



NI-Days, September 27th, 2011



Students Develop a Battery Electric Vehicle using NI CompactRIO

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K.U.Leuven - Mechanical Engineering

1. Introduction
2. KUL-EV2
 - Requirements
 - Concept & Implementation
3. NI CompactRIO
4. Conclusion



1. Introduction

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1. Introduction

Electrification project

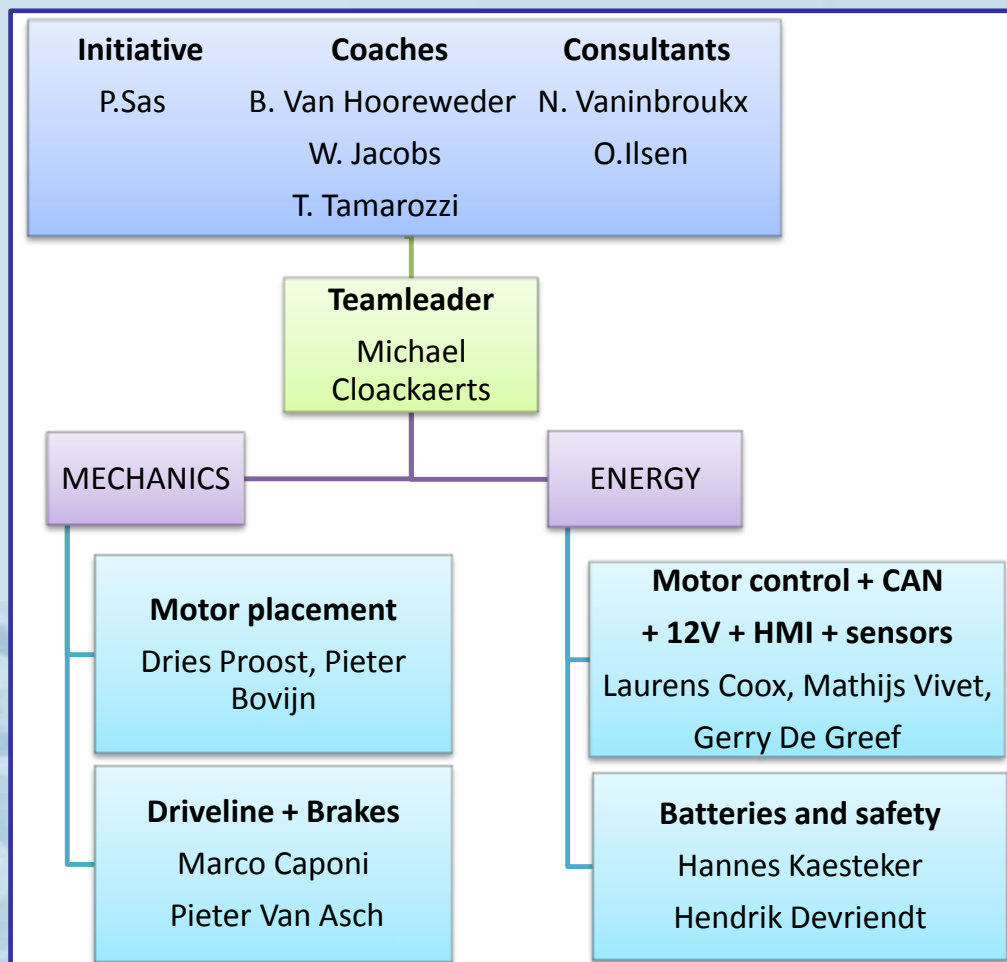
Objective:

Conversion of conventional vehicle to battery electric vehicle

- Integrated lab sessions K.U.Leuven dept. Mech. Engineering (PMA)
 - 10 engineering students, first master year
 - Limited budget
 - 20 working days
 - Car, motor, controller, NI Labview and CompactRio available
-
- Work in team
 - Exploit engineering knowledge
 - Explore new domains (batteries, e-motor, control,...)

1. Introduction

Teamstructure & sponsors



1. Introduction

Team



1. Introduction

2. KUL-EV2

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2. KUL-EV2

Requirements



Original car

- Daewoo Matiz 1991
- Total mass = 950kg
- Internal combustion engine
- Top speed = 140km/h



Electric car

- Maximum total mass = 1000kg
- Range = 60km
- Top speed = 120km/h
- Motor = SR-type, 300VDC, 30kW
- Regenerative braking
- On-board charging (<4u)

2. KUL-EV2

Concept - Mechanics

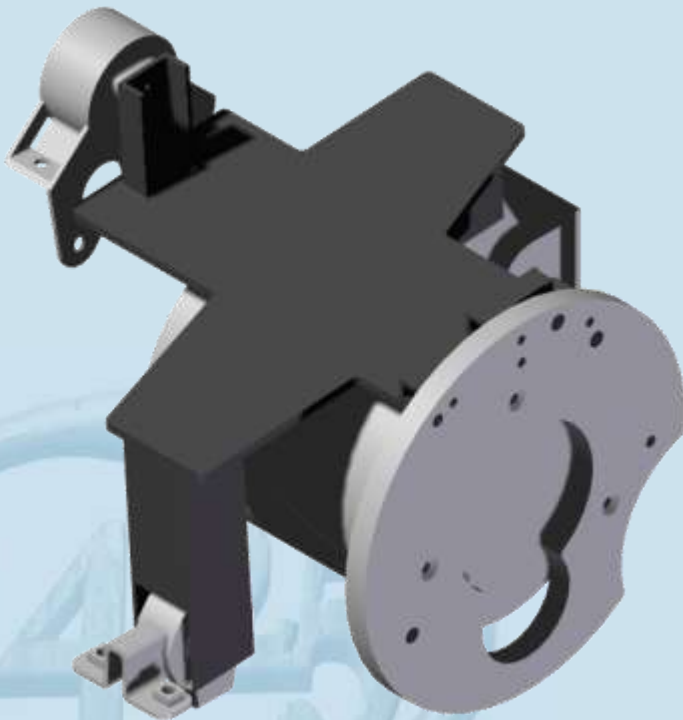
- SR-motor on original gearbox
 - Design of adaptorplate, frame and flexible coupling
 - SR-motor, 10000rpm & 200Nm



2. KUL-EV2

Concept - Mechanics

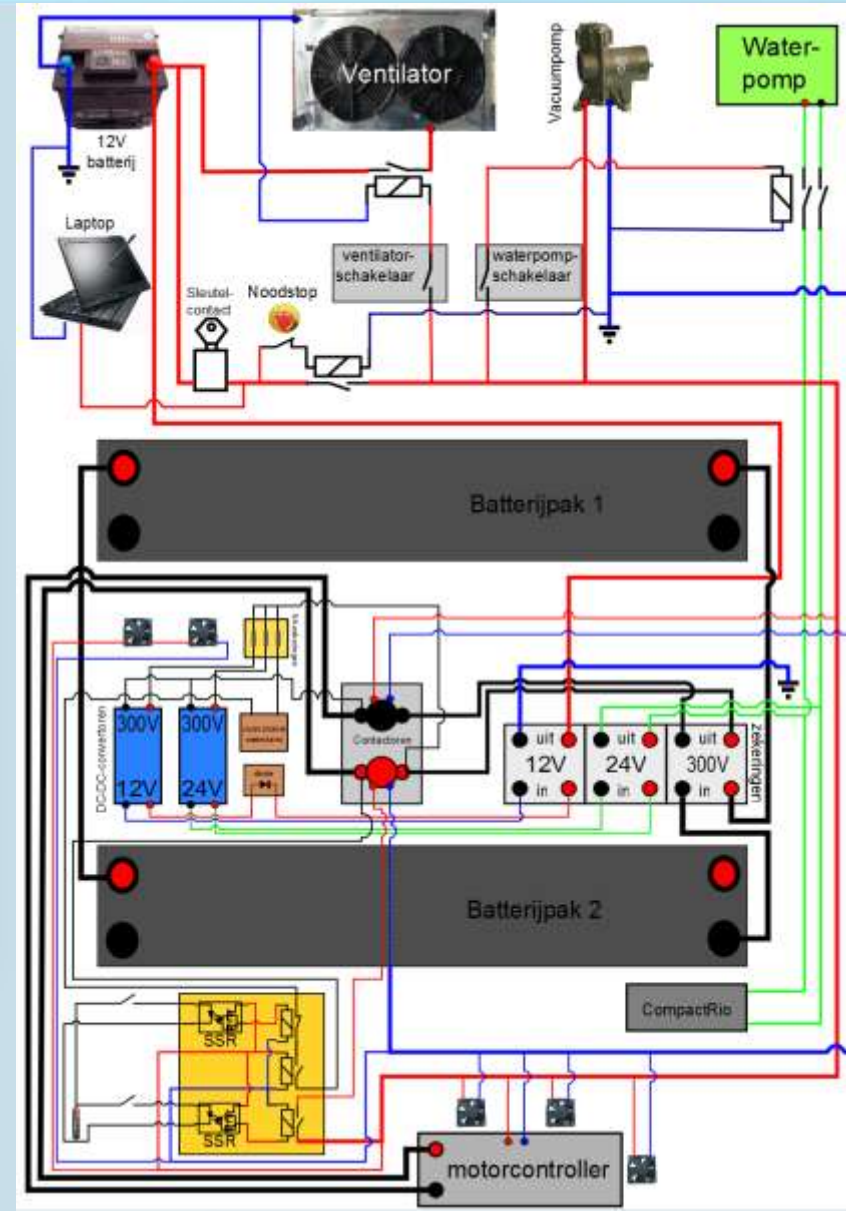
- SR-motor on original gearbox



2. KUL-EV2

Concept - Energy

➤ Electrical scheme



2. KUL-EV2

Result



1. Introduction

2. KUL-EV2

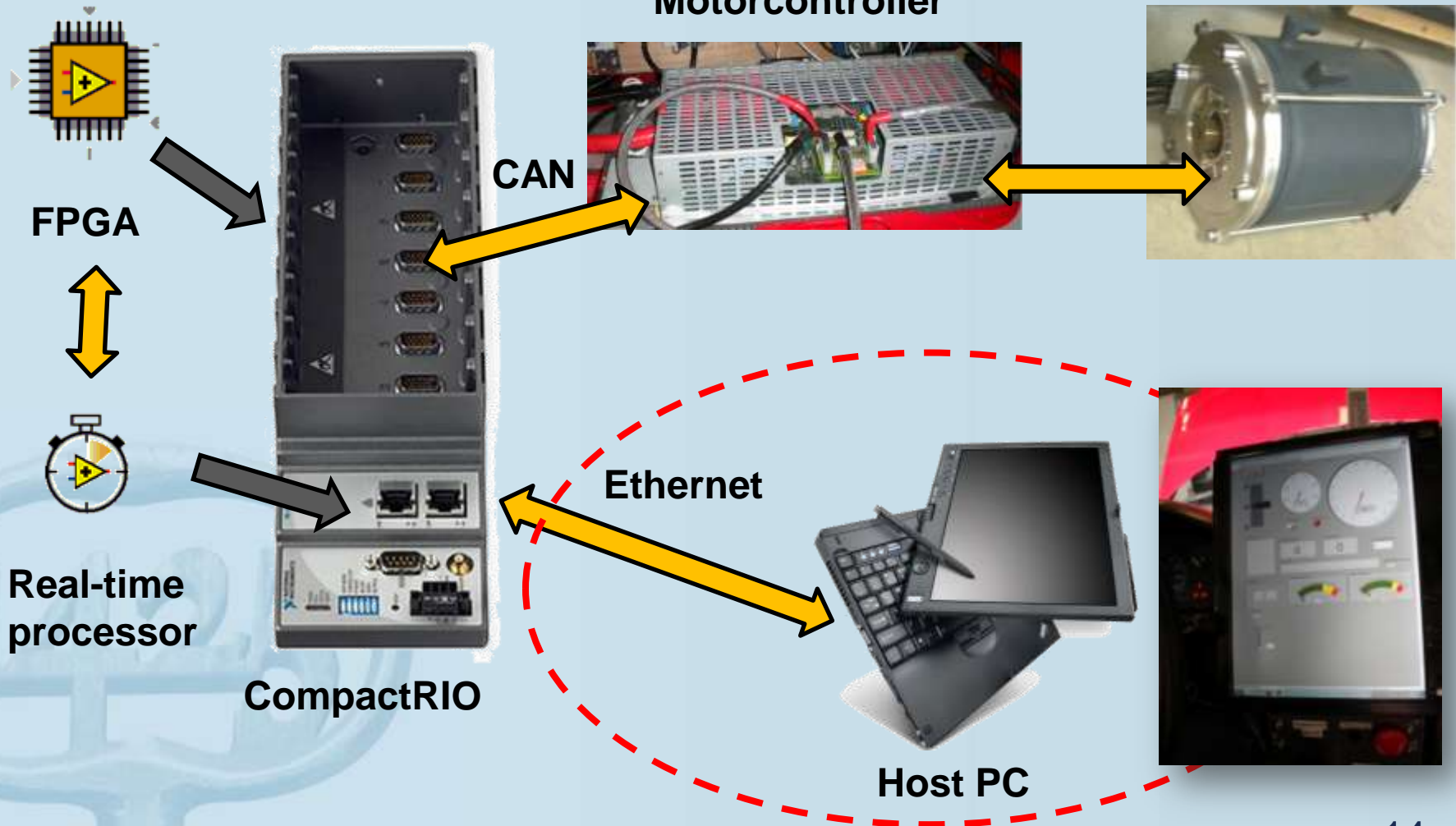
- Requirements
- Concept & Implementation

3. NI CompactRIO

4. Conclusion

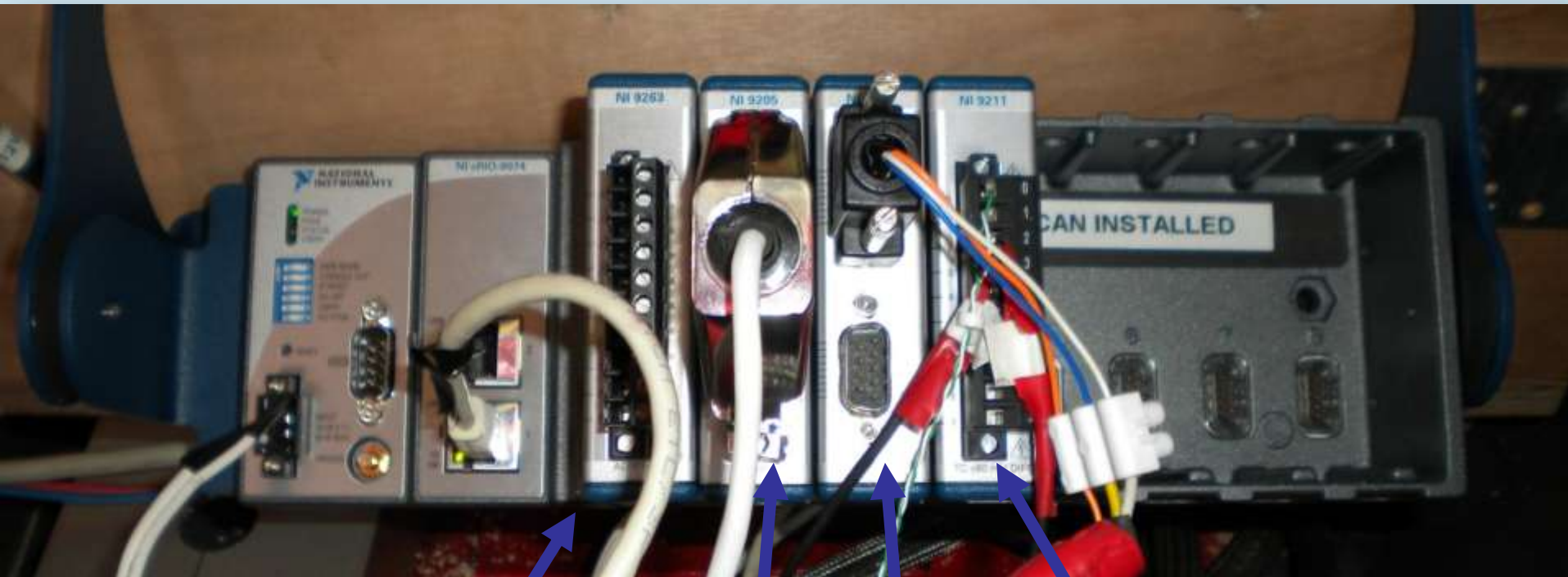
3. NI CompactRIO

Strategy



3. NI CompactRIO

Modules



Analogue
Output
NI 9263

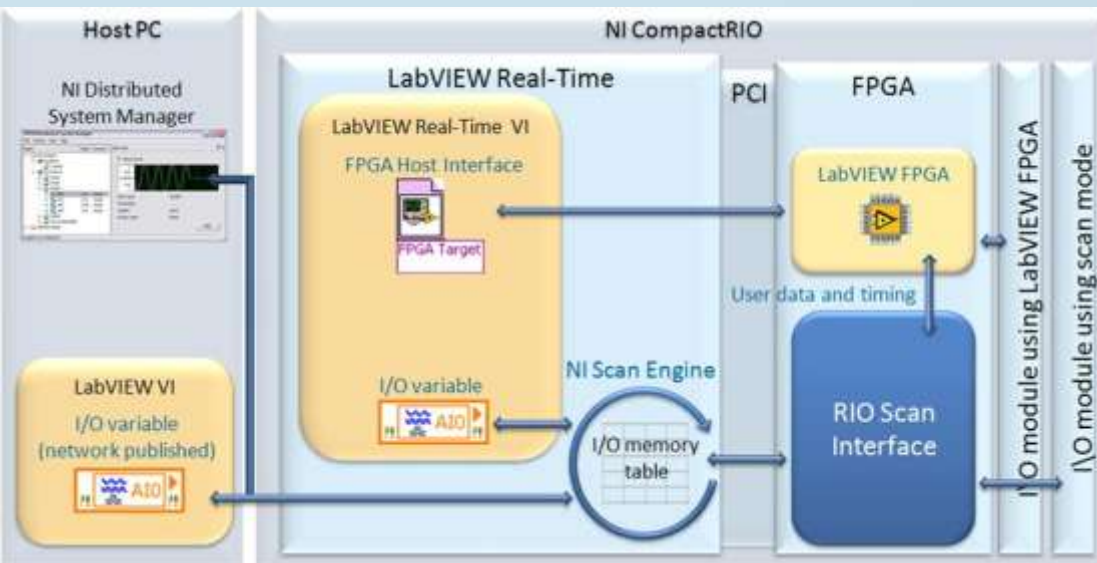
Analogue
Input
NI 9205

CAN
NI 9853

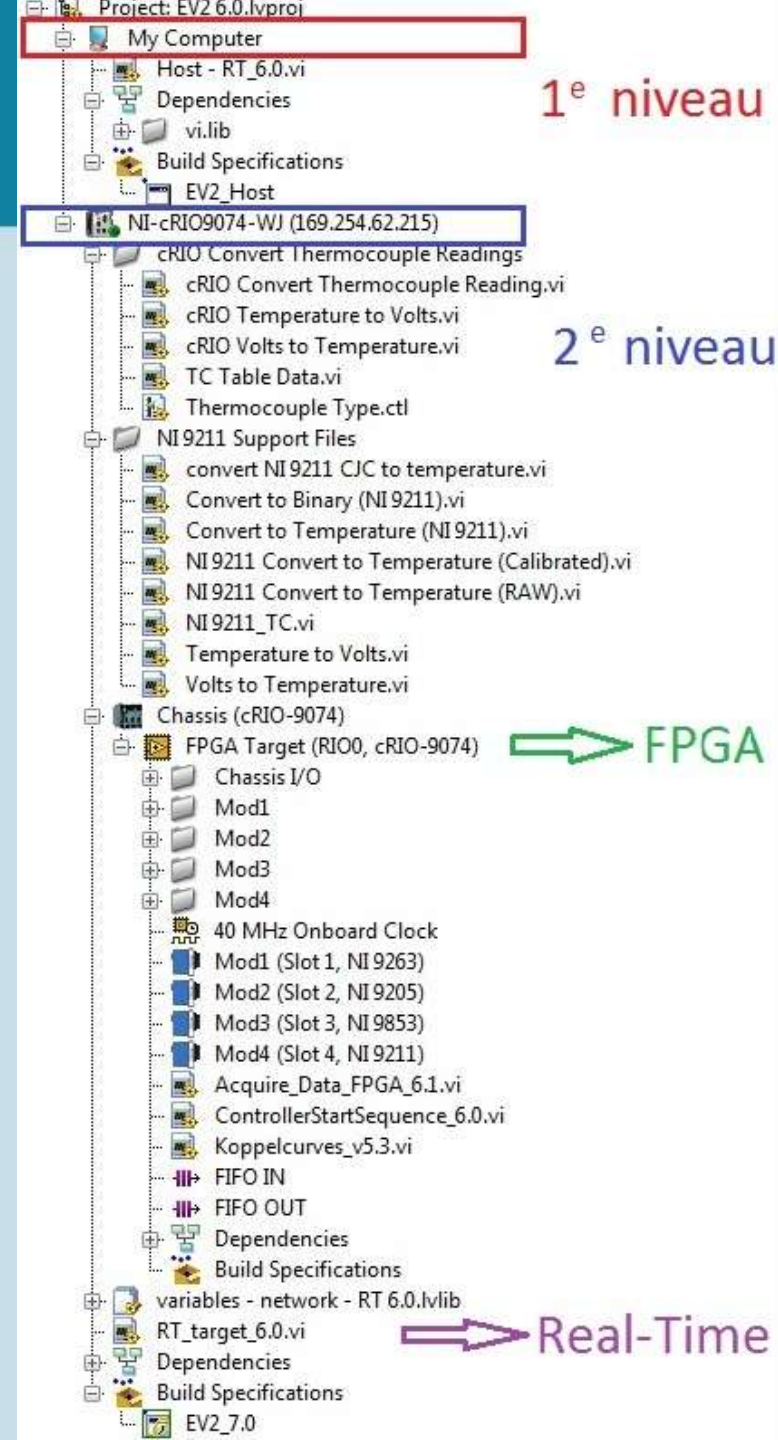
Thermecouple
NI 9211

3. NI CompactRIO

NI Project



CAN-module not compatible
with SCAN-interface



3. NI CompactRIO

FPGA

➤ Collect measured signals

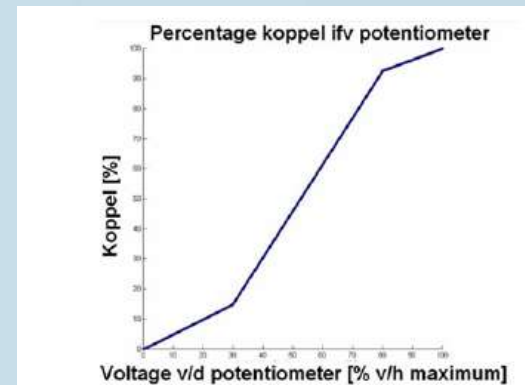
Temperatures, speed, potentiometers
Throttle, regenerative braking



➤ Calculate required torque

Based on signals and torque curves
Safety for speed and temperature

➤ Send torque request to real-time program



3. NI CompactRIO

Real time

➤ 3 loops

- CAN read from motorcontroller and CAN-to-variable conversion
- CAN write to motorcontroller (highest priority, 10ms)
- Communication with host VI (lowest priority, 100ms)



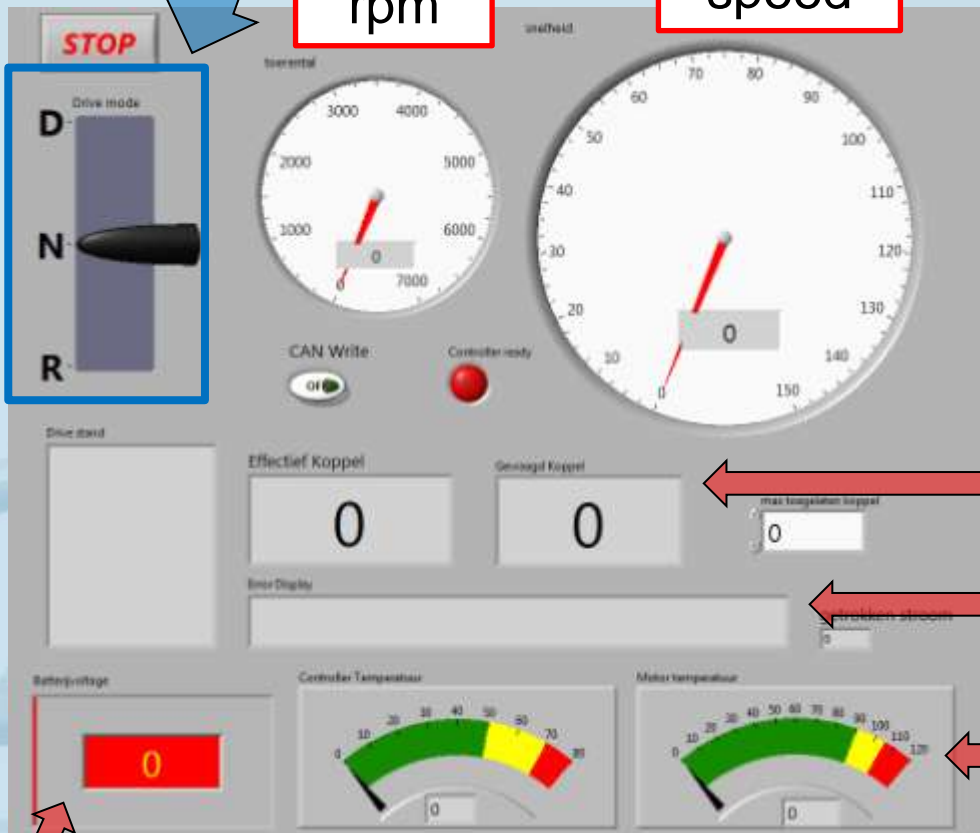
3. NI CompactRIO

Host VI

Drive mode

rpm

speed



Torque

Errors

Temperature

Battery voltage



3. NI CompactRIO

Secondary functions

- System to pre-charge capacitors in motorcontroller
- Safety [contactor switch off, temperatures, warnings]
- Battery monitoring system
- Range extender



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3. Conclusion

- Result = Battery electric vehicle with good HMI
 - SR-motor controlled via CAN and NI Labview / CompactRIO
 - High educational value
 - Working in a team (communication, planning, meetings)
 - Exploring new domains
 - Realistic problem solving
 - Contact and negotiation with sponsors
 - Future work
 - Li-ion batteries + battery management system
 - Range extender + control
 - Power measurements
- } NI Labview
} NI CompactRIO





KATHOLIEKE UNIVERSITEIT
LEUVEN

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Thank you for your attention



www.mech.kuleuven.be/elektrificatie