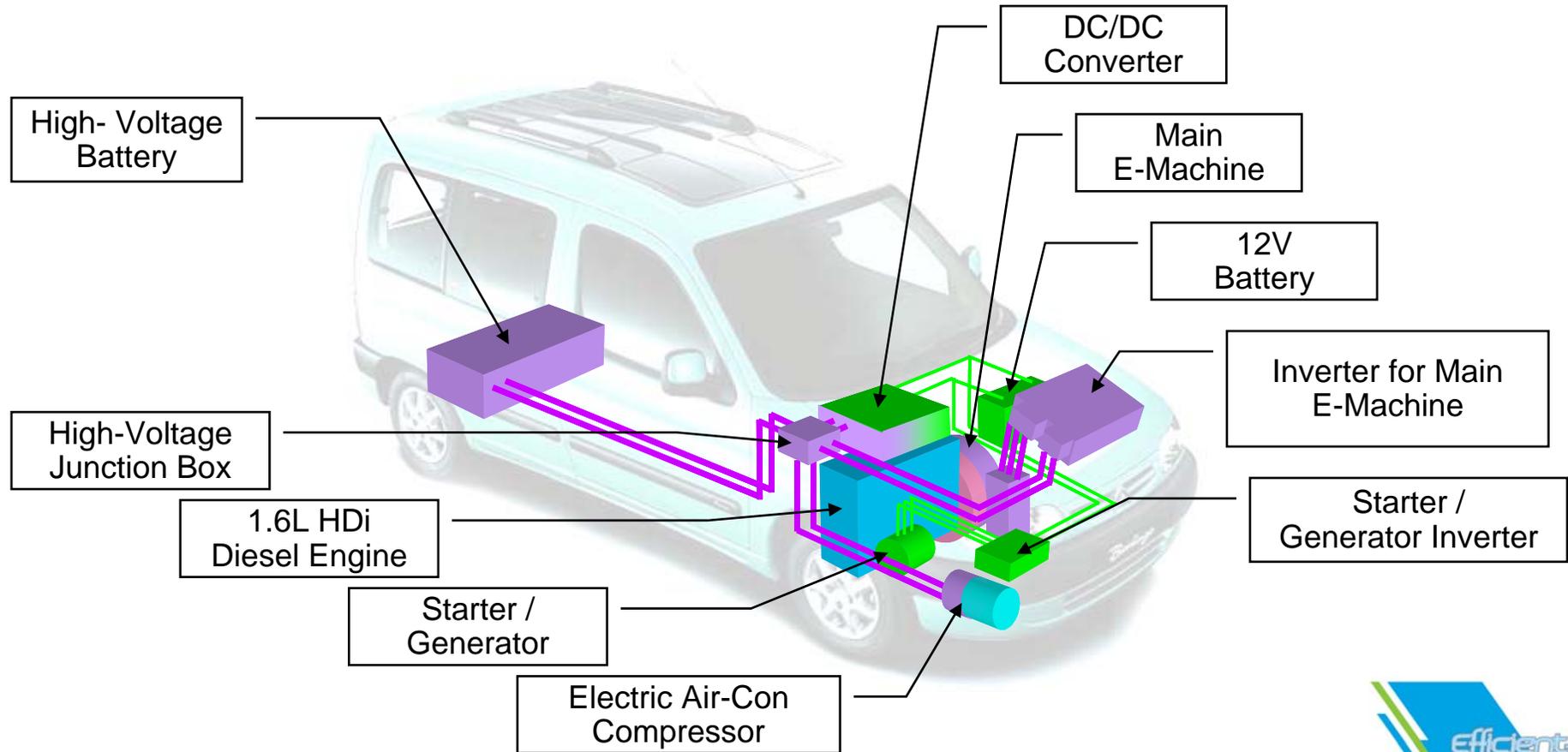


# Integration of Safety and CO<sub>2</sub> Reduction for Hybrid and Electric Vehicles

**Richard Saady**  
**Ricardo UK**

**Safety and CO<sub>2</sub>: Can we both tackle climate change and make road transport safer?**  
**23 November 2009**  
**Institution of Mechanical Engineers, 1 Birdcage Walk, London, SW1H 9JJ**

# Full hybridisation gives 30% fuel reduction but requires adding components, all of which have potential hazards



**The introduction of high-voltage electrical components in HEVs and EVs lead to new safety hazards**



PSA PEUGEOT CITROËN



Ultra Low Carbon Car Challenge funded by



Department for Transport

# Safety considerations for HEVs and EVs revolve around identifying the hazards from the battery pack, high voltage and quiet operation



Hazards associated with EVs and HEVs



**Chemical**

- What if the battery pack leaks?
- What if the cells catch fire?



**High Voltage**

- An electric shock is potentially lethal



**Recharging**

- On-street charging stations
- High voltage plug / electrical connector
- Cable trip hazard



**Quiet Operation**

- Risk to pedestrians and cyclists
- How do you know if the vehicle is operational?



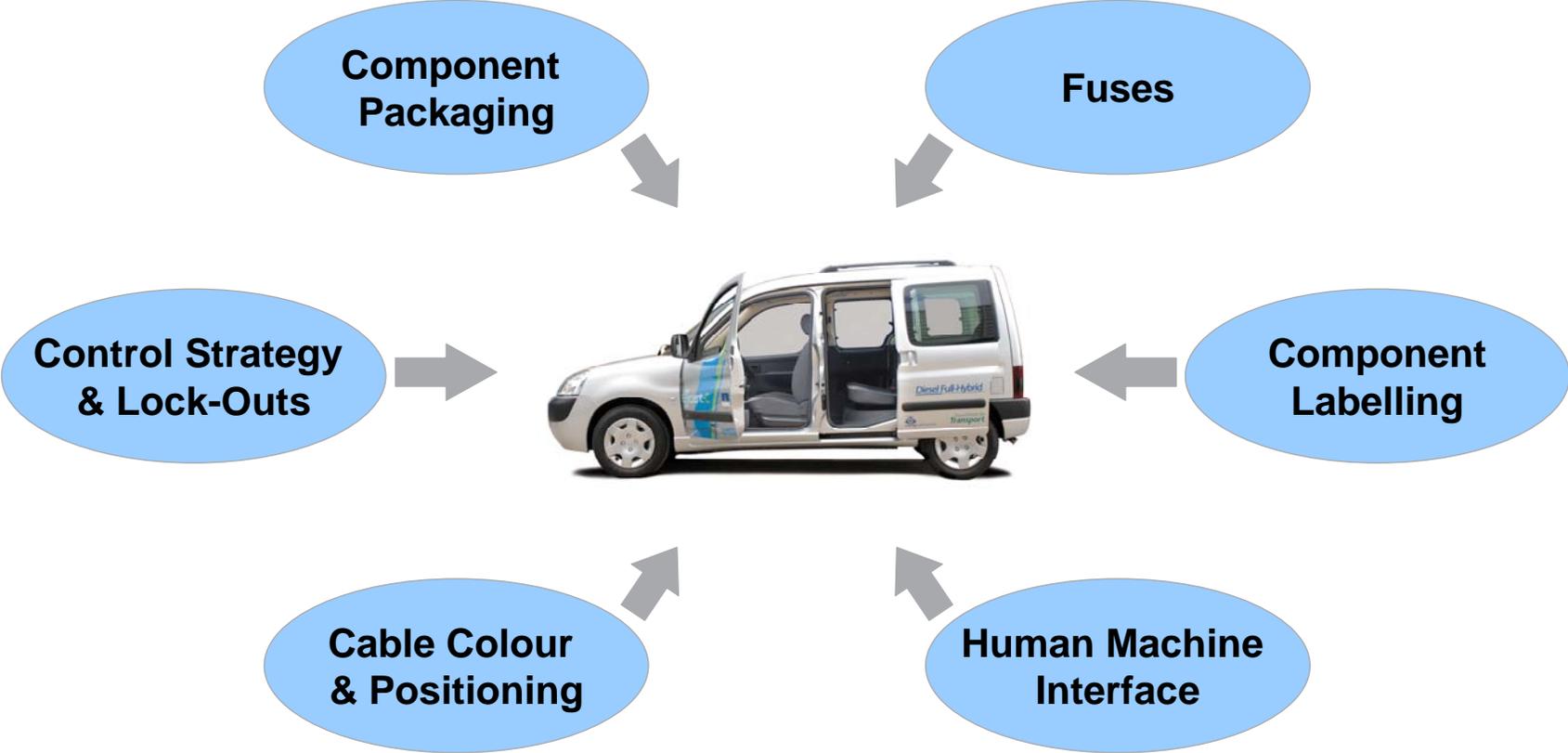
**Regenerative Braking**

- How do you know if the car in front is regenerating?

# Engineers can mitigate against most hazards through careful vehicle design



## Hazard Mitigation – On-Vehicle



*But what about the hazards that result from vehicle use?*

# The quiet operation of EVs and HEVs has a positive environmental benefit, but increases the risk to pedestrians and cyclists

## Advantages



- EVs and HEVs produce less exterior noise than conventional vehicles, producing a positive benefit for environmental noise

***“Environmental noise, caused by traffic, industrial and recreational activities is one of the main local environmental problems in Europe and the source of an increasing number of complaints from the public.”***

European Commission

- Reduced exterior noise level reportedly gives a negative impact on pedestrian safety
  - HEVs at slow speeds (5 mph) must be 40% closer to pedestrians than ICE vehicles before their location can be audibly detected <sup>1)</sup>
- A minimum noise level to be emitted by vehicles has been proposed
- Some manufacturers are fitting EVs and HEVs with artificial noise generation systems to reproduce the familiar sound of a combustion-engine

## Disadvantages

***Research is required to develop the technology that ensures pedestrian safety, while reducing environmental noise***

# ITS has an increasingly important role in aiding intelligent vehicles improve road safety and achieve better operating efficiency

## Driver Information Systems

- Enhanced driver feedback



Improve Drivers

## Semi-Autonomous Control

- Improved vehicle system management



Improve Vehicle Systems

## Fully Autonomous Control

- Remove driver inefficiencies
- Intelligent traffic management
- Cooperative control strategies



Improve Vehicle Cooperation

Reduce Congestion

Improve Road Safety

Cut Emissions

# CoDriver is an in-vehicle electronic hazard warning system, enhancing driver awareness of impending route hazards

## Background

- Drivers currently rely on existing road signs to make them aware of potential road hazards
- Road-signs do not cover all potential hazards
- Road accidents and fatalities can be reduced through provision of enhanced driver information relating to hazards

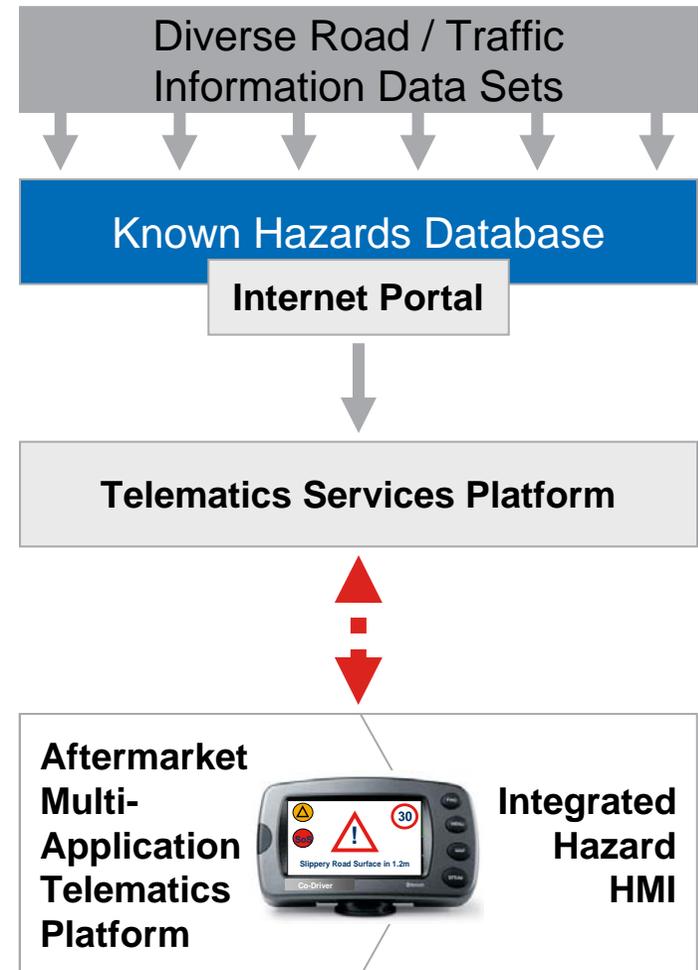
## Concept

- Off-vehicle system collates data sources relating to hazards and transmits this to vehicles
- Smart electronic module presents hazard information to the driver in a suitable timeframe to allow a relaxed and controlled response
- System can be used to report hazards

## Benefits

- Relatively low-cost module, which can be fitted in the aftermarket
- Advisory nature increases driver acceptance compared with interventional device (e.g. speed or acceleration limiter)
- Could be added as a feature to existing systems
- Reduction in road traffic fatalities

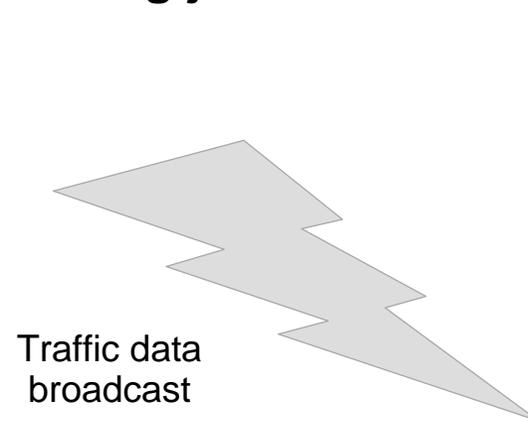
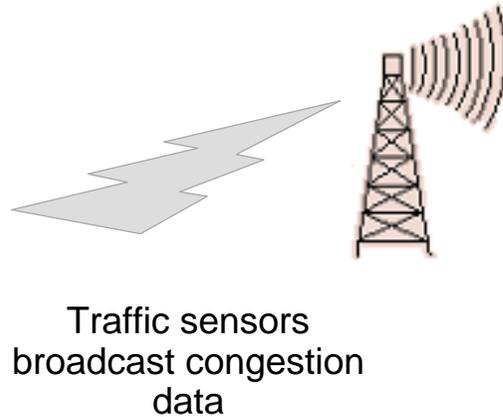
## Co-Driver Project



# Electronic horizon data can be used to improve vehicle system efficiency through intelligent use of energy management

## Example – Electronic horizon applied to impending junction

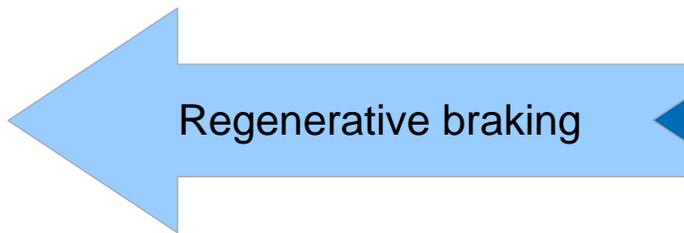
Heavy traffic across junction increases probability of stop being required



Vehicle aware of location and impending road topology



Determine appropriate strategies based on enhanced awareness



State of Charge increases  
i.e. Regenerate batteries



State of Charge reduces  
i.e. Use more electric power

# The Sentience Programme has demonstrated the use of electronic horizon information to improve the efficiency of vehicle systems



## Approach

- Collaborative R&D programme co-funded by innovITS, started March 2007
  - innovITS is the UK Centre of Excellence for transport telematics and technology for sustainable mobility ([www.innovITS.co.uk](http://www.innovITS.co.uk))
- Collaborative partners from the automotive, infrastructure, mapping and telecoms domains

## Situation and objective

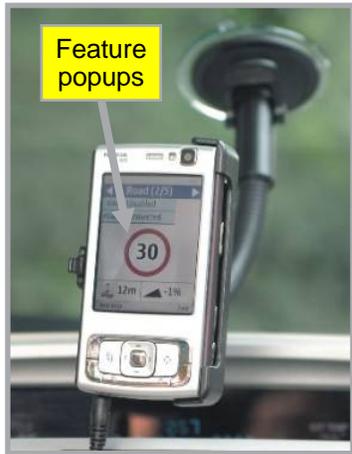
- Development of systems that use electronic horizon data to improve the fuel efficiency of hybrid vehicles
- The Sentience architecture incorporates vehicle to infrastructure communications to access electronic horizon data

## Results and benefits

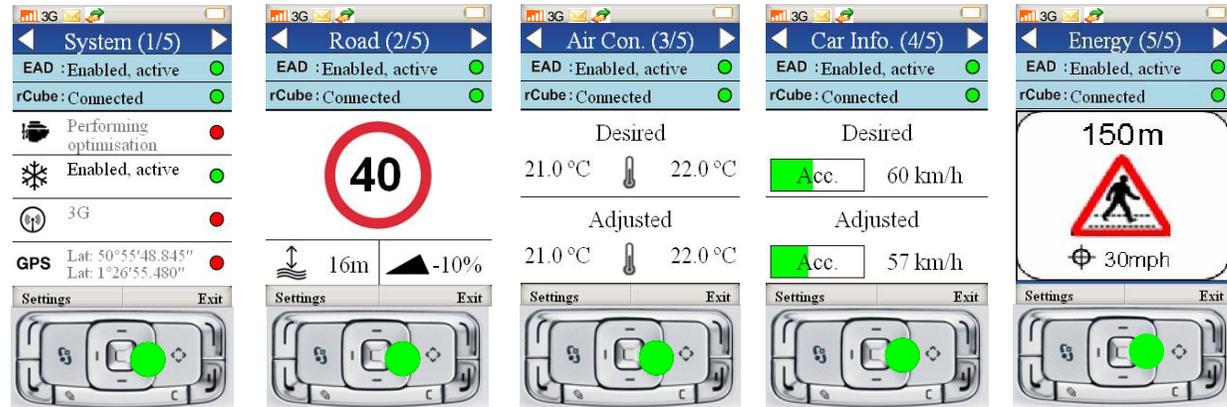
- Initial track and road testing results, show potentially significant savings are possible
  - Real world road test (in evenings) has already shown a fuel consumption reduction of over 5%



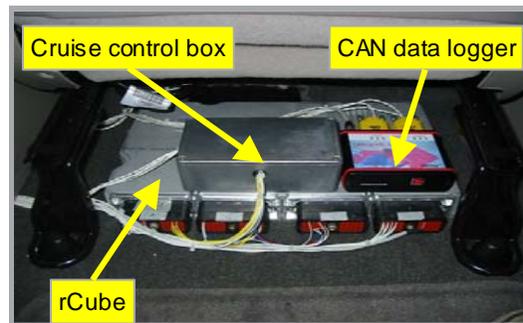
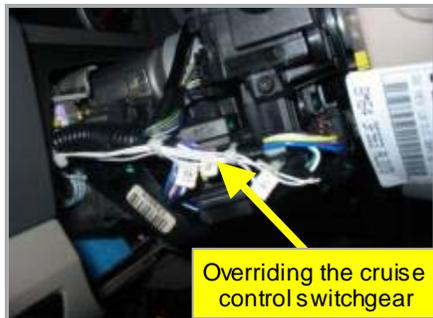
# Sentence uses a Nokia N95 Mobile Phone to provide the remote communications and HMI interface, and minor modifications to the vehicle for enabling fuel economy features



## HMI Main Tab Screens



## Vehicle modifications



# Conclusions

- Hybrid and electric vehicles have the potential to reduce transport CO<sub>2</sub> emissions
- This technology introduces new safety hazards, but these can be mitigated against through careful design and the application of intelligent control and user interfaces
- Clearly ITS has a significant role to play in reducing hazard risks and CO<sub>2</sub> through improved efficiency
  - The ITS/IV development toolkit is progressing
  - The automotive, telecoms and infrastructure domains are moving forward in developing new systems and technologies that utilise ITS and Telematics
- As Vehicles become more of the integrated transport solution greater benefits will be achieved
- Ricardo is an active participant in this arena