HUTCHINSON®

We make it *possible*

Simulation multi-domaines pour le management thermique

HUTCHINSON®

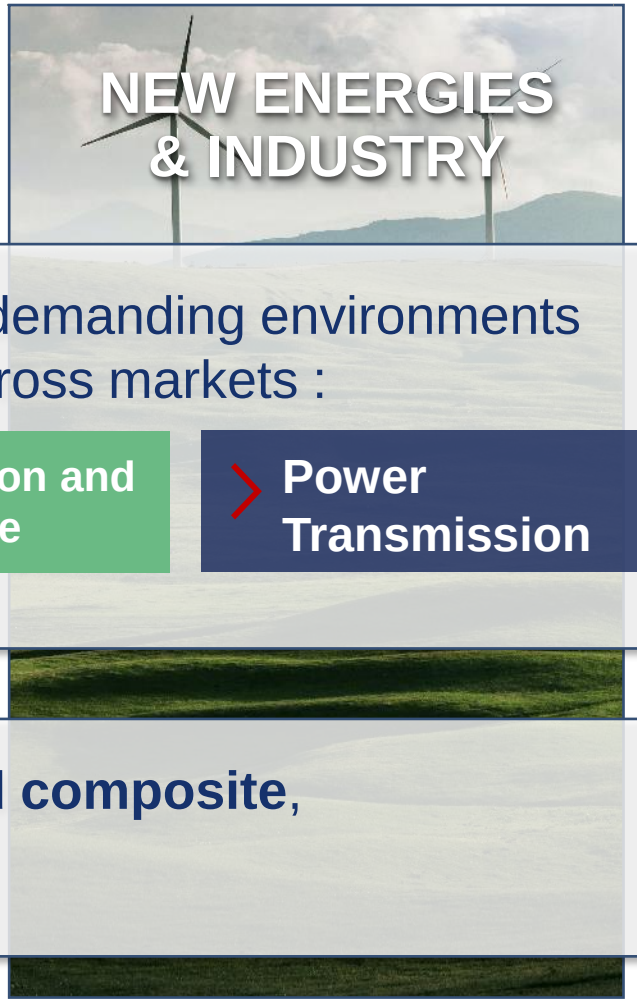
We make it *possible*

01

Hutchinson Presentation

OUR MISSIONS

Markets



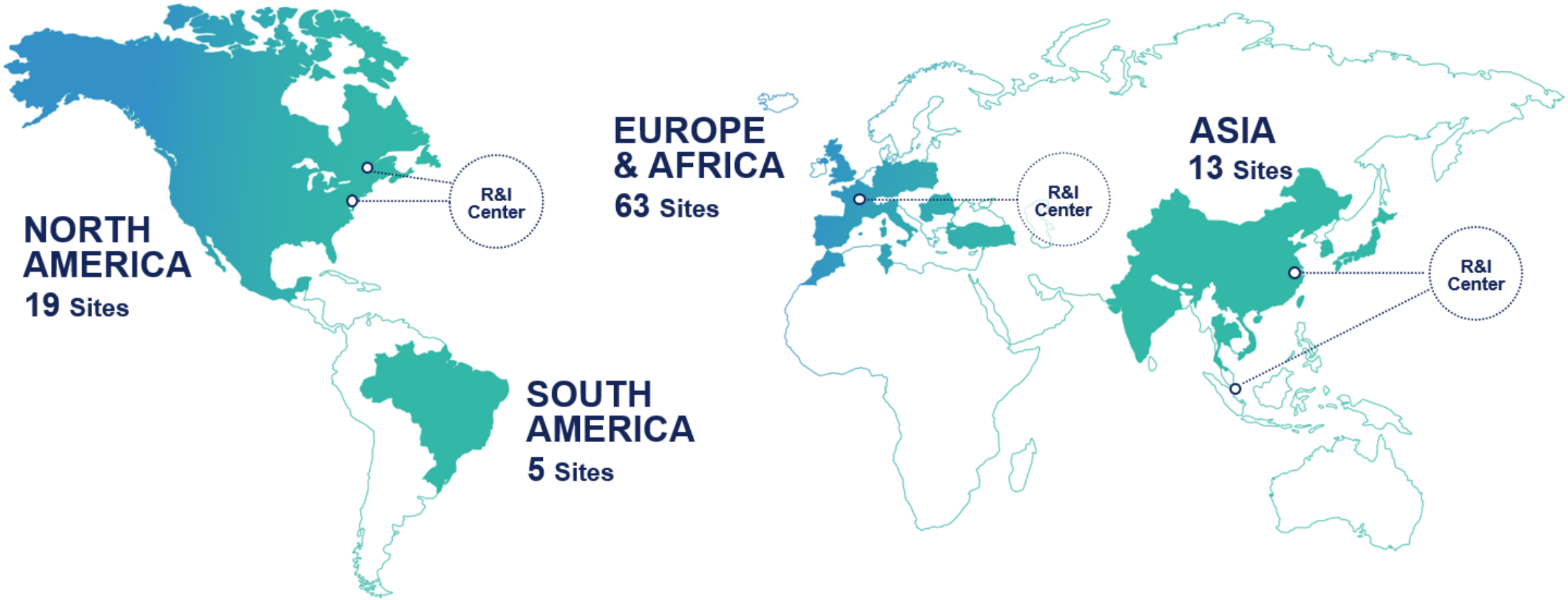
- We tackle **safety, comfort** and **energy efficiency challenges** in demanding environments through engineering of **multi-materials sustainable solutions** across markets :

Solutions

- **Acoustics & Vibration**
- **Sealing**
- **Fluid & Thermal Management**
- **Protection and structure**
- **Power Transmission**

- We leverage **science** and **technology expertise** in **materials** and **composite**, **mechatronics**, **sensing**, and **data management**.

A GLOBAL FOOTPRINT



40,000 Employees

25 Countries

100 Sites

4,8 Billion Revenue in 2023

5% of our revenue invested in R&D

5 Research & Innovation Centers

40 Development Centers

FROM FLUID TRANSFER TO THERMAL MANAGEMENT

Multimaterial Assembly

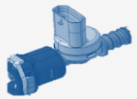
- ICE focused hose products
- Standard material expertise

Flow Transfer

- Increased passive complexity
- Connecting elements QC
- IHX

Sensors & Heating

- Functionalized mechanical parts
- Mechatronic elements
- Printed P&T sensors



Smart Valves

- Active loop management
- Systemization and material differentiation

Thermal Management Modules

- Complete loops
- Numerical simulations

Thermal Management Systems

- VTMS global expertise and data collection
- H2 & EV solutions

Fluid Transfer

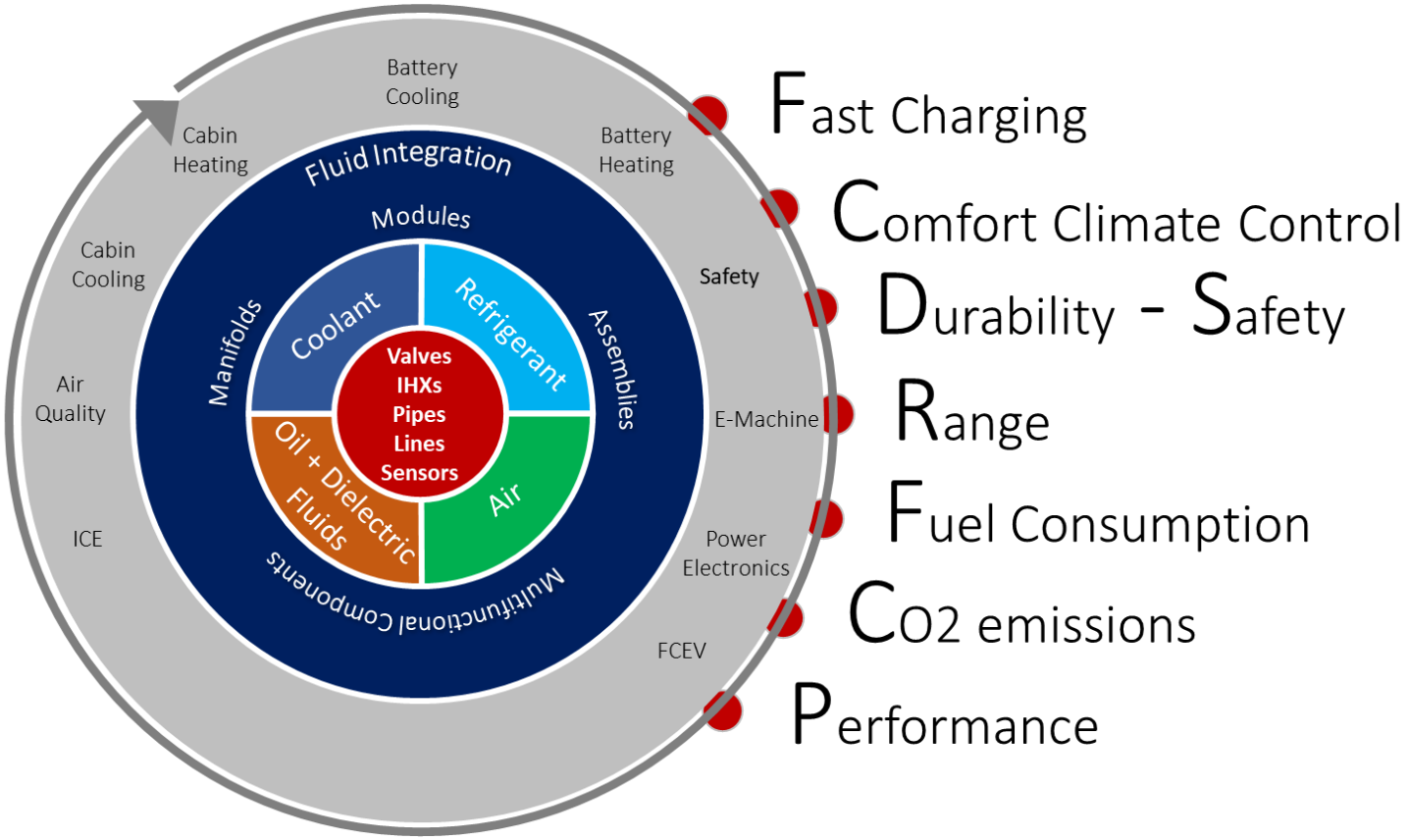
Fluid Management

Thermal Management & Energy Efficiency

FROM FLUID TRANSFER TO THERMAL MANAGEMENT

Thermal Management Modules

- Complete loops
- Numerical simulations



Mechatronics development is key for Thermal Management

HUTCHINSON MECHATRONICS PRODUCTS

2014 — Model Based Design

2016 — Hardware in the Loop

2018 — Code Generation

2021 — Multi-Domain Modeling (Simscape)

2024 — MATLAB EXPO

We make it ***possible***

with

MathWorks®

2014 — Active Vibrations Control

2018 — Active Vibration Control

2023 — Integrated Thermal Management Module

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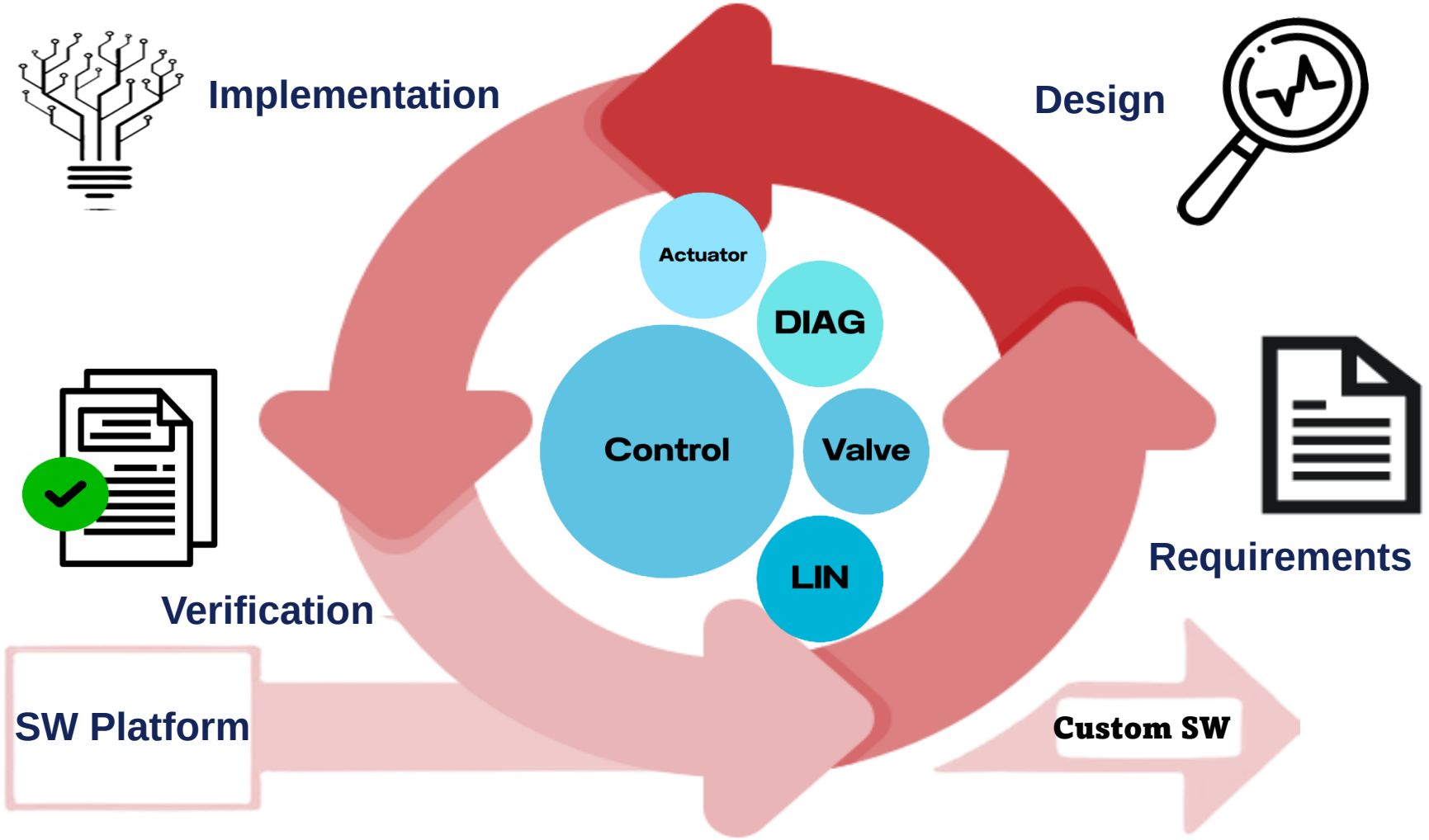
02

Technological Ambition for Thermal Management Products

SW PLATFORM FOR THERMAL MANAGEMENT



Deliver optimal technical solution that meets customers' needs

KEY OEM REQUIREMENTS

High expertise needed, only for the best-in-class suppliers!

Cost

w/w-o position sensor

Process

Product development

Performances

Low current - Travel time - Accuracy

Vehicle Integration

LIN – Adaptated speed/torque - Compacity

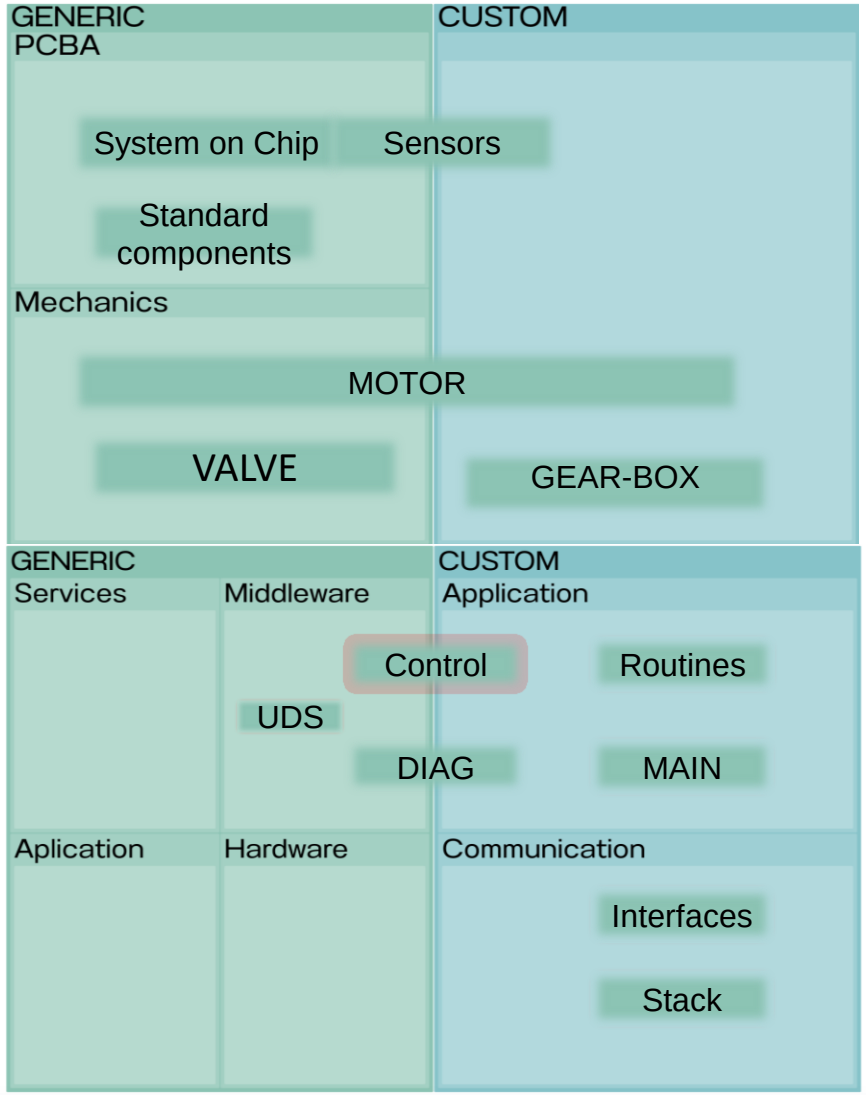
Constraints

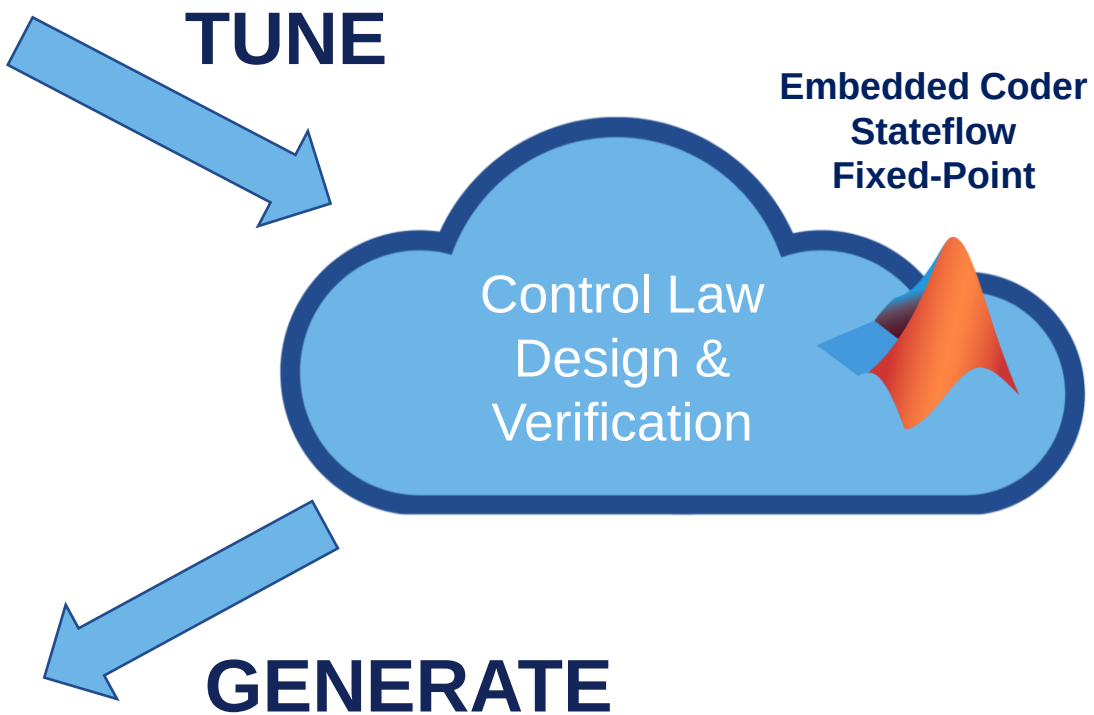
T < 100° - Chassis Vibrations - EMC Level 5

CUSTOM SOFTWARE DESIGN

PRODUCT

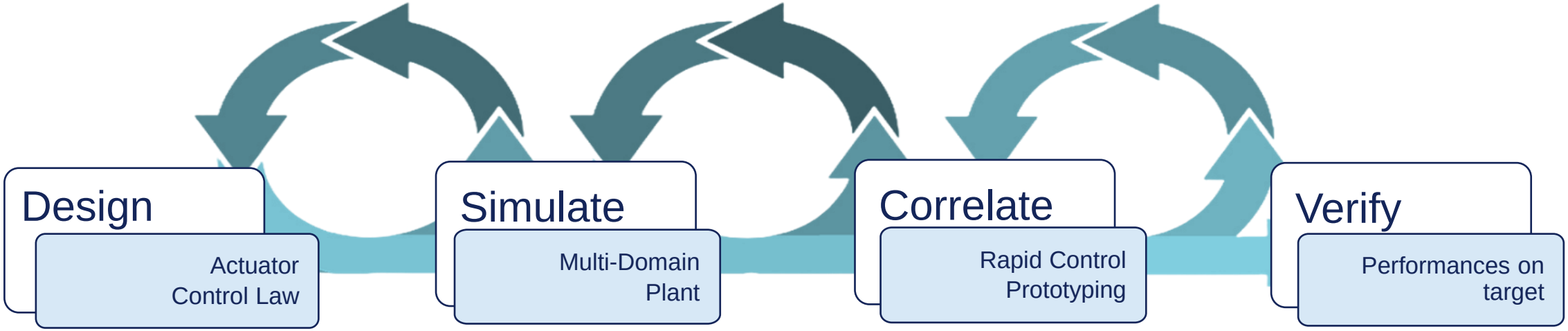
SOFTWARE PLATEFORM



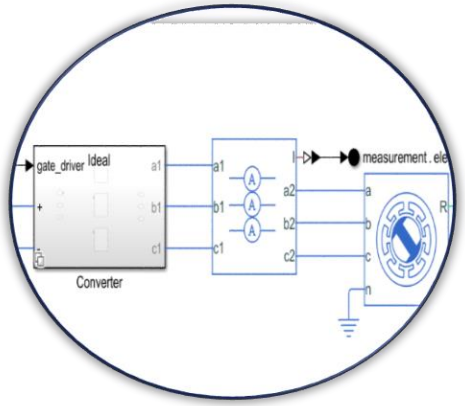


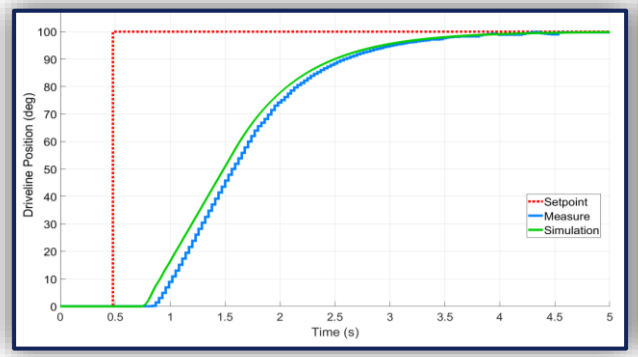
Control law adaptation for each specific product

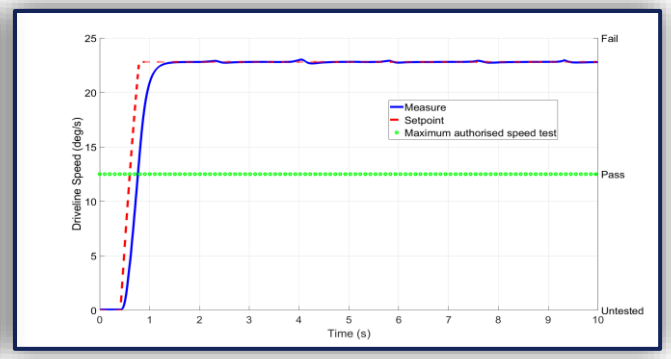
CONTROL LAW IMPLEMENTATION



Req: Output valve travel less **than 32°/s**







Iterative methodology to speed up development from simulation to target

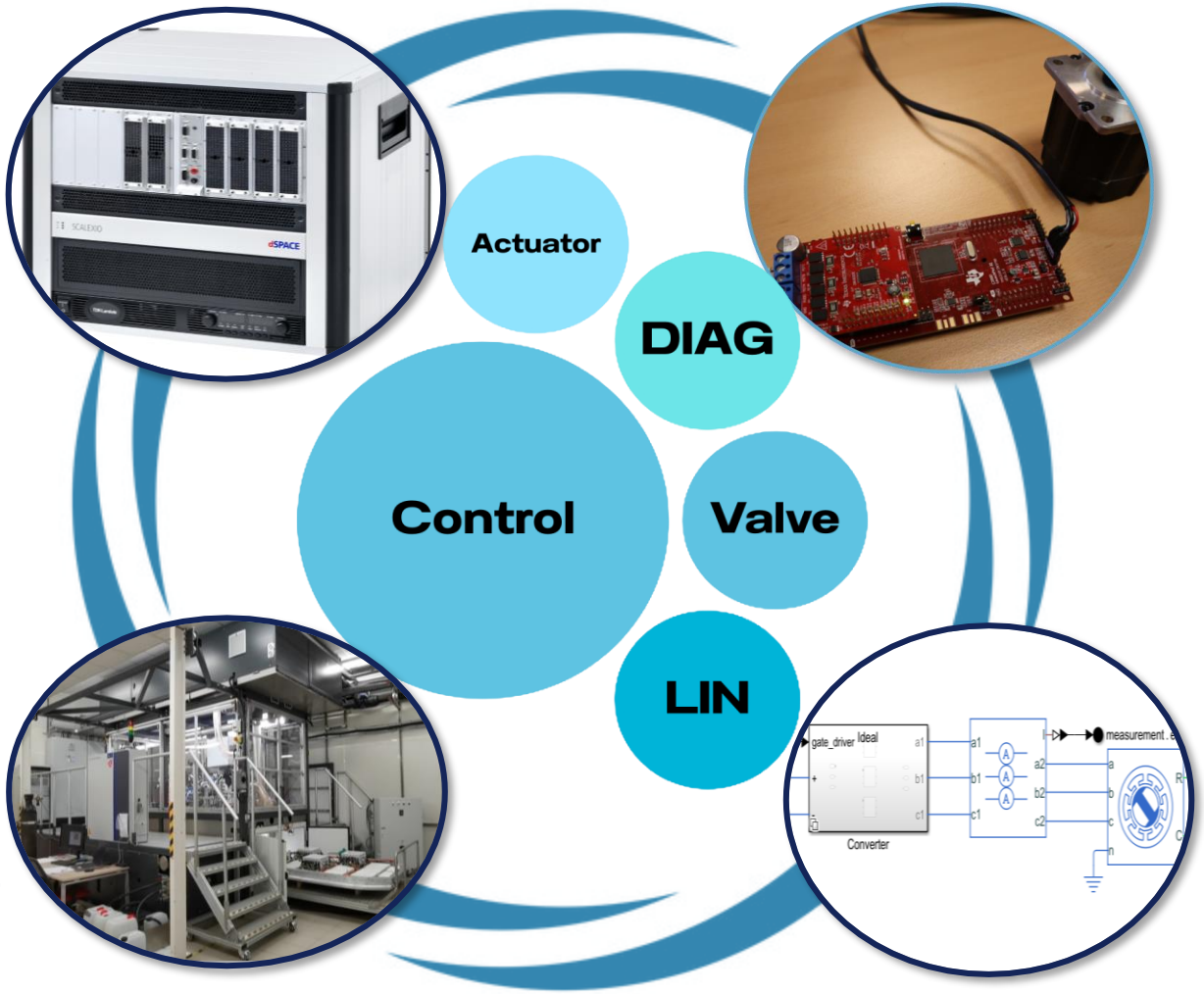
STEP BY STEP VERIFICATION

Hardware-in-The-Loop

Performances on actual ECU

System In the Loop

Performances on representative environment



Rapid Prototyping

Performances on actual target

Model In the Loop

Performances in simulated environment

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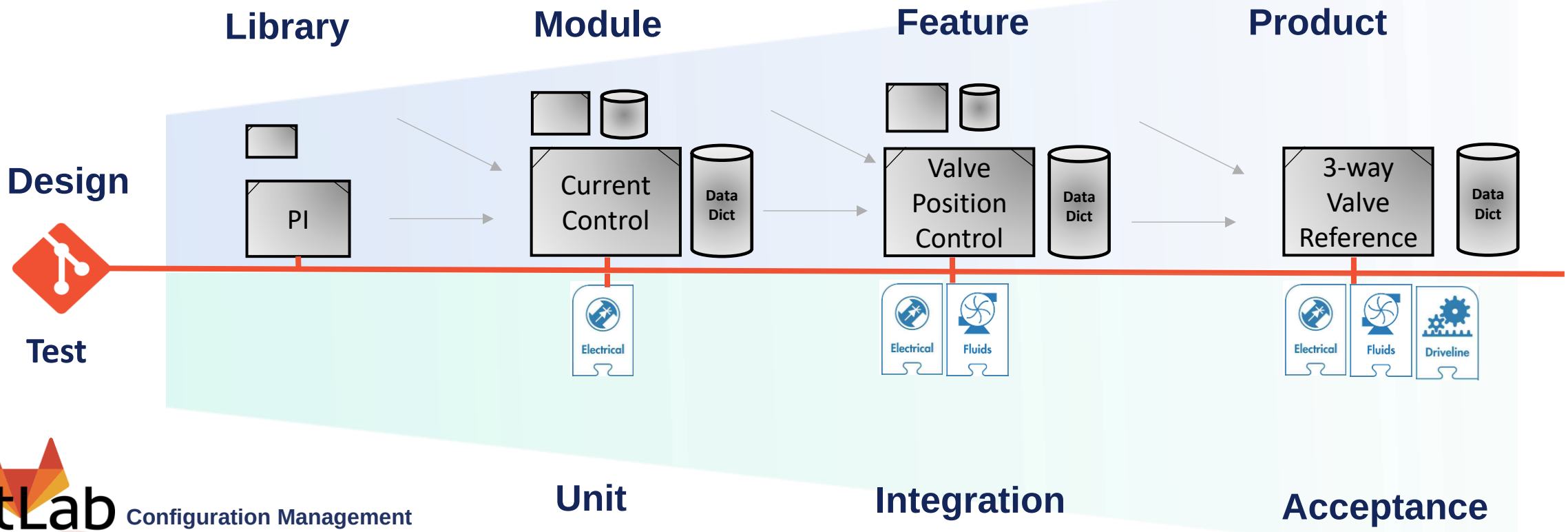
03

Lever on tools to achieve objectives

MODULAR ARCHITECTURE & PRODUCT DIVERSITY



GitLab **Configuration Management**

Continuous Integration

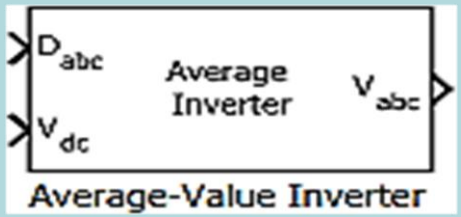
Req: Output valve travel less **than 32°/s**

Lever on SW best practices: Git/Continuous Integration/Re-use

MULTI-DOMAIN PLANT MODEL WITH DIFFERENT RESOLUTIONS

Standard Plant Model

Electrical



Inverter

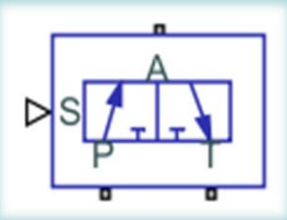
Transistor

Mechanical

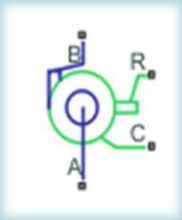
BLDC

Gearbox

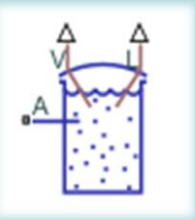
Hydraulics



Valve



Pump

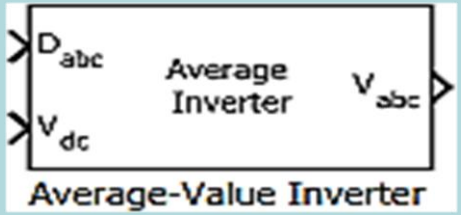


Thermal Circuit

MULTI-DOMAIN PLANT MODEL WITH DIFFERENT FIDELITY LEVELS

Standard Plant Model

Electrical

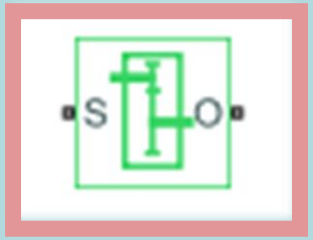


Inverter

Transistor

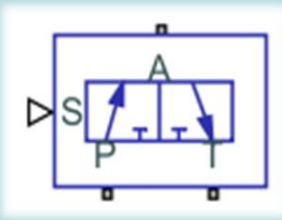
Mechanical

BLDC

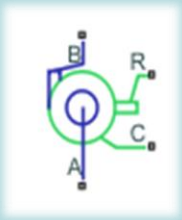


Gearbox

Hydraulics

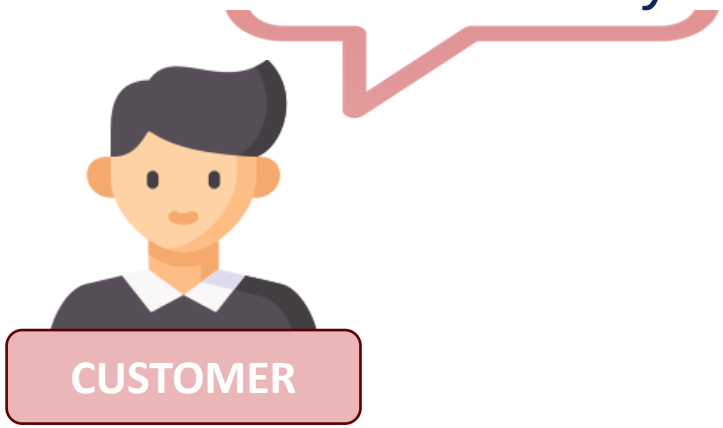


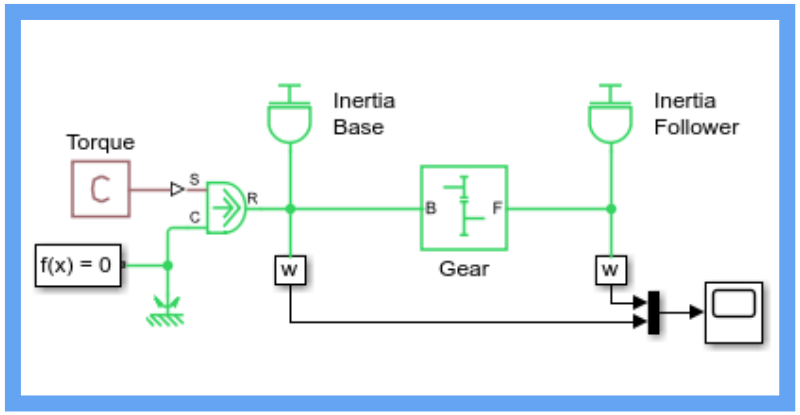
Valve

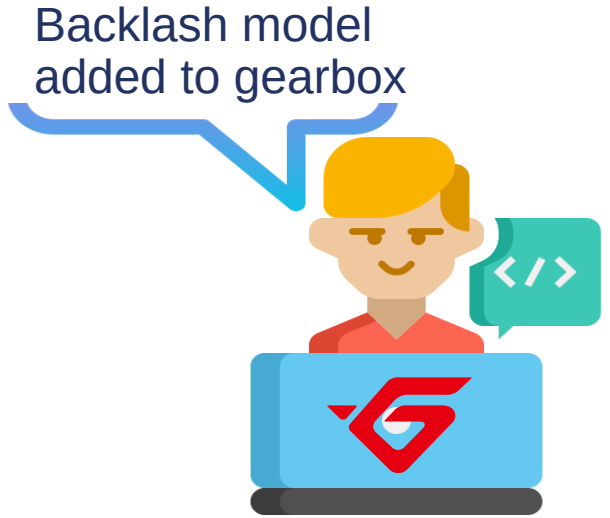


Pump

Thermal Circuit



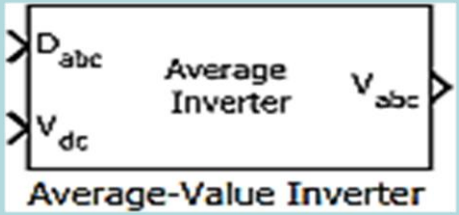




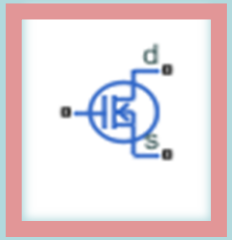
MULTI-DOMAIN PLANT MODEL WITH DIFFERENT FIDELITY LEVELS

Standard Plant Model

Electrical



Inverter



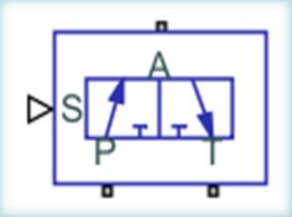
Transistor

Mechanical

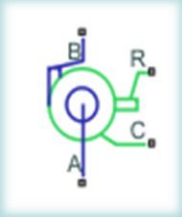
BLDC

Gearbox

Hydraulics



Valve



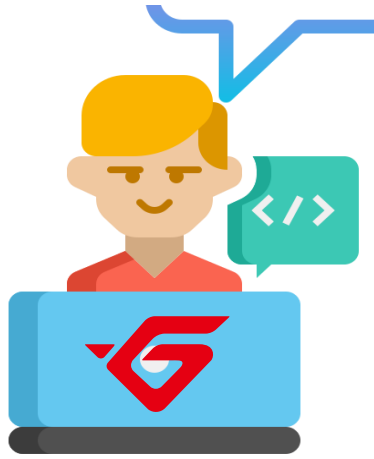
Pump

Thermal Circuit

Transistor peak Current ?


```
* PSpice Model Editor - Version 17.2.0
*$
.SUBCKT DRIVER_INF INPUT GND CONSUMPTION GATE SOURCE PARAMS:
+ DELAY=30N R_LOAD=47K C_LOAD=330P
*
V_V3          CM GATE 0
R_R11         GND CONSUMPTION  1
```

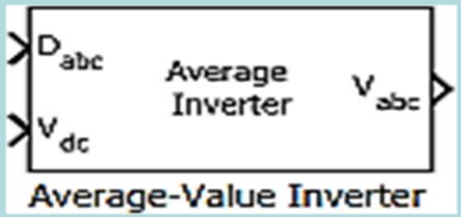
Integrate transistor reference (NETLIST)



MULTI-DOMAIN PLANT MODEL WITH DIFFERENT FIDELITY LEVELS

Standard Plant Model

Electrical



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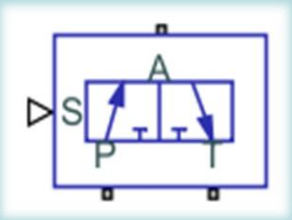
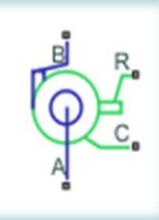
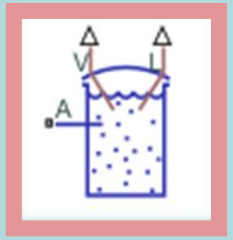


Valve

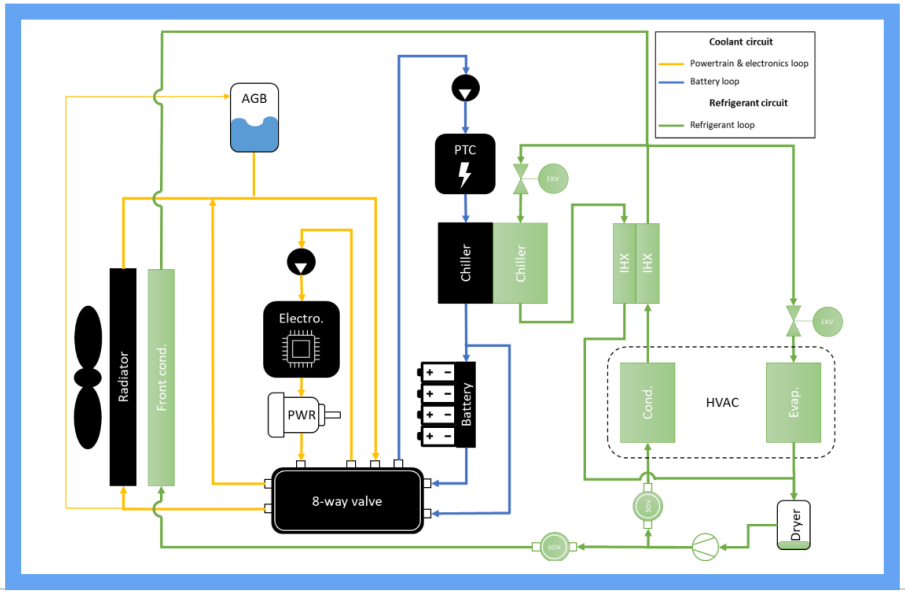


Pump

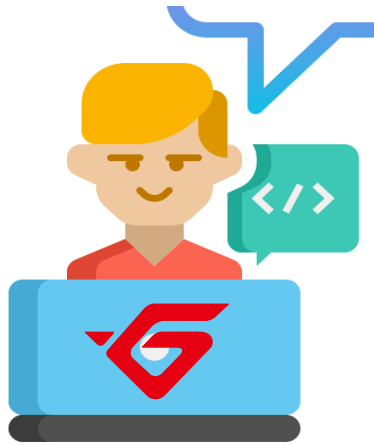


Thermal Circuit

ECU life cycles ?



FMI gateway to AMESIM vehicle model



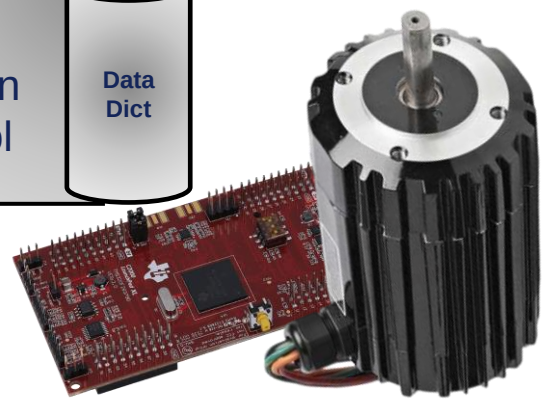
CORRELATION WITH PHYSICAL MODEL

Embedded Coder
Motor Control Blockset

Current Control — Data Dict

Rapid Control Prototyping Verification before Integration

Valve Position Control — Data Dict



Maxon **TI** **Magtrol**

Configuration Management with GitLab facilitates prototyping activies

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We make it *possible*

04

Conclusion

KEY LEARNINGS

Technological ambition

- Modular SW platform for thermal management products

How ?

- Process development
- Modular architecture to address product diversity
- Tools are key to achieve objectives

Hutchinson added-value

- Technical exchange with customers to best fit its requirements
- High-level of quality

TRENDS

SW Factory — Efficiency, agility and reactivity

Virtual ECU — Now required by OEMs

Certification — QM (EV) or ASIL-A (Fuel Cells)