



Architecture Transition Towards a Future Architecture Thinking at Volvo

2020-10-16



- Anders Magnusson
- Volvo Group Trucks Technology
- Official role at Volvo:
 - Logical Architect (main focus is ALL application software for trucks)
 - Global Technology Specialist for the AB Volvo group within architecture
- Graduated: 1987
- At Volvo since: 2008

Volvo Group

On the road

In the city

Main focus of today presentation, but it does not mean that its use is limited to this!



Off road

At sea



General Introduction

Improvements do not come without a change

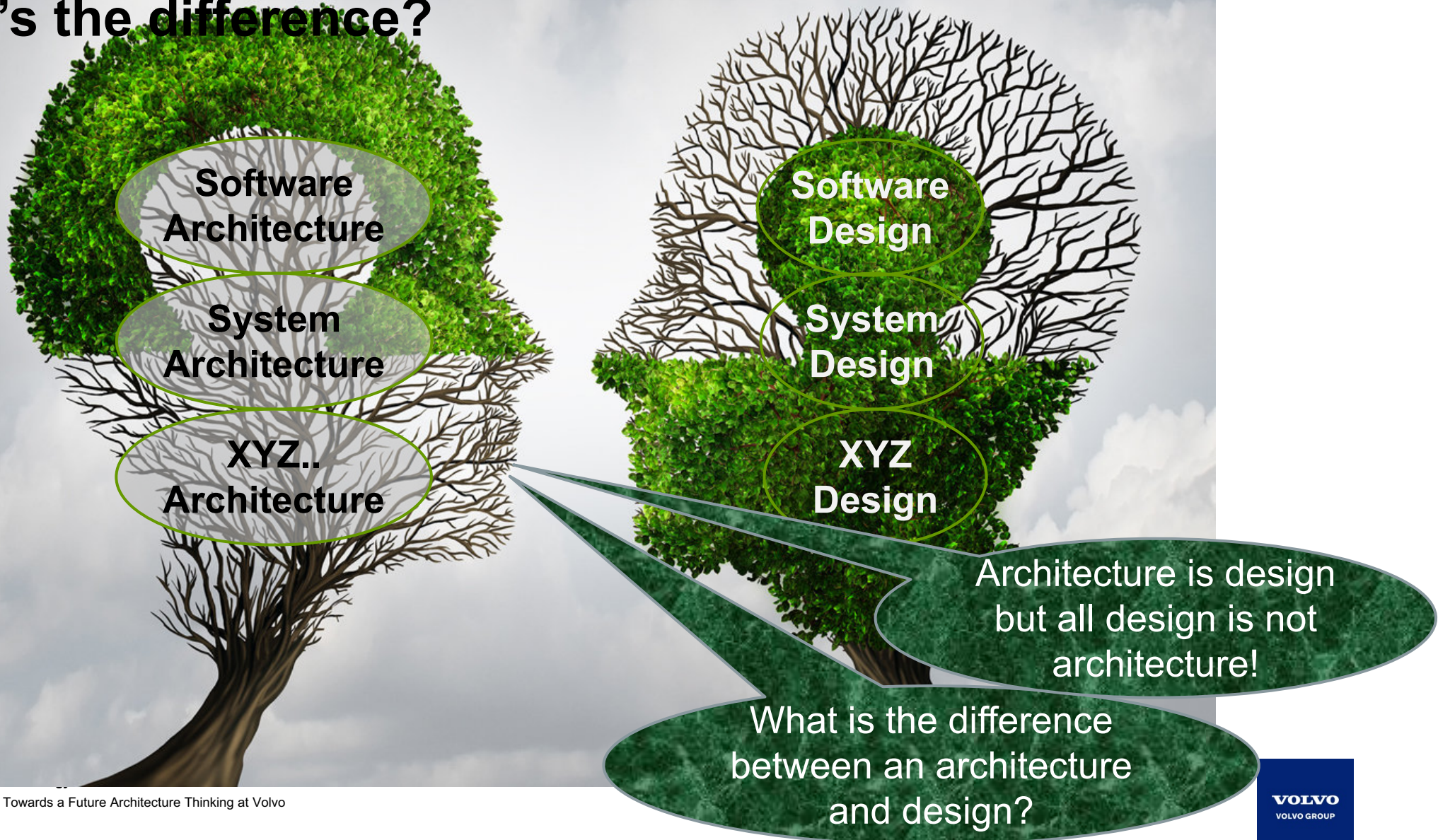
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What "Architecture" Evokes!

How does it comes that we use the term "Architecture"?

The terms **Architecture**, **Architect** and **Architecting** come with a baggage.

What's the difference?



What "Architecture" Evokes!



A typical style from
the 1940's

Changing the style
is quite expensive

"Architecture
Transition"



A typical style from
the 2010's

Why change?

Maintenance cost, Energy
consumption, Larger
family, Very dark, ...

What "Architecture" Evokes!

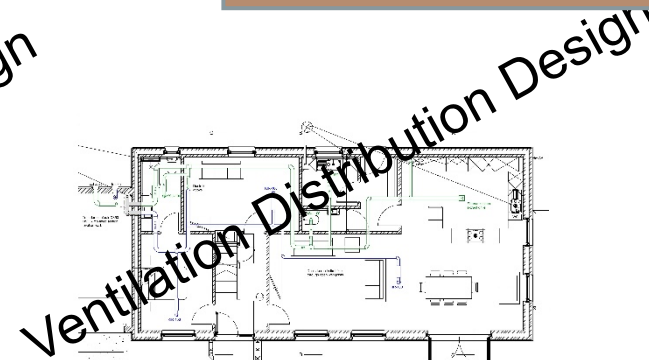
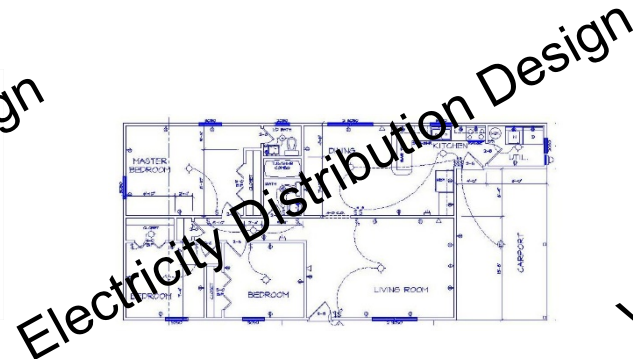
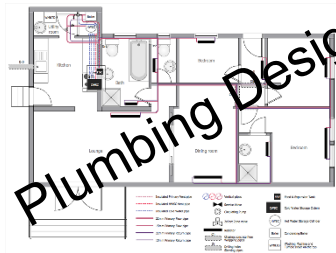
An architect's sketches define fundamental properties of the building.



"Architetural Style"

"Soft Properties"
(Aestics)

The architecture drawings works a **framework** for various kinds of design to relate to.

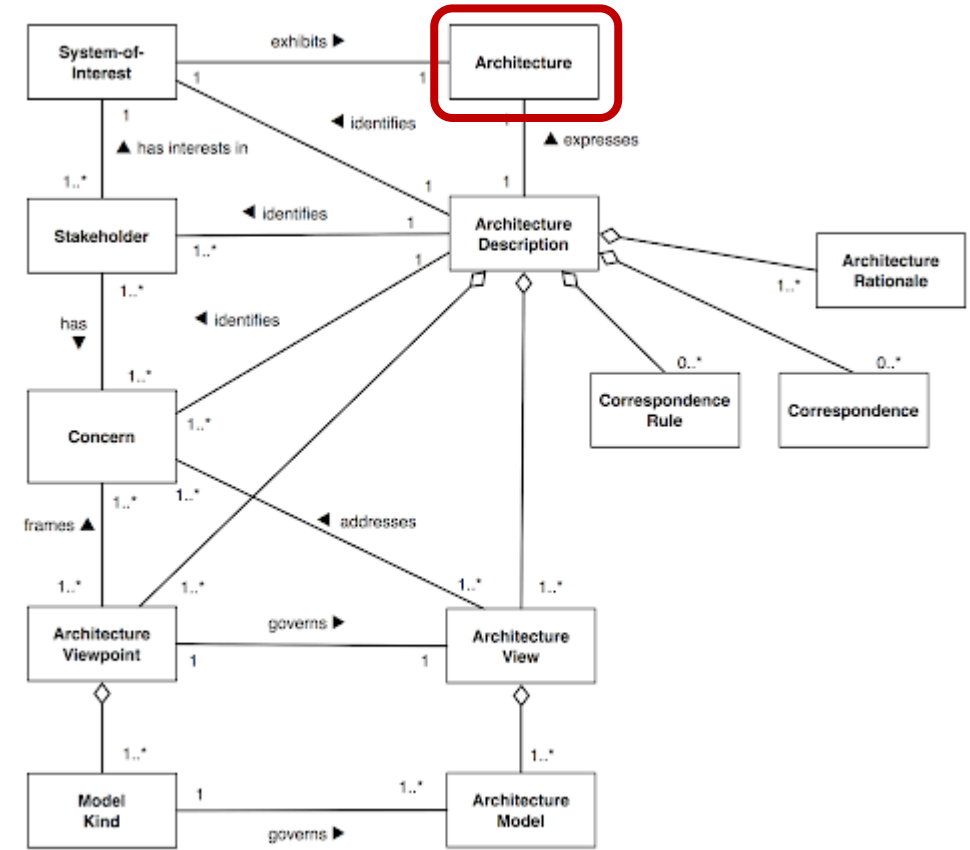


... Design

Architecture definition according to ISO/IEC/IEEE 42010

Fundamental concepts or properties of a system embodied in its components, their relationships to each other and to the environment and the principles guiding its design and evolution.

- Architecture always point at a specific system
 - What is treated as a system is in the eye of the beholder!
- Architecture & Architecture Description are different things
- As for building you can have different perspectives (viewpoints) at a system

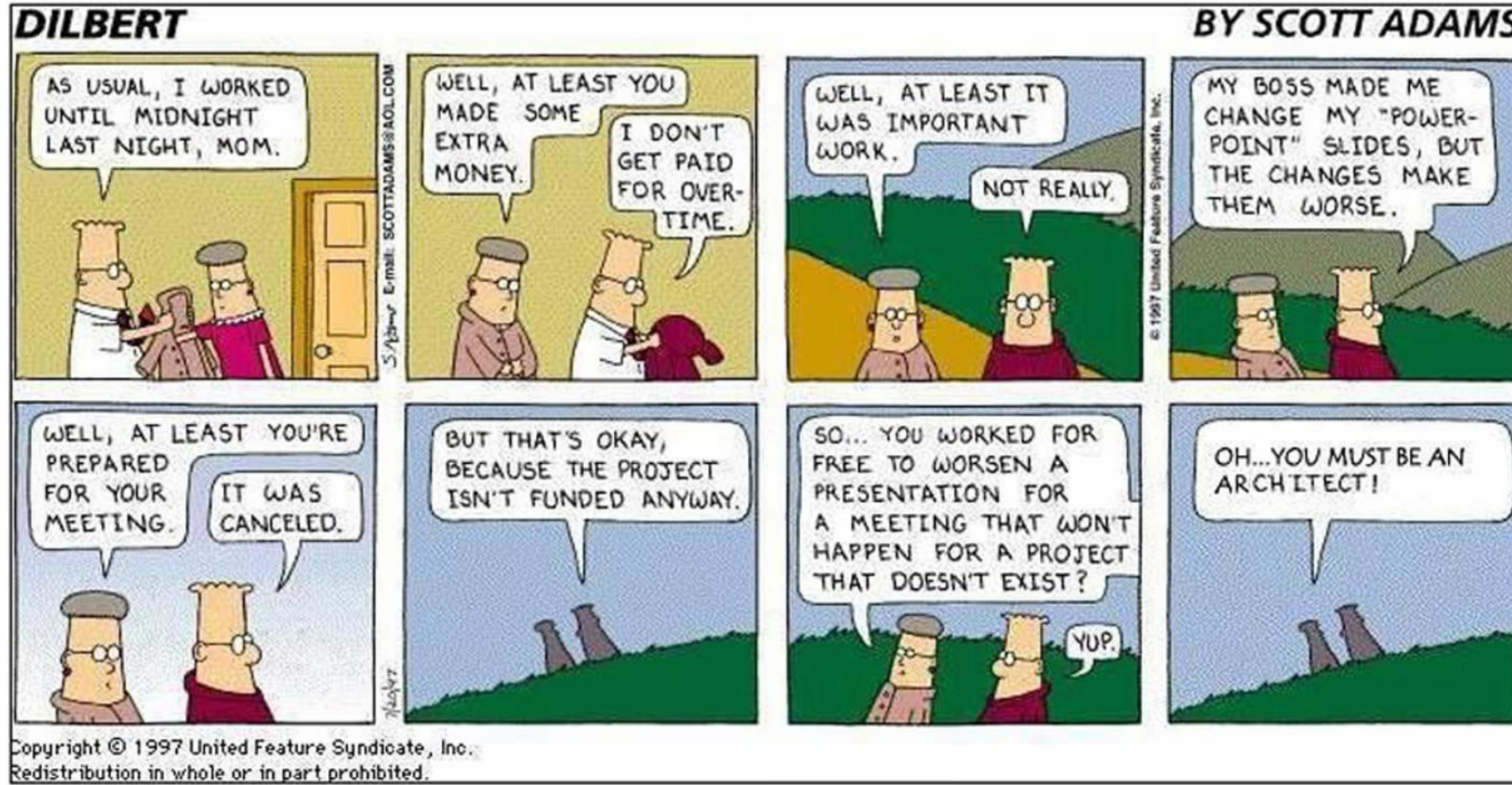


Architecture vs. Design

- Design goodness flows from the ability to do architectural reasoning, enabled by:
 - the existence of an architecture, in top of the design
 - the internal regularity (conceptual integrity) of the architecture
 - That means; a small set of design ideas (principles, patterns) is used throughout the design.



Just so you know how it is to work as an architect



A typical week for me

Time Reporting		OWN WORK		
	T3 WoW framåt; Room O2			
XF Architecture Team Meeting O3-A16 Higgins Lance	PEMS Room AB3S-4 10-12p Bjernetun J		Kort uppföljning; Tyst run	PEMS Room AB3N-8 10-14p Nordholm Linus (Consultant)
	Placeholder#31: Describing Room O2-10 16-22p Yadav Atul			Skype-; Sky
		Organisational changes ii		
	T3 Epics; Room O2-3 6-8p;			
Presentation: SOA based Skype Meeting + Room C Hari Hara Krishnan Milin	ACC TAS-Fura Refactoring WS, follow-up Room O2E-18 Johansson Henrik (5)	Workshop: Internal Design of VMPP in VEESP/VAS (T3) Room O3-A12, 18 seats, inside Magnusson Anders (3)	EEPC Review meeting (aka SCRB) Skype & room Goumy G	WoW Room O2-1 Hansson Pe
1-till-1 Anders; Room C				Gruppmöte Room O2-10 16-22p Karlsson Daniel (b)
				Fika; Karlsson Daniel (b)

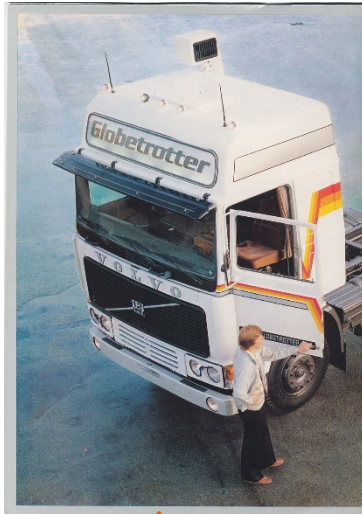


Why Change – A Selection of Architecture Challenges?

Improvements do not come without a change

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"Architecture" @ Volvo Group Trucks Technology!



Mechanically
defined vehicles!

"Architecture
Transition"



Software defined
vehicles?

What is going on ... one snapshot



Volvo Group Trucks Technology

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... and specifically Architecture Challenges

- Architecture is not just done for fun but you want to achieve something specifically such as:
 - lower effort to add new features,
 - support an application on multiple run-time platforms,
 - make it possible to continuously provide new features to applications already in operation
 - ...
- We talk about **architectural concerns** (quality attributes or –ilities)!

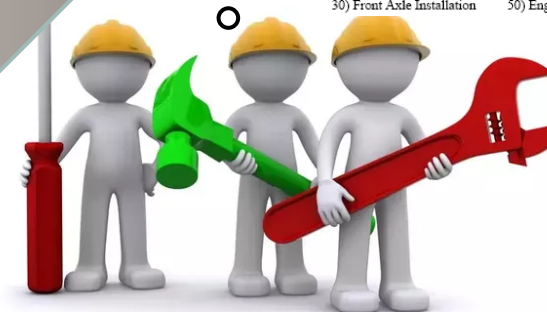
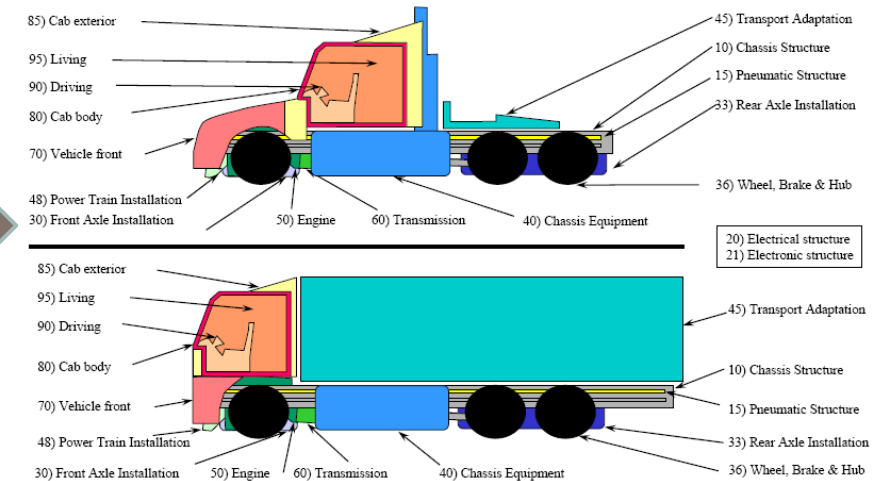


... and many of these are
contradictory and orthogonal

Geometry-Oriented Mindset Dominates @ Volvo GTT

We are bound to an existing **Thought Style**

Geometric-Oriented Vehicle Module Structure



Mechanic Engineer Collective

Geometry-Oriented Mindset Dominates @ Volvo GTT

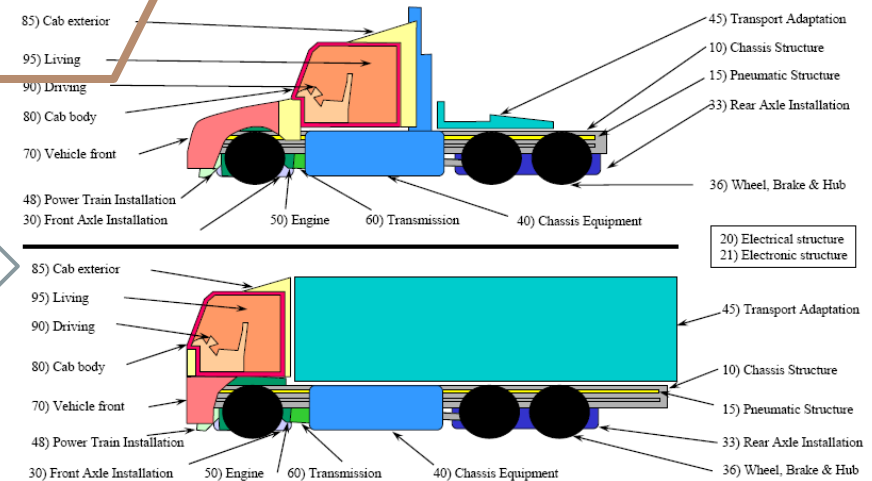
It is hard to find a natural place for

- **Brake Blending,**
- **Cruise Speed Controller,**
- **Cruise Distance Controller,**
- **Lane Keeping Controller,**
- **Energy Recuperation,**
- **Automatic Window Cleaning**

... in this geometry-centric mindset!

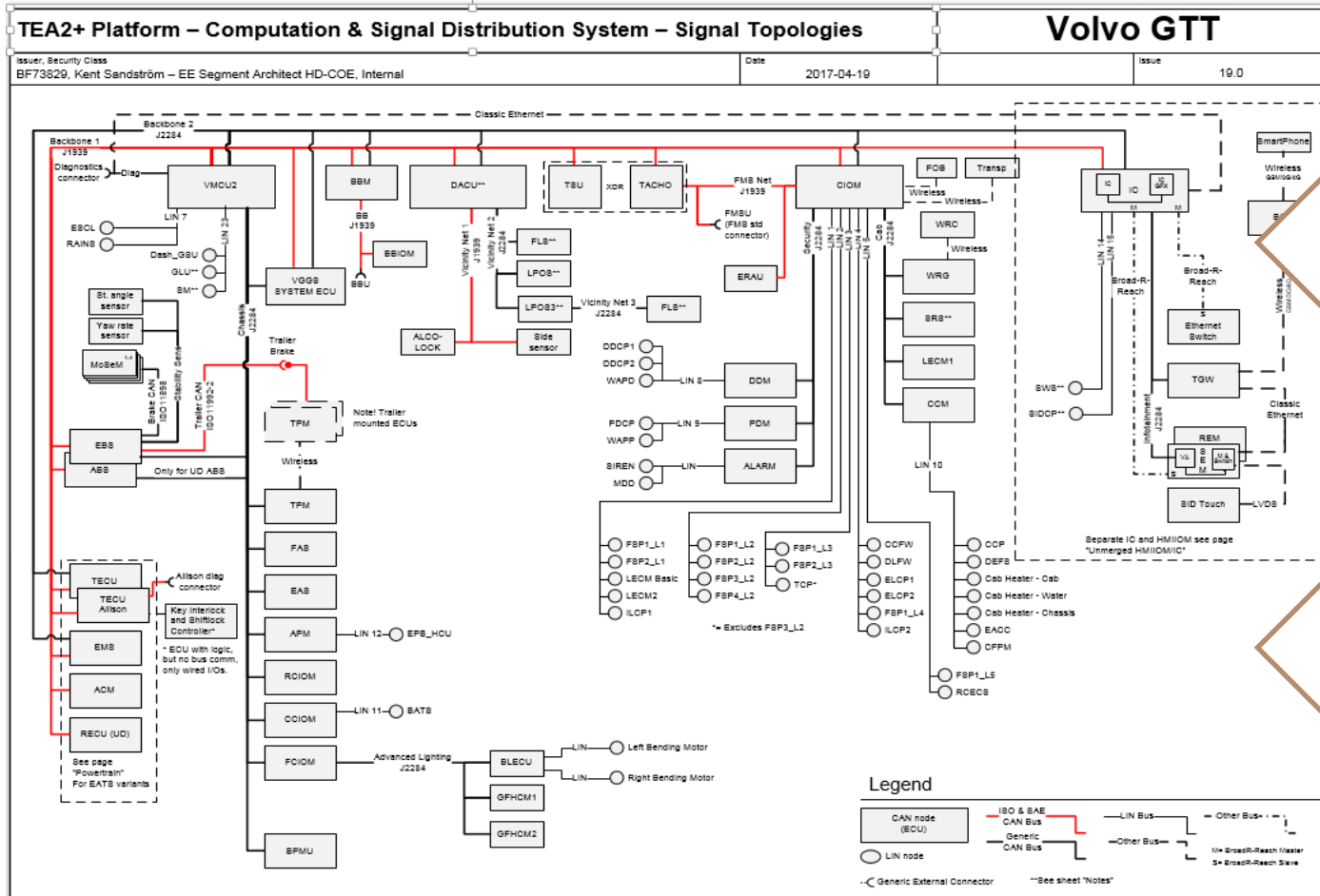
Understand-
ability

Functionality



**A geometry-oriented mindset is rather poor for software reasoning
and for functionality reasoning in general!**

... and software is not really covered in topologies ...

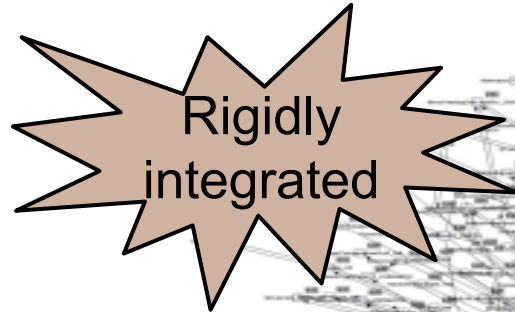


Commonly denoted as **THE** EE Architecture

Focus on wiring
mechanic boxes
together via
commuication
wires

... an illusion of simplicity gives a false picture of the complexity!

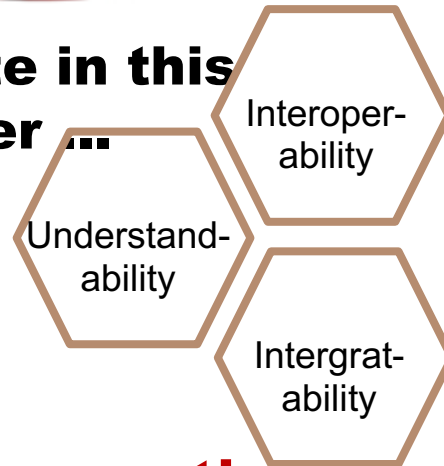
Software interaction points increases the complexity a lot ...



**Try to navigate in this
as a newcomer ...**

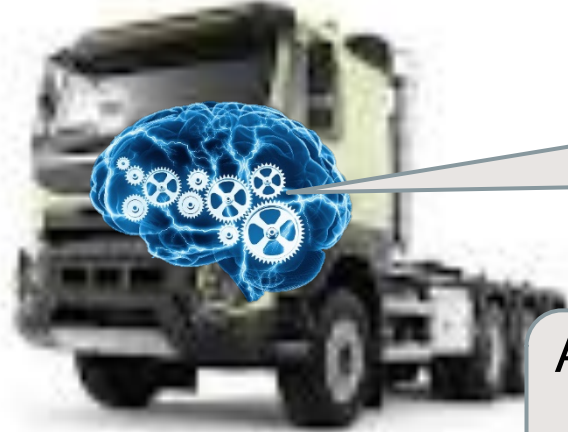
TEA2 Platform:

- No clear ownership of data/information
- No clear ownership of interface, signals (ports) are not describing ownership
- Function-oriented – data flows between functions



**... so far software has grown in a rather
ad hoc fashion feature by feature!**

There will not be less software ...



In all situations, perhaps not in games, **software** is there to **help, simplify** and in the end **replace** human performed things = **various degrees of automation.**

A growing amount of customer value in our trucks is facilitated through software, and that continuously!

Extensibility

Change-ability

Development Efficiency

**-30% Dev.
Effort**

Rapid increase interest for higher automation levels

Rapid increase interest for electrification and hybridization

Rapid increase interest for building higher level services based on access to vehicle-related information.

There will not be less software (cont.) ...



Daimler: The entire conventional drivetrain being replaced by a new electrically driven rear axle with electric motors

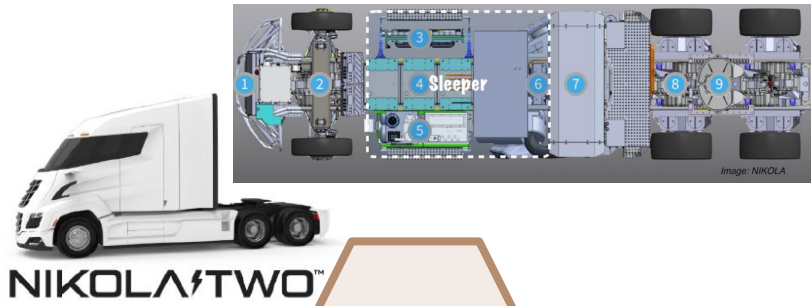
eCascadia uses wheel-end motors to produce up to 730 peak horsepower.



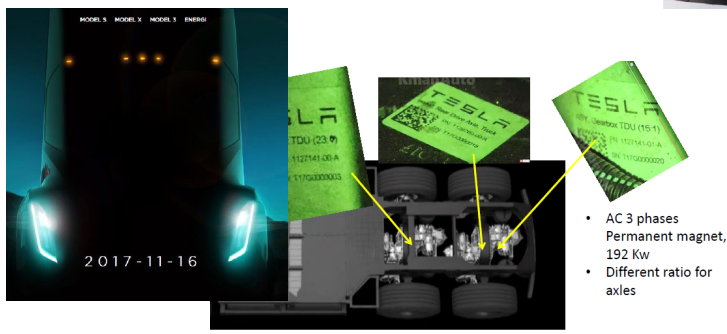
NIKOLA: Fully-electric and hydrogen fuel cells for semi-trailers.



NIKOLA TRE™



GM Shows Off Autonomous Cargo Hauling Concept Vehicle

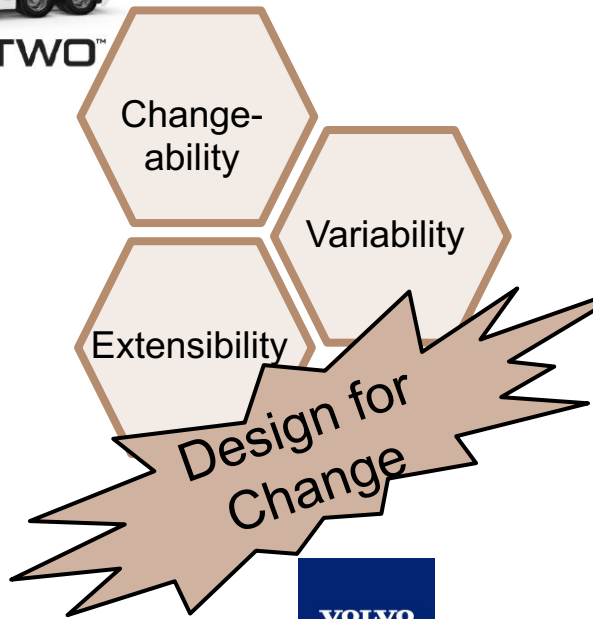


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- AC 3 phases
- Permanent magnet, 192 Kw
- Different ratio for axles

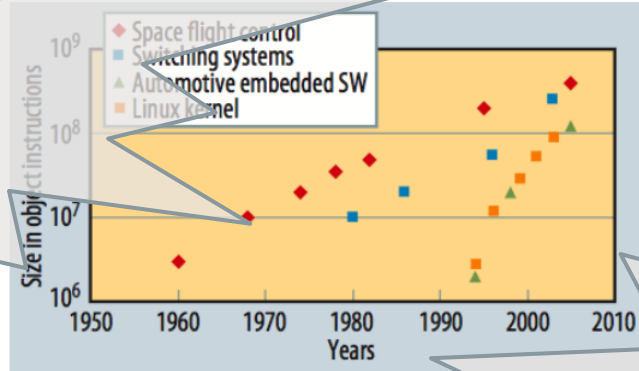


Einride uses e-moss NL for the chassis/electric driveline

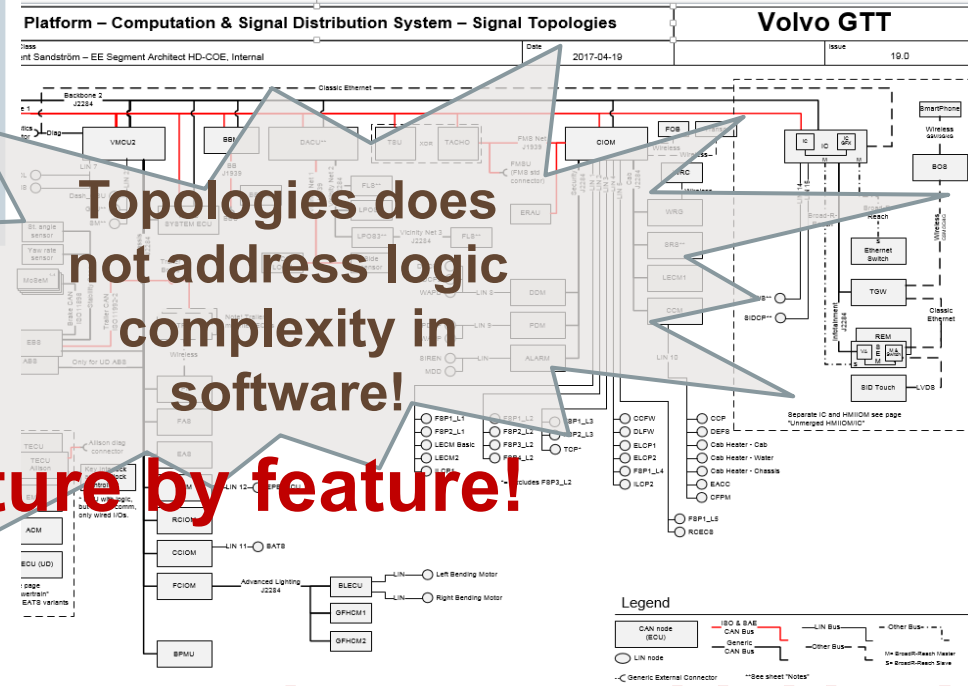


... continuation as before is that an option?

Topologies does not very well support reasoning about functionality, logic, behavior!



Topologies does not address logic complexity in software!



... we need to establish software-centric system thinking!

Large Scale & Strategic Reuse



There are many things that are common but also a lot of variances!



Reusability

Main reason for GTT is that of establishing (strategic) and large scale of reuse and thus share costs.

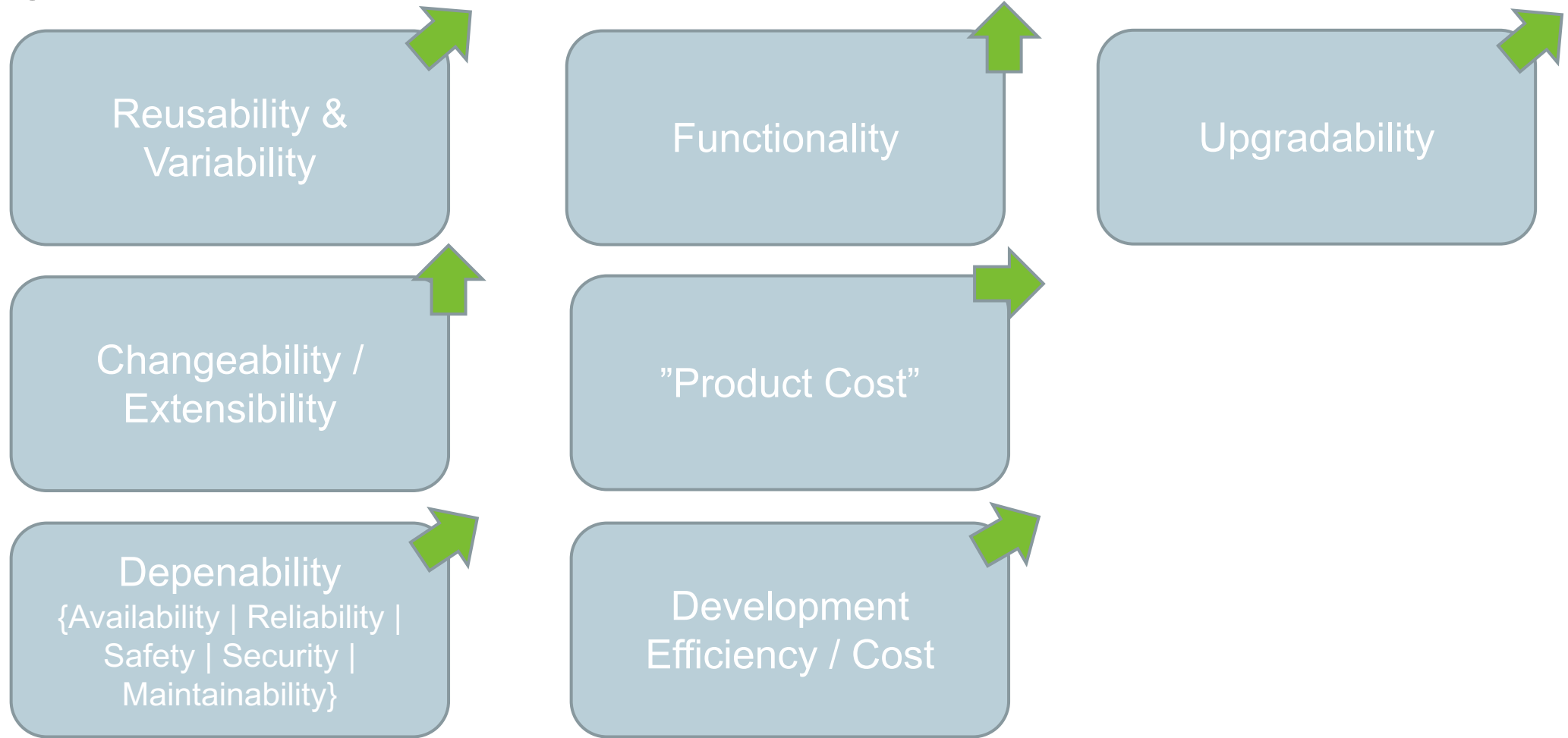
Variability

At Volvo we have do not only have one family of similar manufactured products (product classes) but many – a multi product family situation - where many features are common but also a lot of uniqueness!

Current Solution

Market & Business Needs

Key architecture concern trend for trucks

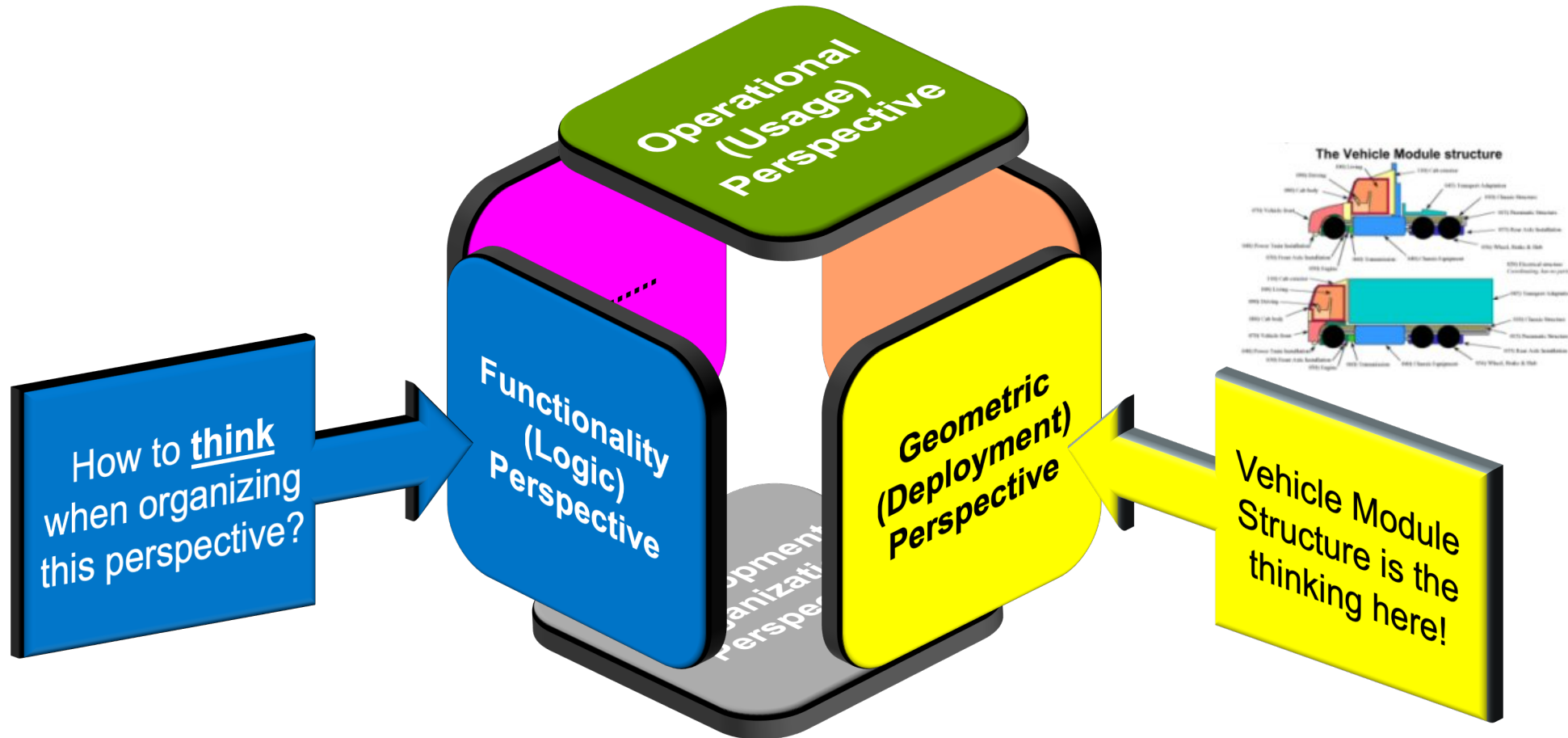




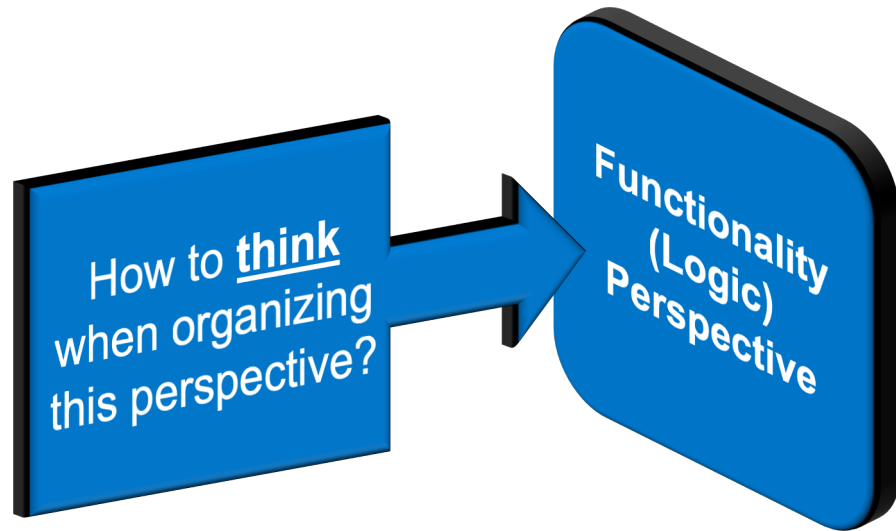
Architecture Thinking

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Functionality (Logic) Viewpoint Introduction ...



Functionality (Logic) Viewpoint Introduction ...



Going from a human performing monitoring & control to ...

Functionality
Perspective

SAE LEVEL -1?

Monitor movement
with eyes, ears and
dangerous situations

Control movement
by moving/rotating
the handle



«Source System»
Physical Perimeter System

«Functionality System»
Cab Tilting Force Generation

End Position
Detection

«Functionality System»
...

«Source System»
Energy Supply
& Distribution
System

«FS»
... «FS»
...

«Source System»
Torque Supply
& Distribution
System

«FS»
... «FS»
...

You can take these modules of functionality and
deploy them differently geometrically

... having a Vehicle Monitoring & Control System

Functionality Perspective

SAE LEVEL 1-5

«Source System»

Vehicle Monitoring & Control System

Monitor movement through software (& electronics)

Control movement through software (& electronics)



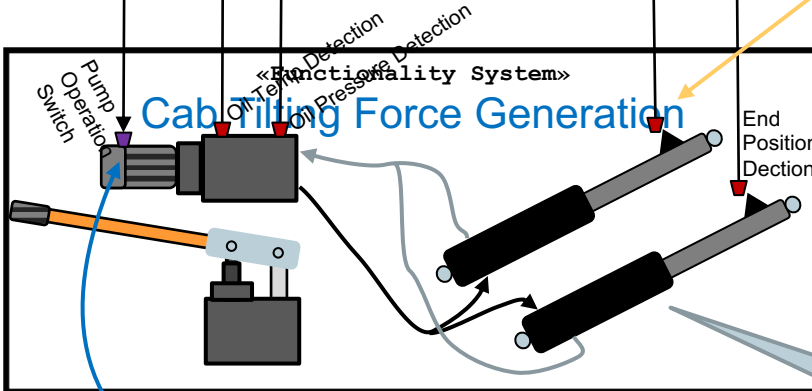
«Source System»

Physical Perimeter System

The flag/bell is here replaced with a sensor switch.

«Functionality System»

Cab Tilting Force Generation



Actuator
Sensor

You can take these modules of functionality and deploy them differently geometrically

«Source System»

Energy Supply & Distribution System

«FS»

24V Supply & Distr. System

«FS»

...

«FS»

...

«Source System»

Torque Supply & Distribution System

«FS»

...

...

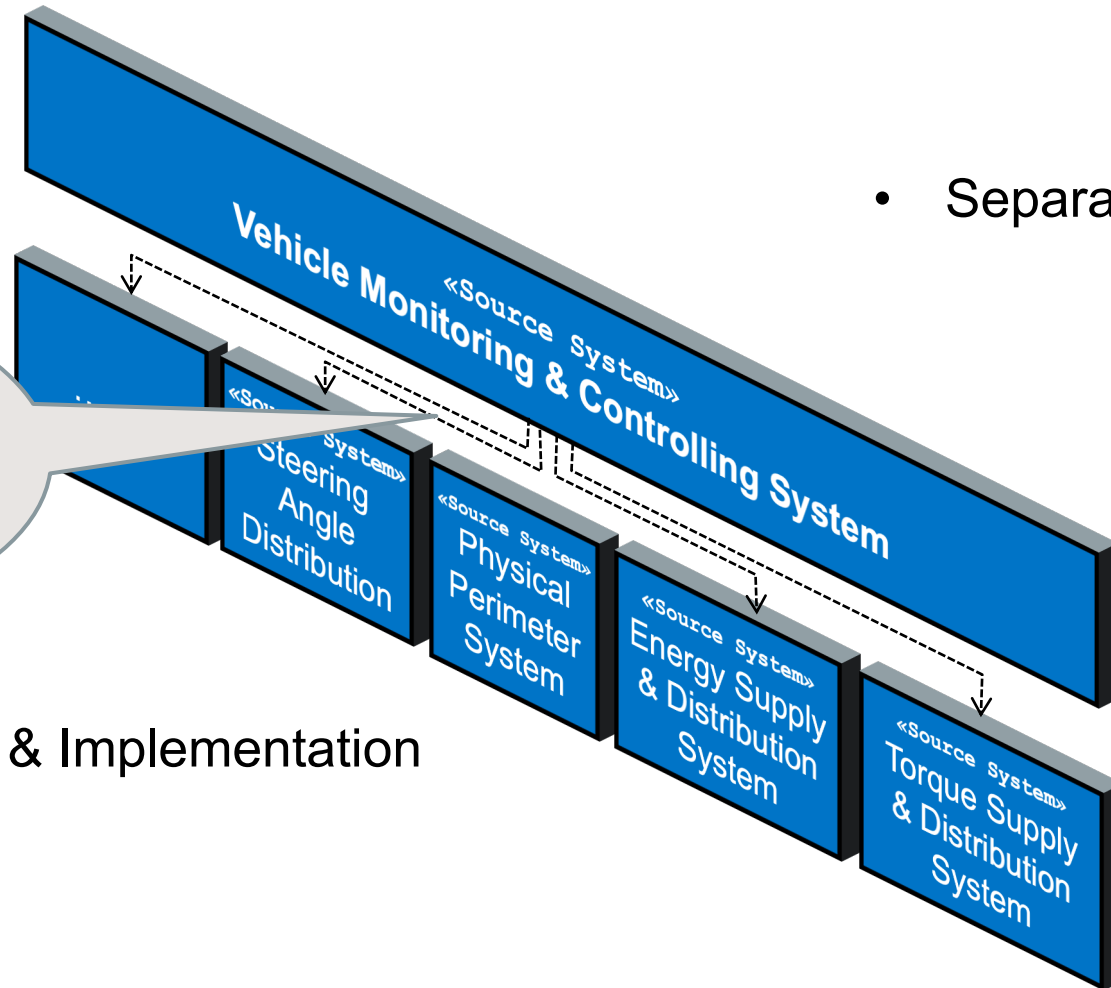
Vehicle Monitoring & Controlling System

single vehicle
focus

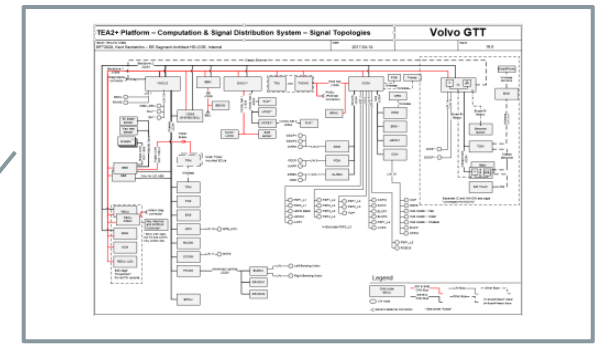
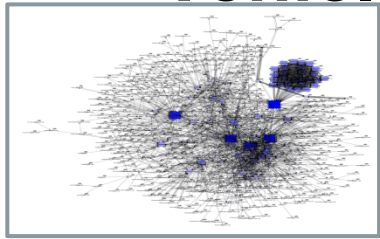
Although "separated" things in a large system can never be completely separated but there are dependencies

- Separation of Concern

- Separation of Policy & Implementation



Vehicle Monitoring & Controlling System



- The main reasons:
1. Different nature and concerns
 2. Different life cycles
 3. Different kinds of complexities

Door

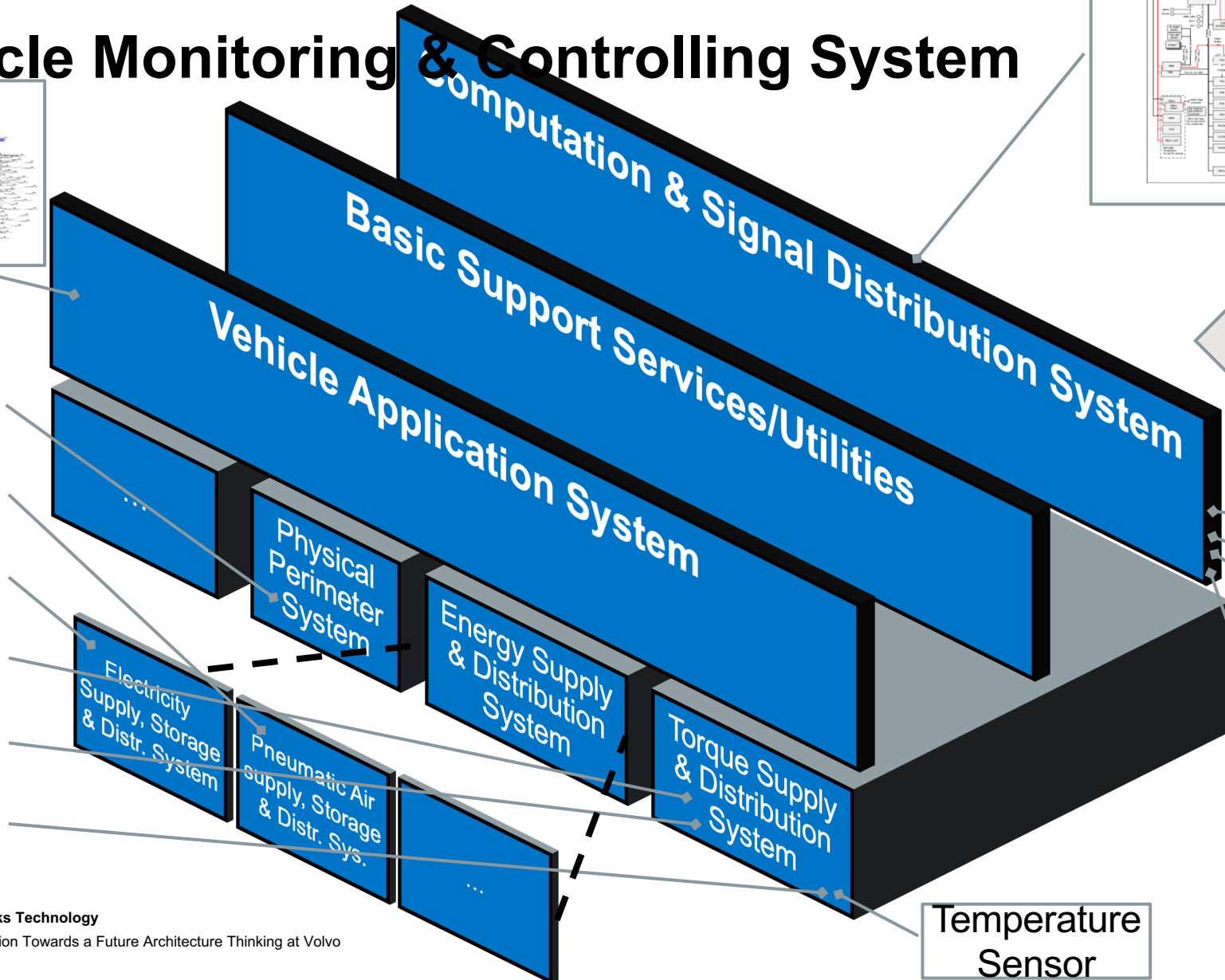
Air Tank

Battery

Wheel

Differential

Friction Brake



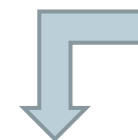
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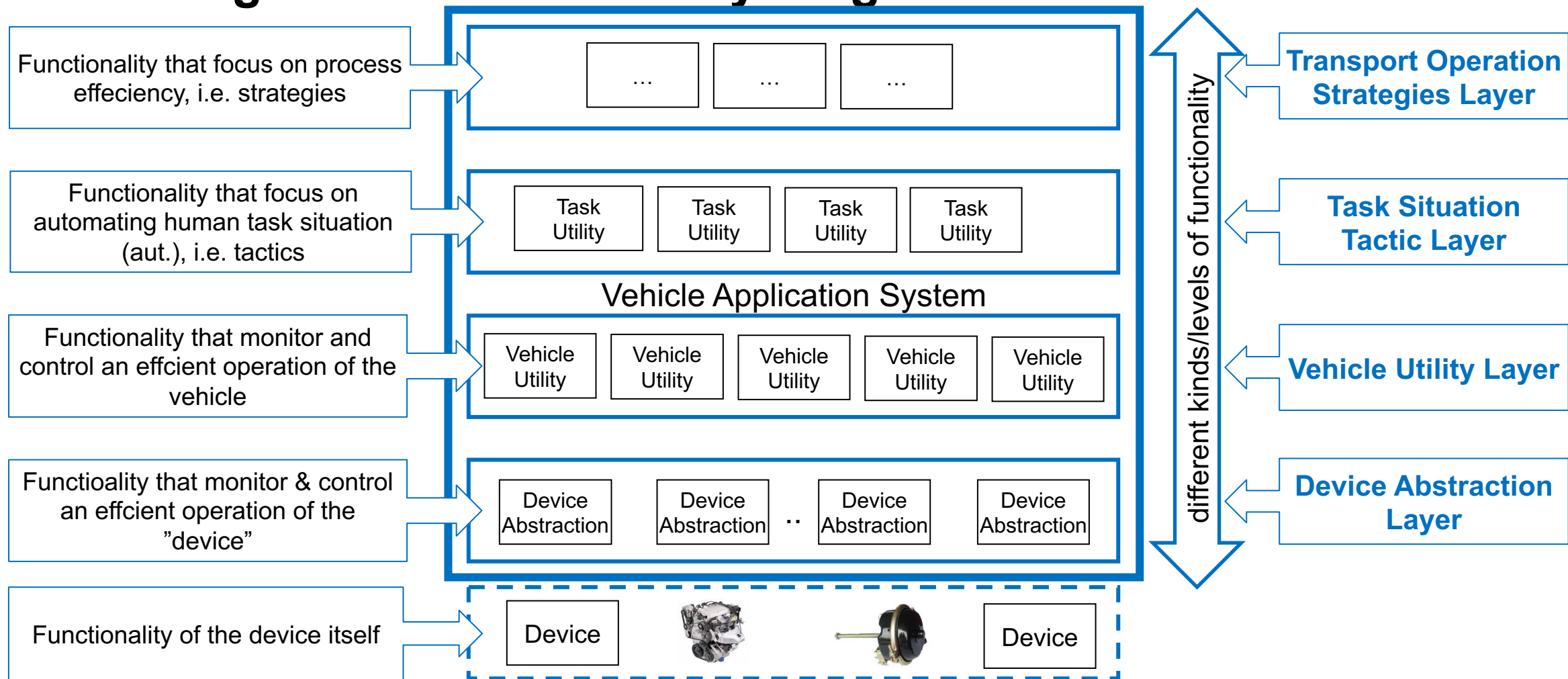
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VOLVO
VOLVO GROUP

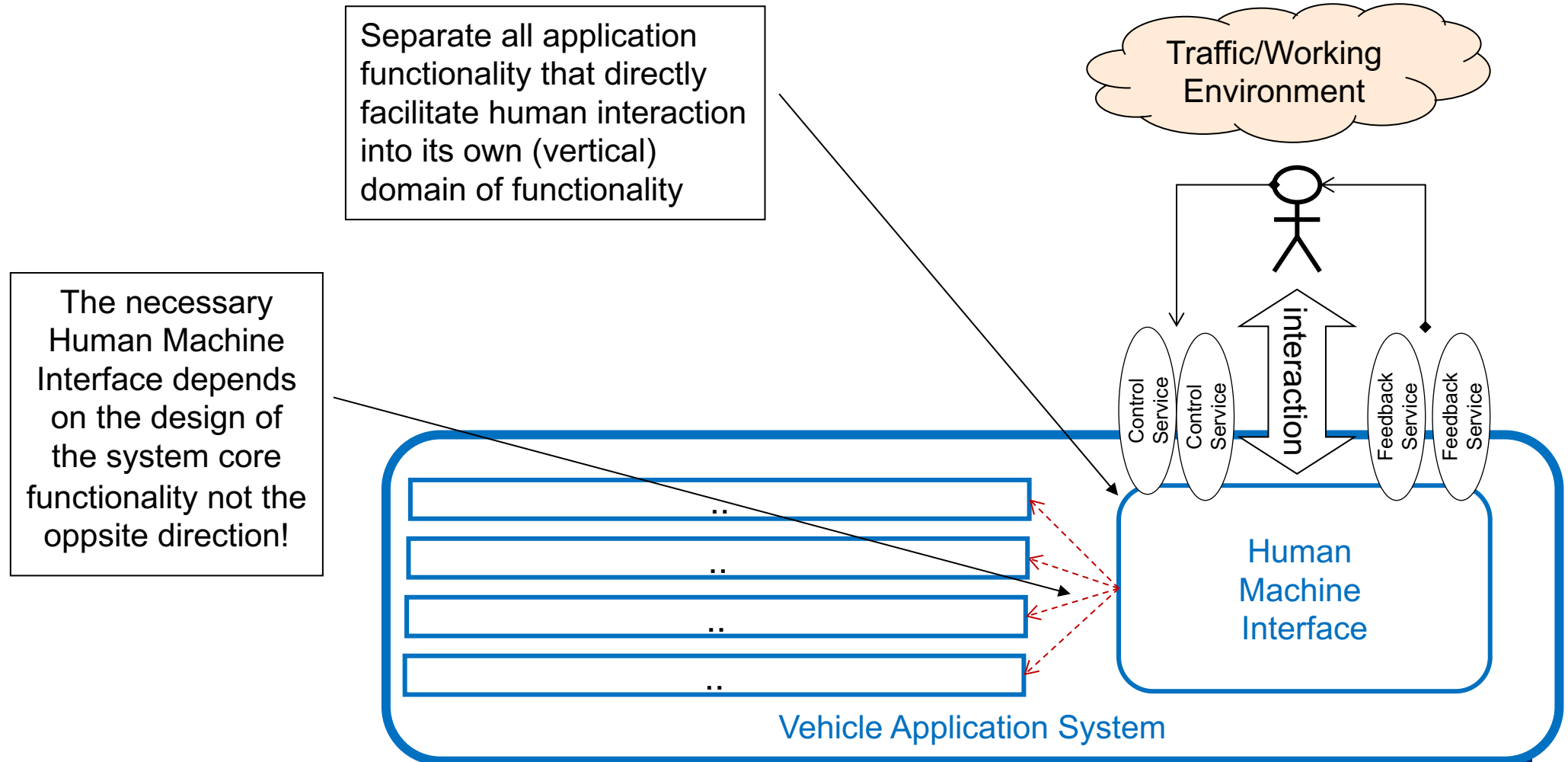
Zooming in at VAS: Basic Layering



Enables an hierarchical control design style

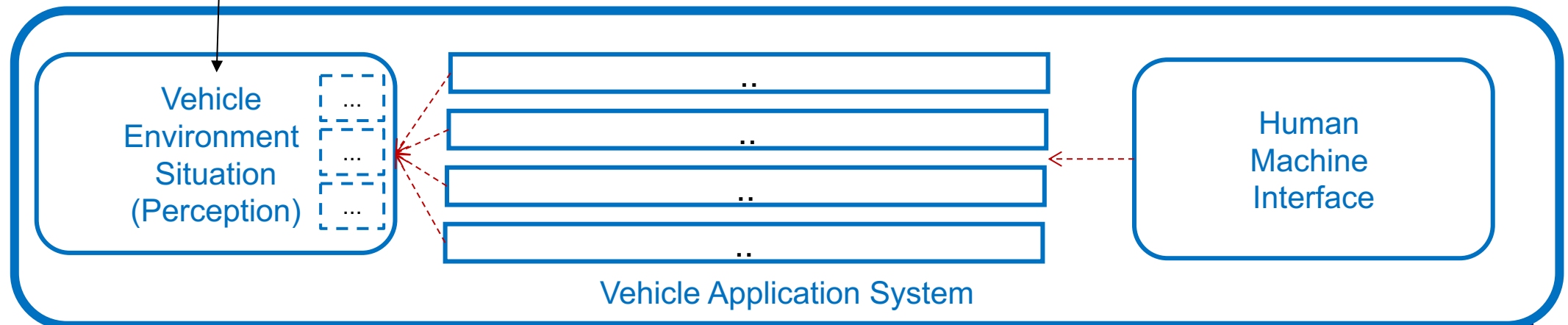


User interaction is a concern itself



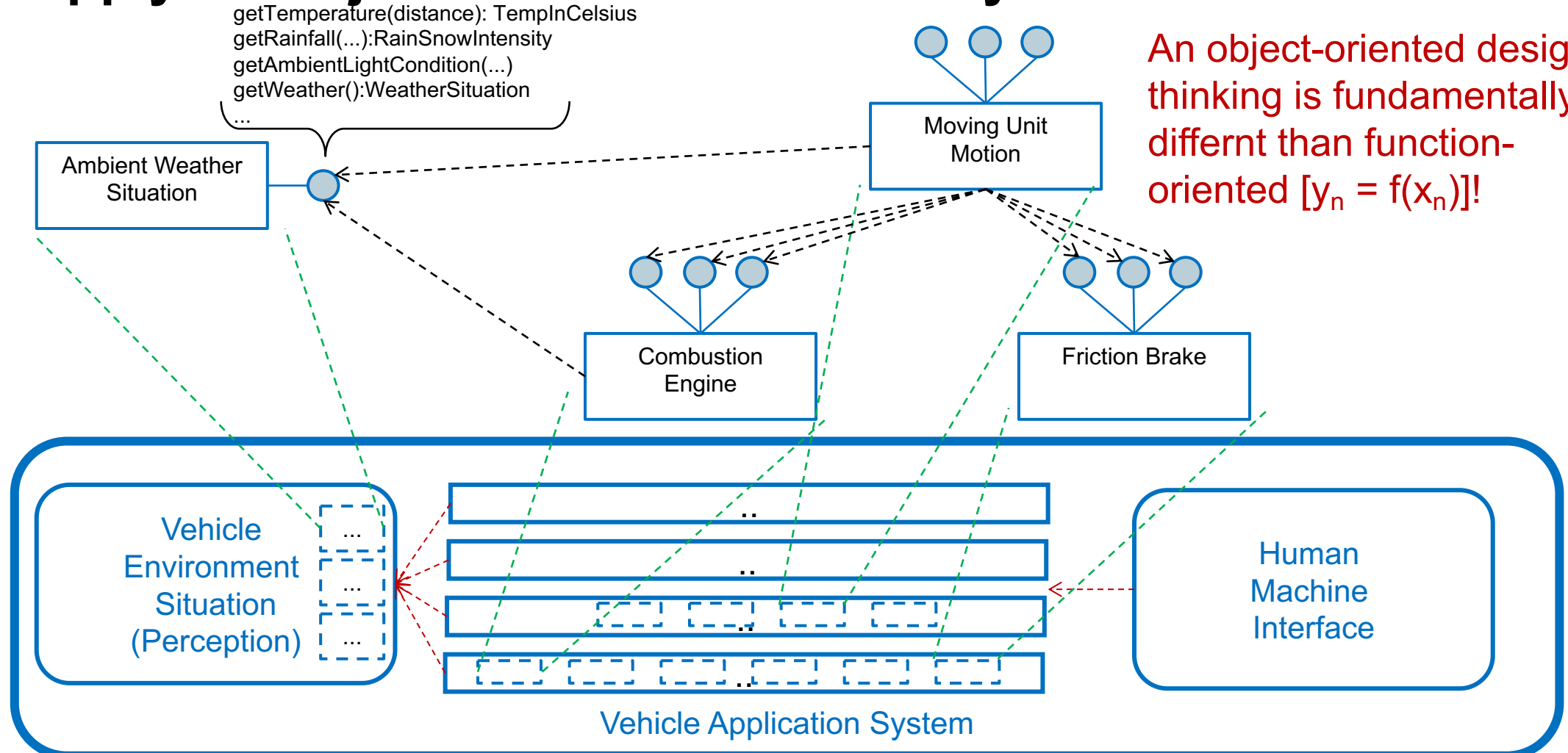
Replacing human “eyes” - Ego Vehicle’s Environment

Separate application functionality directly in place to facilitate an awareness of the ego vehicle's environmental situation (model of the environment) into its own (vertical) domain of functionality



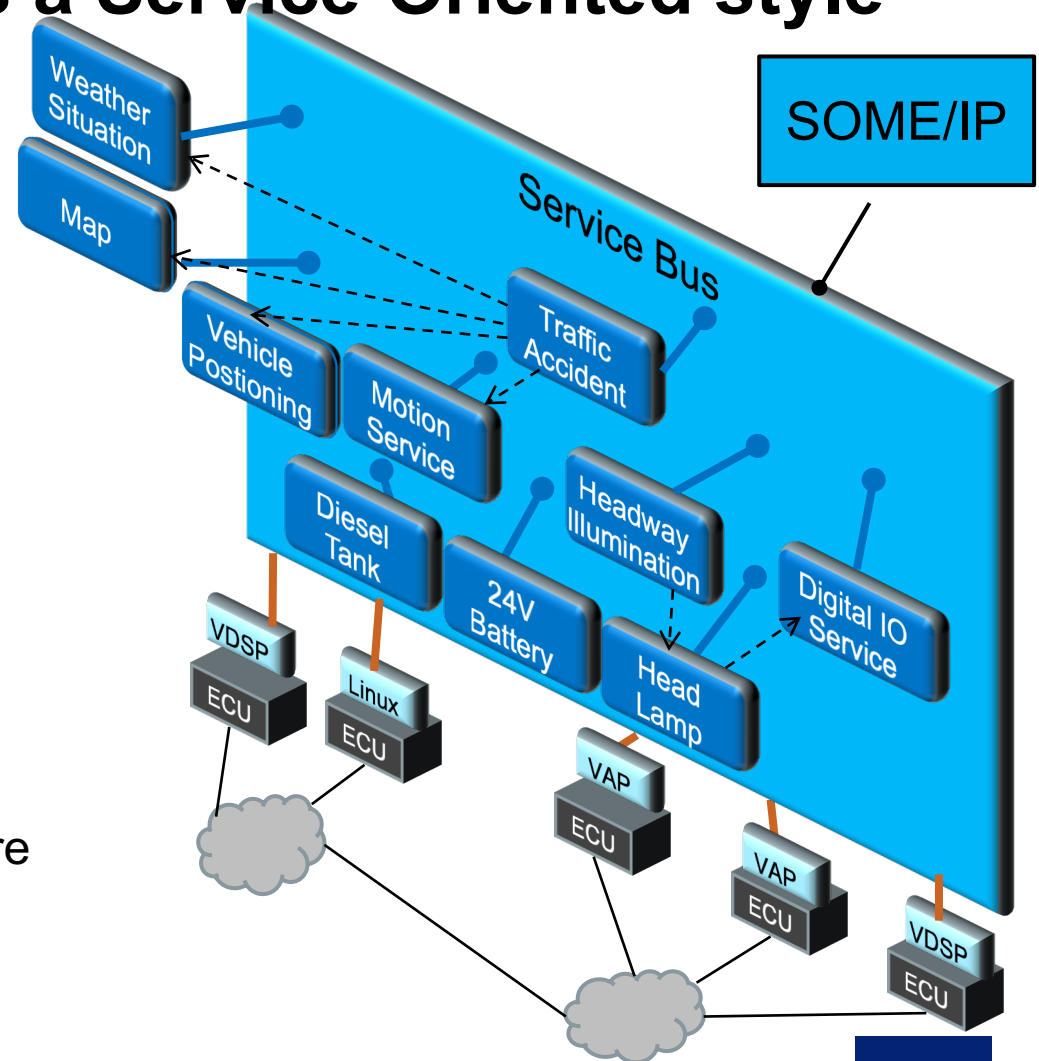
+ apply an Object-/Service-Oriented style

An object-oriented design thinking is fundamentally different than function-oriented [$y_n = f(x_n)$]!

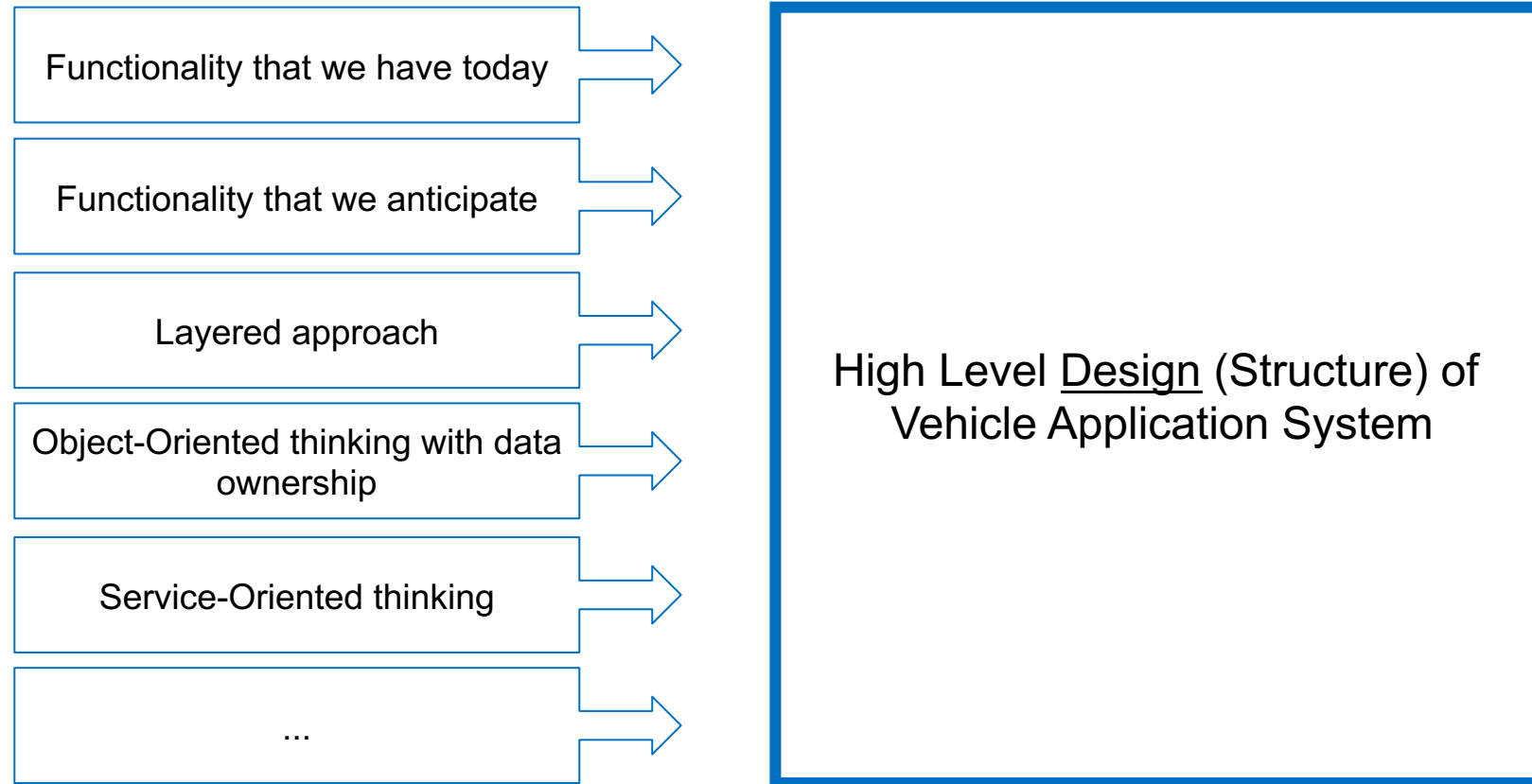


... next step is to move towards a Service-Oriented style

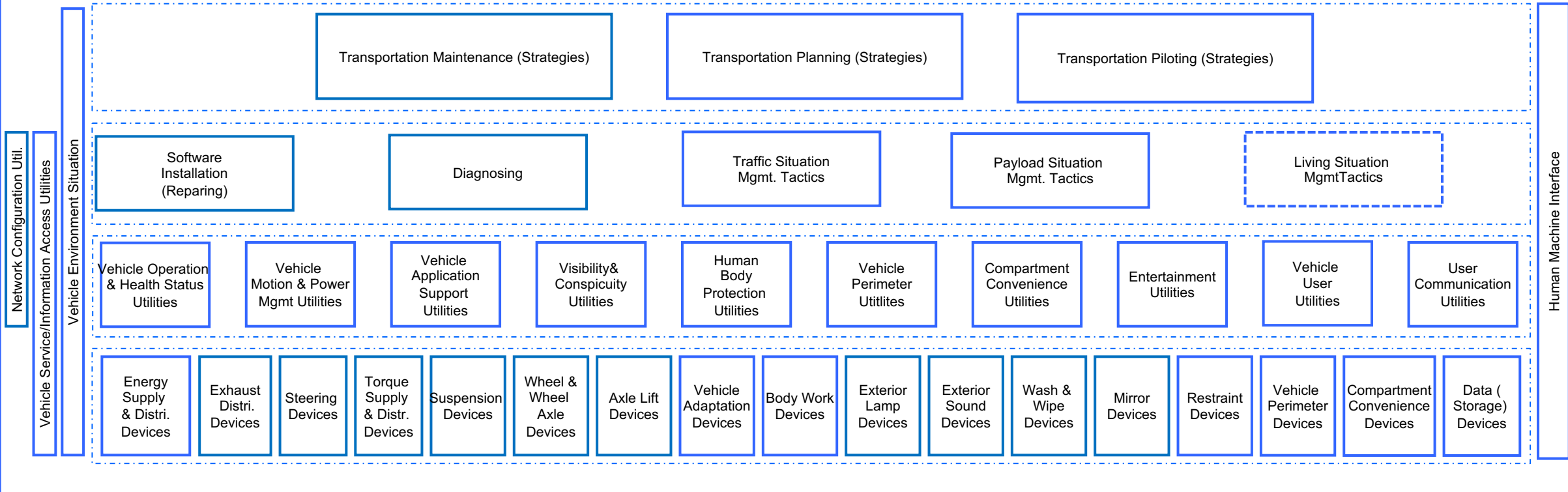
- Basically it is about distributed object-oriented applications running in heterogeneous operating system (platforms) providing their services via some kind of broker mechanism, called a Service Bus.
 - Services are expected to be platform independent and able to be called in a generic way not dependent upon a particular programming language.
- Emphasis is on creating components called services, which are small, discrete units of software that provide a specific functionality and can be reused in every application.



Converting Architecture Principles into a Design



«Functionality System»
Vehicle Application System



«Functionality System»
Basic Support Services/Utilities

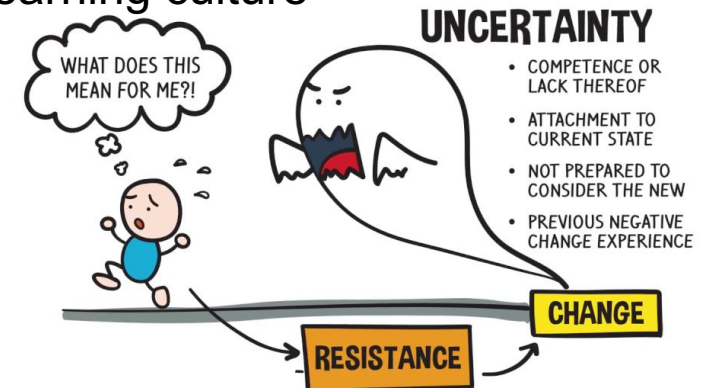
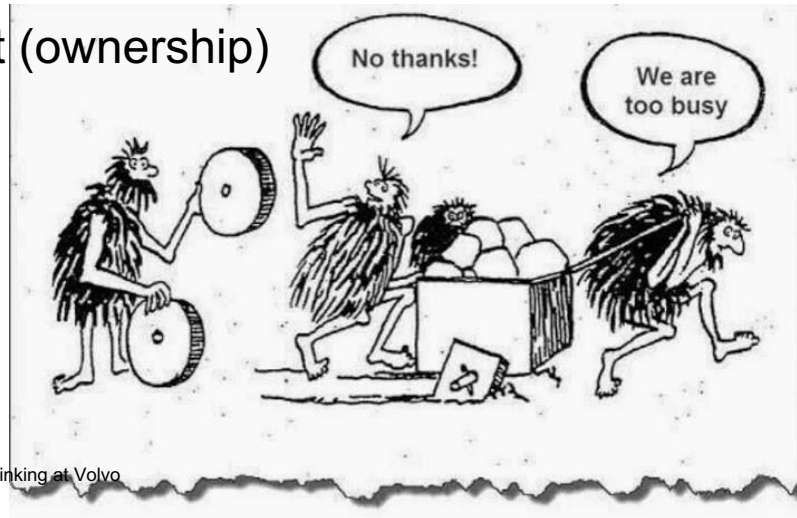
«Functionality System»
Computation & Signal Distribution

Resistance to Architecture Change (Volvo)

- The cost of making architecture changes
 - Maintaining an old product line while developing a new one in parallel
 - Future is always downprioritized over immediate deliveries
 - Organization waited too long to make architecture changes
- Sounds good as long it doesn't impact me at personal level
 - Understanding
 - Competence / Education, e.g. going from the mindset in Simulink to an object-/service-oriented design style is really challenging.
 - Company learning culture

- Organization impact (ownership)

-





- Architecture is very much about how you think when you design, system, software, electronics, ...
- So, how can you change and impact an existing "thought style"?
- What is your own "thought style"?

