E-VECTOORC

(Electric Vehicle Control of individual wheel Torque for On- and Off-Road Conditions)

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Green Cars Clustering Event

European Green Cars Initiative

Presentation Outline

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1. Project Objectives

To address **the individual control of the electric motor torques of fully electric vehicles** to enhance safety, comfort and fun-to-drive in both on- and off-road driving conditions. The key objectives of the project are:

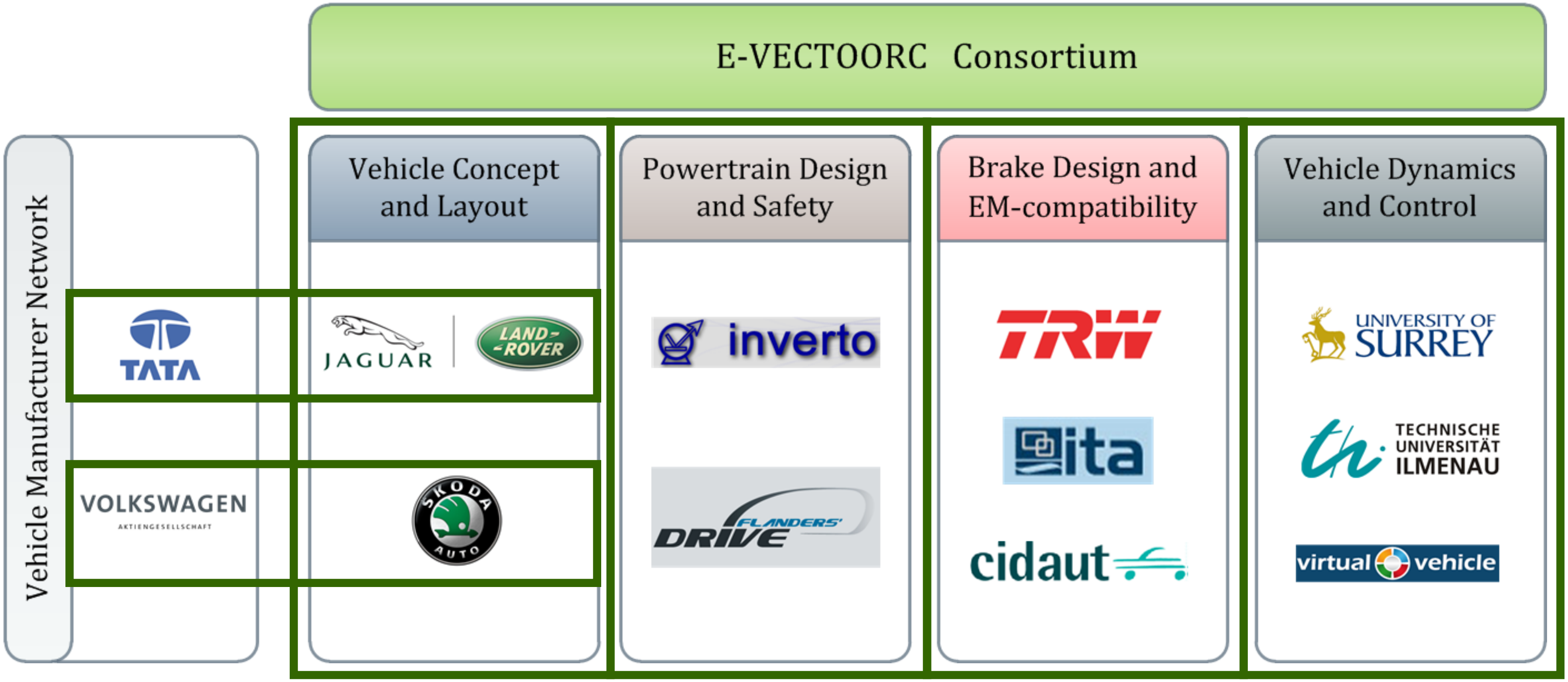
•Development and demonstration of yaw rate and sideslip angle control algorithms based on the combination of **front / rear and left / right torque vectoring** to improve the overall vehicle dynamic performance.

•Development and demonstration of novel strategies for the modulation of the torque output of the individual electric motors to enhance **brake energy recuperation, Anti-lock Brake function and Traction Control function.** The benefits of these strategies include reductions in:

i) vehicle energy consumption;
ii) stopping distance;
iii) acceleration times.

2. Project Partners

11 highly committed partners, with complementary skills and expertise:



- 4 large industrial companies (Jaguar Cars Limited, Land Rover, SKODA Auto and TRW), 2 SMEs (Inverto and ViF), 3 research centres (CIDAUT, ITA and Flanders' Drive), 2 universities (TUIL and Surrey)
- 6 involved countries (Austria, Belgium, Czech Republic, Germany, Spain, United Kingdom)

3. Project Data

Starting Date: 1st June 2011

Project Conclusion: 31st May 2014

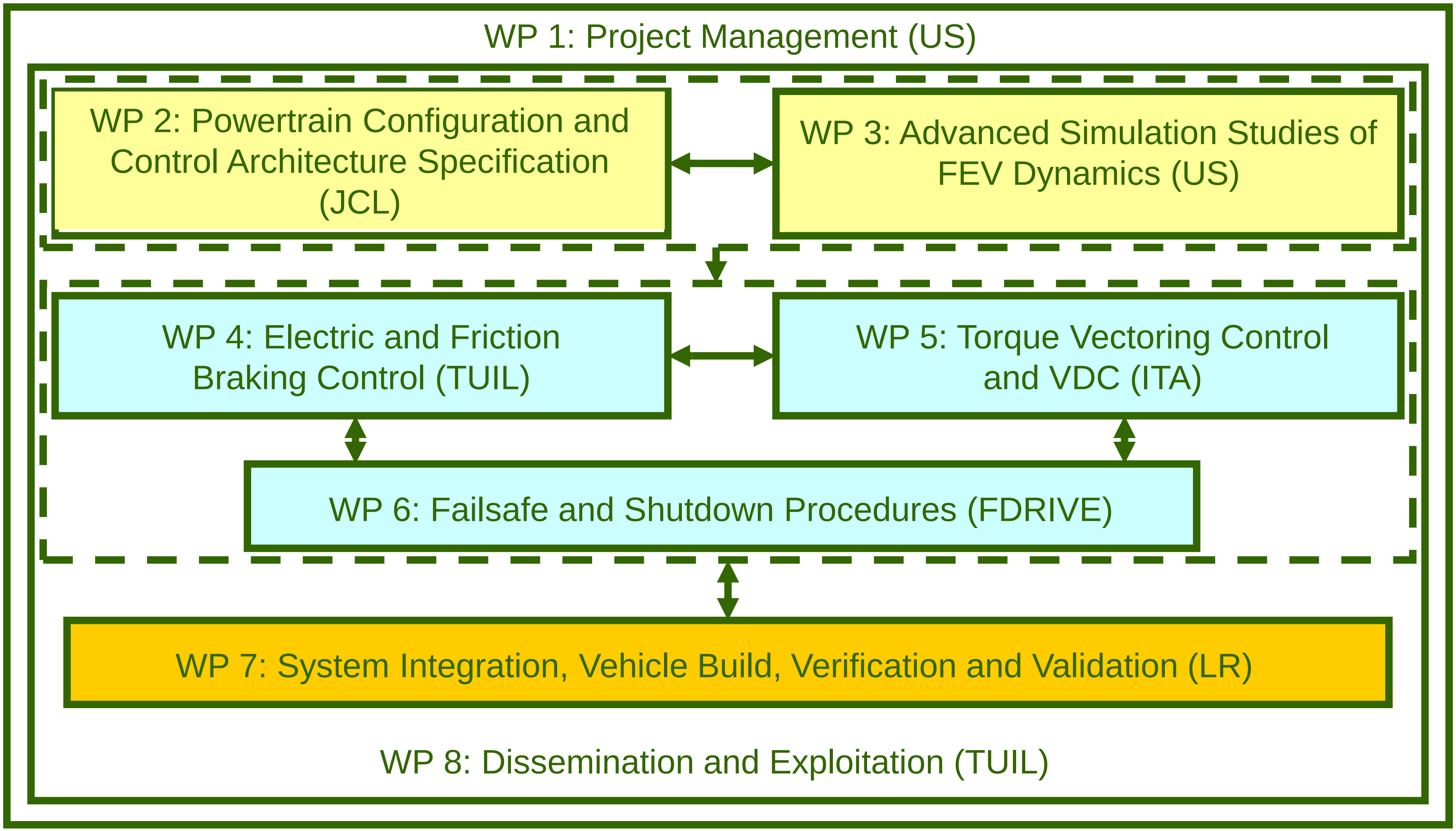
Overall Budget: 4.763 million Euros

EU Financial Contribution: 3.095 million Euros

84.7% of MMs on Research and Technical Development of the control algorithms and related hardware

Fully functioning and robust vehicle demonstrator (capable of reproducing vehicle layouts with 2, 3 and 4 electric motors) deriving from the FEV demonstrator of the Flemish project RepMep (coordinated by Flanders' Drive)

4. Work Packages and Approach

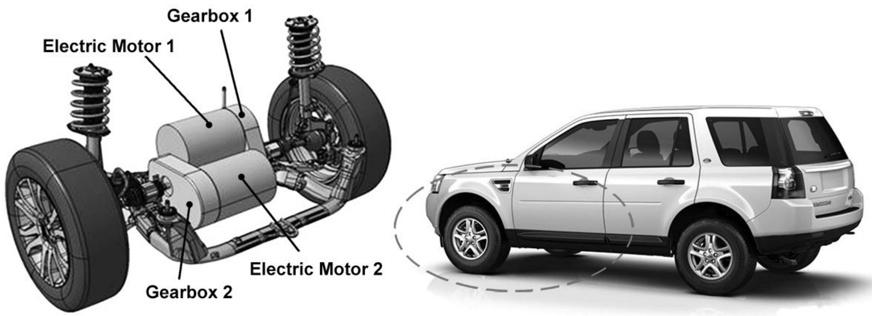


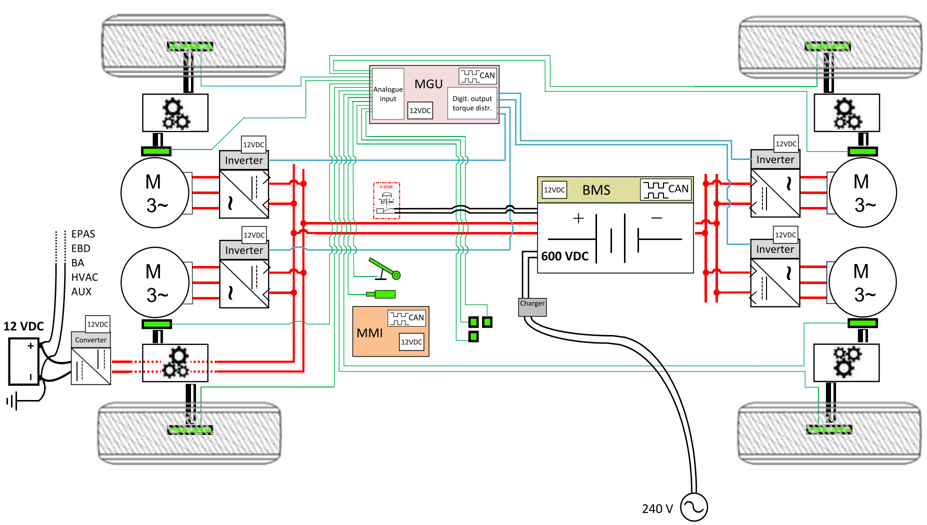
5. Technological Challenges

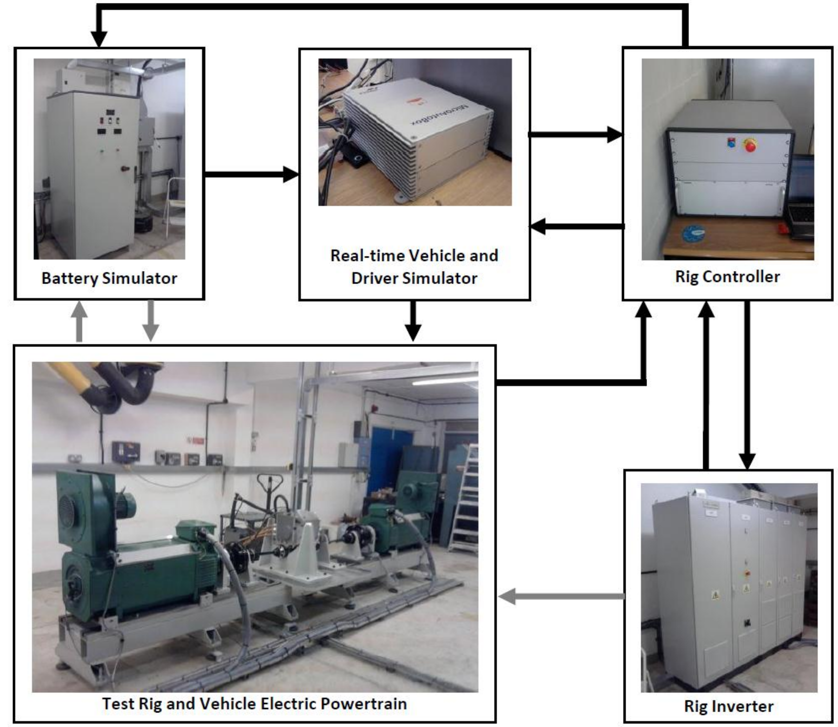
Subsystem	Goals
Base Brake Control	•**High regeneration capability** (pure regeneration at any deceleration level up to 30 km/h for the unladen vehicle, and progressively decreasing regeneration capability as a function of vehicle speed).
ABS	•**ABS modulation entirely achieved through** the control of the **regenerative torque**; •**5% of minimum stopping distance reduction** during ABS braking in low friction conditions achieved during the experimental validation using the vehicle demonstrator.
TC	•**5% reduction in time** for the part of the acceleration tests characterised by the TC intervention in low friction conditions.
Yaw Rate Control	•**Full compensation of the variation of the under/oversteer characteristic induced by braking and traction**, with slip angles up to 5°, and partial compensation for larger slip angles; •**Linear steady-state understeer characteristic** with lateral accelerations up to at least 0.7 g; •**Reduction of the amplitude of the yaw rate oscillations** during dynamic steering manoeuvres; •**Trade-off between vehicle dynamics and energy consumption;** •**Automated methodology** for the tuning of yaw rate control algorithms based on the application of the Moment Method.
Vehicle Demonstrator	•Capability of reproducing and testing **vehicle layouts with 2, 3 and 4 individually controlled electric motors**; •Capability of **2 hours of uninterrupted testing in heavy working conditions**; •195 km/h of maximum vehicle speed.

6. Exploitation Potential

Land Rover Freelander Vehicle Demonstrator







Control solutions developed for in-board motors can be easily adopted for in-wheel motors, whereas a technology transfer in the inverse direction could be rather complicated (i.e., control solutions developed for in-wheel motors can pose problems when implemented with in-board motor configurations).