MODEL BASED ENGINEERING OF THE KIIRA AND KAYOOLA EVS ELECTRIC VEHICLES USING MATLAB TOOLS

Presented to

The Nelson Mandela –African Institution of Science and Technology

Presenter: Richard Madanda
Director Product Development Kiira Motors Corporation

Presentation Content

- About the Presenter
- About Kiira Motors Corporation
- Electric and Hybrid Vehicles
- Matlab Model Based Development Process
- Development of the Electric vehicle in Matlab Simulink
- Control System Generation and Deployment- Motohawk

The Presenter

- ❑ Director Product Development Kiira Motors Corporation
- ❑ Deputy Chairperson of the UNBS TC117. The Uganda National Bureau of Standards Committee of Transport and Communication Committee
- ❑ Bsc. Electrical Engineering Makerere University, Kampala Uganda. 2011
- ❑ Msc. Embedded Systems Eindhoven University of Technology, Eindhoven, Netherlands. (2015)

Kiira Motors Corporation

- Kiira Motors Corporation(KMC) is a Mobility Enterprise Established to Champion Value Addition in the Nascent Mobility Industry in Uganda through Technology Transfer, Contract Manufacturing and Supply Chain Localization;

- Operationalized in 2018, the Company is Fully Owned by Government with Shareholding of 96% and 4% Makerere University;

- Kiira Motors Corporation has a Fully Constituted 13 Member Board of Directors Chaired by Hon. Prof. Sandy Stevens Tickdori-Togboa with an Independent Majority;

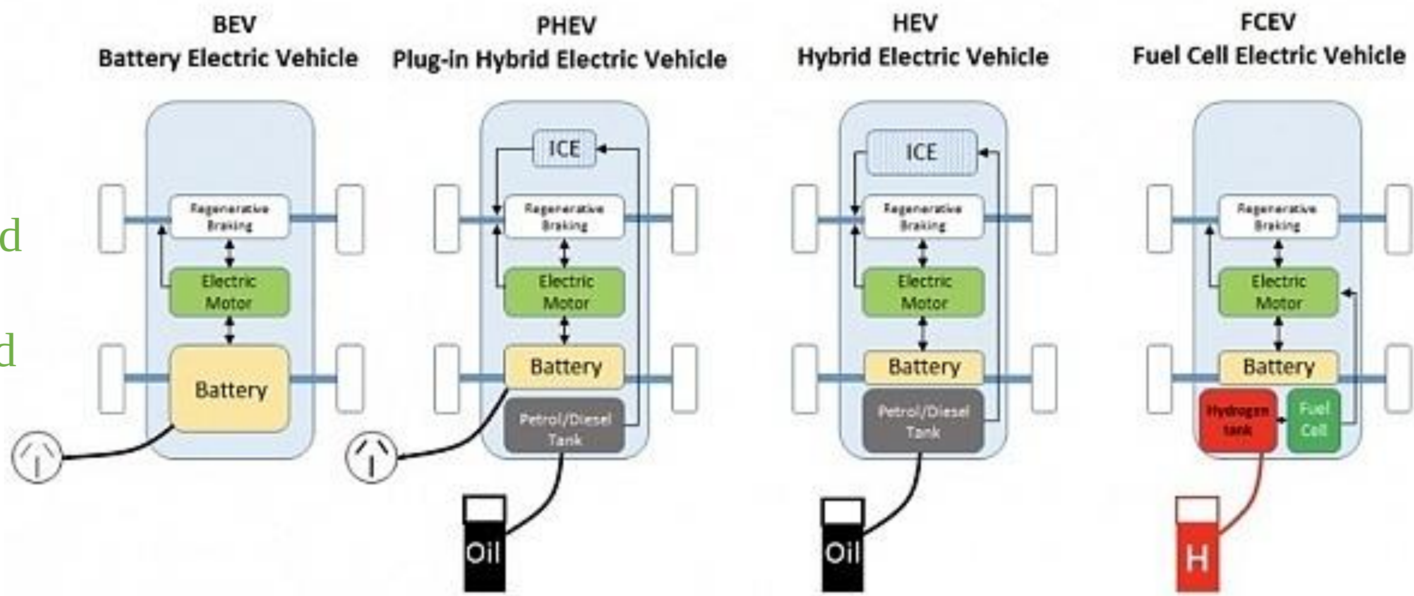
- The Core Business of KMC is to Develop, Make and Sell Sustainable Mobility Solutions (Motor Vehicles, Parts, Systems & Services) in Africa.

https://www.kiiramotors.com/

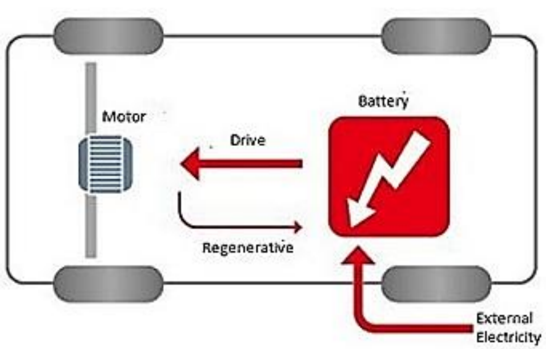
Kiira Motors Promotional Video

Electric and Hybrid Vehicles

The World is going Green and Electric!



Battery Electric Vehicle (BEV)

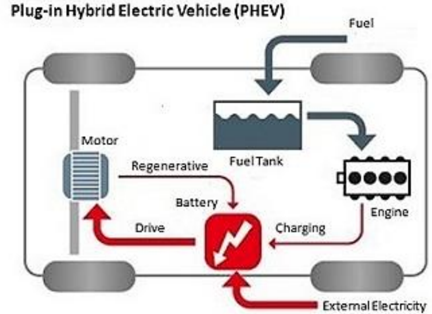


Components of BEV

- Electric motor
- Inverter
- Battery
- Control Module
- Drive train

Architecture and Main Components of PHEV

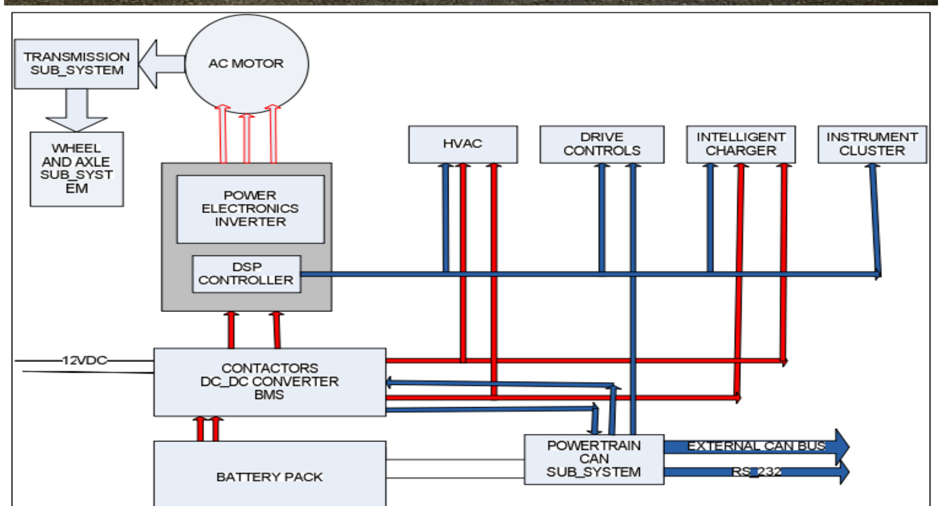
Plug-in Hybrid Electric Vehicle (PHEV)



Components of PHEV

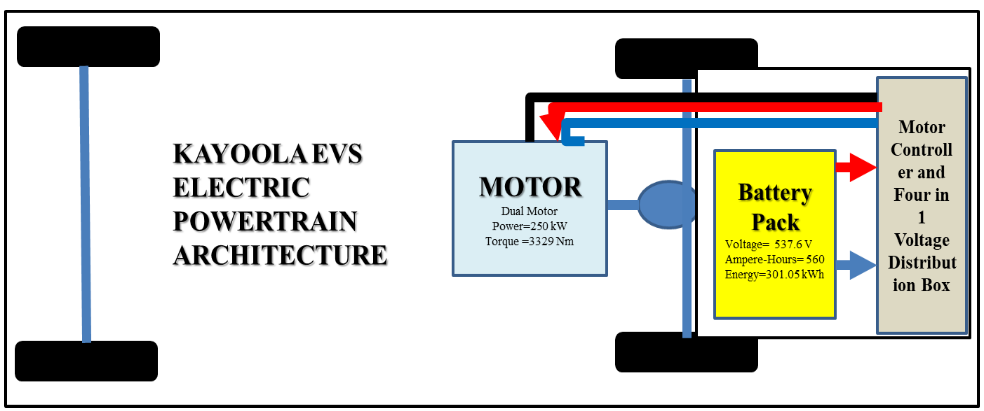
- Electric motor
- Engine
- Inverter
- Battery
- Fuel tank
- Control module
- Battery Charger (if onboard model)

The Kiira EV



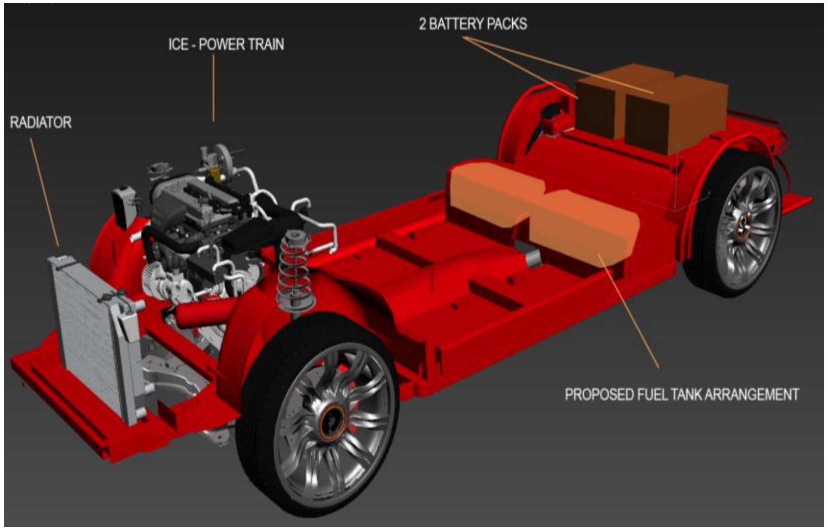
Vehicle characteristic	Sedan Pure Electric
Overall dimensions(mm)	3000*1600*1500
G.V.W(kg)	1,500
Curb Weight	1,000
Carrying Capacity (Seating/Standing)	Carrying Capacity 90(40+3+1 Seats and rest Standing)
Max. Speed(km/h)	80
Max Motor Power(kW)	20
Torque	3,300
Consumption Rate Consumption(kwh/km)	0.1 kWh/km
Grade ability(%)	>18
Range(km)	80
Battery Pack	BMS Li-ion Battery Pack, Air cooled & electronically controlled via the Battery Management System
Battery Bank Energy Capacity	40 AH
Battery Bank Voltage Range	207 V
Battery Cell Life cycle	≥3000
Cell Depth of Discharge	80%
Max. Motor Power (kW)	20
Max. Motor Torque (Nm)	60

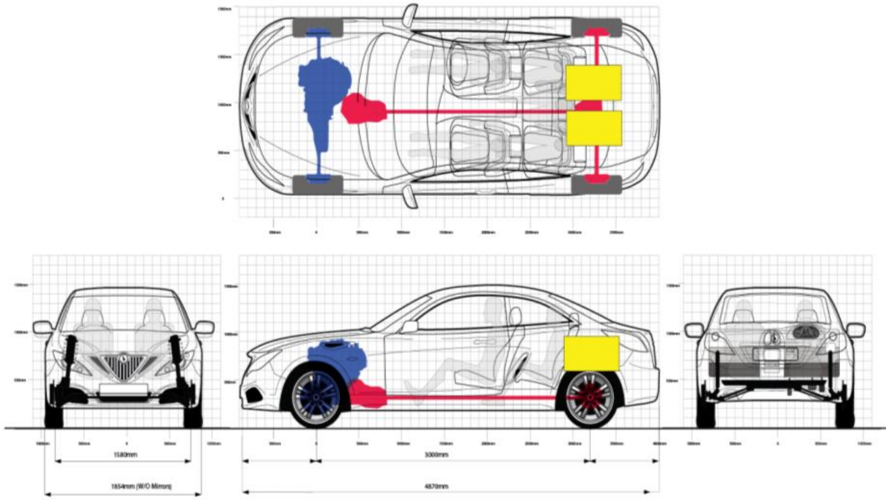
The Kayoola EVS



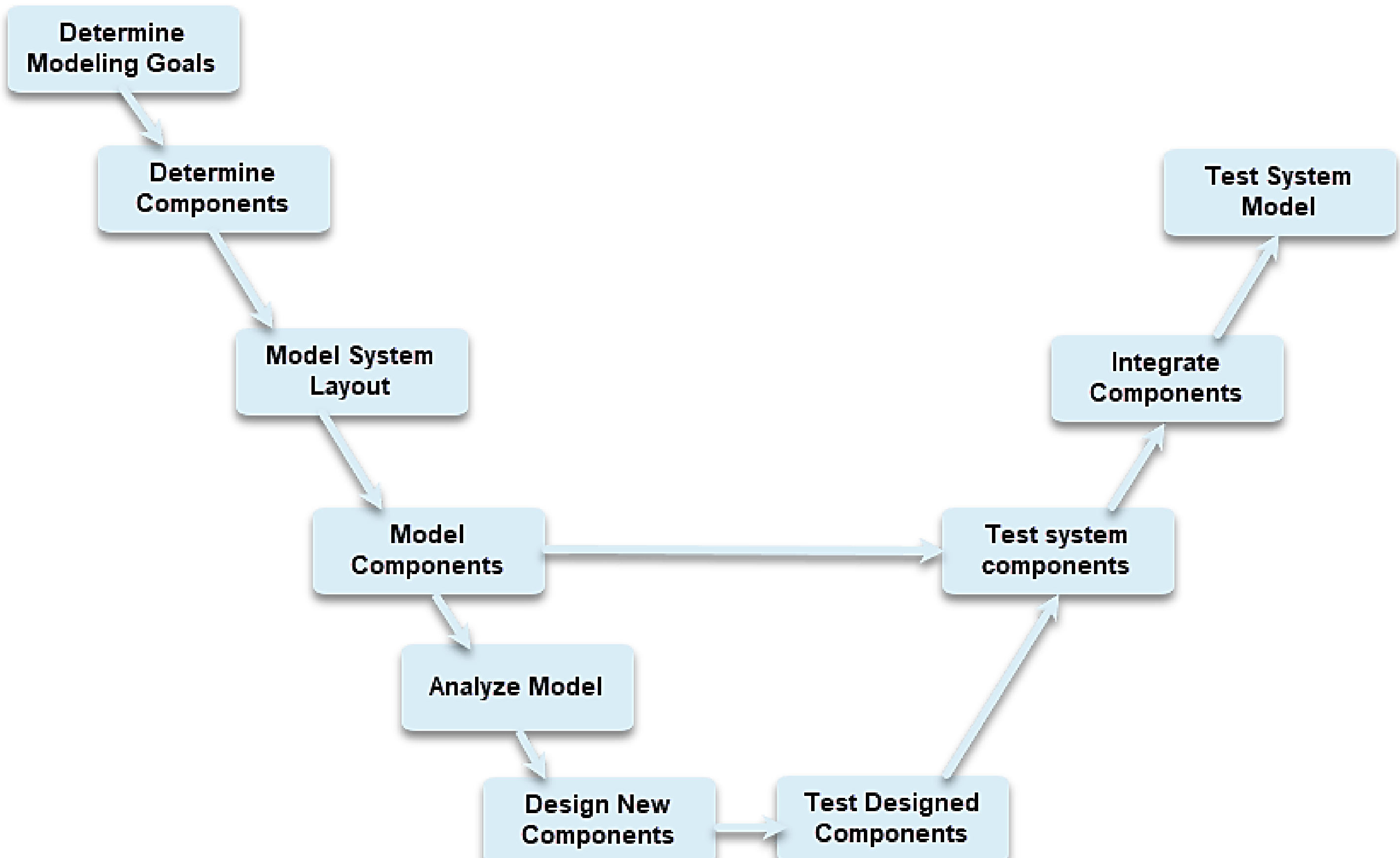
Bus characteristic	Low entry city bus pure electric
Overall dimensions(mm)	12190*2550*3200
G.V.W(kg)	18,000
Curb Weight	13,000
Carrying Capacity (Seating/Standing)	Carrying Capacity 90(40+3+1 Seats and rest Standing)
Max. Speed(km/h)	80
Max Motor Power(kw)	245
Torque	3,300
Consumption Rate Consumption(kwh/km)	Less than 1.3
Grade ability(%)	>18
Range(km)	300
Battery Pack	BMS Li-ion Battery Pack, Air cooled & electronically controlled via the Battery Management System
Battery Bank Energy Capacity	560AH
Battery Bank Voltage Range	537.6
Battery Cell Life cycle	≥2000
Cell Depth of Discharge	80%
Max. Motor Power (kW)	245
Max. Motor Torque (Nm)	3,300

The Kiira EVS- Case Study for Hybrid

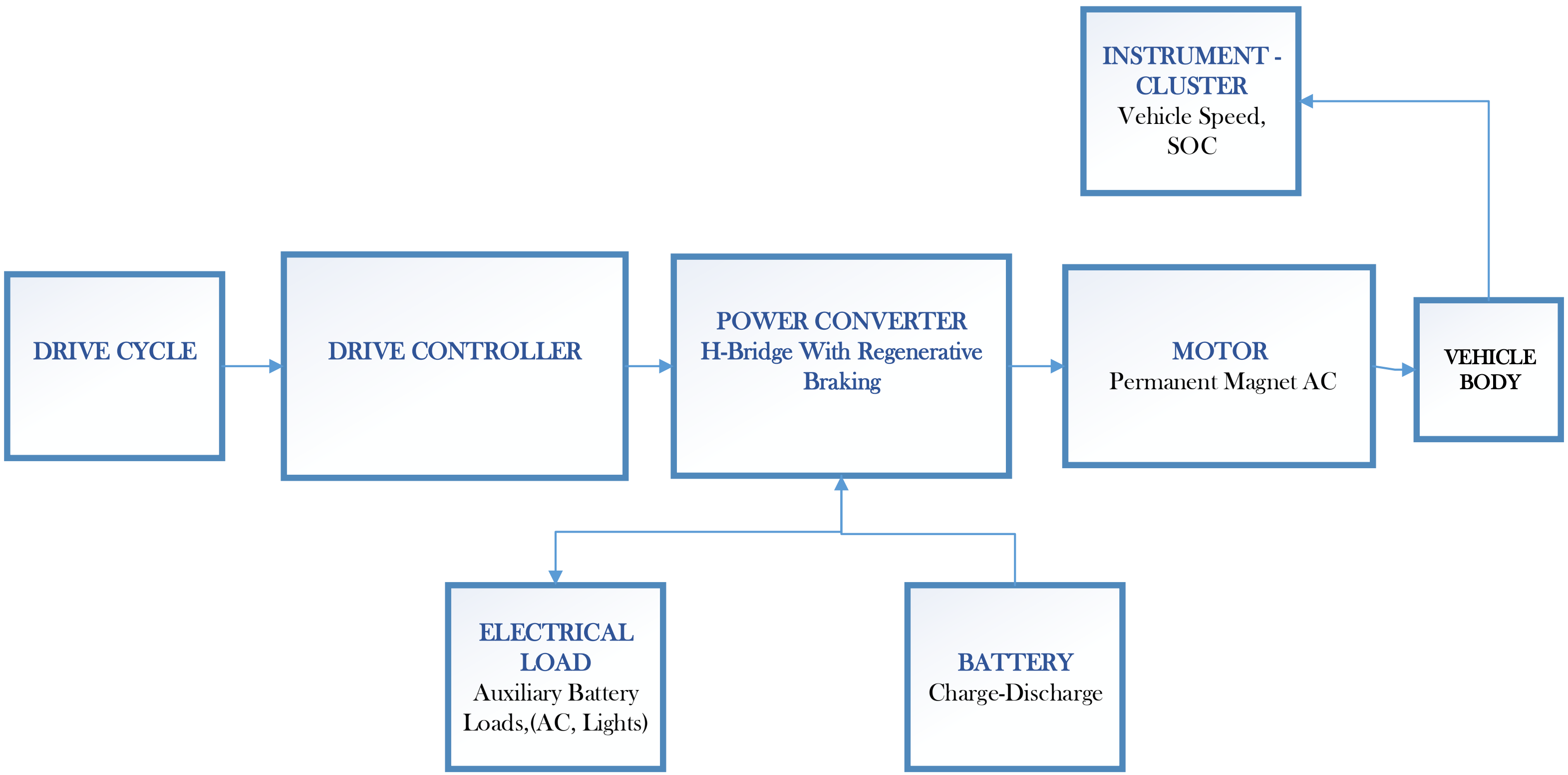




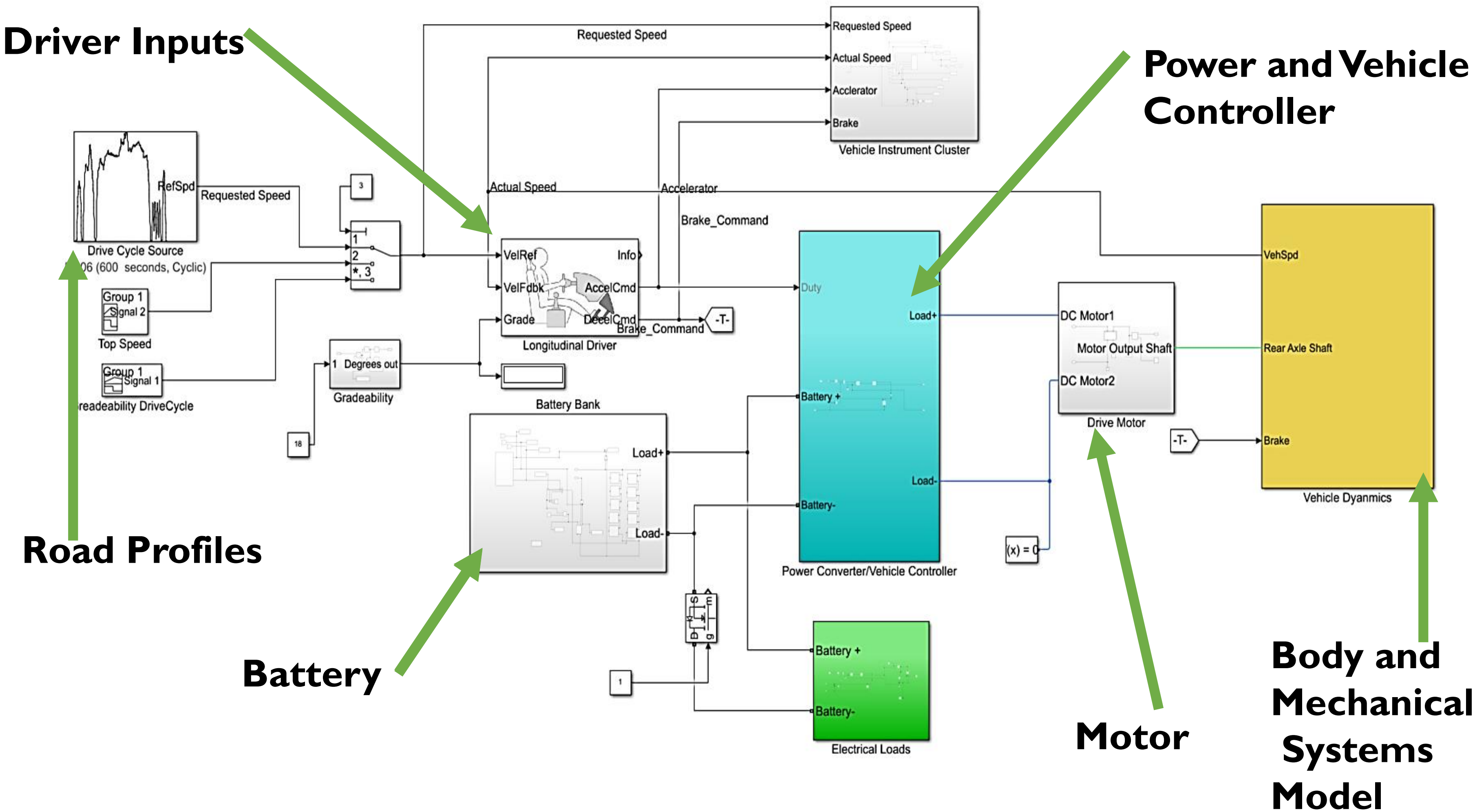
Matlab Simulink Model Based Development Process



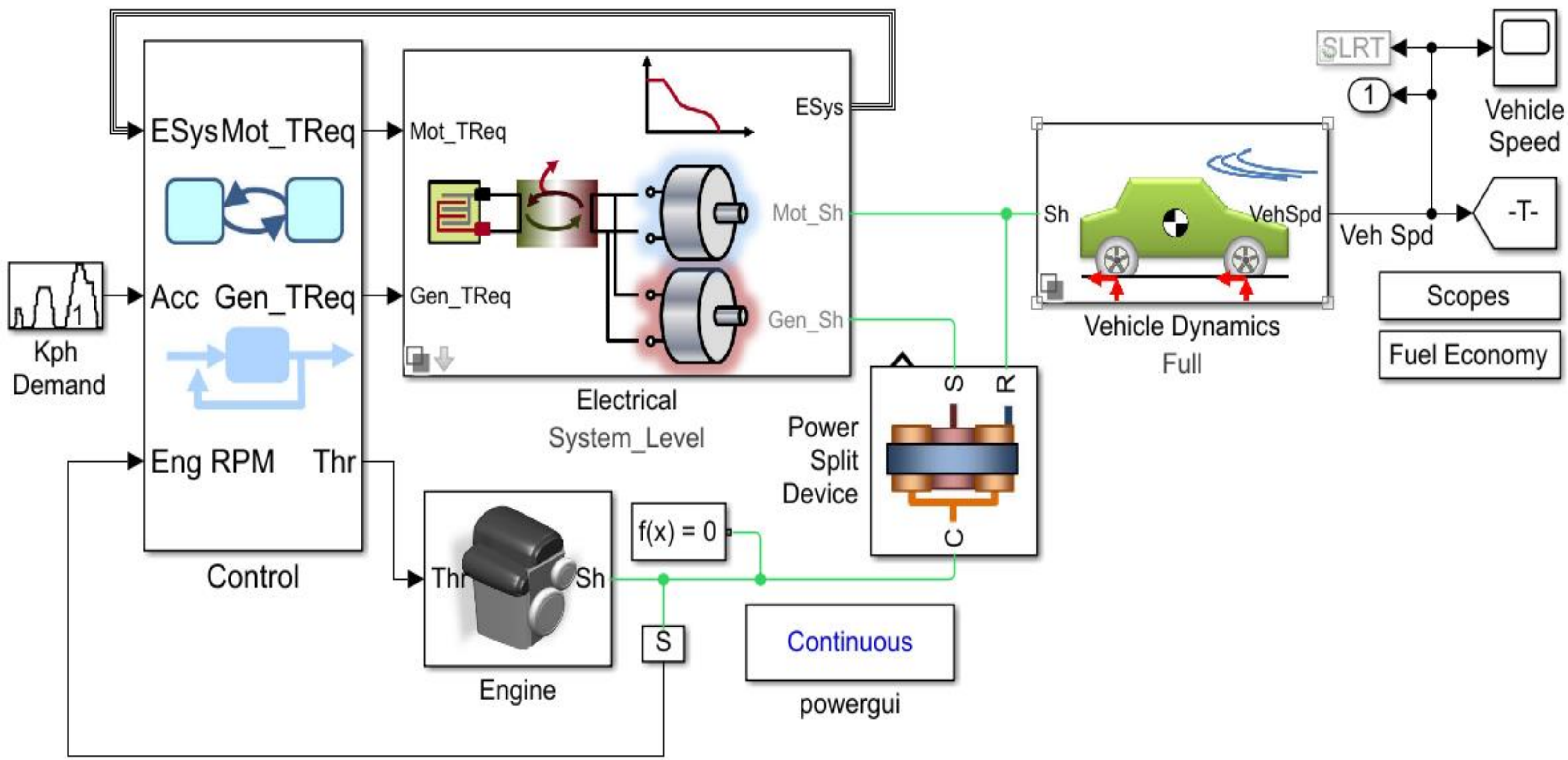
Determination of Electric Vehicle Components



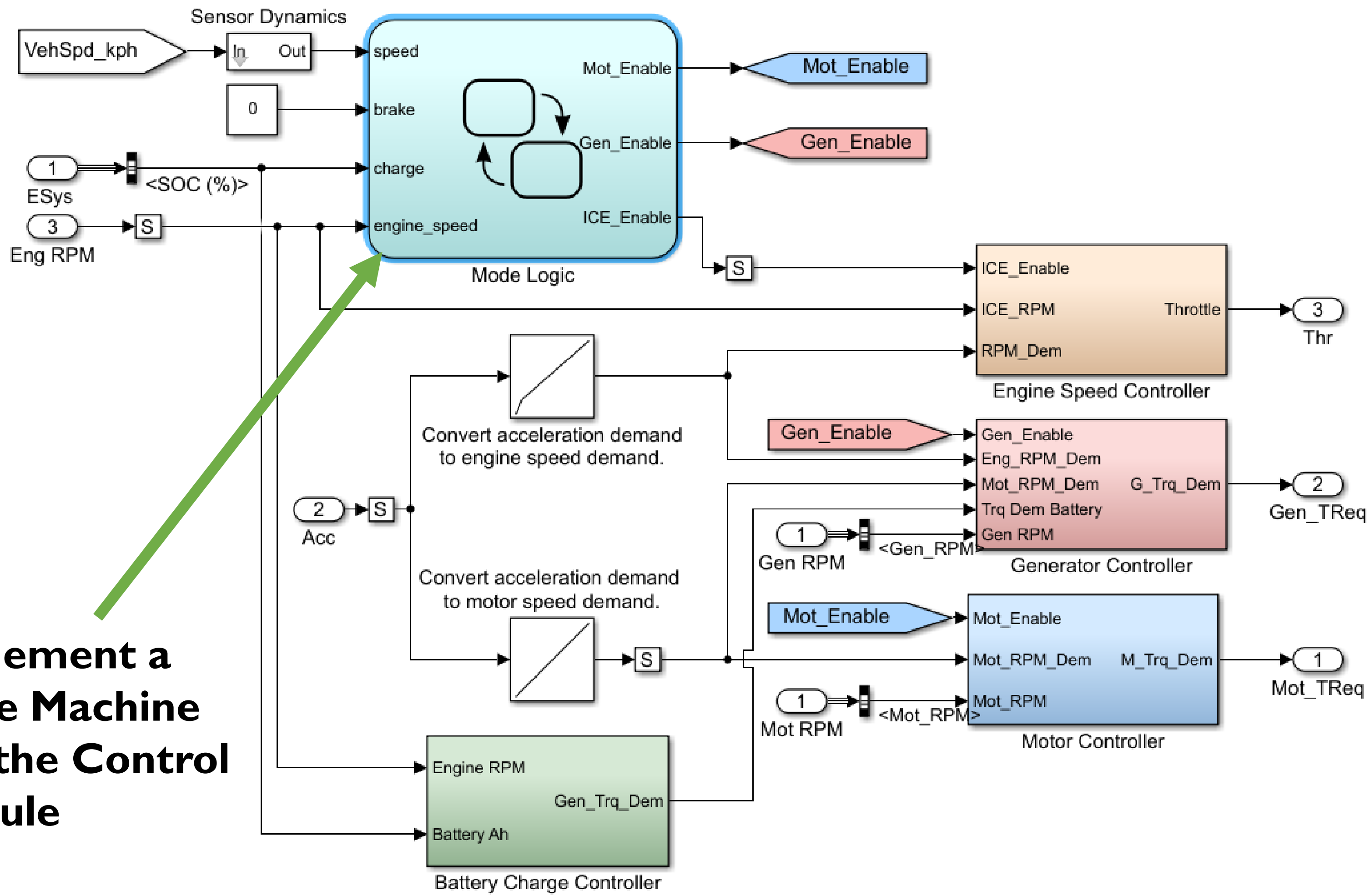
Kayoola EVS Model-Matlab Illustration



Hybrid Electric Vehicle Model

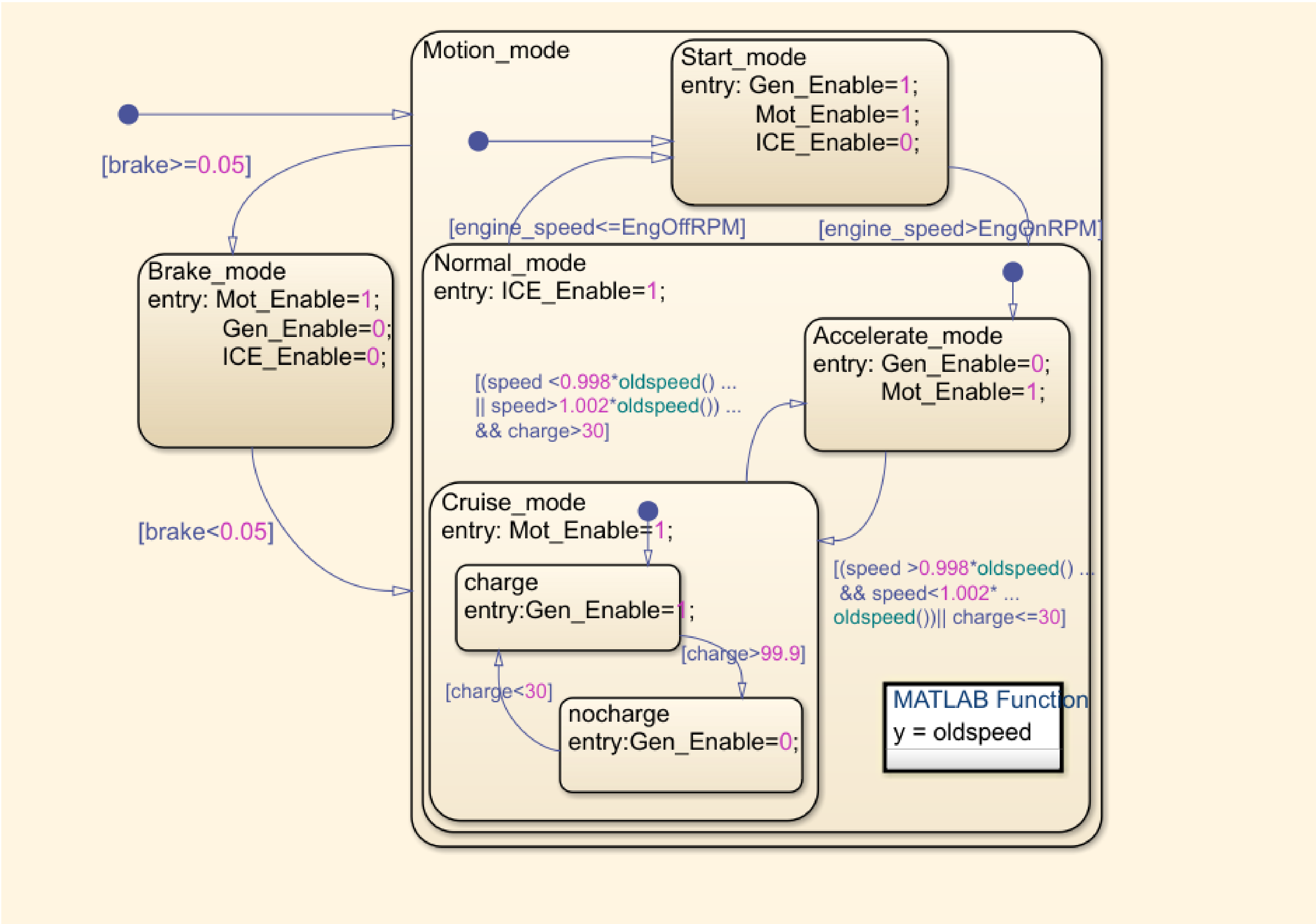


Control System Model



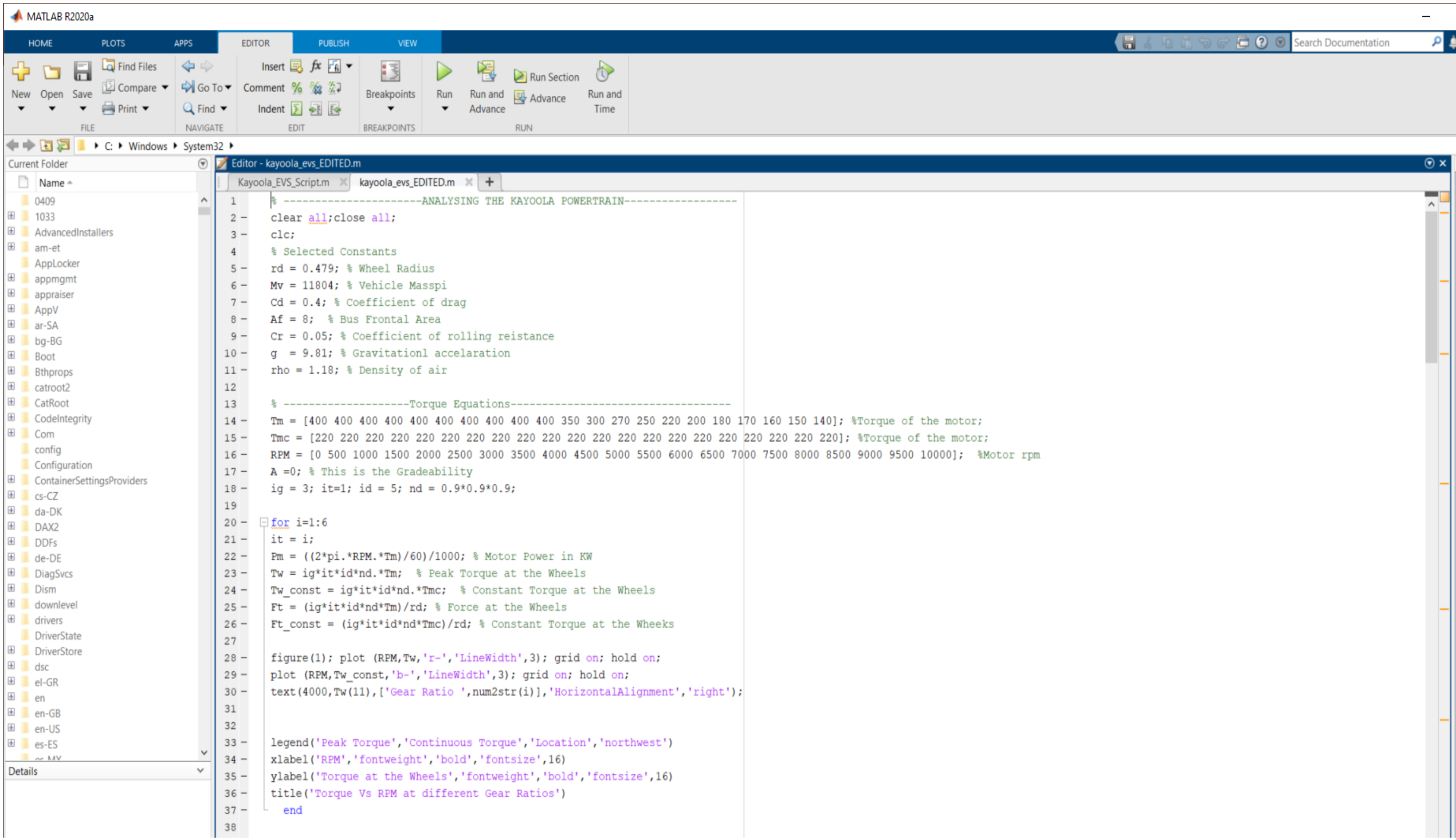
Implement a State Machine for the Control Module

Control System-HEV State Machine



Automate-With Illustration

The Design Space is always Huge. Use Scripts to run iterations



Control System Application Generation and Deployment

Model-Based Design with Motohawk

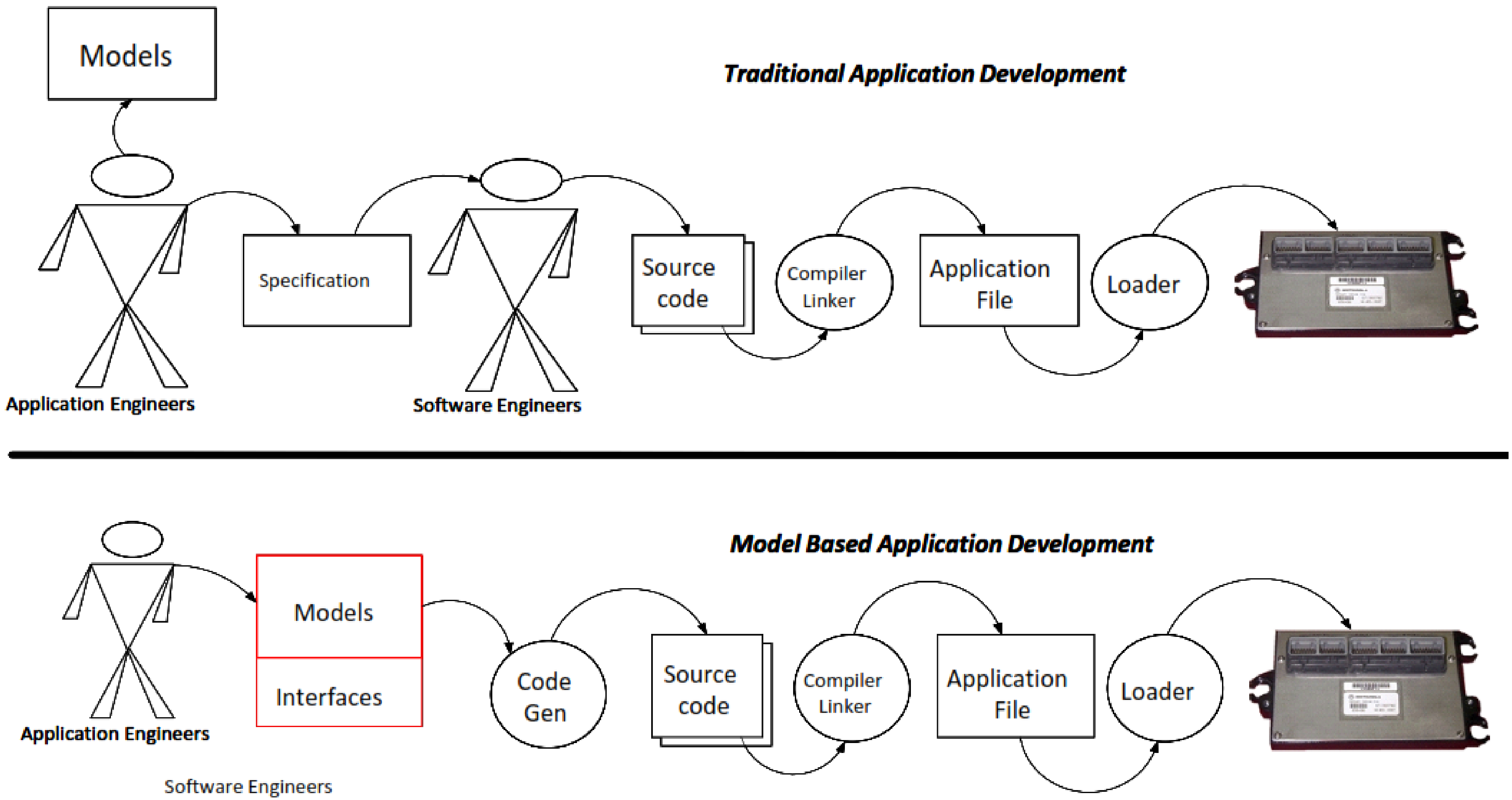
Motohawk

Goal: MotoHawk makes it possible to run a Simulink model on a Woodward module.

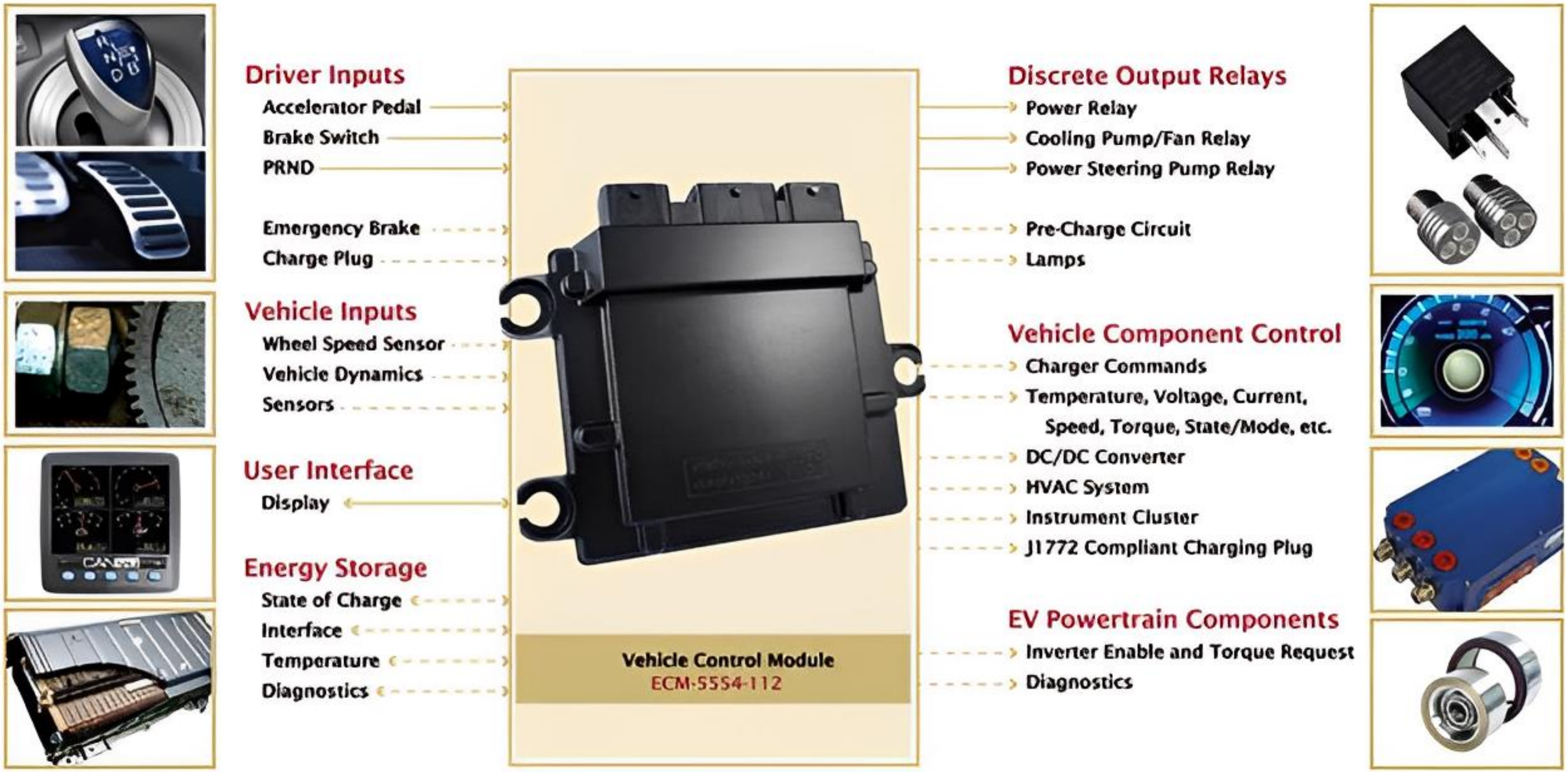
Capability: It allows access to I/O of the modules, tasks scheduling, manipulation of memory usage, creation of calibration and more importantly, it allows a single step build of an entire application.

Code Generation: Moto Hawk extends Simulink and Real-Time Workshop Embedded Coder to generate code necessary to interface with the resources of the modules and control their behavior.

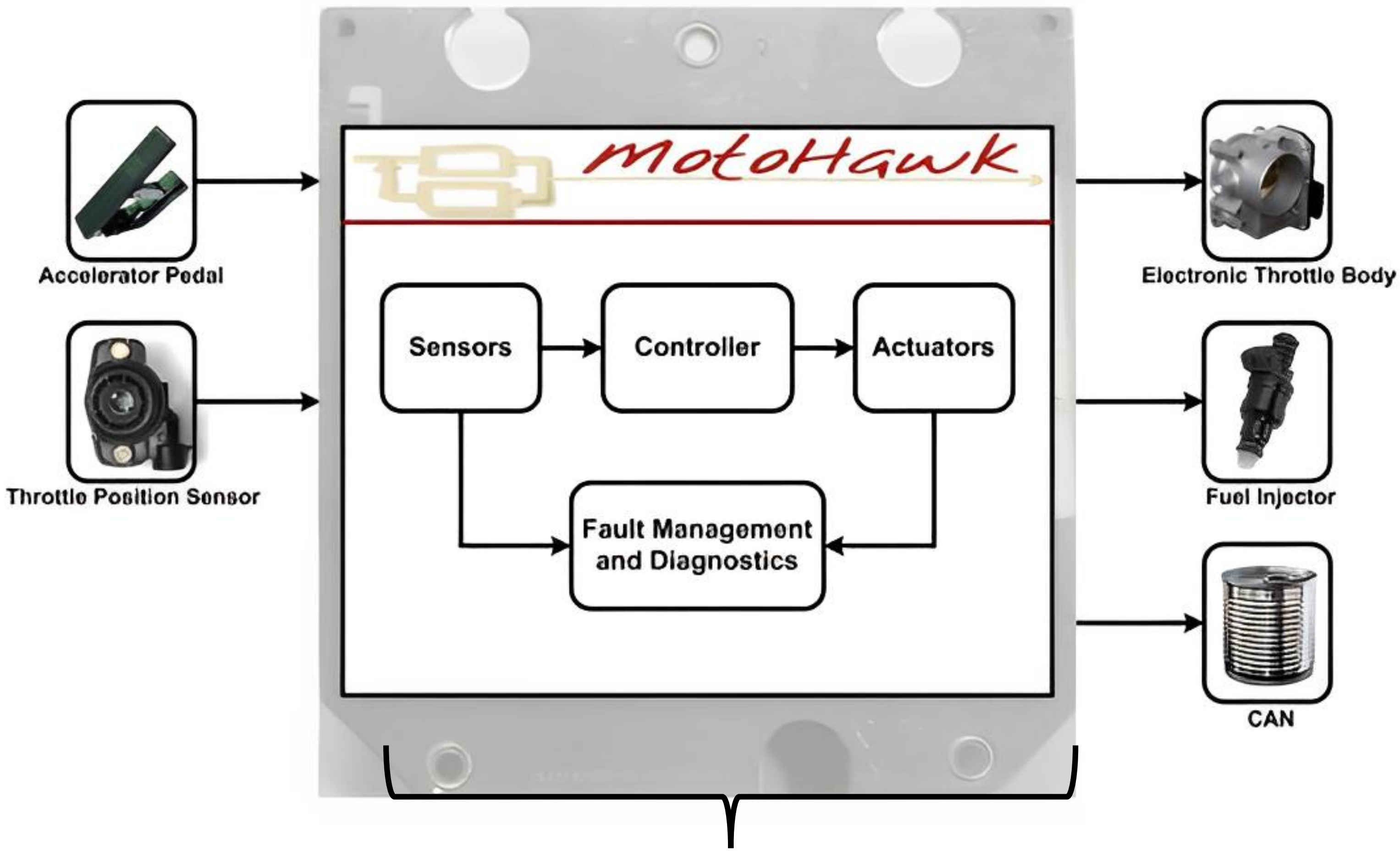
Model-Based Design Vs Traditional Design



System Peripherals



Motohawk Model-Based Architecture



VCU programmed with Motohawk to condition input signals from the sensors, send the right output to the actuators and also handle fault management and diagnostics

Motohawk- Data inputs

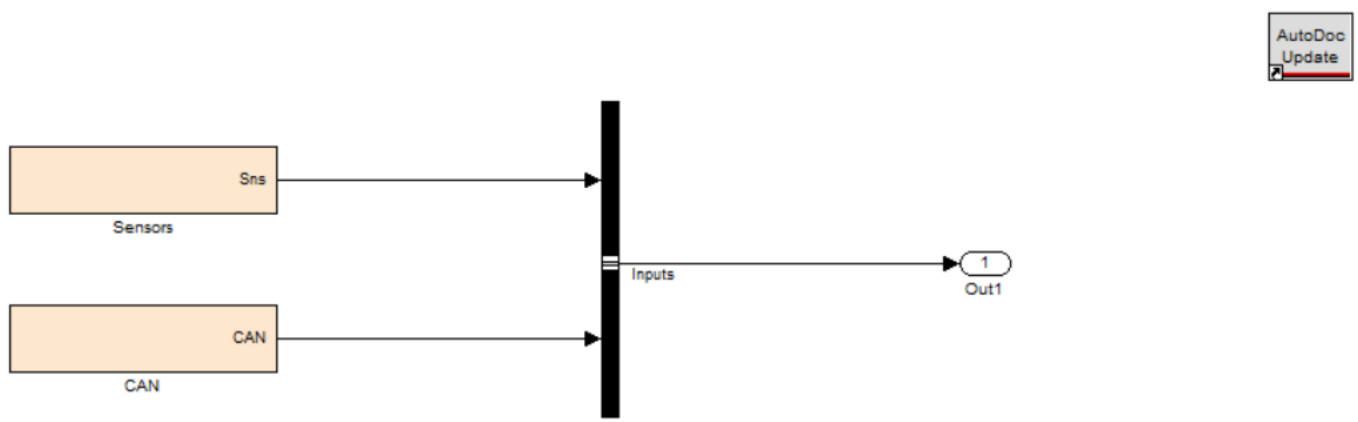
Data inputs to the Vehicle Control Unit can either be through CAN or analog input pins. CAN is preferred choice in the automotive industry

1.1 Inputs

EVCMk_2 / FgndTasks / SENSORS / Inputs

Objective

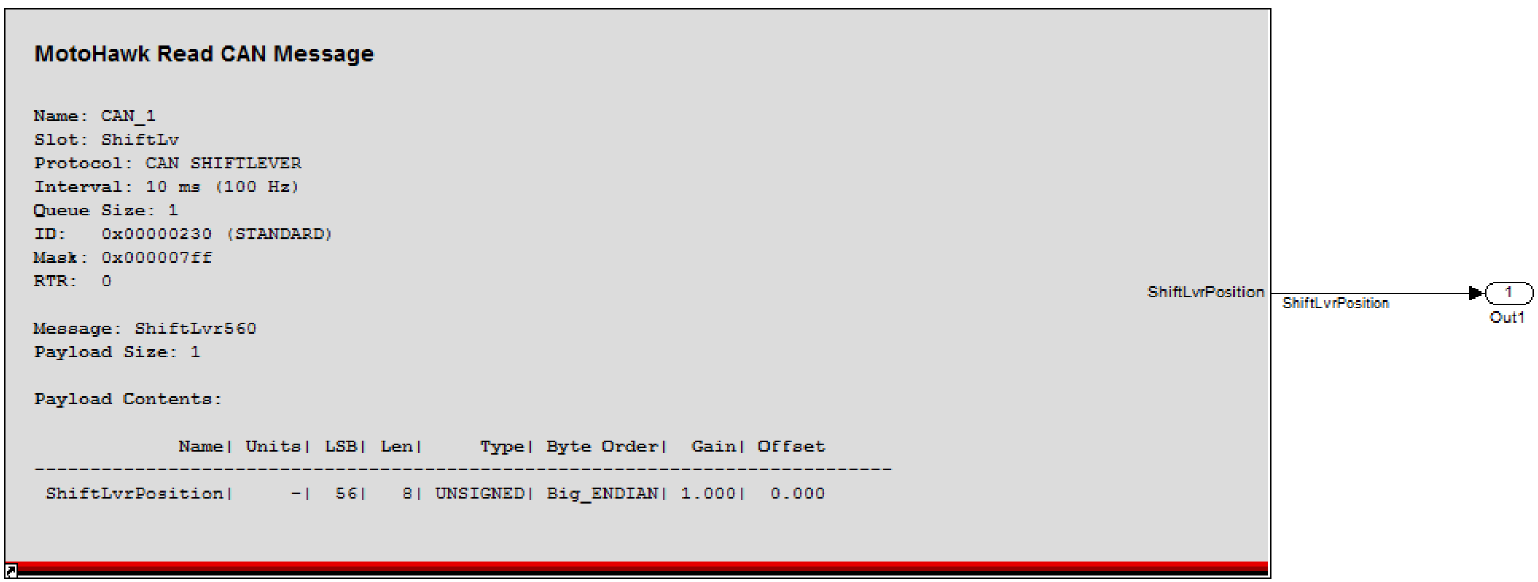
This subsystem contains the physical electrical signals sensors under the 'SENSORS' subsystem and CAN enabled sensors under the 'CAN' subsystem



Motohawk – Data Inputs

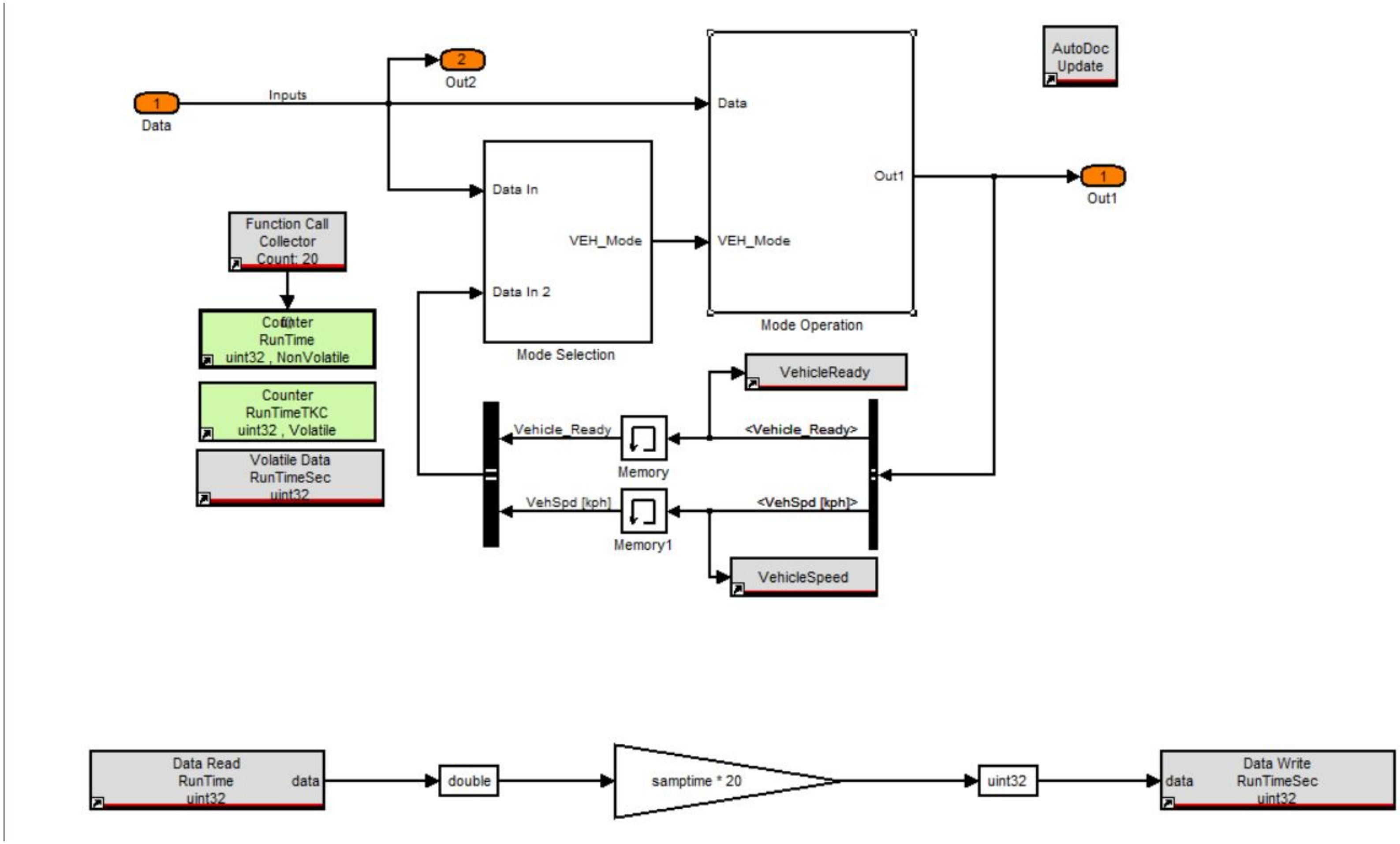
Motohawk, through Matlab Simulink provides blocks that can be used to interface the vehicle's CAN network.

The CAN Read block below reads CAN messages from the vehicle's Shift Lever into the system.



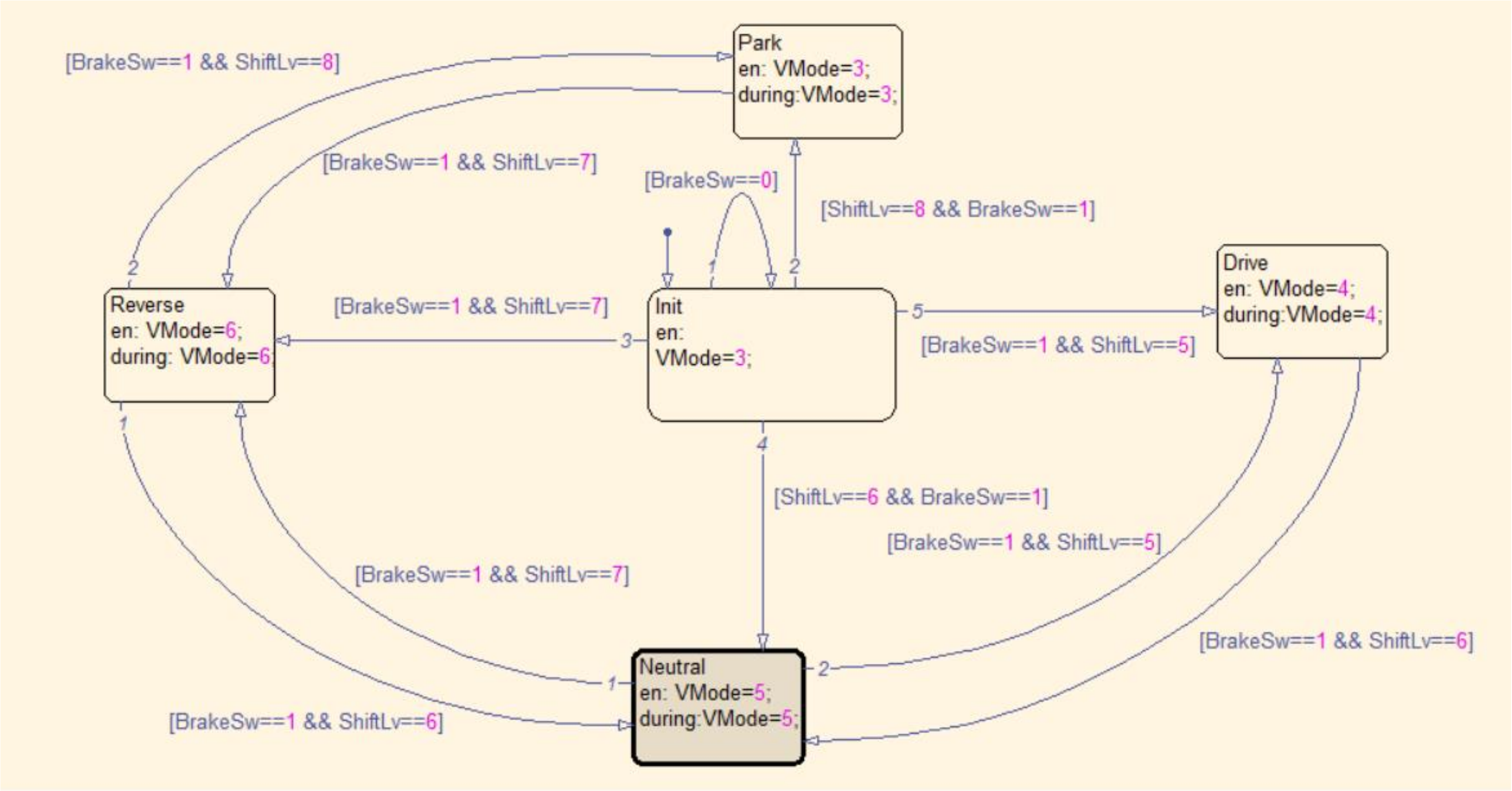
Motohawk – Control Logic

Control logic is developed using default Matlab simulink blocks, as well as Motohawk blocks



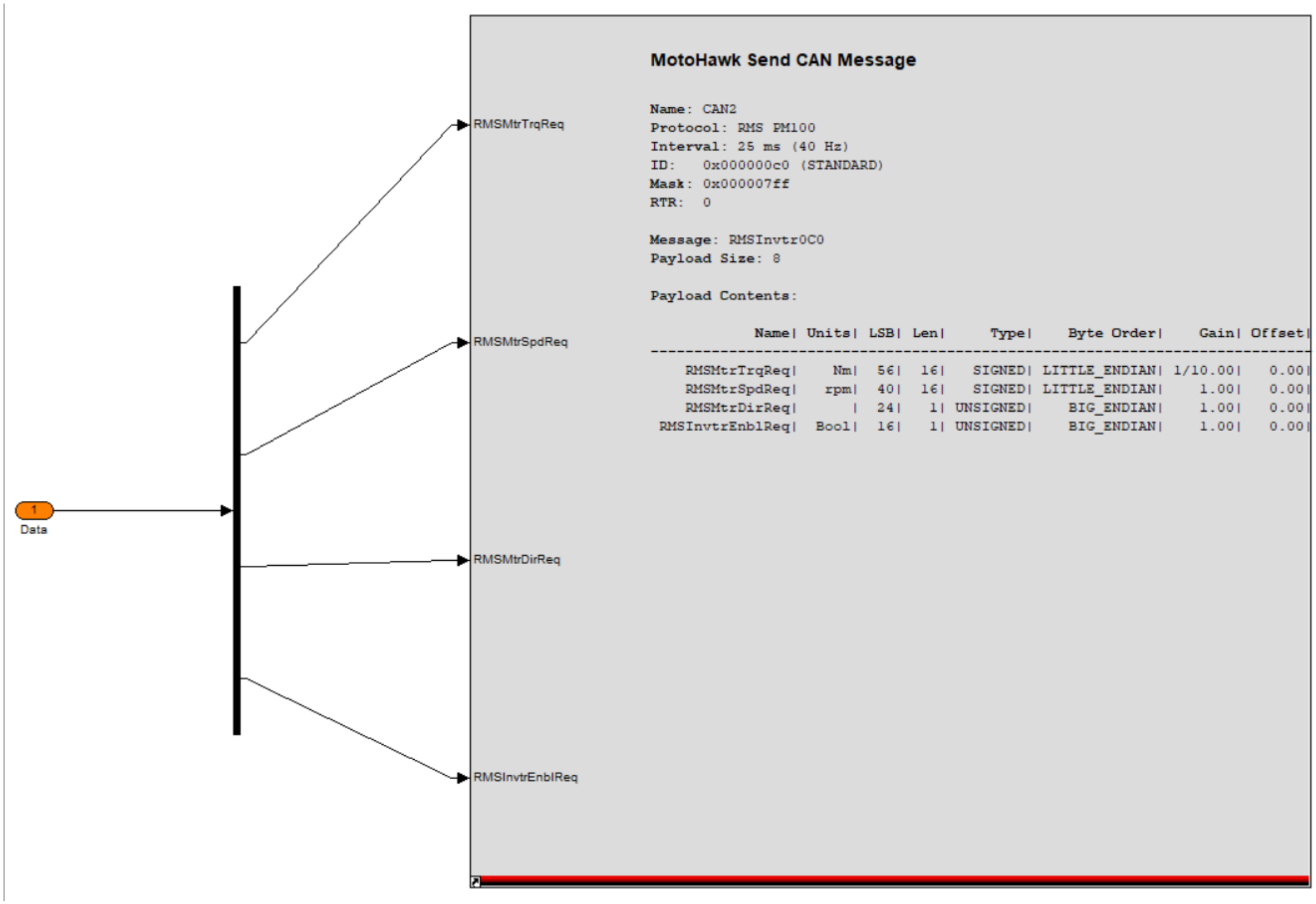
Motohawk – Control logic

The code snippet below illustrates the vehicle mode arbitration logic using Matlab Stateflow. The Inputs in this case are the shift lever and brake switch signals.

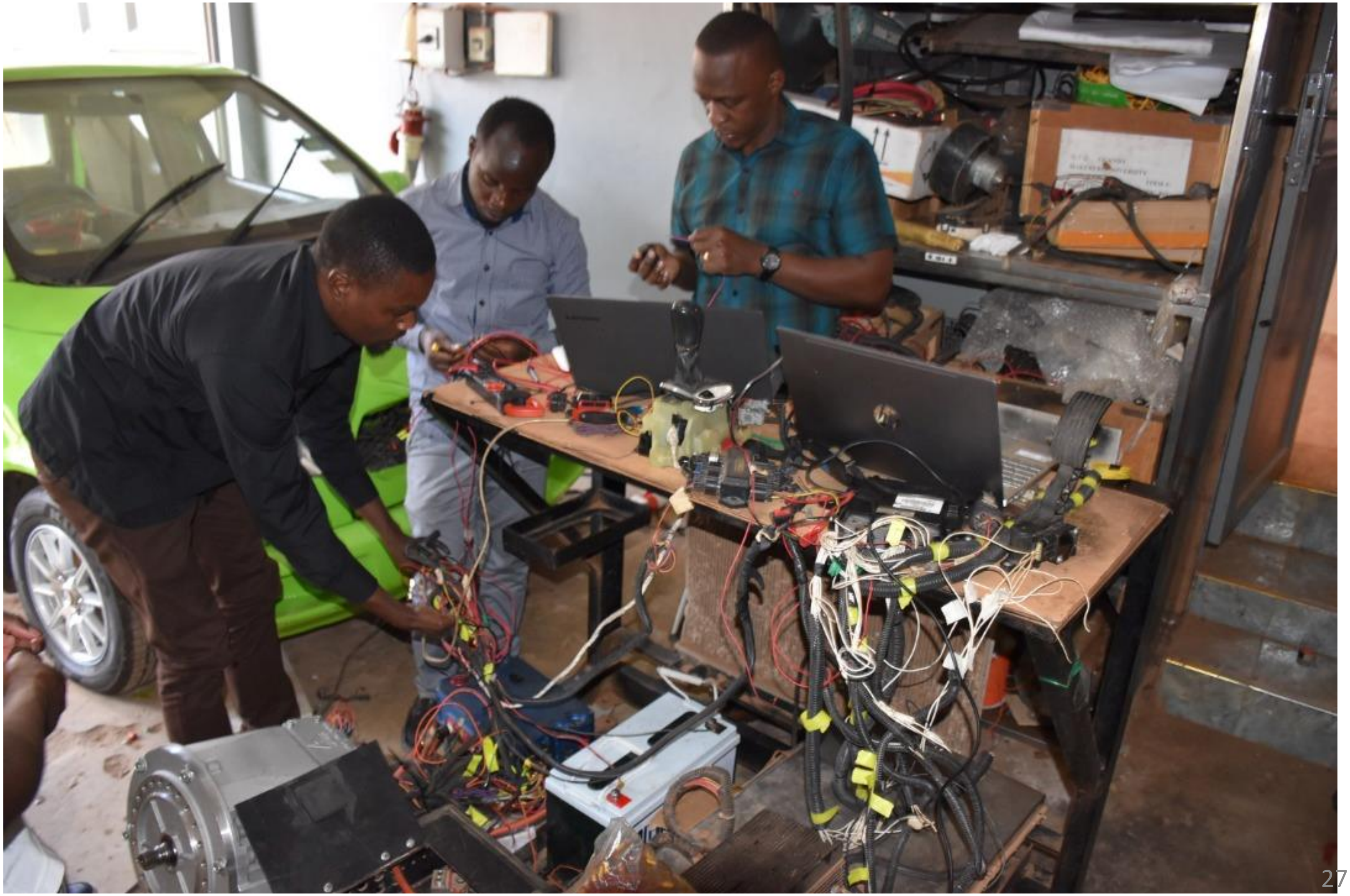


Motohawk – Vehicle Actuators

Control Signals are sent to the actuators either through CAN or output pins. The code snippet below illustrates the transmission of control signals to the vehicle motor controller through CAN



An off-board setup with the vehicle Control Unit and Motor



KIIRA MOTORS CORPORATION

THANK YOU