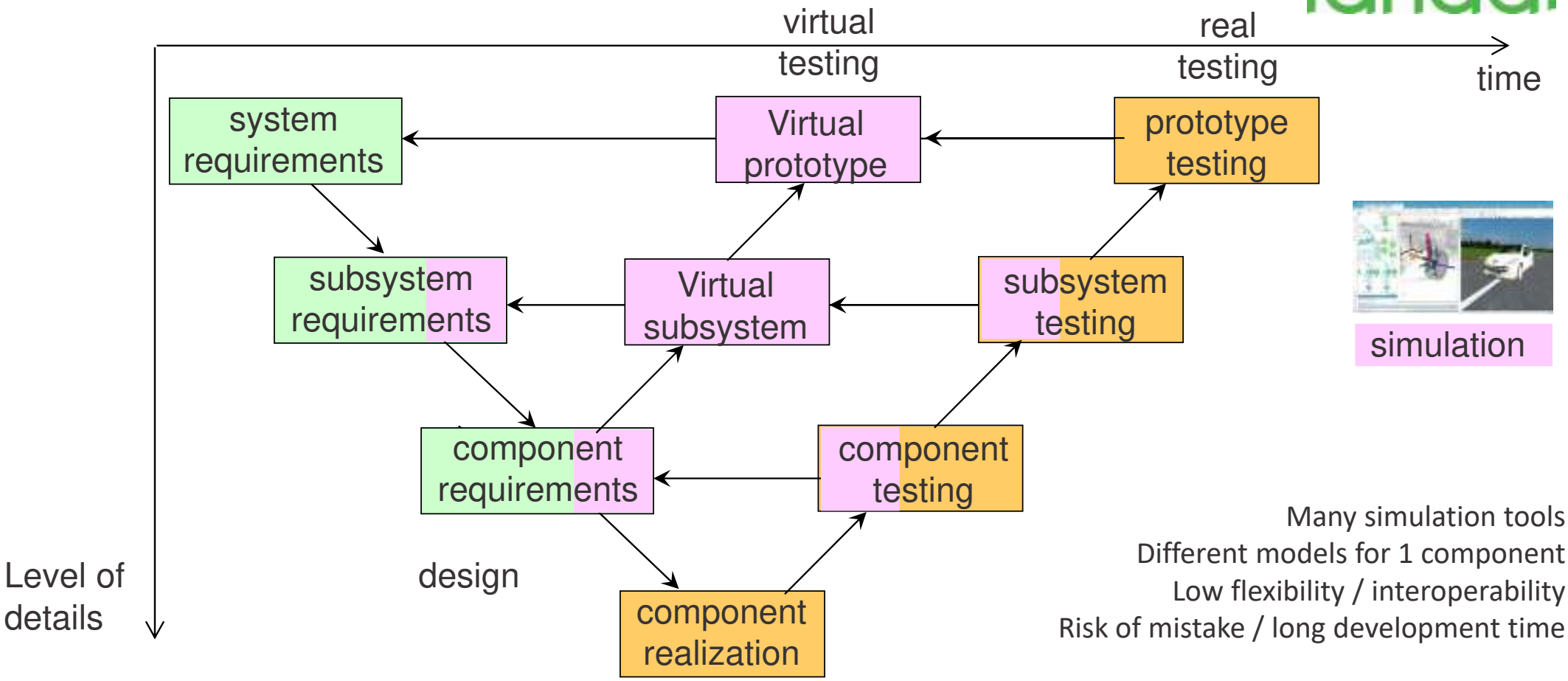
H2020RTR20

www.project-panda.eu

Powerful Advanced N-level Digital Architecture for electrified vehicles and components

Alain BOUSCAYROL
University of Lille
PANDA coordinator

W-model & digitalization

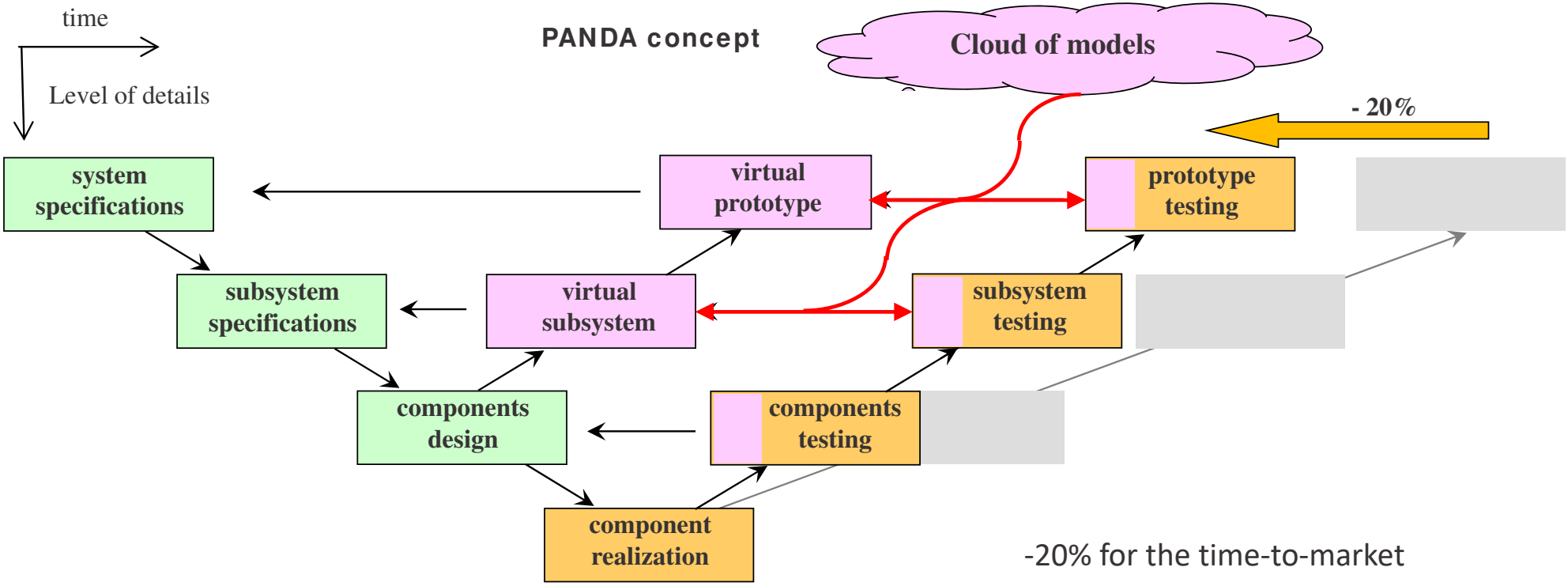


simulation

Many simulation tools
Different models for 1 component
Low flexibility / interoperability
Risk of mistake / long development time

PANDA objective

Disruptive and **open access model organization** in the development process for fast and efficient development of innovative EVs



-20% for the time-to-market

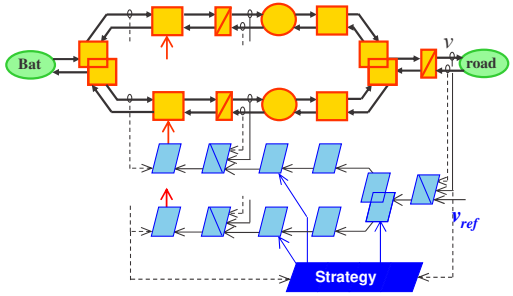
PANDA disruptive simulation method

- **Functional simulation:**

  Most of the simulation tools are based on a structural description
  for an easy interconnection of different components/subsystems
  but conflicts of association to be solved by the solver

  PANDA use a functional & causal description (fixed I/Os) ⟹
  for a faster simulation and more flexibility

Energetic Macroscopic Representation
(graphical formalism for model & control organization)



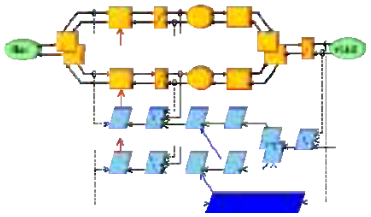
- **Cloud of model:**

  Most of virtual/system simulations are developed on co-simulation
  to interconnect the software of each team
  but co-simulation increase the computation time

  PANDA use cloud of models with a common software
  for seamless interoperability and real-time simulation

PANDA supports

EMR formalism



L2EP Université de Lille

Application to an industrial software

Simcenter Amesim

SIEMENS Ingenuity for life

study cases

Electric Vehicle

Renault ZOE

GROUPE RENAULT

Fuel Cell Vehicle

MobyPost

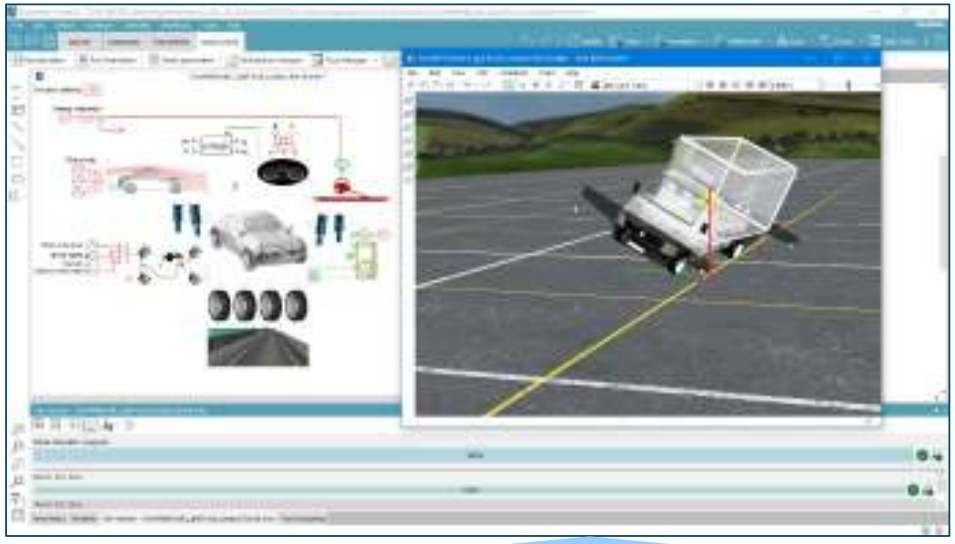
UBFC

Hybrid Vehicle

48V-based P-HEV

Valeo

Simcenter Amesim



Model-based system testing

Pre-design

Systems sizing & integration

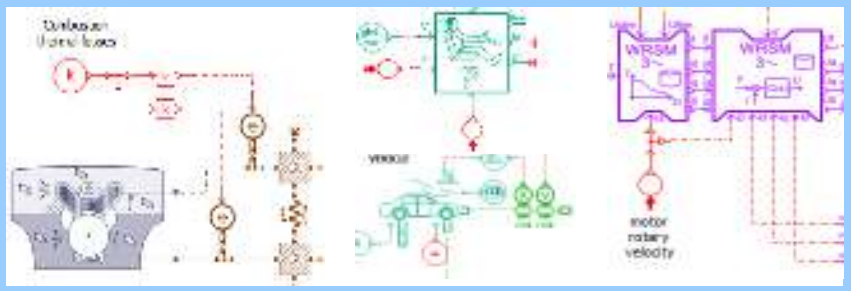
Performance balancing

Controls validation

Advanced industrial Multiphysics simulation package

based on **structural libraries for models** and a functional library for control

new **EMR-based functional library** for models & control



48 libraries (6500 models)

- Hydraulics
- Pneumatics
- Thermal
- Electrical
- Mechanical
- Signals, etc.

Example of simulation of a BEV

Tazzari Zero of Université de Lille

1

$$J\frac{d}{dt}\Omega_{gear} = T_{dcm} - T_{gear} - f\Omega_{gear}$$

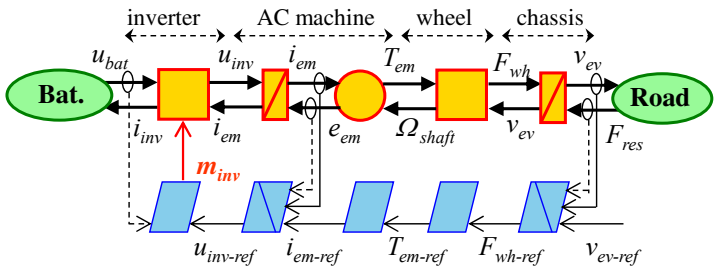
$$L_{arm}\frac{d}{dt}i_{dcm} = u_{chop} - e_{dcm} - R_{arm}i_{dcm}$$

$$\begin{cases} u_{chop} = m_{chop}\,V_{bat} \\ i_{chop} = m_{chop}\,i_{dcm} \end{cases} \quad \begin{cases} T_{dif} = k_{dif}\,T_{gear} \\ \Omega_{dif} = k_{dif}\,\Omega_{wh} \end{cases}$$

$$\begin{cases} T_{dcm} = k_{dcm} i_{dcm} \\ e_{dcm} = k_{dcm}\Omega_{gear} \end{cases} \begin{cases} T_{gear} = k_{gear}\,T_{dcm} \\ \Omega_{gear} = k_{gear}\,\Omega_{diff} \end{cases}$$

modelling equations

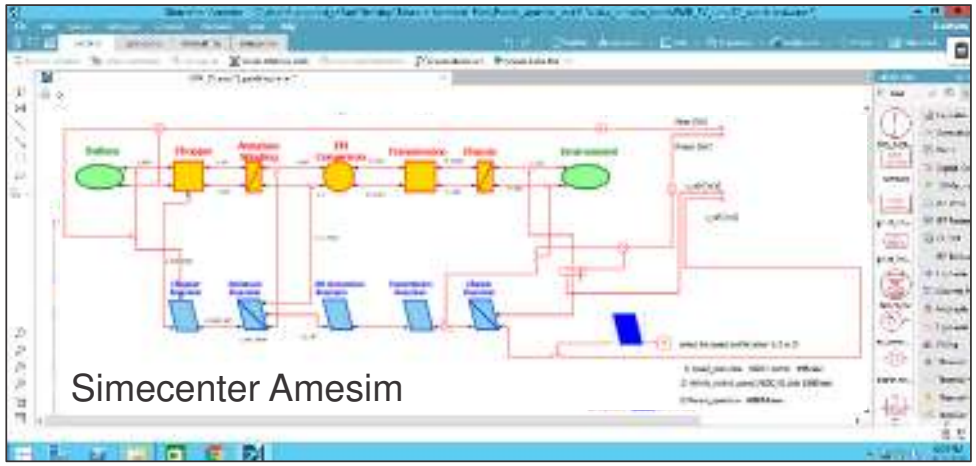
2



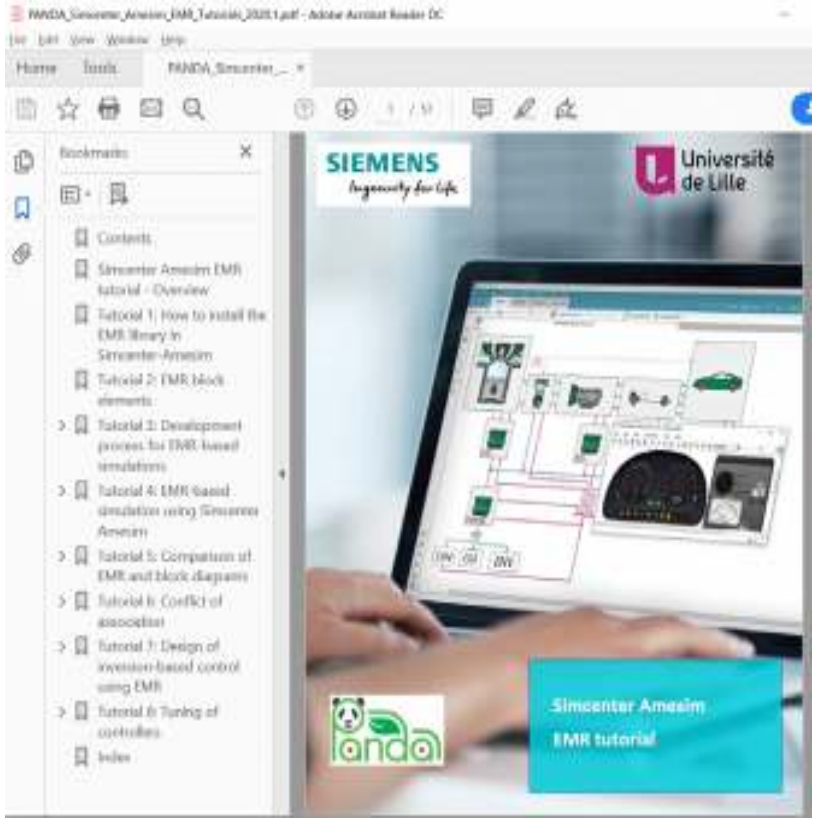
model & control organization using EMR

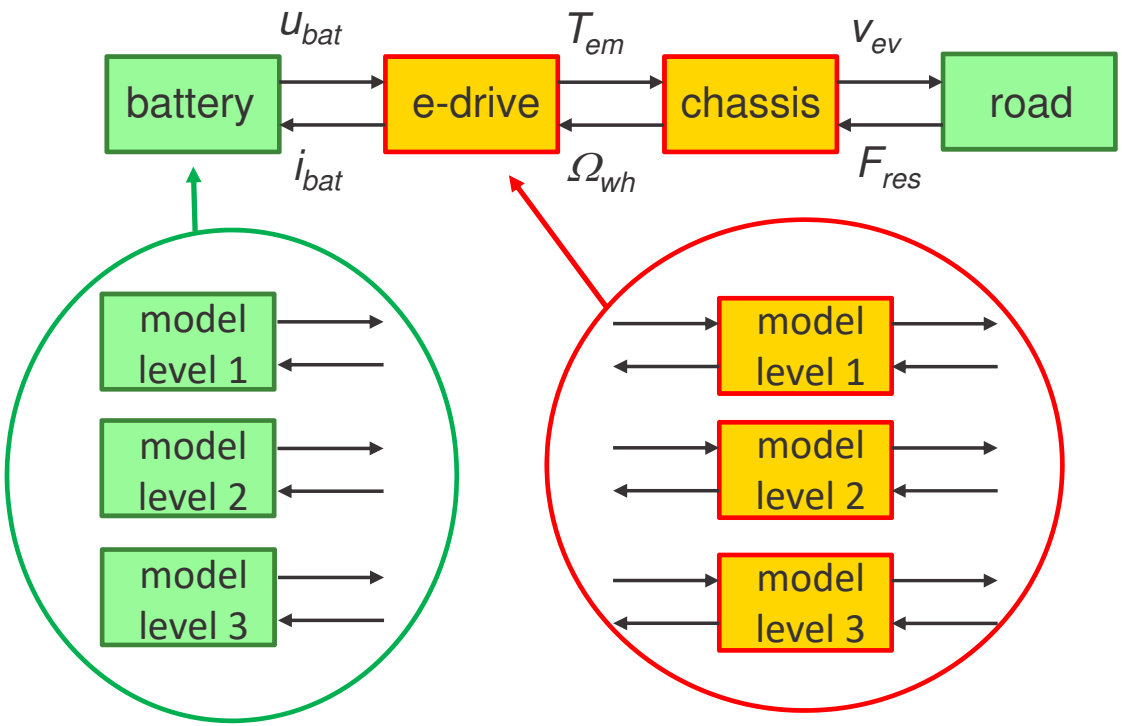
3

New EMR library In Simcenter Amesim



Multi-level modelling simulation



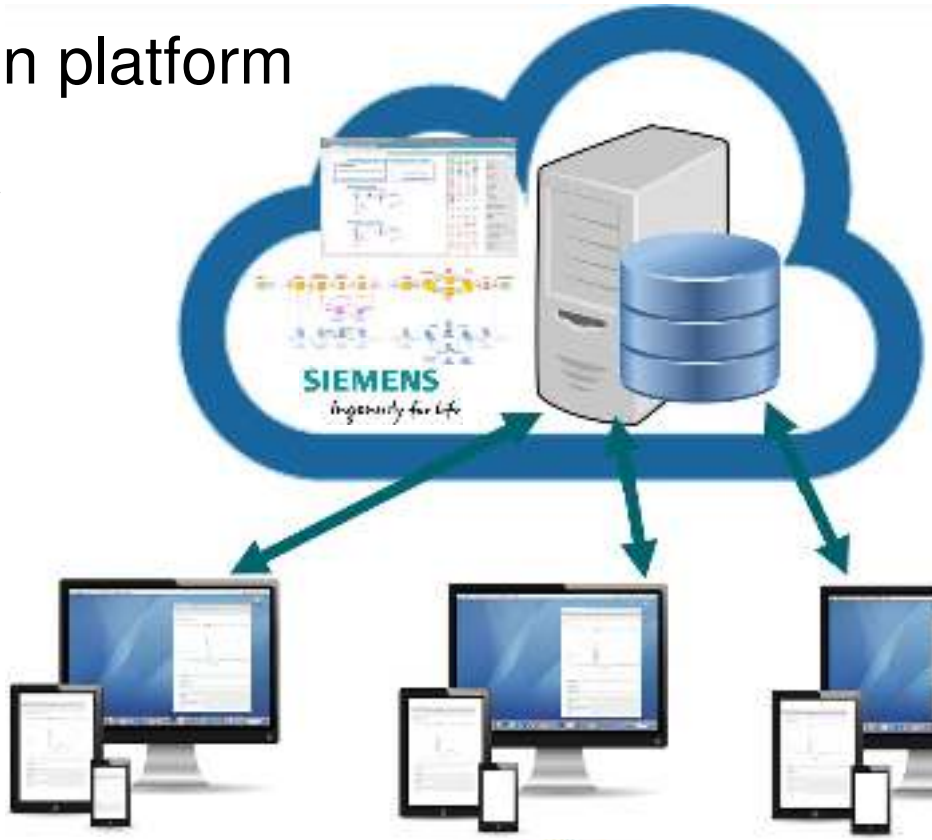


- Different models can be **interchanged by "plug & play"**

Cloud simulation platform

- with cloud EMR library and computing facility

- **fast sharing models and knowledge between partners**, for seamless integration of a complete vehicle model



- Development of models
- EMR organisation of models

GROUPE RENAULT | Université de Lille

Simulation of BEV

UBFC

Simulation of FCV

Valeo | Université de Lille

Simulation of P-HEV

SIEMENS ingenuity for life | VUB VRIJE UNIVERSITEIT BRUSSEL | UNIVERSITATEA TEHNICĂ | BLUWAYS | Valeo | Université de Lille | UBFC | TÜV SÜD | RENAULT

Stand alone or cloud simulation

possibility of black-box models for IP

Upload Simulation results

upload simulation files

download component model

stand-alone simulation on local computer

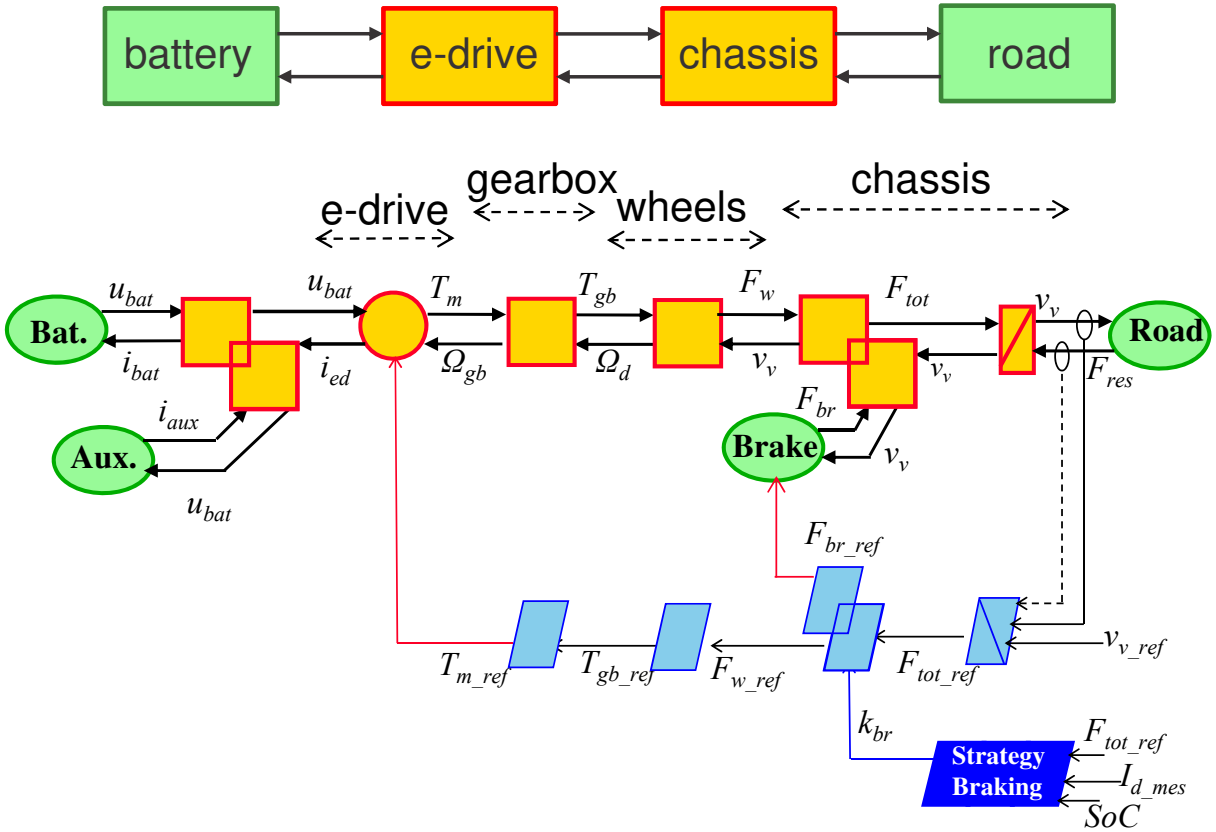
Cloud-computing simulation in the cloud

The EMR of the studied BEV

GROUPE RENAULT Renault ZOE

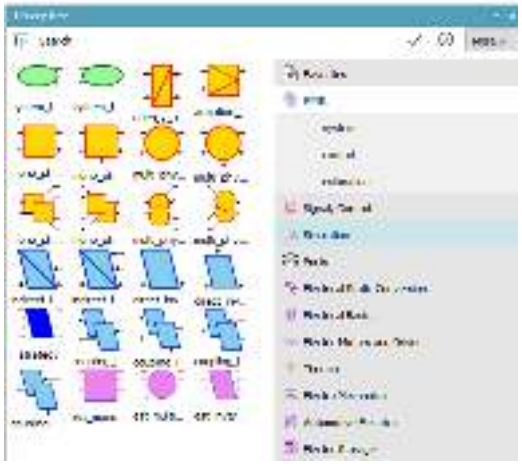
Li-Ion
41 kWh / 400 V
290 kg

Synchronous Machine
65 kW

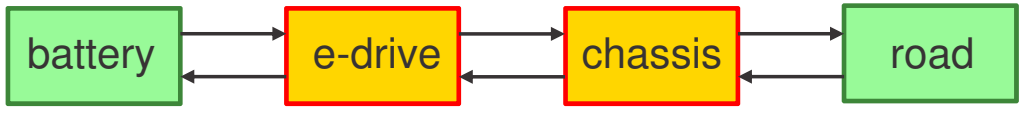


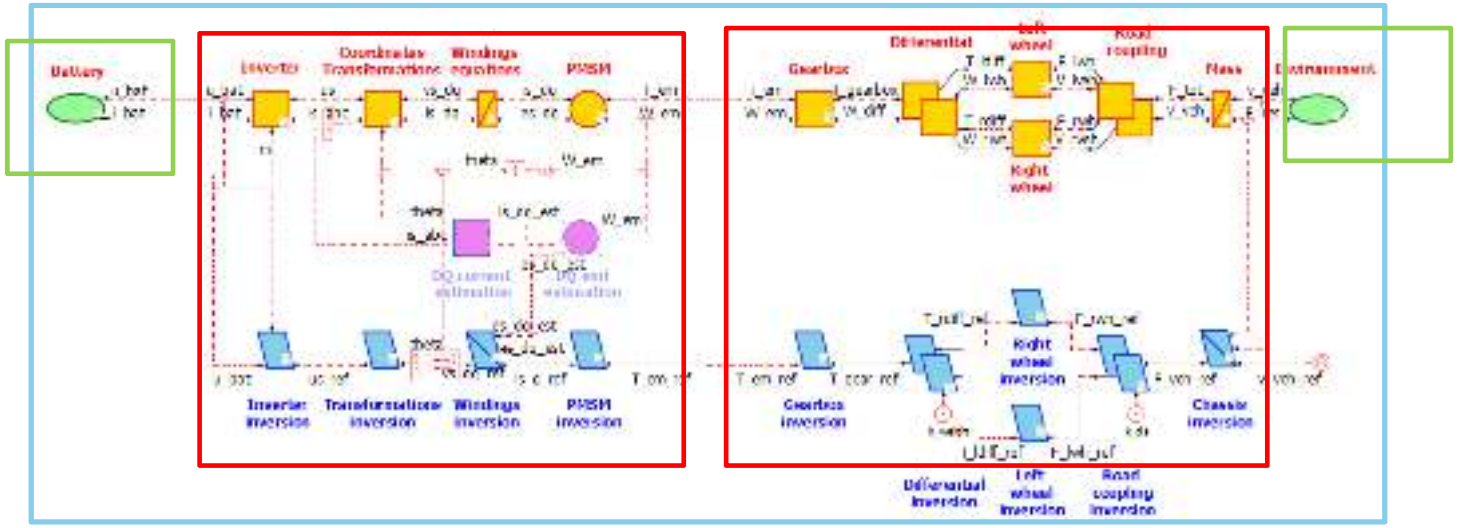
source
power
control

The simulation model



From the EMR library

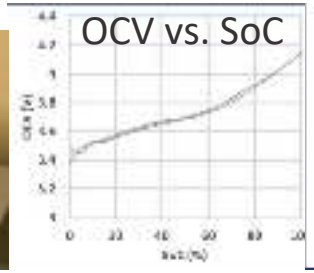


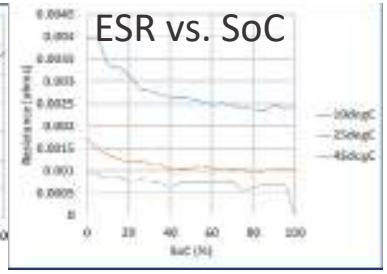


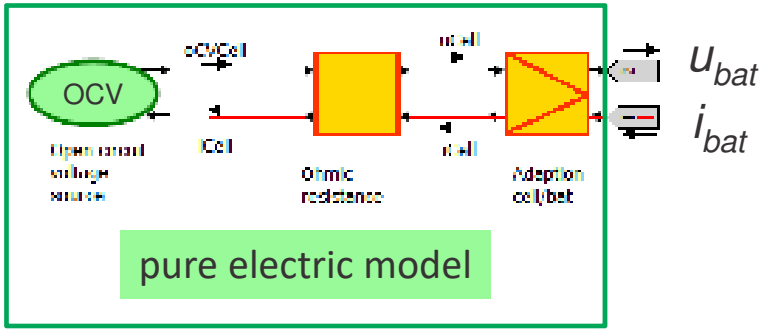
Example of a simulation model in Simecenter Amesim

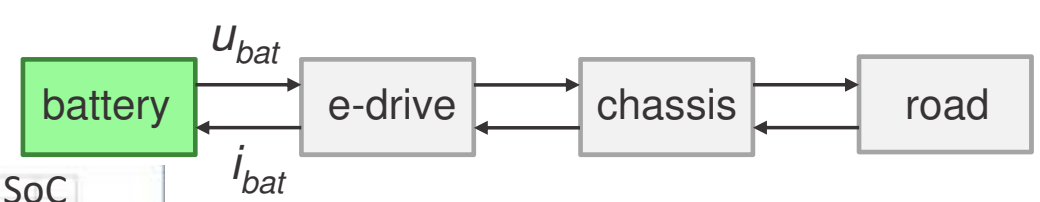
Different level of battery models

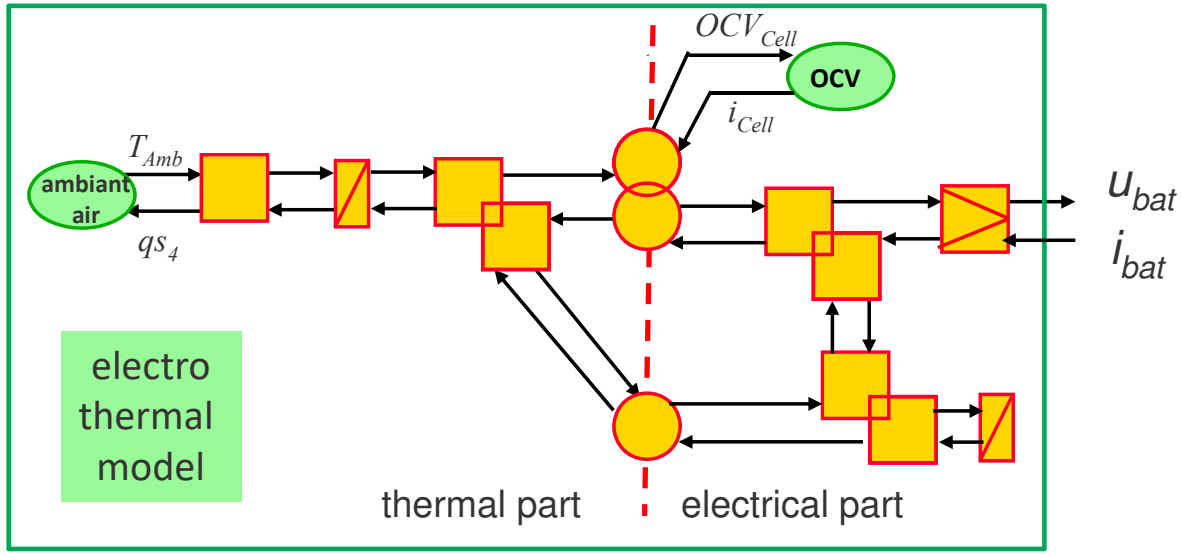
Model identifications





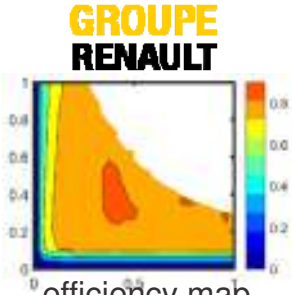


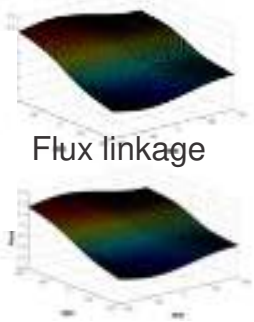


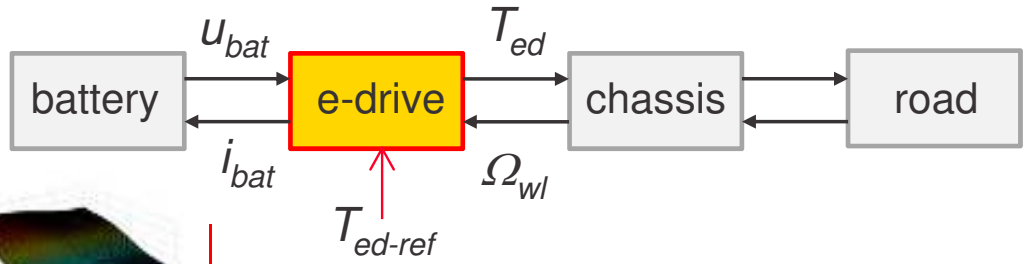


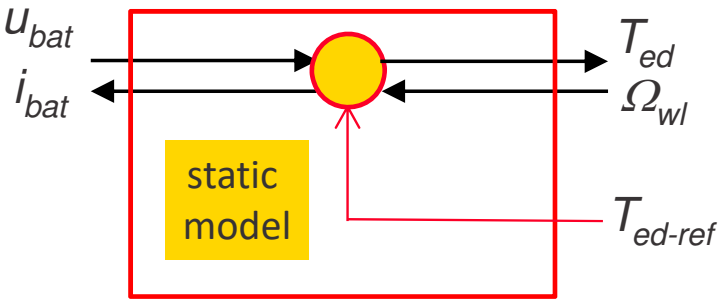
Different level of e-drive models

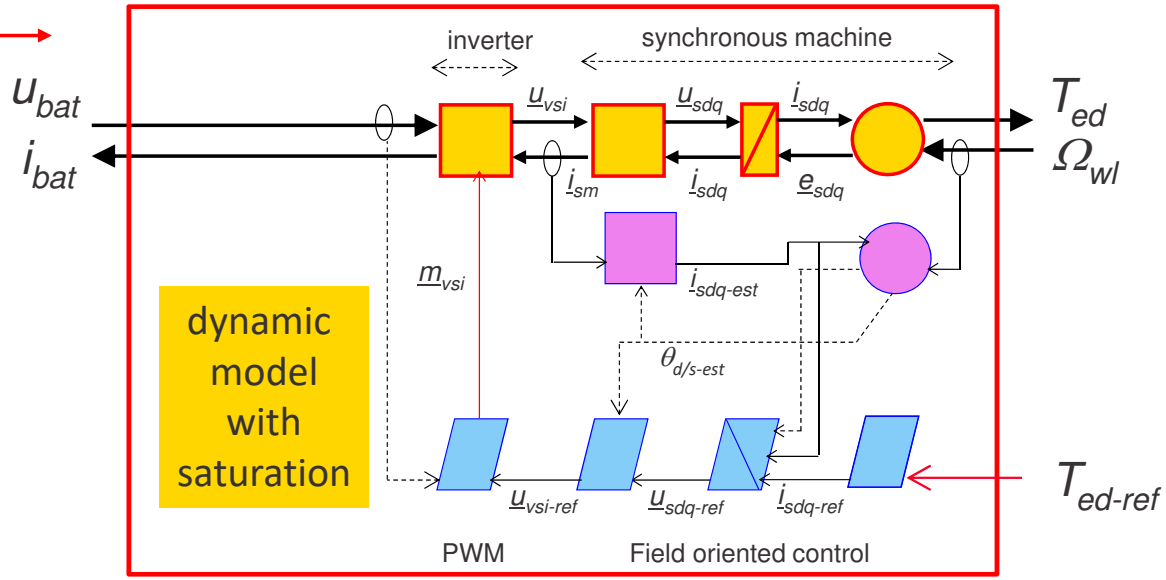
Parameter identifications











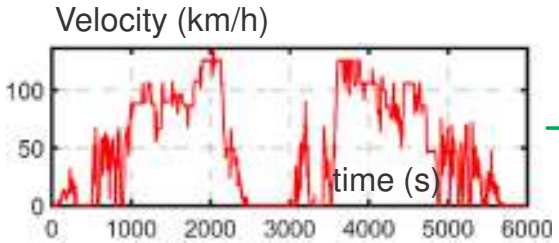
Model validation

measurements

different real driving cycles
from RTR track

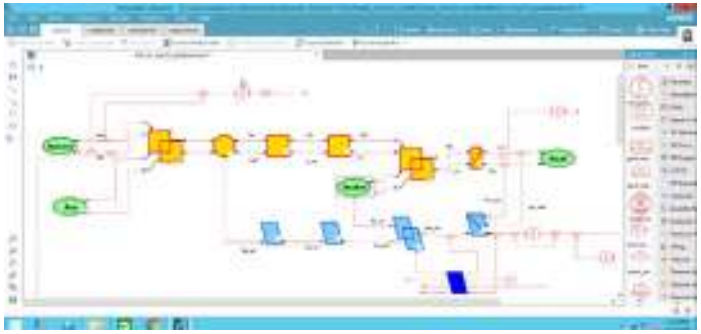
measurements

GROUPE RENAULT

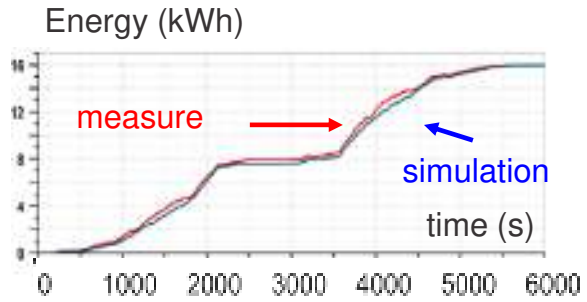


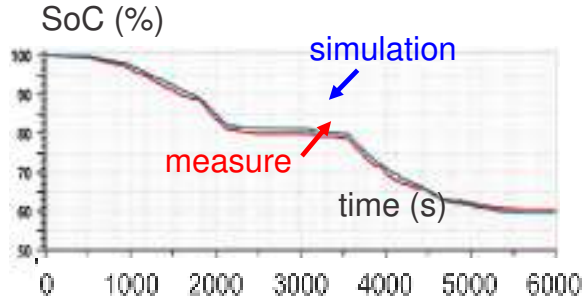
Extra-urban real driving cycle

input



results





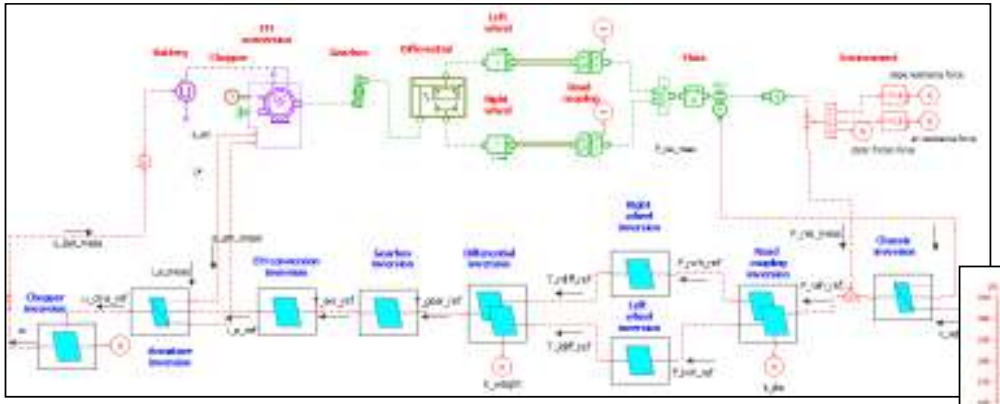
Error on energy < 2%
for different driving cycle

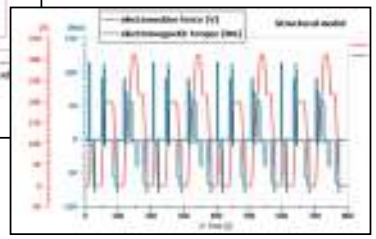
PANDA - GA 824256

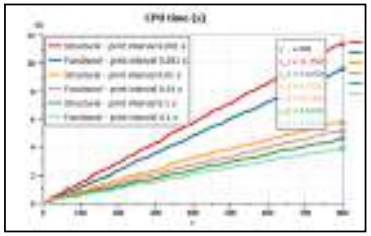
Comparison structural vs. functional

Simulation of Renault ZOE

Classical structural library (Simcenter Amesim)

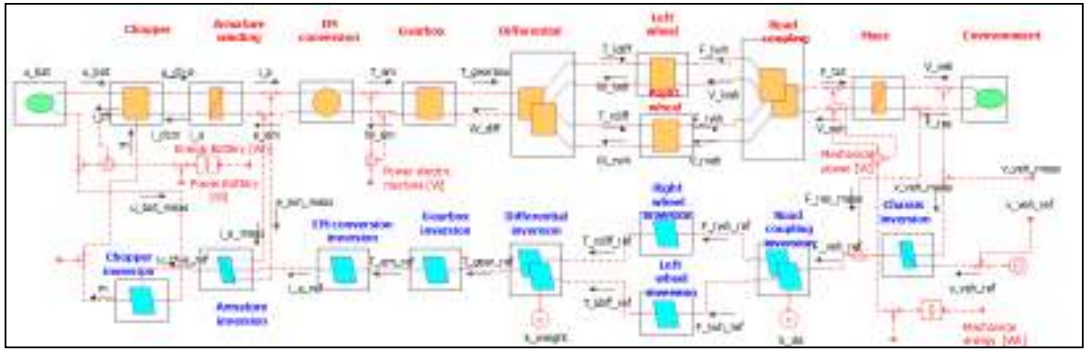






First Results

New EMR-based (functional) library in Simecenter Amesim

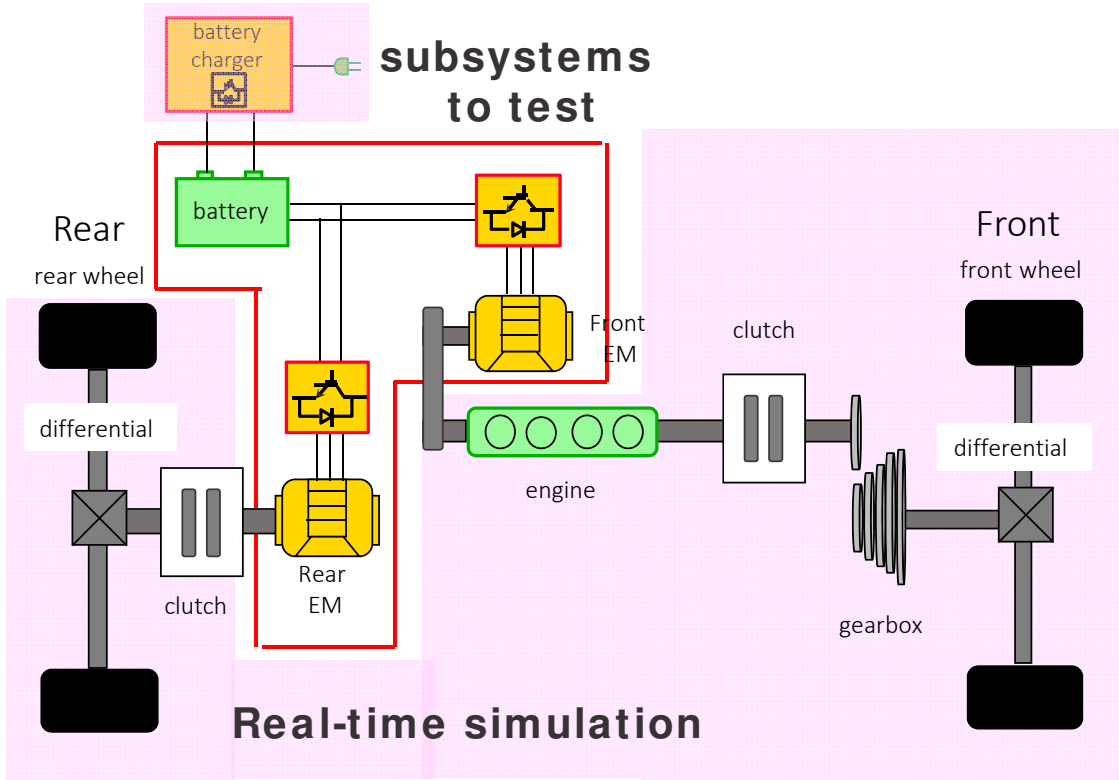


- same model / control
- same accuracy
- -15% of computation time with the functional library

[Husar VPPC'19]

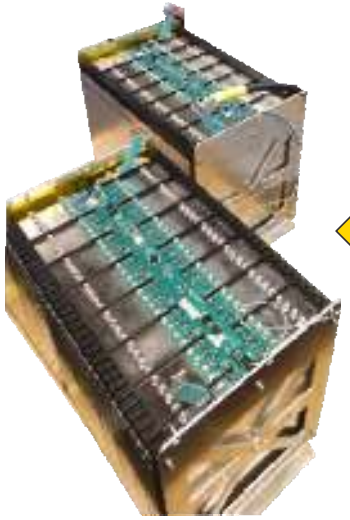
Next step: P-HEV virtual & real testing

hybridized Peugeot 308 with a 48 V battery and 2 electrical drives for P-HEV



Next step: HIL testing of battery

Real battery under test

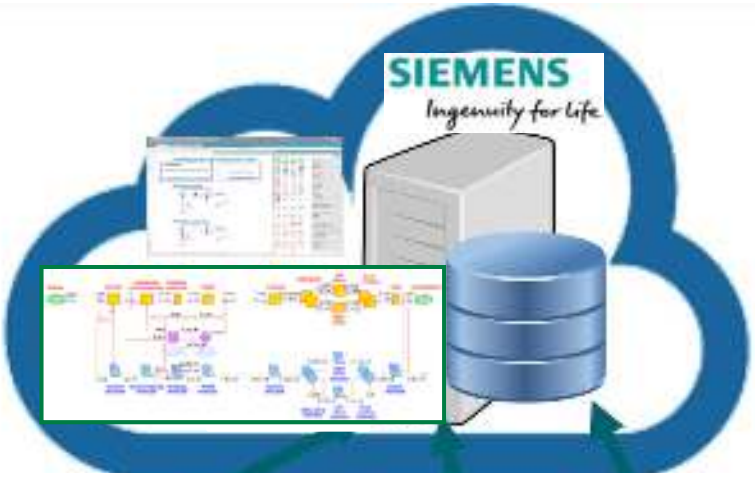


BLUWAYS

power

Power interface & real-time simulator

Typhoon HIL



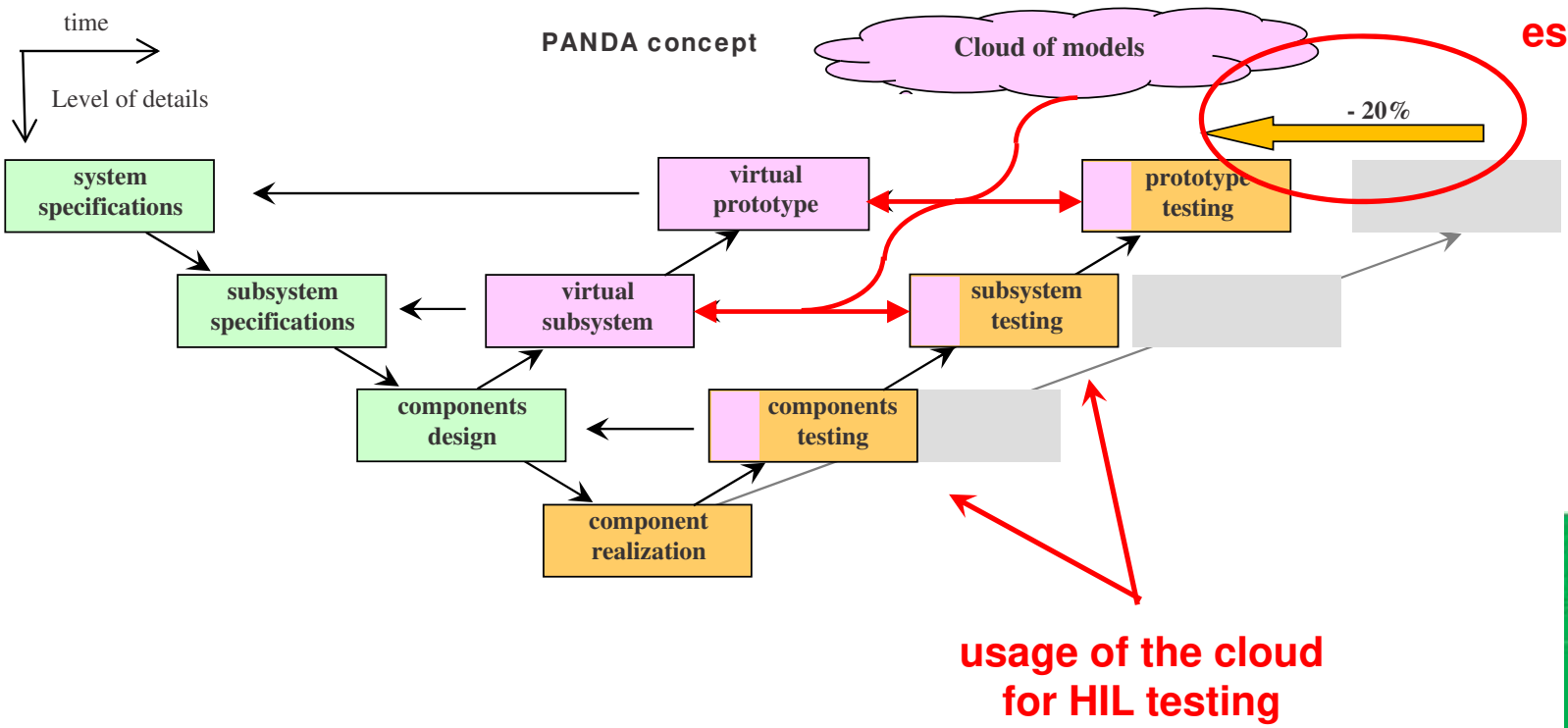
stand-alone HIL

(upload files)

cloud-based HIL

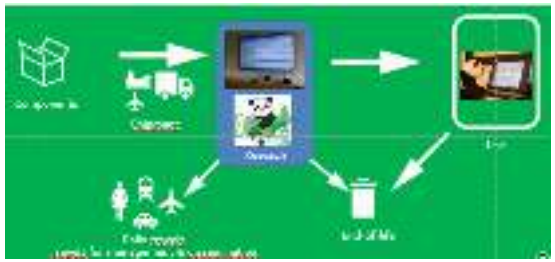
(real-time exchange)

PANDA perspectives



estimation of the reduction time-to-market

estimation of CO2equ of PANDA and mitigation



Our PANDA
Thanks you for your attention !

H2020 PANDA project

https://project-panda.eu/

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References

[Bouscayrol 2012] A. Bouscayrol, J. P. Hautier, B. Lemaire-Semail, "Graphic Formalisms for the Control of Multi-Physical Energetic Systems", Systemic Design Methodologies for Electrical Energy, tome 1, Analysis, Synthesis and Management, Chapter 3, ISTE Willey editions, October 2012

[Desrevaux 2020] A. Desreveaux, A. Bouscayrol, E. Castex, R. Triguie, E. Hittinger, G..M. Sirbu, “Annual variation in energy consumption of an electric vehicle used for commuting ", Energies, vol 12, n°18, September 2020, pp 1-15, (ULille, Rochester Inst. Tech. (USA), Renault Technology Romania, within the PANDA H2020 project GA # 824256)

[Husar 2019] C. Husar, M. Grovu, C. Irimia, A. Desreveaux, A. Bouscayrol, M. Ponchant, P. Magnin, “Comparison of Energetic Macroscopic Representation and structural representation on EV simulation under Simcenter Amesim”, IEEE-VPPC’19, Hanoi (Vietnam), October 2019 (Siemens Software & ULille within the H2020 PANDA project, GA # 824256)

[PANDA 2020] A. Bouscayrol, A. Lepoutre, C. Irimia, C. Husar, J. Jaguemont, A. Lièvre, C. Martis, D. Zuber, V. Blandow, F. Gao, W. Van Dorp, G. Sirbu, J. Lecoutere, “Power Advanced N-level Digital Architecture for models of electrified vehicles and their components”, Transport Research Arena 2020, Helsinki (Finland), April 2020 (within the PANDA H2020 European Project, GA # 824256).