EECE 401 Senior Design I
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Howard University

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Introduction

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- Problem Statement
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- Hybrid Architecture
- University Level Research
- Main Approach
- Rapid Control Prototyping
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Current Issues

- Foreign Energy Dependency
- Rising prices of petroleum/crude oil
- Carbon Emission effect on the environment
- Federal Laws mandating increased fuel economy

Vehicle exhaust emissions

EcoCAR
The NeXt Challenge

Problem Statement

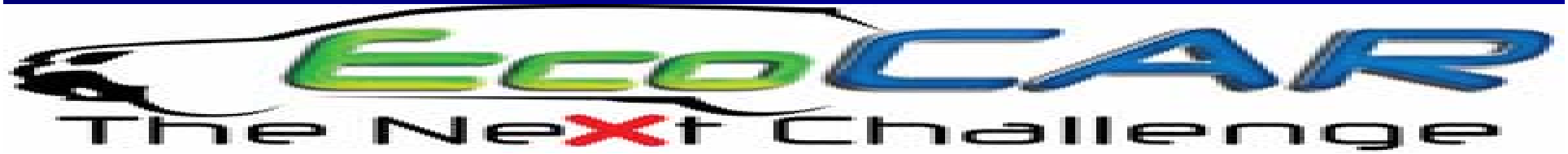
EcoCar Next Challenge Year 1 of 3:

- Design Simulink Model of control strategy for Hybrid vehicle
- Download control strategy to target prototype controller
- Conduct Hardware-in-the Loop tests on control strategy

EcoCAR The NeXt Challenge

Design Requirements

- Performance:
  - Design control strategy by DOE specifications for Software in the Loop testing by the end of Fall 2008.
  - Complete Rapid Control Prototyping by January 30, 2009.
  - Complete HIL testing by March 5 2009.
- Compliance:
  - Must meet ISO 11898 (Section 1-5) requirements for high-speed CAN applications.
  - Must meet ISO 11519 (Section 1-3) requirements for low-speed CAN applications.

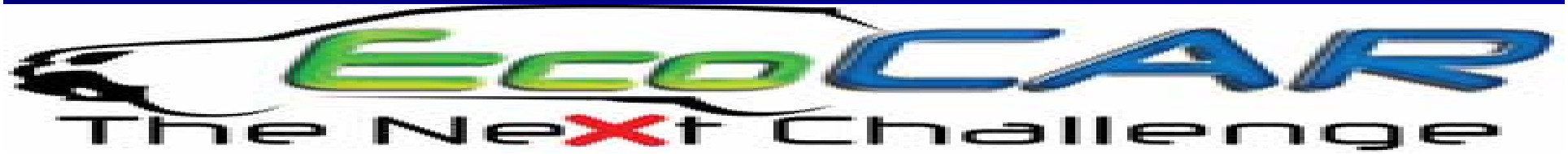


Design Requirements

Safety:

Battery Disconnect Module (BDM) engages:

- Airbag deployment
- Isolation fault detection
- High Voltage Interlock Loop (HVIL)
- Diagnostic code indicating system fault
- Ignition off
- Manual Disconnect



Hybrid Model Architecture

ARCHITECTURE OF HEVs

PARALLEL HEV

- he propulsion power may be supplied by the ICE alone, by the electric motor, or by both.
- More efficient than series

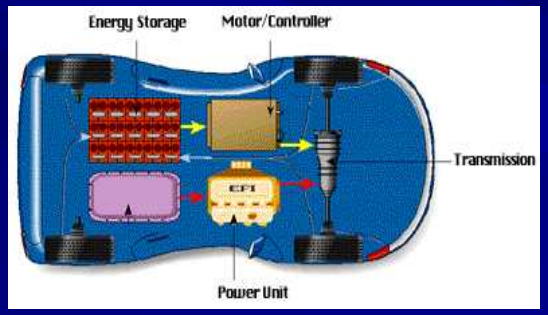


Fig 1. Architecture of parallel HEV

SERIES HEV

- Needs three propulsion devices, the ICE, the generator, and the electric motor.
- Relatively low efficiency

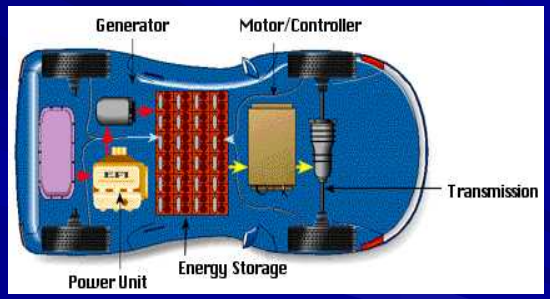


Fig 2. Architecture of series HEV

SERIES-PARALLEL HEV

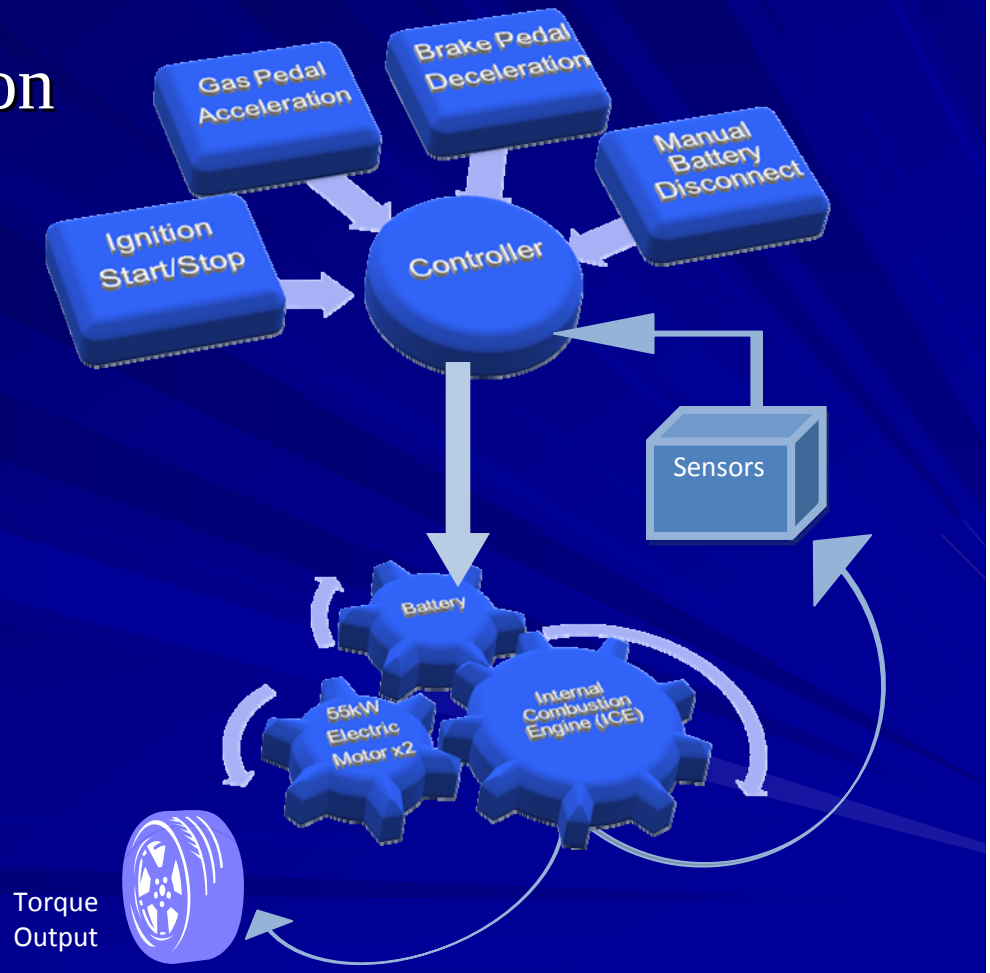
- Incorporates features of both series and parallel HEV's
- Most efficient

Main Approach

GM 2-ModeTransmission

5 Vehicle Modes:

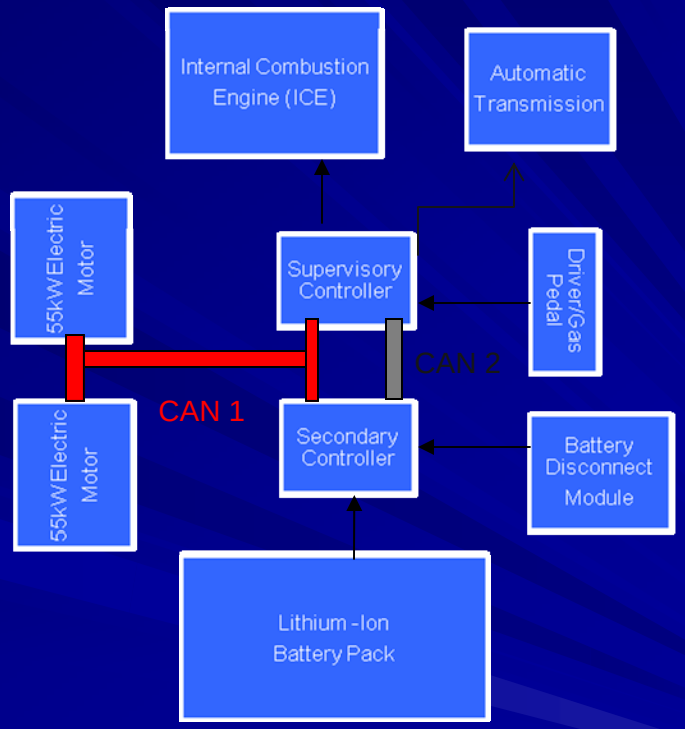
- Ignition start
- Acceleration
- Cruise
- Deceleration
- Engine Shut-off



System Overview

Main Approach

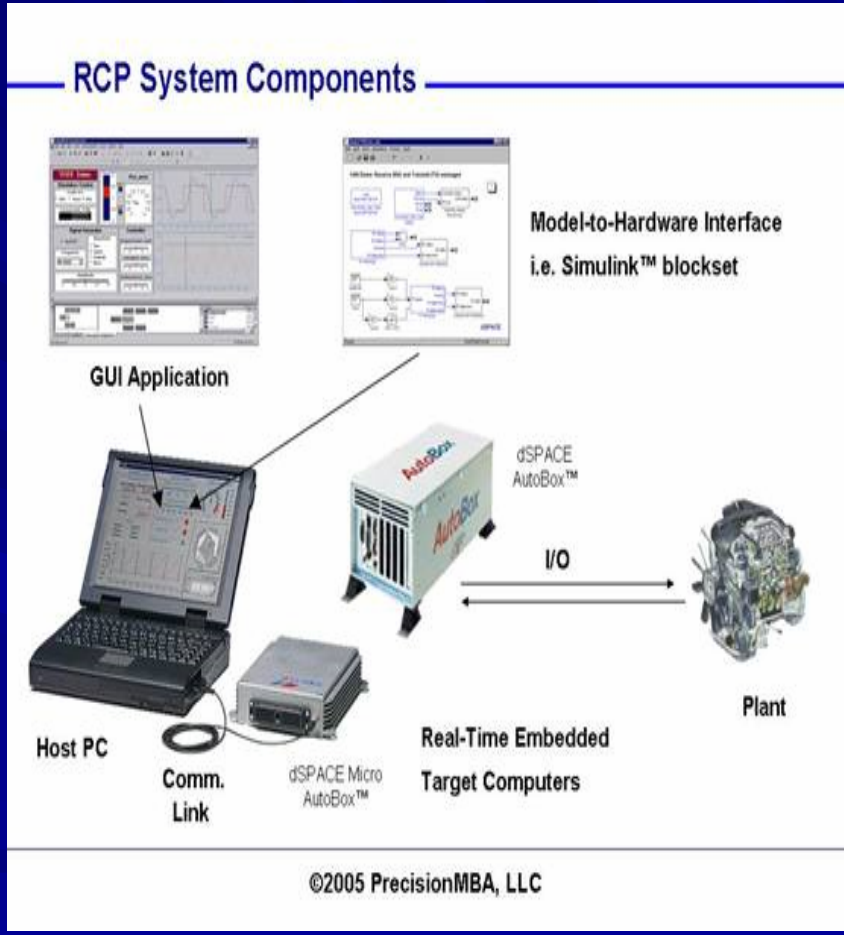
- Safety is key Priority
- Controllers error-check each other
- Supervisory controller oversees mode switching
- Secondary controller oversees battery state and BDM



Overview of Dual Controller Approach

Rapid Control Prototyping

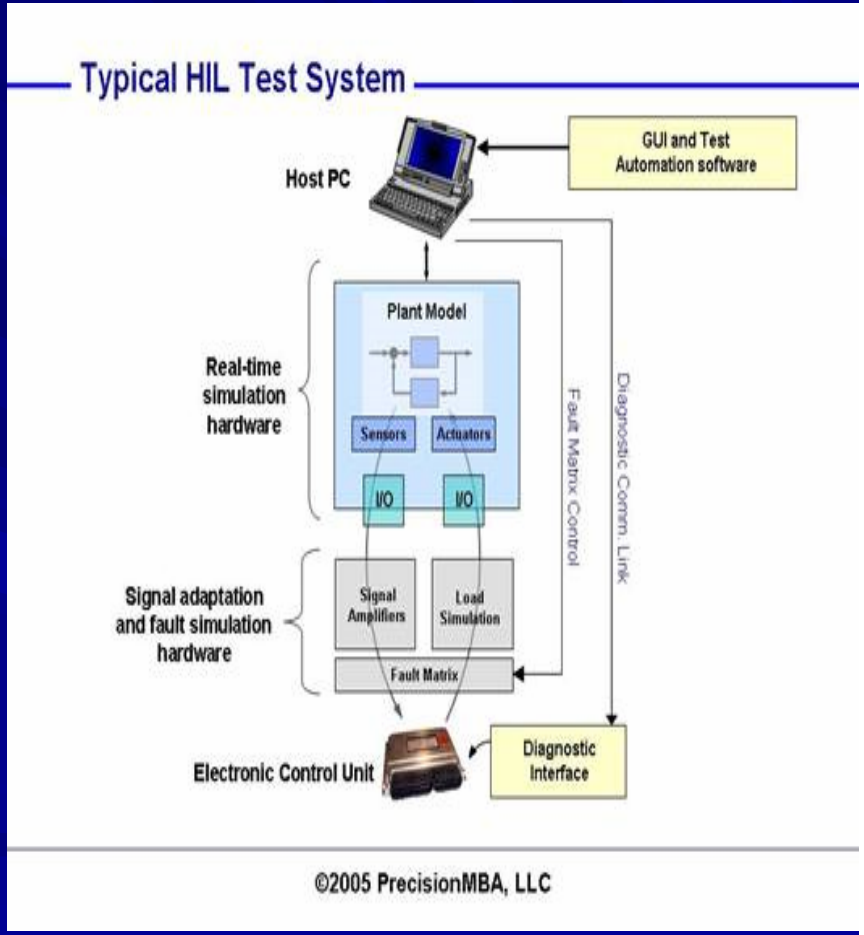
- Pre-HIL step
- SimuLink model Downloaded to dSPACE micro-auto box
- Extensive C-coding NOT required



Hardware in the Loop

WHY HIL??

- Enable Simultaneous Engineering
- Simulate desired conditions
- Dangerous situations are NO-RISK!!
- Reduce time and COST!!



University Approaches

University of Wisconsin

- Control Strategy:
  - Present battery state
  - Driver inputs to CIDI Engine
- Output:
  - Signal from gas pedal to controller with a torque output from engine

Virginia Tech

- Control Strategy:
  - Split Parallel Architecture (SPA)
  - Power-train request higher negative torque increasing the charge on the battery and reducing fuel dependency
- Output:
  - Less weight lowers fuel in-take
  - Vehicle operation modes

Deliverables

- Hardware in the Loop tested Control Strategy.
- Prototype Control Strategy downloaded into dSPACE Micro-Autobox.
- Detailed notes on design and results from testing.

Tasks

Description	Duration (Days)	Start	End
Choose Power-train Architecture	30	Wednesday October 1, 2008	Tuesday October 30, 2008
Develop Block Diagram for Control Logic	14	Wednesday November 1, 2008	Wednesday November 14, 2008
Develop SimuLink Model of Control Strategy	13	Monday November 17, 2008	Friday November 30, 2008
Software in the Loop testing of Control Strategy	16	Monday December 1, 2008	Wednesday December 17, 2008
Rapid Control Prototyping	14	Wednesday January 7, 2009	Wednesday January 21, 2009
Hardware in the Loop testing	34	Monday January 26, 2009	Tuesday Friday February 30, 2009

Conclusion

- Eco-car Next Challenge sponsored by GM & DOE
- GM 2-Mode Transmission Architecture chosen
- Already identified 5 Vehicle Operating Modes
- Using 2 Controllers for enhanced communication, safety and fault checking
- SIL testing completed by Fall 2008.
- RCP completed January 26, 2009.
- HIL completed by February 30, 2009.

Questions?