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SEE MOBILITY E-VOLV(E)ING:

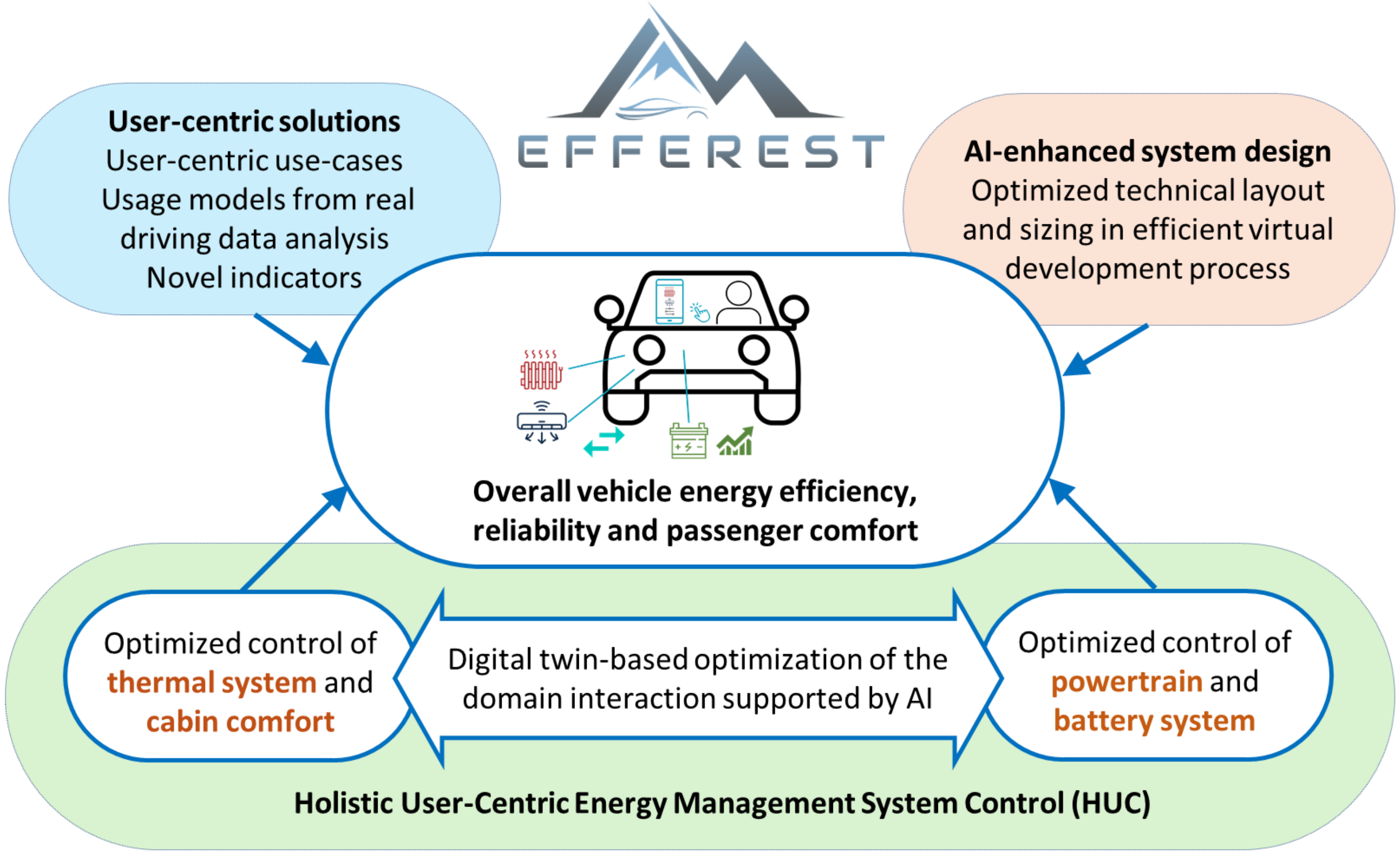
Smart Components for the Software-Defined Vehicle of the Future

Smart cabin climatization through comfort-based HVAC control

Sebastian Möller, VIRTUAL VEHICLE GmbH, EFFEREST Project

Project Overview

- EFFEREST targets a decisive leap forward in the **novel use of data** to achieve energy efficient electric vehicle (EV) designs, **matching enhanced user acceptance with efficient vehicle operation.**



- HORIZON-CL5-2023-D5-01-01 - IA
  - User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)
- 11 partners from industrial and research backgrounds (entire value chain)
  - Coordinator: Virtual Vehicle Research GmbH
- Duration: 36 Months (Jan. 24)
- Total project budget: 6,4 Mio EUR
  - Total project funding: 4,9 Mio EUR

Project Partners

VUB – Vrije Universiteit Brussel
Hi-fi and data-driven models of e-drive comp.
Assessment models

BOSCH
Model Based Systems Engineering, Co-design
Requirements and use-cases, cloud-based control

virtual vehicle
Project coordination
HVAC and comfort ADTs and control
Human centered systems

MAGNA – MAGNA POWERTRAIN
HVAC and comfort system
Calibration & validation
Test infrastructure

BOSCH
VCU control software strategy and implementation
Cloud-vehicle eco-systems

CLEPA – European Association of Automotive Suppliers
Exploitation, standardisation
Communication, dissimination

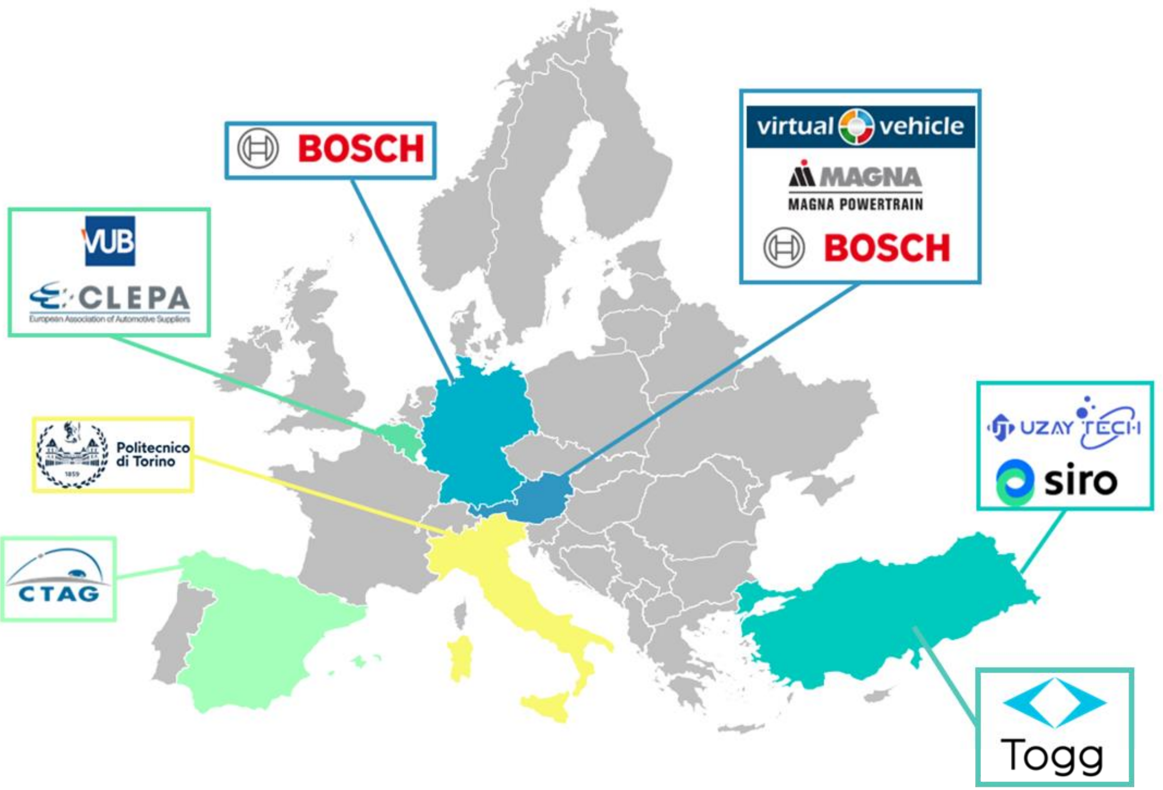
UZAY TECH
High-fidelity and data-driven modelling of driver
Driver data analyzing

Politecnico di Torino
ADTs and predictive controllers, AI algorithms
HUC architecture

siro
Battery systems expertise and data collection
3D CFD and algorithms

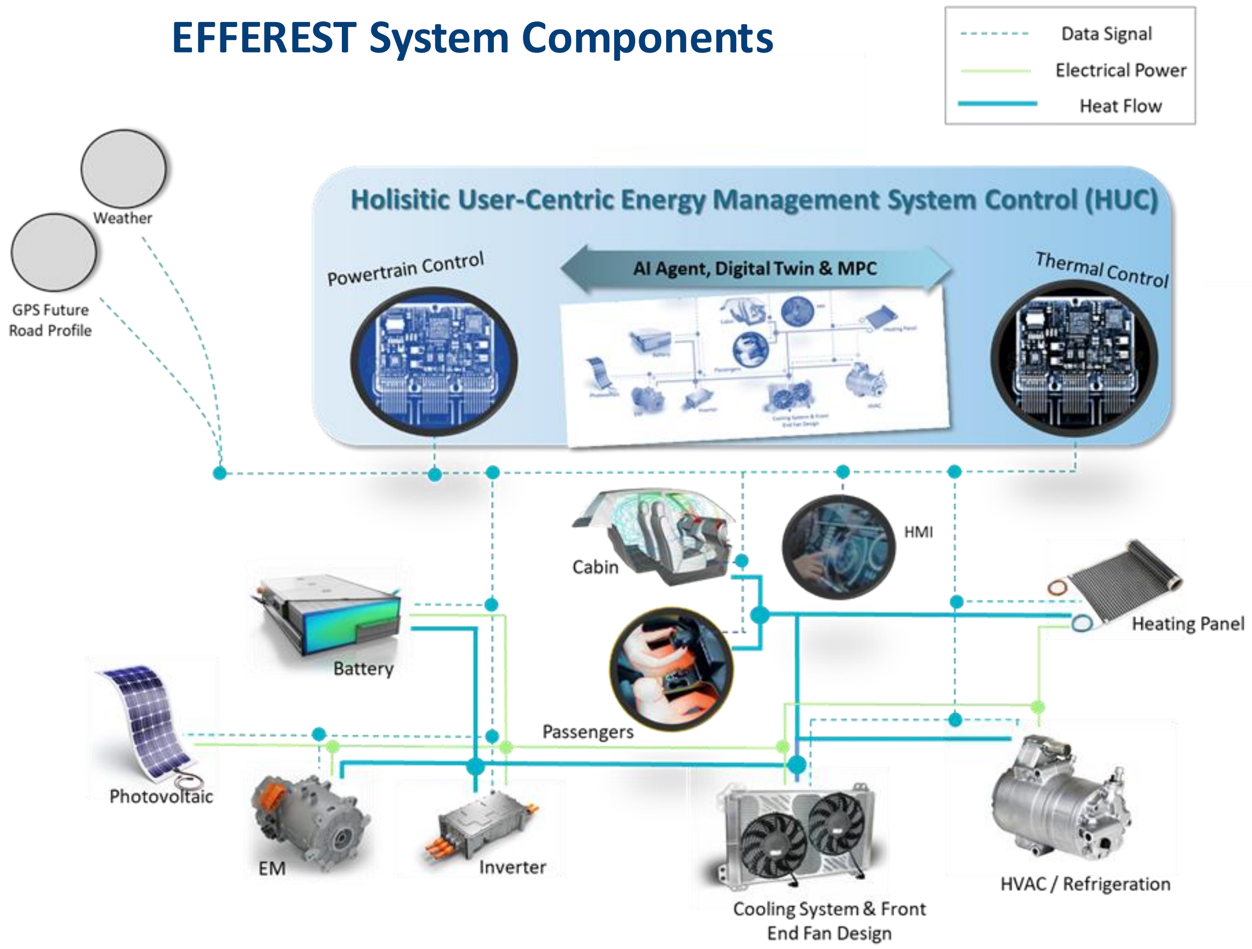
CTAG
Thermal comfort testing
Smart heating/cooling surfaces and integration

Togg
Full vehicle development
Integration and modelling support

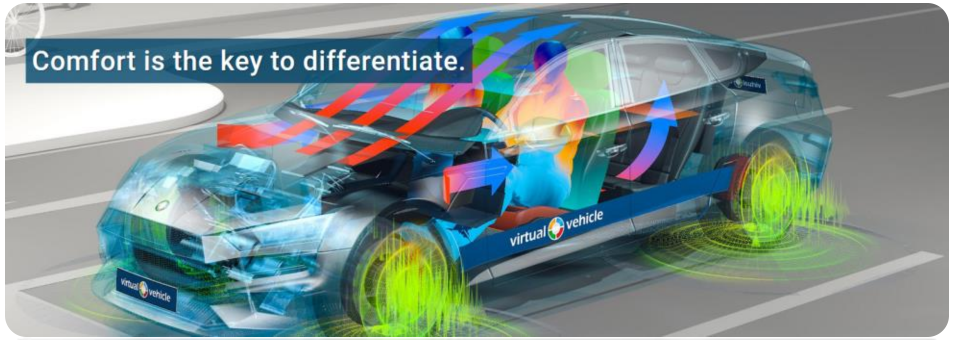


Key Factor Thermal Comfort Control

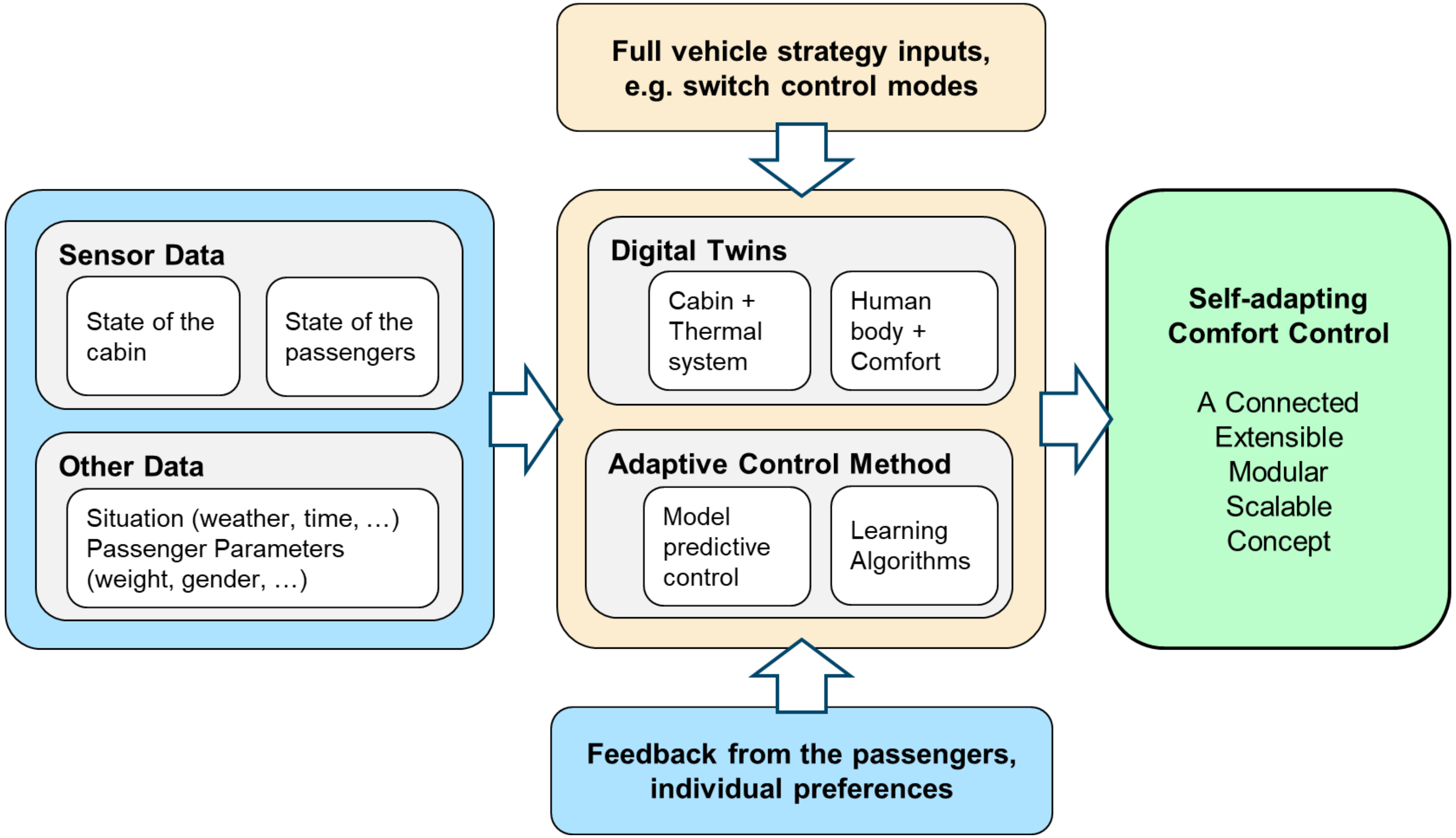
EFFEREST System Components



- Key factor for user acceptance
  - Increased comfort by considering individual preferences
  - Ease of use for complex comfort systems
- Significant efficiency potential
  - Minimized energy consumption by focusing on the passenger and its specific characteristics
  - considering specific use-cases
- Strong interdependencies in the EV system
  - Thermal system combines conditioning of the cabin and propulsion components
  - Cost and efficiency potential through co-design and right-sizing from the systems perspective
- And:

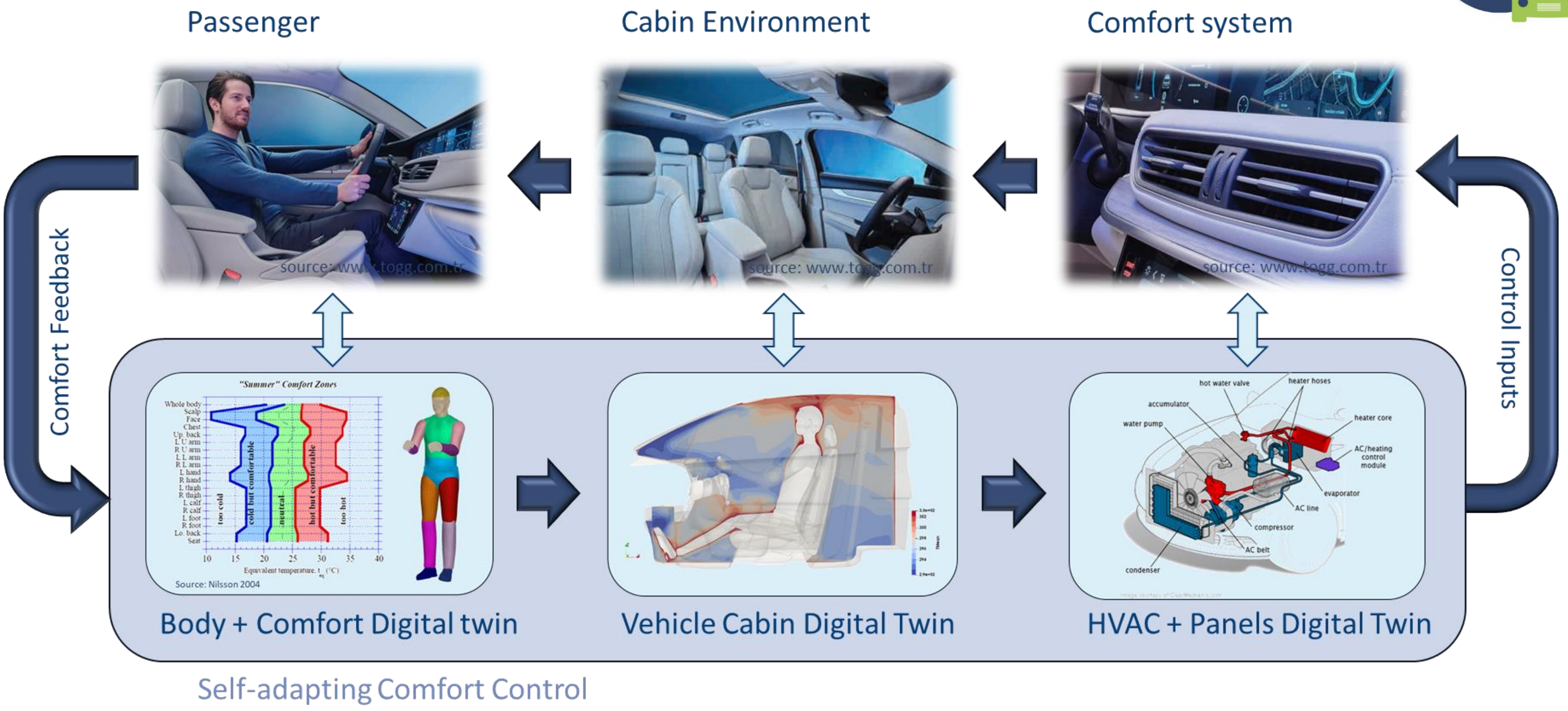


General Approach for Self-adapting Comfort Control



- Minimizes the need for user interaction through model predictive control (MPC)
- Utilizes adaptive digital twins with sensor feedback from the plant
- Comfort digital twin learns from qualitative user feedback via machine learning (ML) methods
- Flexible cost-function based control integrates additional criteria from high-level vehicle control: e.g. safety, derating, comfort modes

Control Strategy



Digital Twin Development

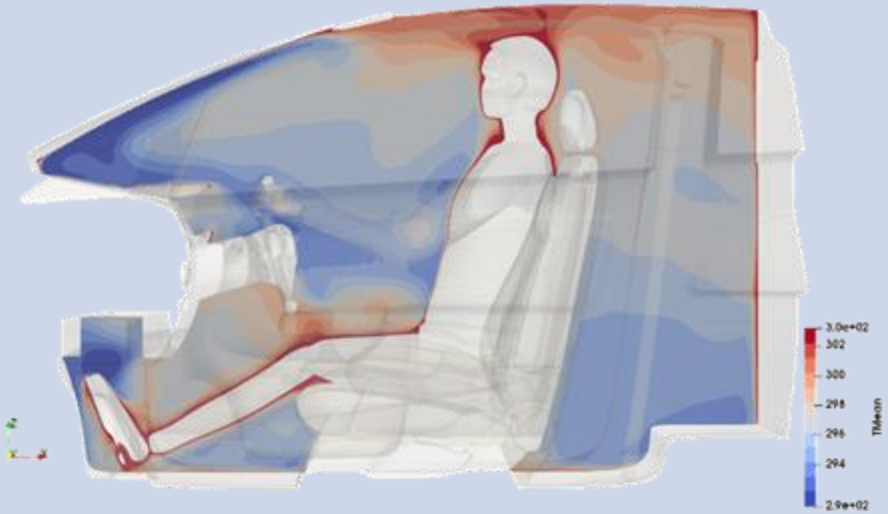
Comfort Model

- Dynamic model of the thermal auto-regulation of the human body and comfort perception
- ML-based model order reduction for MPC application

ANDI comfort dummy (source CTAG)

Cabin Model

- Coupled 1D and CFD model reproducing the dynamic heat distribution in the vehicle cabin
- Model order reduction POD/DMD techniques to reduce the computational efforts massively



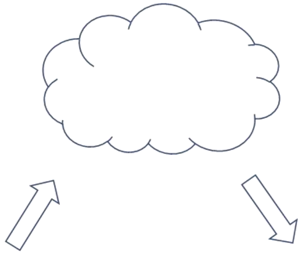
Outlook

Source: Yanfeng Automotive Interiors

Adaptive Digital Twin Modularity

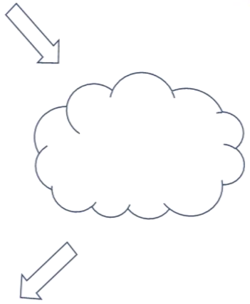
Transferrable User Profiles:

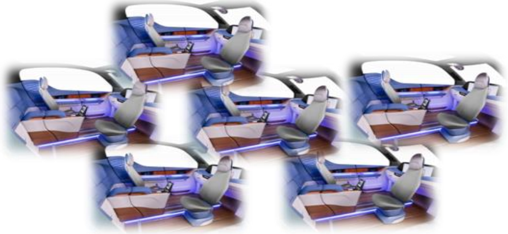
- Continuous learning of individual characteristics and preferences
- Application in vehicles of differing types



Complex Cabin Configurations:

- Continuous learning of thermal cabin characteristics in single vehicles
- Application to many cabins of the same type





Extended Applications

Special boundary conditions: e.g. extreme weather

Other vehicle types: Light Duty Vehicles LDV, Light Commercial Vehicles LCV

Research platforms at VIRTUAL VEHICLE

E-VOLVE
EV FOR LIFE, VALUE, EFFICIENCY

EFFEREST

www.efferest-project.eu

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