Scania

Software development and testing

Agenda

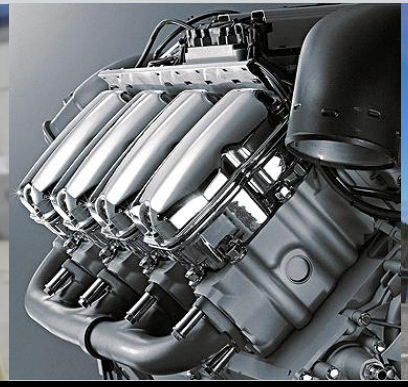
- General info about Scania
- Software development at Scania
- Scania’s electrical system
- Integration testing
- Distribution of real-time data

Main message

- Scania is a software company
- Scania has a high degree of in-house development of ECUs
- A lot of freedom and possibilities to learn new things

Corporate statement

Scania’s goal is to deliver optimized heavy trucks, buses, engines, and services, offer our customers the best total economy and thereby be the leading company in our business segment. The foundation is Scania’s core values, our focus on methods and our motivated coworkers.



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Haulage

Construction

Distribution

Special purpose

Network and services

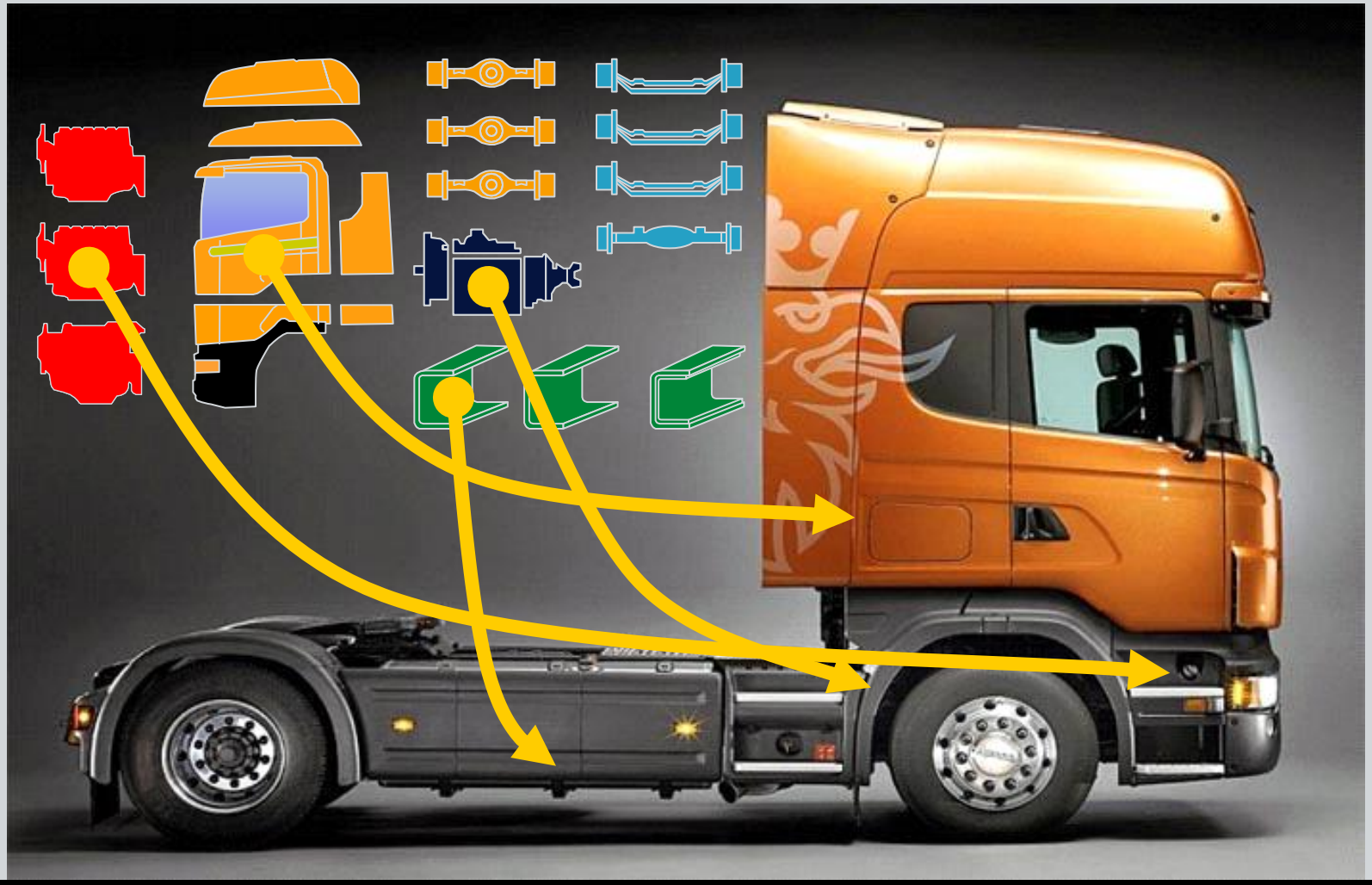
Premium products and services

Intercity and coach

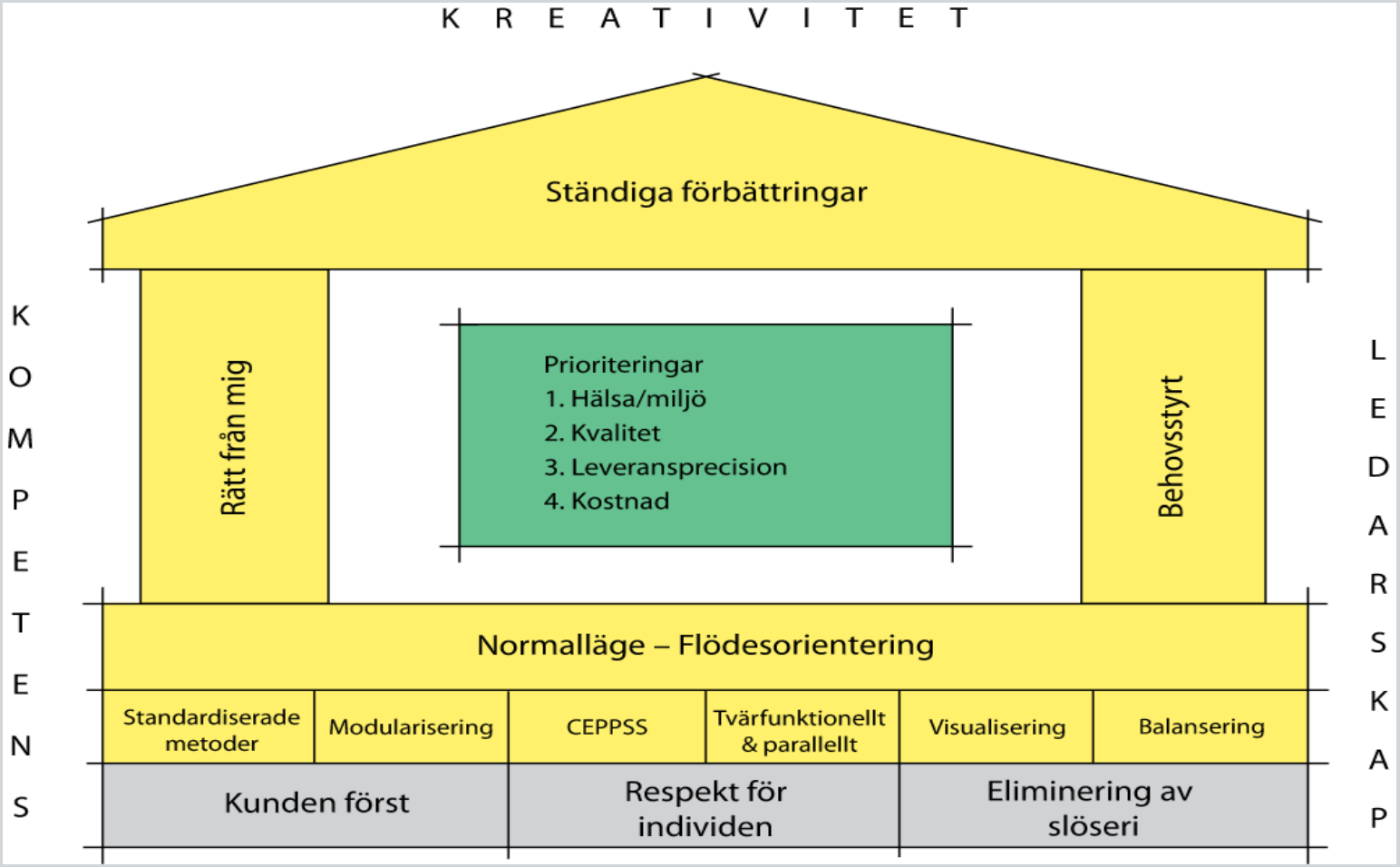
City and intercity

Engines

Modular product system



R&D Factory


K R E A T I V I T E T
Ständiga förbättringar
K O M P E T E N S
Rätt från mig
Prioriteringar
1. Hälsa/miljö
2. Kvalitet
3. Leveransprecision
4. Kostnad
Behovsstyrt
L E D A R S K A P
Normalläge – Flödesorientering
Standardiserade metoder
Modularisering
CEPPSS
Tvärfunktionellt & parallellt
Visualisering
Balansering
Kunden först
Respekt för individen
Eliminering av slöseri

Scania Technical Center

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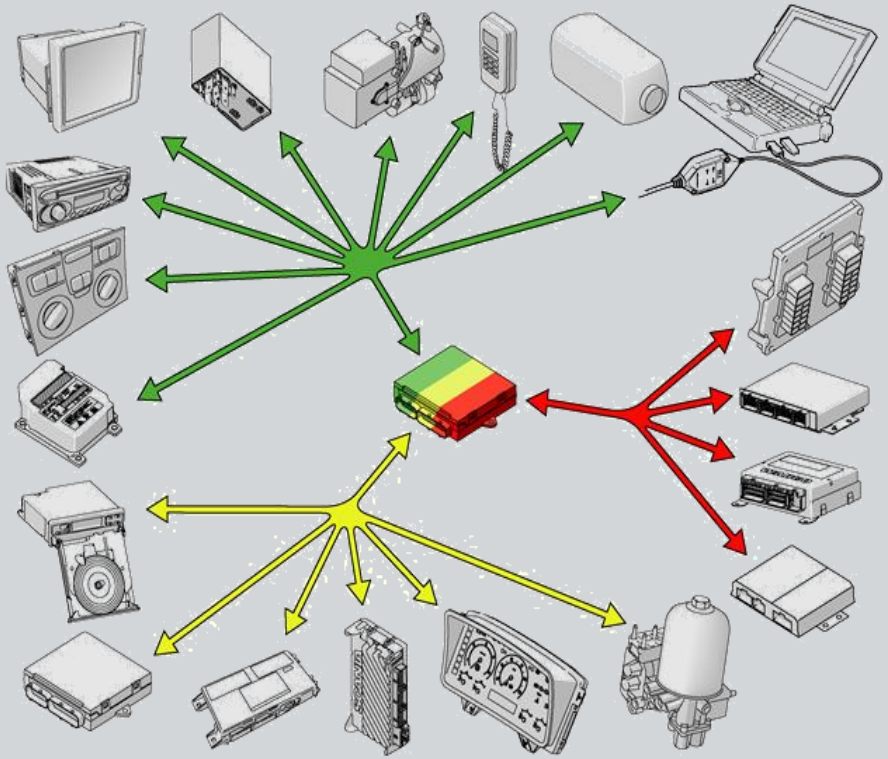
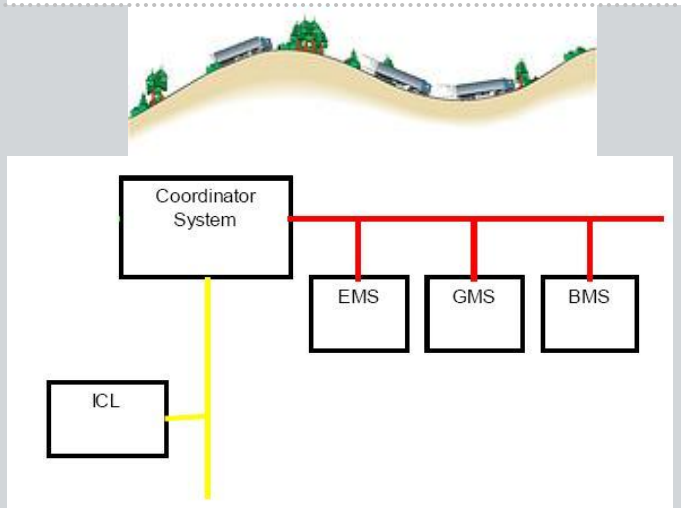
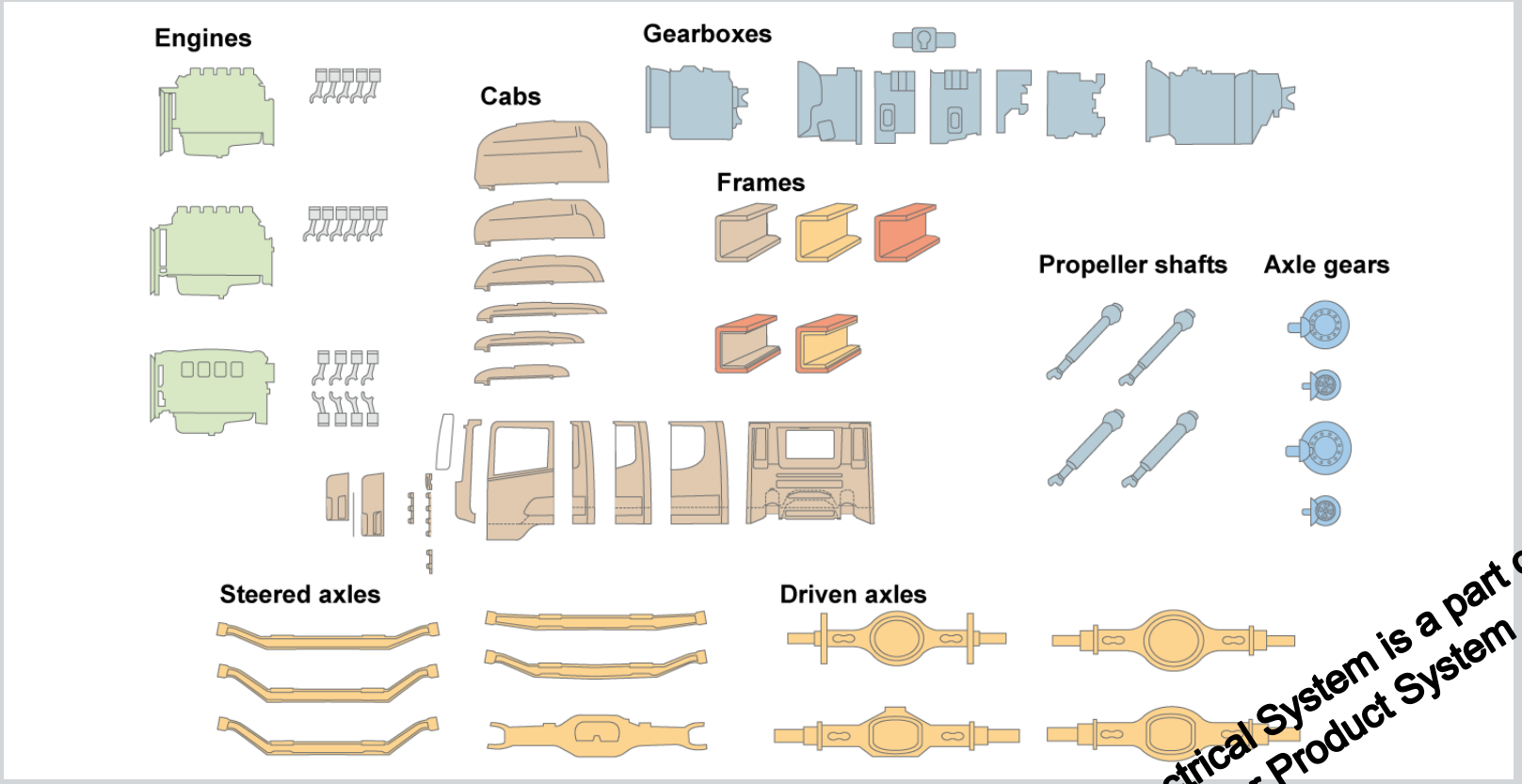
SESAMM – Scanias electrical system





Modular Product System



- Well balanced performance steps
- Standardised interfaces
- Same need - identical solution

Scania Electrical System is a part of the Modular Product System

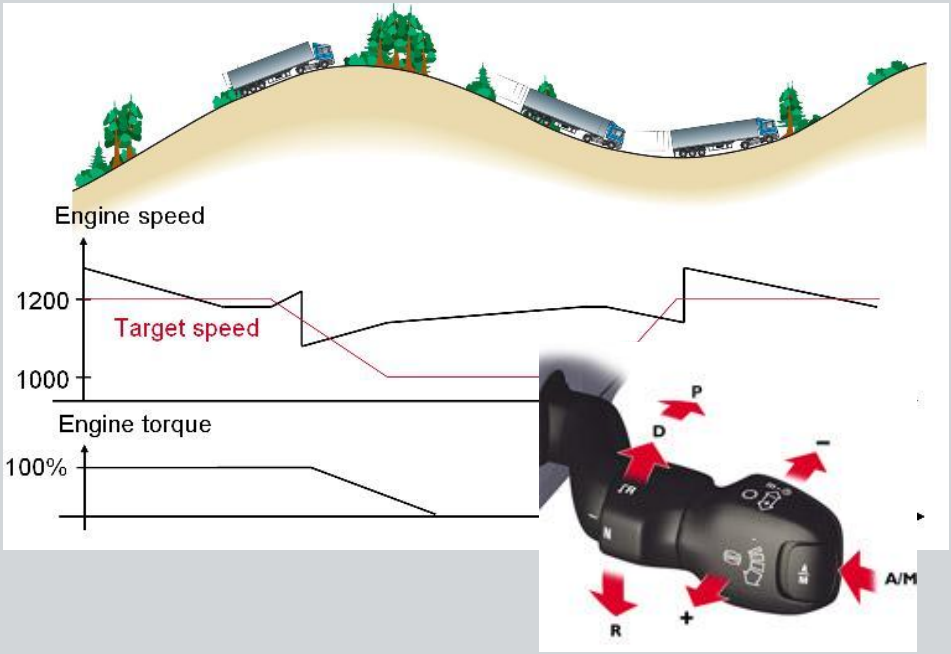
Scania Electrical System - Principles

- One common electrical system for all vehicle types
- Function allocation independent of vehicle specification
- Backward compatible
- Rebuildability
- High level of functionality in degraded mode
- Segments
- In-house development of SW in strategic nodes
- CEPPSS (Continuous Evolution of Properties Planned in Small Steps)

User Functions

– A User Function describes a vehicle function from which the user has a direct benefit

–The complete set of User Functions describes Scanias electrical system

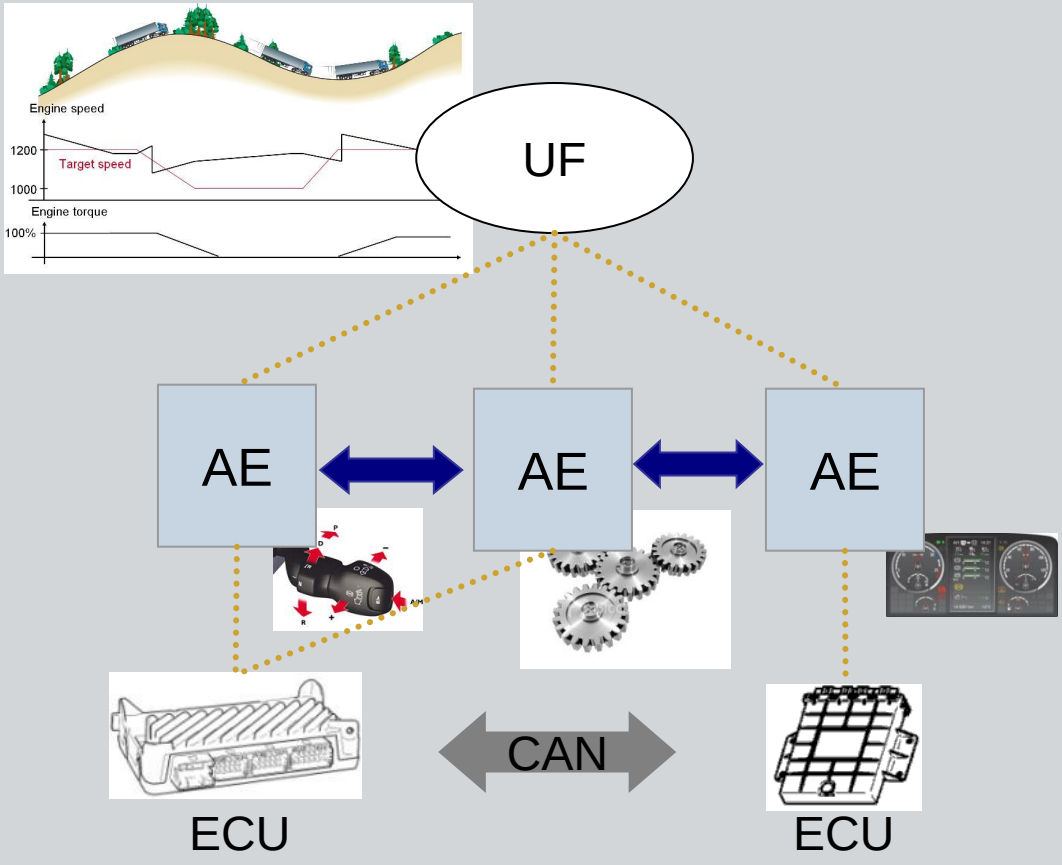


Opticruise –
UF 493 ”Transmission automatic”

More examples:
UF 352 ”Bus Stop Brake”
UF 415 ”Hill Hold”
UF 511 ”Rear Wheel Steering”

Allocation Elements

– An Allocation Element describes a logical component of a User Function as implemented in an ECU



Benefits

- Scalable
  - Few ECUs on low cost vehicles
  - Possibility to add systems and segments for increased content
- Modularised
  - Encapsulation and modularisation reduces communication need and complexity
  - Possible to chose degree of centralisation
  - Clear organisational responsibility for components and functions
- Evolution
  - CEPPSS
  - Balancing complexity and backwards compatibility
- Testing
  - ECU system level testing possible locally before delivery to integration test
  - Stepwise integration possible
- Isolation between ECU systems
  - Easier to prove freedom of interference and avoid unnecessary mixed criticality
- Flexibility in subsegments
  - Possibility to adapt interfaces quickly to new systems without affecting main segments
  - Often in-house SW in main nodes
- Builds on proven concept

Where are we in the organisation?

Mainly RE and NE developing SW, but also RB, RC and NB.

Aim

- Our E/E system is ONE system
- We have to see it as a whole system and not only separate parts of it
- ”Small changes” can have/lead to unexpected dependencies
- We have to analyse each change to evaluate its consequence(s)
- Development of the E/E-system is performed parallel in many areas
- It is important to have a process for synchronisation

The release process is Scanias process for packaging the electric/electronic system in our vehicles

What is the release process?

1. Release planning **2. Analyse** **3. Packaging**

A complete delivery of the electrical system per SOP

ECU-system development

n development processes

- SW
- Electric
- Product documentation (System och function)

Release process

- Safety analysis
- Production tools (PSM/PSE/SPCT)
- Integration test report
- Field test report
- Communications specification
- Support for after market (Scomm, MSC)

SOP-release

Aftermarket process

- Tools for aftermarket (SDP3)
- Drivers manual

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Development of SW

SOP

SW-projects (working method e.g.. RUP, SCRUM)

Code-Development

Function- and module tests

ECU-system

Complete E/E-System

Dependency analysis

Analyse/ Modularisation

Safety analysis

Production tools

Integration tests

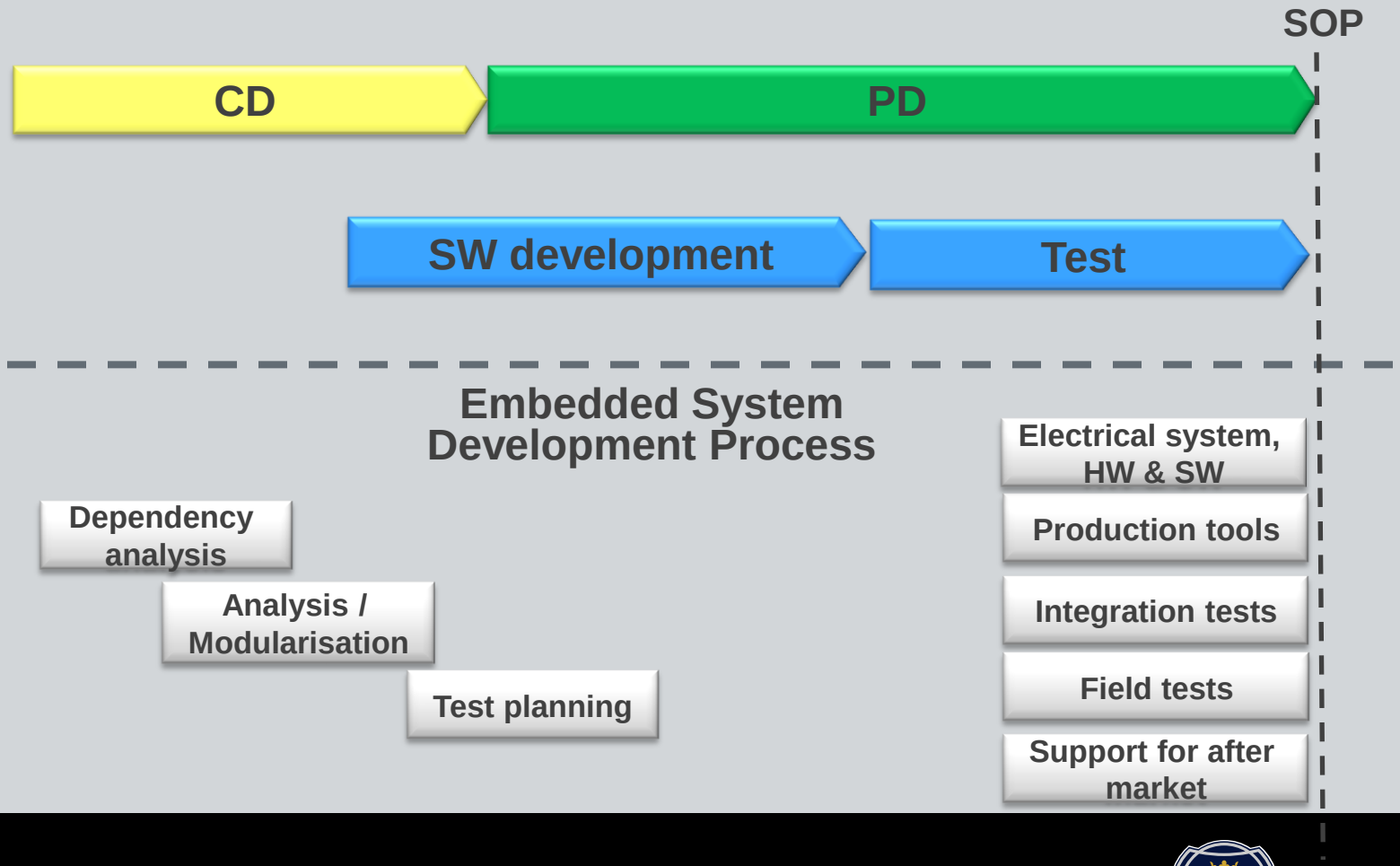
Field tests

Support for after market

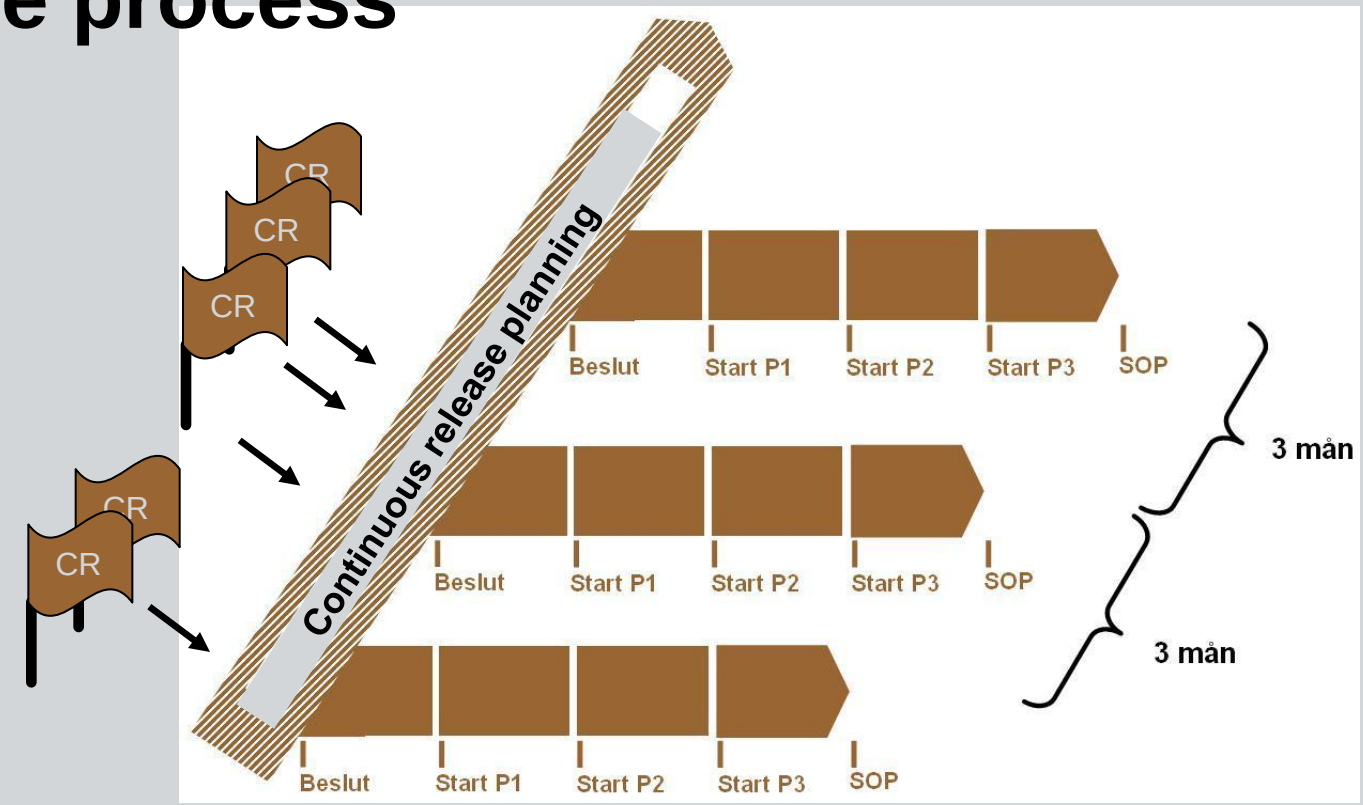
PD Phase1: D ”Impact on electrical system defined”

Release process

Software Development



Release process

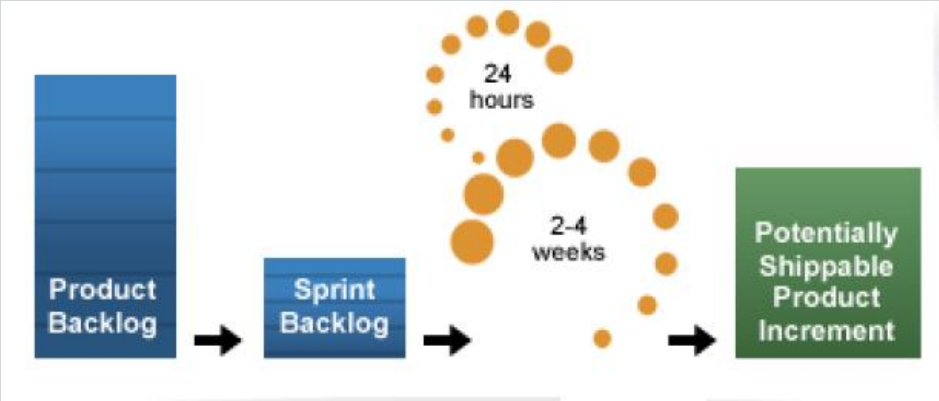


- ✓ Release process is a flow with a pulse
- ✓ Each planned change is flagged with a ***CR***

Abbreviations:
CR = Change Request, P1 = Integr.test 1, P2 = Integr.test 2, P3 =Integr.test 3

SCRUM

Methodology for SW development



SCRUM is determined by

- Iterative
- Increments
- Focused work in short cycles
- Priorization
- Self-organized team

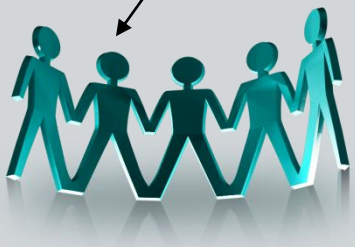
- Everything is timeboxed
- Transparant
- Face to face
- Periodic delivieries

Roles

Req. from,
customers, teams etc.

Product owner

SCRUM master



Team

Ceremonies

Daily SCRUM

Planning

Demo

Retrospective

Backlog

Sprintlog

Deliverable product increment

Artefacts

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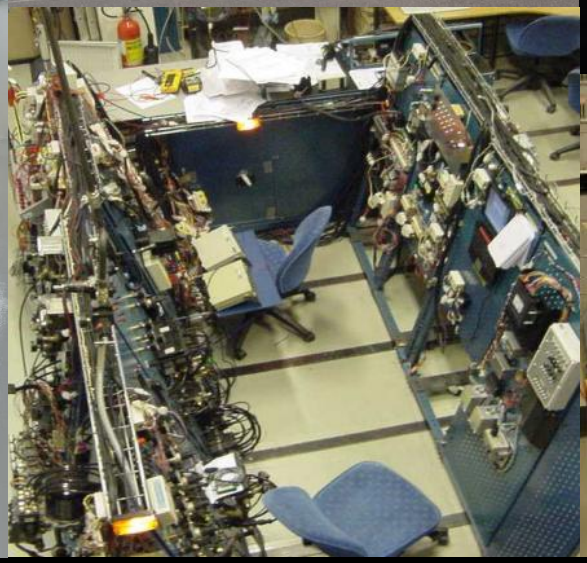
Test environments for integration testing



I-lab: Hardware-In-the-Loop

Electrical signals

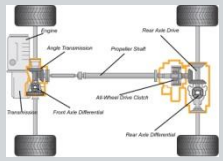
System under test
HW+ SW

Electrical signals

Load simulation

Fault injection

HW

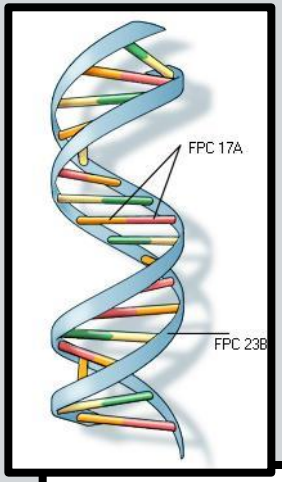


Dynamic vehicle model

Signal handling of control signals

Signal handling of sensors

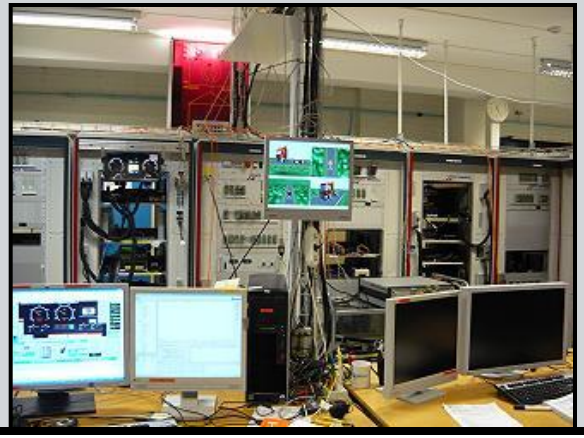
Fault injection



SOPS

+

~180 TC



~250 TC per night

UFT 134.21		UFT 134: Downhill-speed control UFT 134.21: Resume DHSC	ILab2	190Frohm_20459444lab2ready	Passed
UFT 134.20		UFT 134: Downhill-speed control UFT 134.19: Decrease offset	ILab2	190Frohm_20459444lab2ready	Passed
UFT 134.19		UFT 134: Downhill-speed control UFT 134.19: Increase offset	ILab2	190Frohm_20459444lab2ready	Passed
UFT 126.01		EBS malfunction warning on truck/bus, Activation of warning	ILab2	190Frohm_20459444lab2ready	Passed
UFT 123.01	OK - Script works	Parking brake indication, Indicate that parking brake is active in instrument cluster	ILab2	190Frohm_20459444lab2ready	Passed
UFT 120.02		Storing a new idle speed – switching off and on the key	ILab2	190Frohm_20459444lab2ready	Passed
UFT 120.01		Adjusting the idle speed	ILab2	190Frohm_20459444lab2ready	Passed
UFT 119.01	OK - Script works	Engine speed control by accelerator pedal, Varying the acceleration pedal position	ILab2	190Frohm_20459444lab2ready	Passed
UFT 117.05		Activate speed limiter when vehicle speed is above limit	ILab2	190Frohm_20459444lab2ready	Aborted
UFT 117.04		Activate bodybuilder fixed speed limiter with CAN	ILab2	190Frohm_20459444lab2ready	Passed
UFT 117.03		Activate bodybuilder fixed speed limiter with switch	ILab2	190Frohm_20459444lab2ready	Passed
UFT 115.01	OK - Script works	Coolant low level warning, Display information	ILab2	190Frohm_20459444lab2ready	Passed
UFT 114.01	OK - Script works	Coolant high temperature warning, Engine coolant temperature above limit	ILab2	190Frohm_20459444lab2ready	Passed
UFT 112.02		EMS malfunction warning, Amber warning	ILab2	190Frohm_20459444lab2ready	Failed
UFT 112.01	OK - Script works	EMS malfunction warning , Red warning	ILab2	190Frohm_20459444lab2ready	Passed
UFT 110.01	OK - Script works	Engine oilpressure below the limit	ILab2	190Frohm_20459444lab2ready	Passed
UFT 105.09		Traction control (with ABS): Wheel brake control – off-road mode (EBS)	ILab2	190Frohm_20459444lab2ready	Passed
UFT 105.08		Traction control (with ABS): Engine control	ILab2	190Frohm_20459444lab2ready	Passed
UFT 103.01	OK - Script works	White Smoke Limiter, Activation	ILab2	190Frohm_20459444lab2ready	Passed
UFT 099.22		Adjust Cruise Control set speed	ILab2	190Frohm_20459444lab2ready	Passed
UFT 099.21		Engage cruise control, acceleration/retardation/resume. - Deactivate cruise control using off button and brake.	ILab2	190Frohm_20459444lab2ready	Passed
UFT 099.20	OK - Script works	Enable cruise control	ILab2	190Frohm_20459444lab2ready	Passed

Test report

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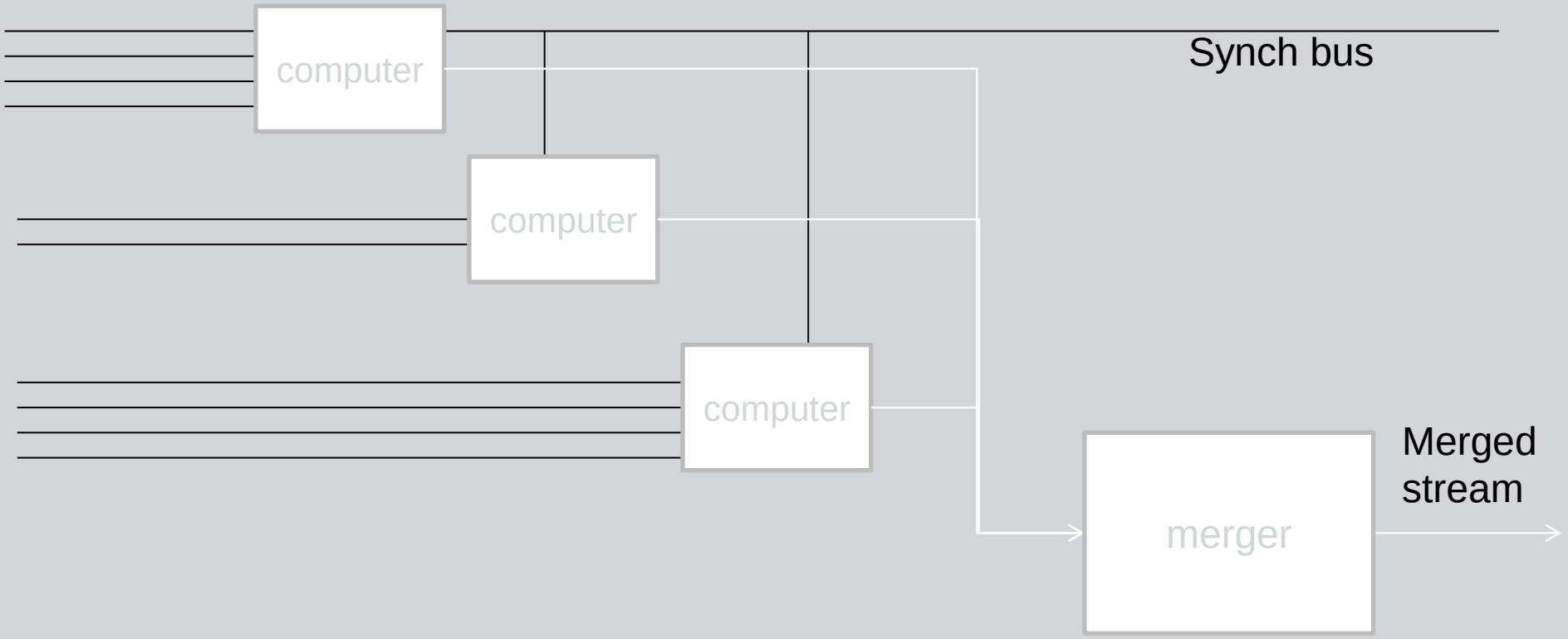
Distribution of real-time data

- Our new integration test lab has a CAN bus solution where maximum CAN length is reached
- To reduce CAN length, buses are not accessible in all cabinets
- However, we still want to get one real-time view of all CAN buses
- This requires a distributed solution

Distribution of real-time data

- We allocate one CAN bus as a synch bus
  - A synch messsage is sent periodically
- The synch bus is accessible from each computer node
- Each computer node receives CAN frames on CAN buses, including synch, and sends them to a merger
- How should the merger be implemented such that it
  - Can cope with the expected number of messages
  - Can present a merged data stream without too much delay

Distribution of real-time data



Distribution of real-time data

- One program for sending synch messages
- One program per computer for receiving and forwarding CAN frames
- One program for sorting frames in correct order
- One program for visualizing CAN frames

Distribution of real-time data

- Merging
  - Robust
  - Handle all kinds of edge cases
  - Maintainable
- Development
  - A C++ version has been implemented. Single-threaded.
  - A prototype using Actor pattern has been implemented. We consider this one to be more robust and maintainble.
    - Programming language with thread local heaps

Distribution of real-time data