using on-line maps, road condition reports etc...



This demo case was already implemented in VICTA lab,  
and the code is available at <https://vehicle.lindholmen.se>

# Sim IV



VTI Driving Simulator

<https://www.vti.se/en/research-areas/vtis-driving-simulators/>

# AstaZero

<http://www.astazero.com>

**ASTAZERO**

THE WORLD'S  
FIRST FULL-SCALE  
TEST FACILITY  
FOR TOMORROW'S  
ACTIVE SAFETY.



# AstaZero



Opened 2014  
One hour from Göteborg  
Four test environments  
Dedicated 4G network  
R&D  
A&V services  
EuroNCAP accr. during 2017

Investing in your future



# Agenda

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# Platooning as a System-of-Systems

(Slides from Jakob Axelsson,  
"SoS introduction", 170829)



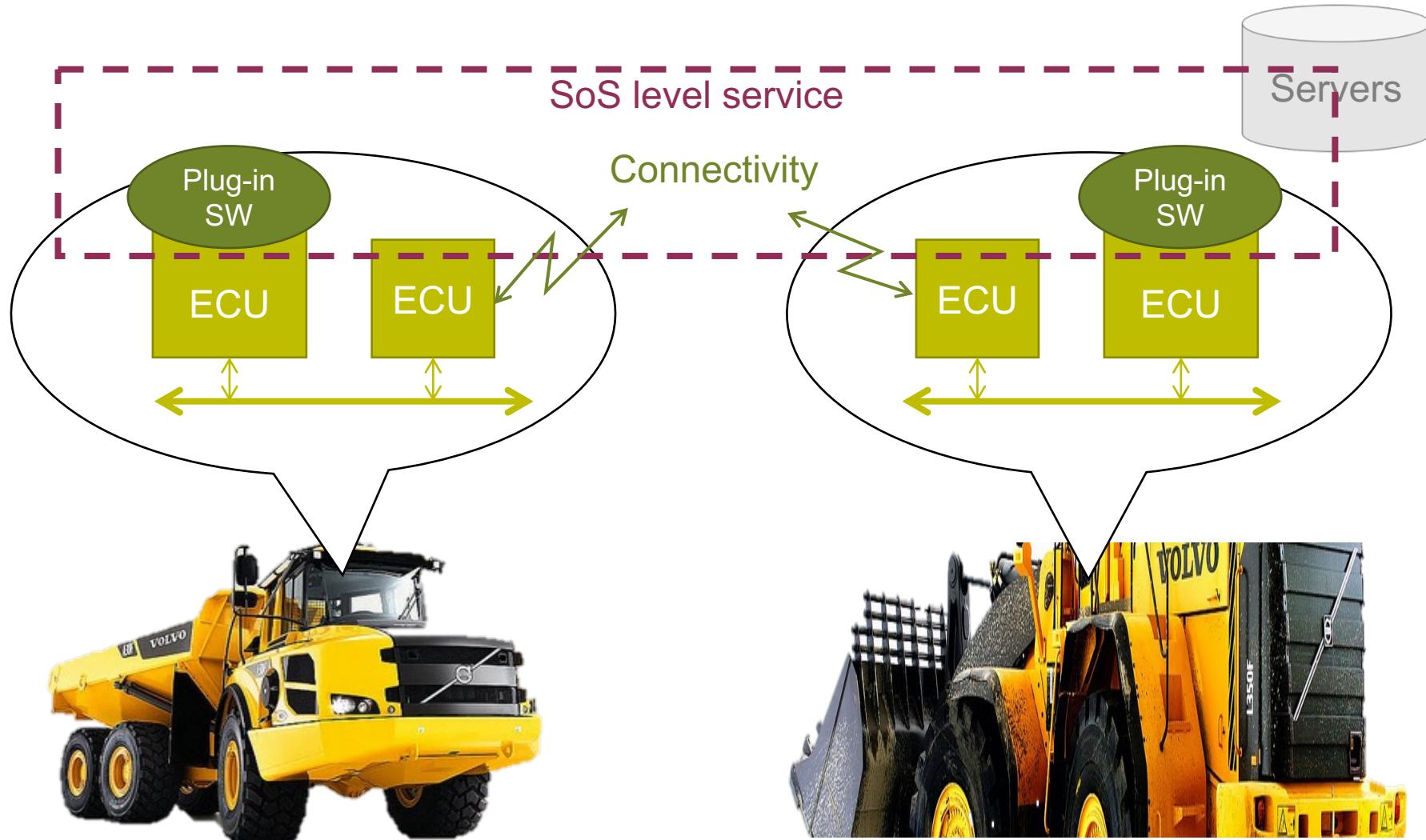
# SoS Characterization

- **Informal definition:** Independent systems that collaborate to reach a higher level goal
- Classical SoS characterization (Maier, 1996) :
  1. **Operational independence of the elements.** The constituent systems can operate independently in a meaningful way, and are useful in their own right.
  2. **Managerial independence of the elements.** The constituent systems not only can operate independently, but they do operate independently even while being part of the SoS. They are acquired separately.
  3. **Evolutionary development.** The SoS does not appear fully formed, and functions and purposes are added based on experience.
  4. **Emergent behavior.** The principle purposes of the SoS are fulfilled by behaviors that cannot be localized to any individual constituent system.
  5. **Geographical distribution.** The constituent systems only exchange information and not substantial quantities of mass or energy.

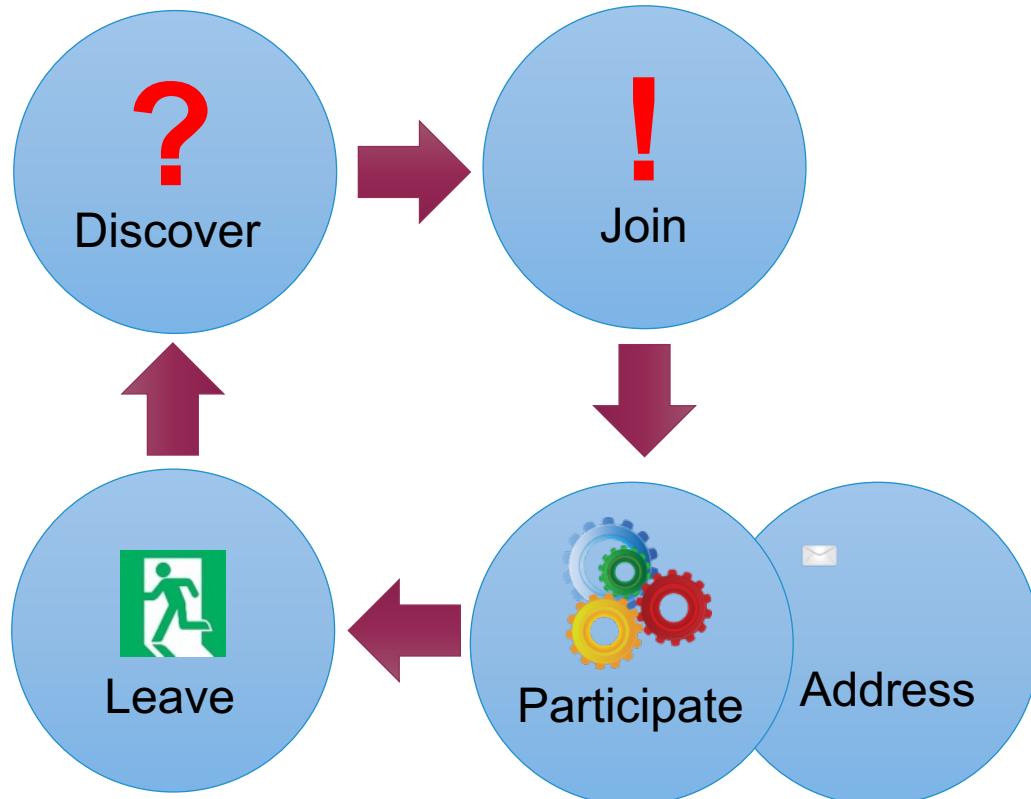
# Platooning as an SoS



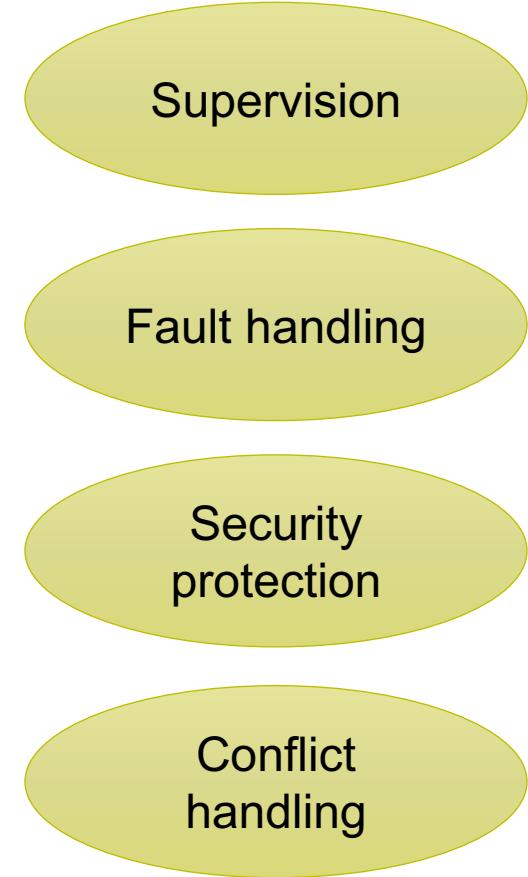
# SoS Based Services



# SoS Core Functions

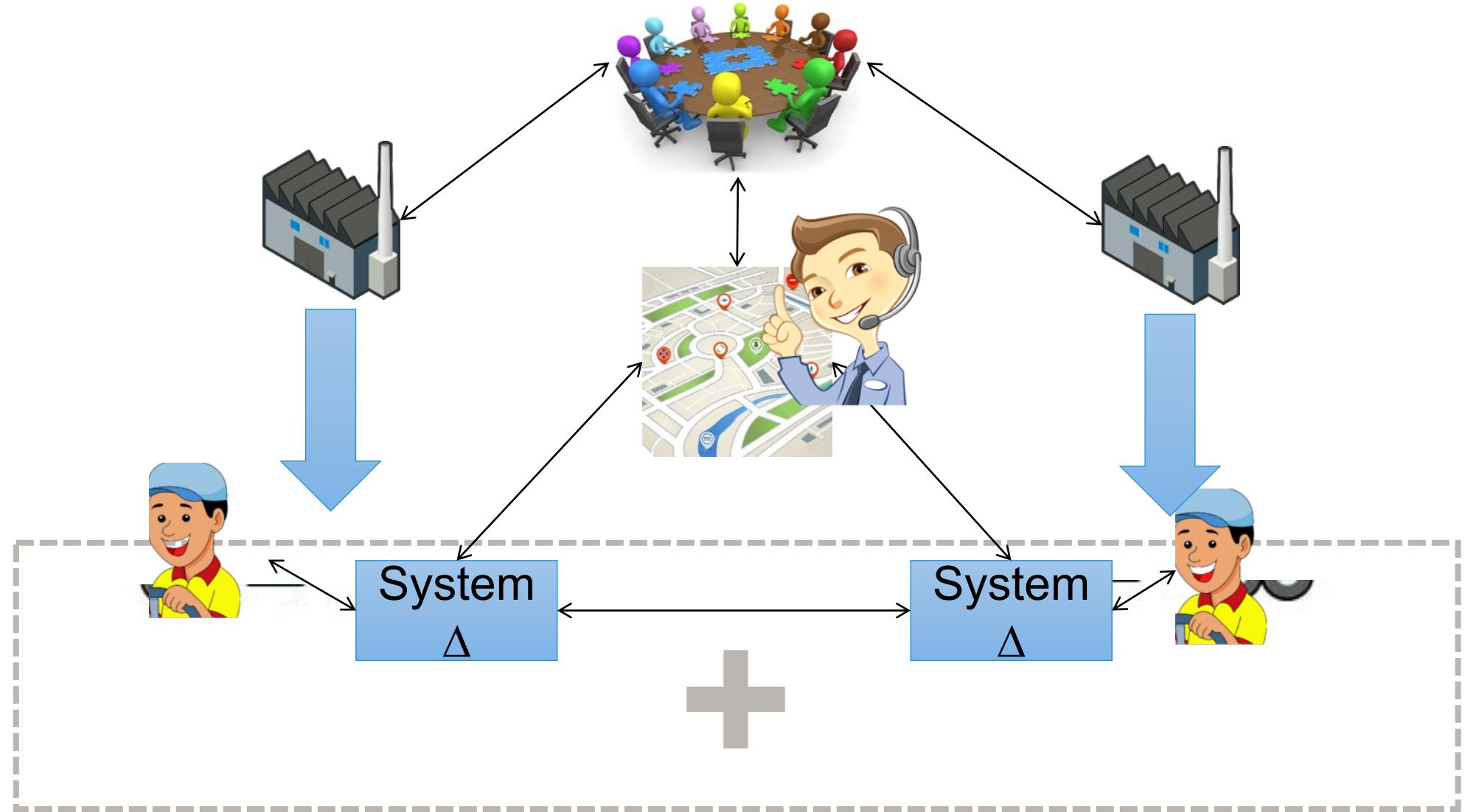


Formation and dissolution



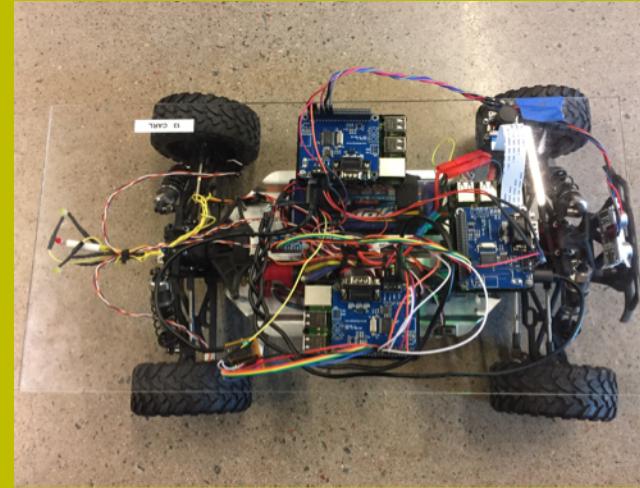
Management

# SoS Architecture

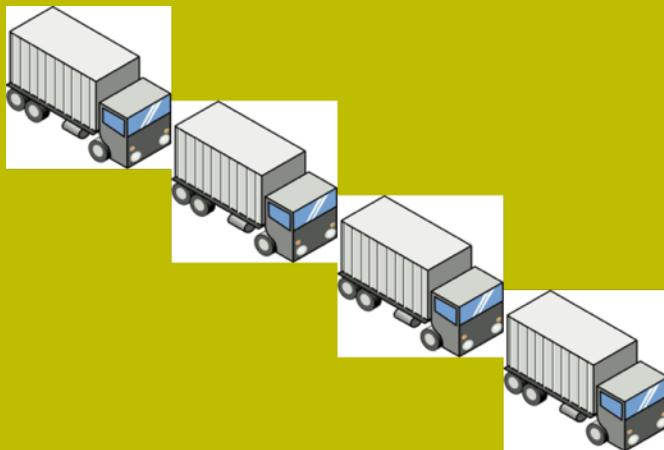


# Student project in 2 steps:

1. Adaptive Cruise Control (longitudinal control)
2. Platooning (longitudinal and lateral control)



# The vision is to have a platooning demo in the lounge at Lindholmen Science Park



- The MOPED cars and the results from the project will be made available for future use at VICTA lab.
- This will enhance the Experiment and Testing ecosystem!

# VICTA Lab located @ LSP, Göteborg



## ■ Contacts

- Kenneth Lind, [kenneth.lind@ri.se](mailto:kenneth.lind@ri.se)
- Kent Eric Lång, [kent-eric.lang@ri.se](mailto:kent-eric.lang@ri.se)
- VICTA lab web page: <http://vehicle.lindholmen.se>